

Technical notice: corrosion of fission products concentrating evaporators at La Hague

1. The fission product concentrating evaporators in the plants on the La Hague site

Plants UP3-A (BNI 116) and UP2-800 (BNI 117) are spent fuel reprocessing plants each comprising about fifteen units, all intended for a specific phase of the reprocessing operations. The plants' operating principle is shown in figure 1.

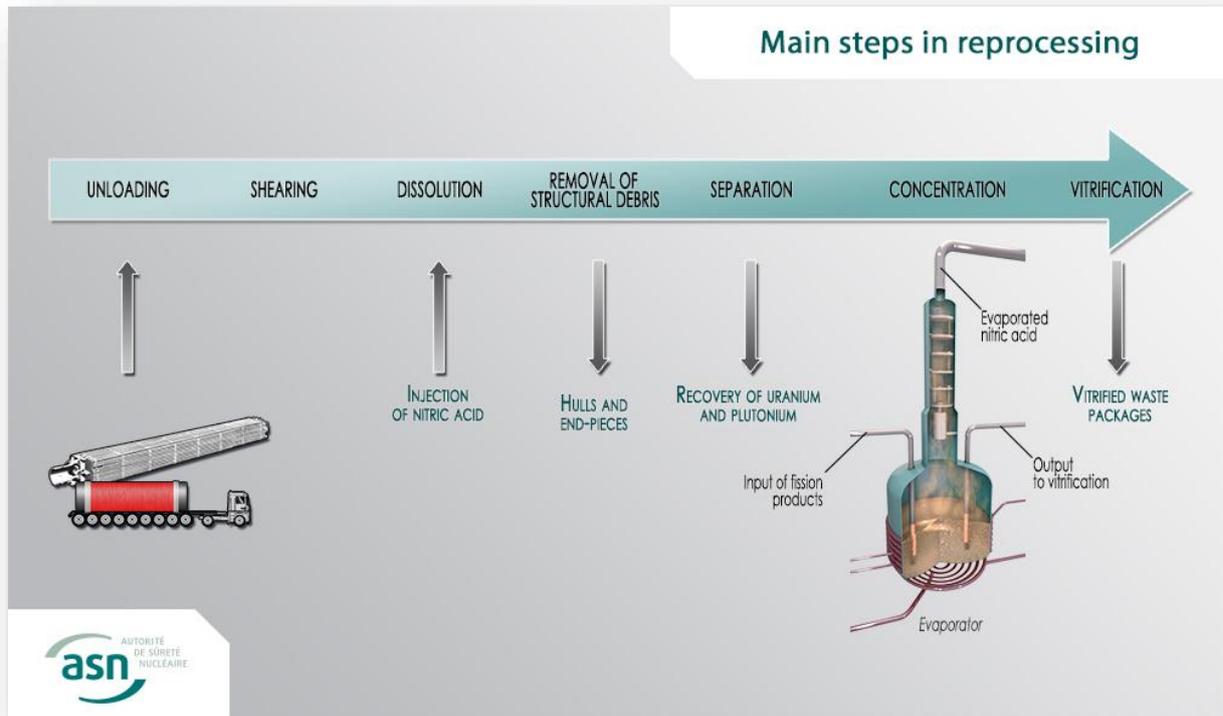


Figure 1: Diagram of operation in the La Hague plants

In these plants, the spent fuel from nuclear power plants is dissolved in acid and the uranium and plutonium are then extracted by means of a chemical process. The remaining part consists of dissolved "fission products", which contain most of the radioactivity of the spent fuel.

In the R2/T2 units of these plants, the fission product solutions are concentrated using evaporators (3 per plant), which heat them in order to evaporate the acid, which is then recycled. The concentrated solutions are then vitrified into glass packages. These packages are stored on the La Hague site for eventual disposal in a deep geological disposal facility.

