Commissioning a secured bottle to transfer highly radioactive solutions between two hot cells

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Context

ATALANTE is a fuel cycle R&D hot-lab. The facility has several shielded lines with master-slave manipulators to carry out R&D experiments on highly radioactive materials. Each shielded line is dedicated to a specific kind of research topic or process, but the lines can also be complementary, especially for analytical or process reasons. Therefore radioactive materials may need to be transferred from one shielded line to another.

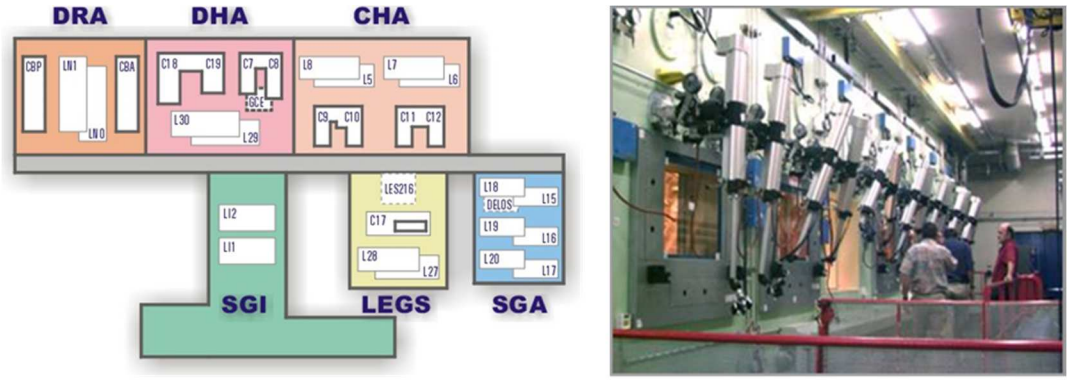

Figure 1: ATALANTE plan and example of a shielded line

Secured bottle: what is it?

The volumes of aqueous solutions that are valuable in the process and need to be transferred, are usually too big to be sent by pneumatic transfer, but too small to be transferred by pipe. Furthermore, the transfer of highly radioactive solutions by pipe also requires additional radiation protection to be set up for workers.

The secured bottle enables 1 to 6 liters of highly radioactive aqueous solutions to be transferred from one shielded line to another. Using a secured bottle provides a high level of security and radiation protection.

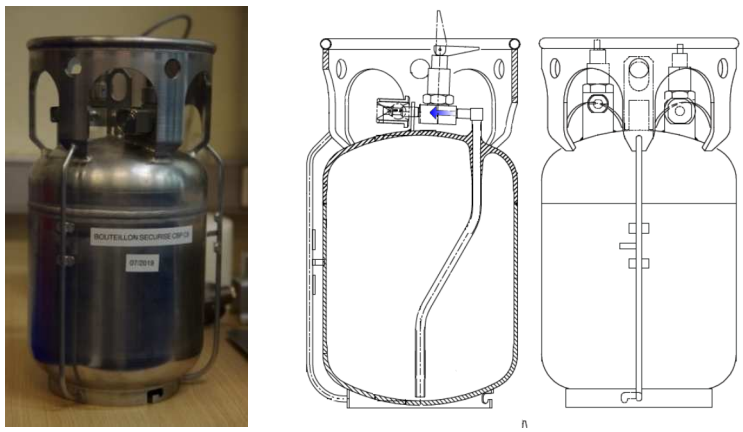

Figure 2: Secured bottle – photo and design

For example, the secured bottle can be filled with fuel dissolution solutions that have the following characteristics:

Solutions from fuel dissolution	Age (years)	Acidity (M)	Activity (GBq/L)	Activity (GBq/L)	Volumetric thermal power (W/L)	Volumetric thermal power (W/L)
UOX	3	3	290	14300	0.270	1.370
MOX	3	3	270	18500	1.240	1.050

Requirements to be respected

The secured bottle must respect 3 main constraints:

- It must be handled and usable with master-slave manipulators.
- It must ensure the containment of highly radioactive solutions, in particular taking into account the release of radiolysis gases.
- It must not lead to any major modification to the structures of the shielded lines. This means that the secured bottle has to be placed in or removed from the shielded line using the same system as that used for solid radioactive waste, i.e. a stainless steel container to avoid contamination and a cask for radiation protection *(Cf. figure 3)*.

