



## **Irradiation of three people during maintenance of an accelerator**

### **Description of incident**

The incident occurred in an ionization treatment facility. This facility, which is operated by four people (two operators qualified to use the device and two handlers), houses an electron accelerator emitting a beam of a maximum intensity of 100 mA at a maximum acceleration voltage of 800 kV. The operation of the machine is controlled by a four position switch:

- “Off”;
- “Control” (allows the use of ancillary equipment without operating the accelerator: i.e. conveyor belt, ventilation system, cooling circuit);
- “Acceleration voltage”; and
- “Electron voltage and source”.

The incident occurred when three agents deliberately locked themselves inside the irradiation room in order to verify the functioning of the ventilation system. They suspected a failure of the system because of adhesion problems between the conveyor belt (used to scroll the products under the beam) and the irradiated products, as well as the presence of some suspicious deposits on the walls and floor of the facility. To start the ventilation while remaining inside, the “control rounds” procedure was instigated. This procedure consists of operating (using the key that closes the access door) four locks placed in different positions, in order to verify that no person is present.

The operator, who remained at the command post and who was to set the machine to “control” mode to start the ventilation system, accidentally triggered the device start up which caused the activation, in standby mode, of the electron source (heated tungsten filament). In this mode, the electron source is hidden by a shield that stops a significant fraction of the x-rays and which is operated by the non-conveyance of the belt.

A few minutes later, one of the operators inside the room detected a bluish glimmer (a sign of the presence of electrons) and heard a suspicious noise; he immediately signaled his two colleagues to evacuate the room, which was done in a few seconds.

### **Radiological Consequences**

The operators in this facility were not wearing dosimeters. The evaluation of the doses received by the parties involved was performed by a dosimetric reconstruction of the accident which involved the following actions:

- Reconstruction of the path the persons took during the various stages of the accident. This involved the routes taken, their specific actions, and the time they were present at the various internal locations. The persons were estimated to be inside the room for five and a half minutes, whereas the electron beam production time was estimated at three minutes.
- Placement of dosimeters, at the various points where the persons were stood, on supports at 1.3 meters from the ground in order to represent the normal

conditions of dosimeter wear (chest) (an exposure to the chest is considered as representative of a whole body exposure).

- The start-up sequence of the accelerator, from the command post, reproducing what had been done the day of accident.
- Development of dosimeter films (films having been exposed for three minutes).
- Addition of measured doses in proportion to operators' time at each location.

The effective doses received by each person were evaluated at **between 30 and 35 mSv**.

### **Lessons to be learned from the incident**

In the case of accelerators, first, there are two basic precautions to take and respect:

- Prohibit the emission of a beam in an irradiation room unless it can be demonstrated that persons have been properly evacuated;
- To shutdown the facility immediately in the event of the intrusion of a person in the room where a particle beam is emitted.

Furthermore, an audible and visible signal during the start up of the device would allow anyone present to quickly evacuate the room.

It is essential to provide personnel with suitable information and training at regular intervals - the two operators had actually received training when they were recruited but this training had not been the subject of a refresher course or review; the two handlers had no training. In addition to the general rules for radiation protection, the training must include specific rules applicable to the facility.

The persons involved must never, under penalty of disciplinary sanction, divert a security procedure even if this is necessary to carry out controls or repairs on the ancillary equipment (ventilation system, cooling circuit, etc.).

Any special procedures or interventions in the facility must be done in the presence of a qualified person in charge of radiation protection.

The qualified person in charge of radiation protection must prepare detailed instructions on the accelerator's mode of operation.

During this incident, an appropriate monitor would have immediately informed the parties involved of the presence of radiation, and would have facilitated the evacuation and reduced the doses received.

It is reminded that it is mandatory to have clear warning signs and signals to indicate the hazard in the room.

It is also recommended that a radiation detection system be installed inside the room.