Report from a French incident

Tritium release and worker exposures in a neutron irradiation facility

Description of the incident

The research laboratory in question uses tritium targets to produce neutrons from a proton beam. The target used at the time of the incident was made of a copper disk whose inner face was covered by a thin layer of tritium impregnated titanium (in the form of HT gas absorbed into the metal, the activity was 150 GBq).

The primary cause of the incident was the shutdown of the water supply to the research facility. The tritium target was cooled by a laminar flow of water over the external surface of the target, in an open loop and without automatic control or measurement. The stopping of the cooling caused drastic heating of the target and the immediate desorption of tritium within the line of the accelerator. The tritium spread in the line under vacuum and a small part contaminated the primary pump oil and the dryers (20 MBq in 20 litres of oil, and 60 MBq in 400 g of alumina, respectively). In addition, because an evacuation pipe for gaseous effluents was disconnected, gaseous tritium was also released into the experimentation hall (which was already evacuated in order to avoid exposure to neutrons during the operation of the accelerator).

The incident was detected by the decline in neutron production. The beam was then stopped manually so that the operators and researchers could access the experimentation hall and inspect the device. They enter in the hall without any special procedures, and without any form of contamination monitoring. Once they realised the target had overheated and the evacuation pipe was disconnected, the experimentation hall was evacuated and closed. Wipe tests, as well as the bioassay tests performed on the staff involved, subsequently confirmed the dispersion of tritium in the experiment room.

Radiological consequences

The people who enterred the experiment room for approximately 15 minutes were slightly contaminated by the tritium present in the atmosphere. A « worst case » estimate, assuming that all of tritium (150 GBq) had been released in the hall (500 m^3) and that the people present had been exposed for fifteen minutes, leads to maximum theoretical individual committed doses (by inhalation) of 0.16 to 1.62 mSv.

The tritium analyses in the urine carried out by the regulatory authorities indicated that the actual internal doses did not exceed 0.05 mSv.

Lessons to be learned from the incident

Technical provisions aimed at strengthening experimentation safety, the proper operation and the real-time monitoring of the cooling of the tritium target, and automatic cut-off of the proton beam in case of target heating were put in place.

The lessons learned from the incident are the following :

- In view of the constant degassing of a tritium target, it is necessary to ensure the continuous evacuation of degassed tritium toward the outside of the buildings using an collection device adapted to normal operation but also to incidents and whose integrity is regularly verified.
- Proper ventilation of the premises where the tritium is handled, using pressure gradients, collection of effluents and release to the exterior reduces the risk of tritium exposure.
- In the case of anomaly requiring an intervention in the experimentation room, the risk of contamination must be taken into account and the following precautions observed:
  - Access should be limited to a minimum number of persons in the presence of the qualified person in charge of radiation protection;
  - Measurement of ambient radioactivity levels ;
  - Use of individual personal protective equipment; and
  - Drafting instructions and providing information and training