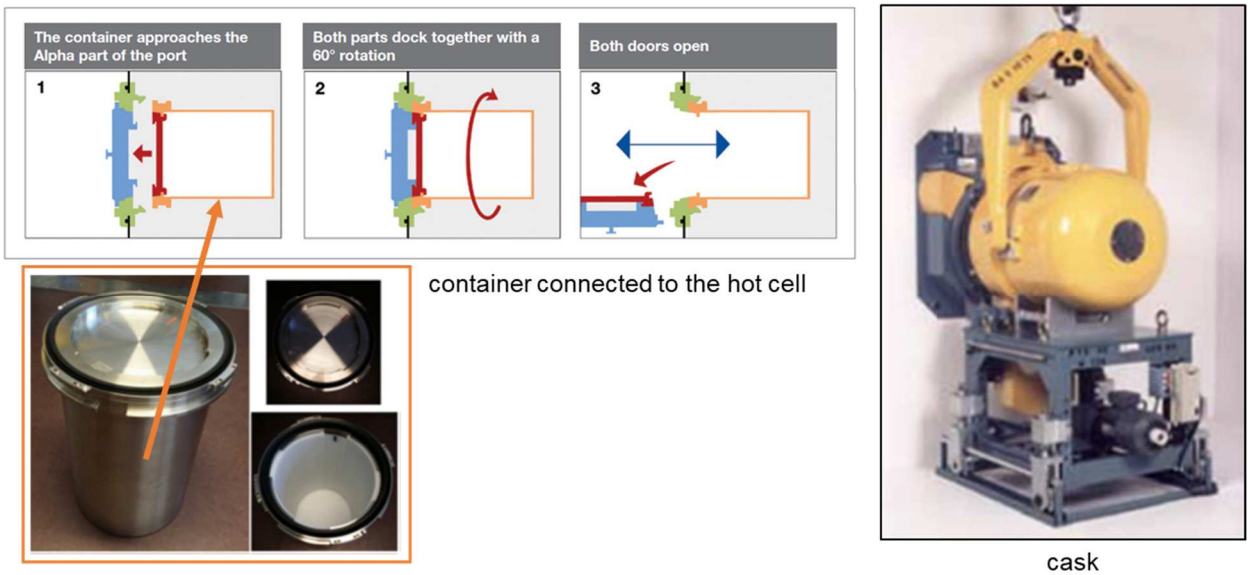

Figure 3: Container and cask used for transferring secured bottle

How does it work?

Before any transfer, the solution needs to be characterized in order to verify its conformity with safety requirements.

Once the transfer has been planned between shielded lines A and B depending on the rules of the procedure, the different steps include:

- filling the secured bottle in shielded line A (*Cf. figure 4*) :
  - from a vessel via a pot for accurate measurement of the volume,
  - or with flasks by means of a funnel,
- transfer of the secured bottle from shielded line A to shielded line B within 10 hours to respect the time limit for radiolysis constraints,
- emptying of the secured bottle in shielded line B,
- retransfer of the secured bottle from shielded line B to shielded line A,
- rinsing and storage in shielded line A.