The evaporators in the R2/T2 units consist of a boiler (in which the fission products solution is raised to boiling temperature), topped by a plate column, where the vapours undergo initial decontamination. The boiler is heated with superheated water at a temperature of about 145°C and a pressure of about 10 bar circulating in circuits consisting of half-pipes welded to the outer surfaces of the boilers.

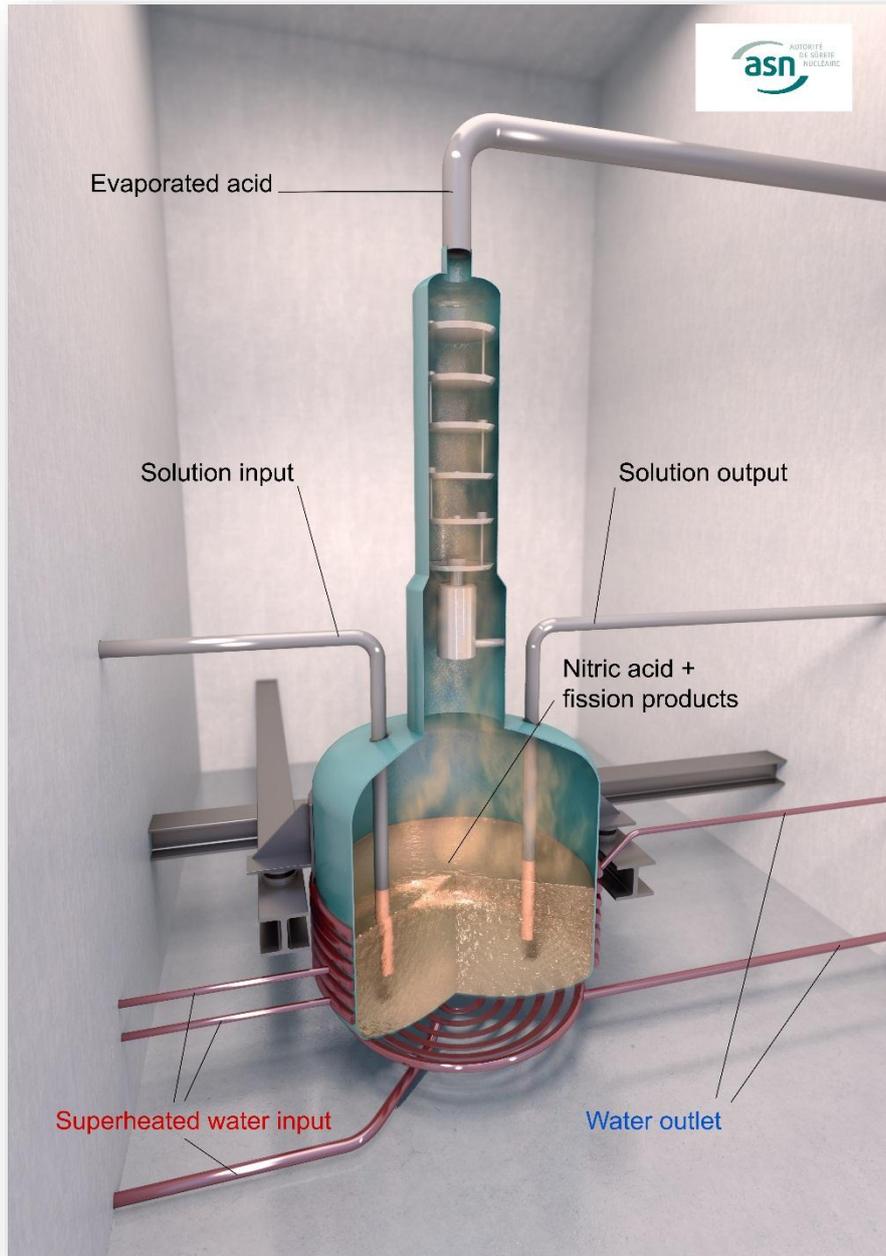


Figure 2: Diagram of an evaporator and details of heating circuit half-pipes

2. Safety implications of this equipment

These evaporators were designed in the 1980s using a steel chosen by the licensee for its corrosion endurance. In the design, the licensee also adopted evaporator wall thickness margins, to demonstrate their satisfactory seismic performance and the ability of the heating coils to withstand pressure, even after corrosion. The evaporators are also installed in individual reinforced concrete pillbox, which are inaccessible to the personnel owing to the ambient level of radioactivity.