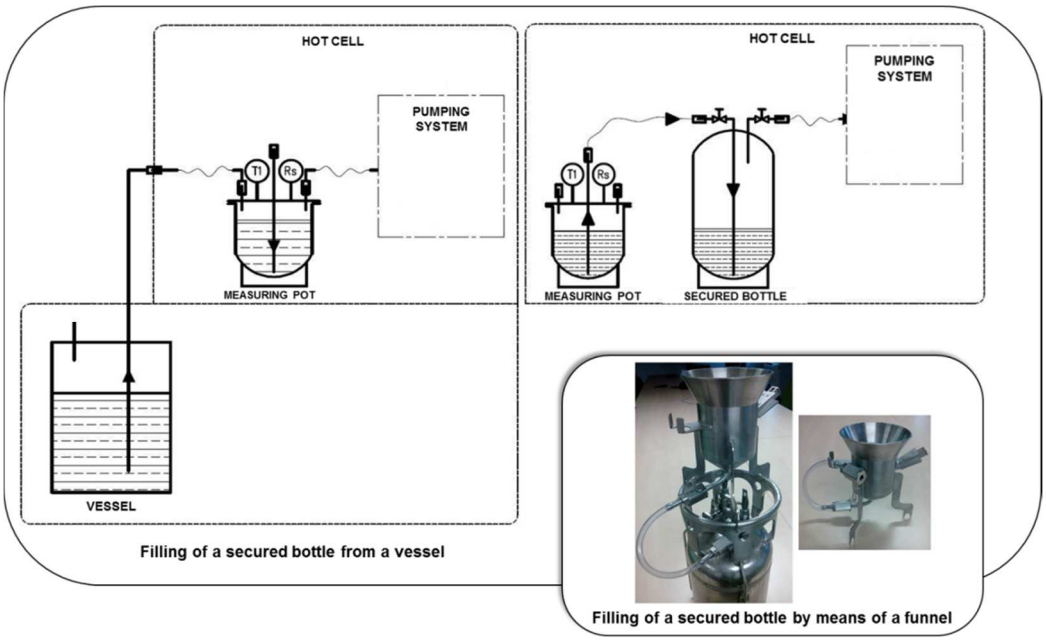

Figure 4: Filling the secured bottle in a hot cell

NSA authorization

The commissioning of the secured bottle has been authorized by the Nuclear Safety Authority, which required the nuclear operator to carry out preliminary safety tests.

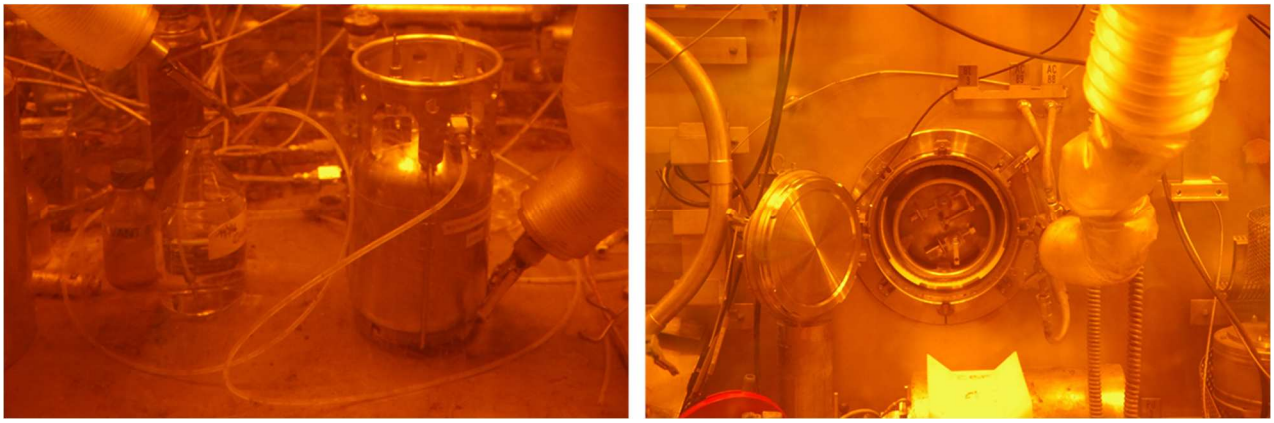

Figure 5: Secured bottle in a hot cell