These provisions meant that the licensee only envisaged the possibility of moderate leaks (such as those resulting from corrosion) and precluded the possibility of a clean break in this equipment and its heating circuit.

Owing to the preclusion of the possibility of a clean break in the evaporators and their heating circuit, the ventilation and air filtration network in the pillbox containing this equipment was not designed for this accident scenario. On the basis of such a hypothesis, it is today impossible either to guarantee that an acceptable radiological atmosphere can be maintained in the facility or to rule out releases into the environment.

The guarantee that the evaporator walls will remain sufficiently thick after corrosion is one condition precluding an evaporator clean break accident scenario.

3. Difficulties with monitoring ageing

Owing to the intense radioactivity of the fluids carried in these evaporators, they have become extremely radioactive and the thickness measurements are therefore performed using articulated rods carrying a measurement probe, operated through one of the walls of the bunkers. Only a limited part of the evaporators is therefore accessible for measurement.

Given the measurement uncertainties and the modelling of the phenomena involved, Areva is required to adopt a prudent approach to ensure that the uncertainties related to the condition of the inaccessible areas are taken into account.

4. Previous measures relating to monitoring of pressure equipment

Owing to the pressure of the water circulating through the heating coils around the evaporators, this equipment as a whole is classified as “nuclear pressure equipment”. These evaporators must therefore follow specific in-service monitoring programmes and undergo periodic inspections set by the regulations. All of these measures are described and substantiated in the operating files.

Following an initial resolution by ASN, serving formal notice in January 2013, Areva satisfactorily updated its operating files and in-service monitoring programmes.

However, Areva did not perform all the periodic inspection operations required and ASN once again served formal notice on Areva, in May 2015, to meet its regulation obligations in accordance with a specified schedule.

5. Correspondence

Since 2006, the nuclear licensees have been required to conduct a complete periodic safety review of their facilities every ten years. During the review of the UP3-A plant initiated in 2010, ASN asked Areva to take thickness measurements on these evaporators in order to check their ageing.

Areva thus carried out measurements in 2012 and 2014: greater corrosion than anticipated was found on the evaporators. Areva informed ASN of this problem at a meeting in October 2014. ASN then asked Areva to produce a report on corrosion rate trends.

In February 2015, Areva transmitted a summary of the corrosion of the evaporators in the R2/T2 units, produced on the basis of the measurements taken in 2014. This summary was the subject of an opinion from ASN's technical support organisation, IRSN, in November 2015.

In late November 2015, Areva forwarded a residual thickness measurements report for the evaporators in the R2/T2 units, which in particular included an analysis of the measurements taken in March 2015.

In December 2015, ASN repeated its requests to Areva, more specifically for a report on the corrosion rate trends in the evaporators, incorporating the measurements taken in September and October 2015. After an initial examination of this report, which revealed faster than anticipated corrosion rates, ASN asked Areva in late December 2015 to submit its envisaged measures and corresponding schedule to reinforce monitoring of the evaporators and minimise the consequences of a possible failure of one of these equipment items. This last request led to a hearing before the ASN Commission on 11 February 2016.

In June 2016, ASN issued a resolution containing prescriptions regulating the continued operation of this equipment. The licensee is required to carry out more extensive investigation into this corrosion, take steps to reduce its development and adopt appropriate emergency-preparedness measures. Reinforced monitoring of facility maintenance outages is also implemented by ASN.