

 Report from a French incident**Exposure during the transportation of technetium-99 generators****Description of the incident**

A dosimeter assigned to a truck driver working for an accredited radioactive source distributor recorded a dose of 11.3 mSv. The dosimeter was delivered on September 1 and returned on October 18 (shipping period of four to six weeks).

Every Saturday morning, the driver collected six technetium-99 generators from an authorized depot at the airport of city A, and then delivered them to hospitals in city B (a 3-hour drive from city A) and city C (a further 3-hour drive).

As required by the obligations for accredited transporters, the distributor carried out an investigation and drew up an incident report. It was discovered that the driver did not use a cart to transport the generators but carried them himself (manually) from the parking lots to the points of delivery. The driver wore his dosimeter in his trouser pocket or on his belt during each work day. The report considered that the driver could have carried the generators himself over a period of two to three hours. Thus, the distributor concluded that carrying the generators from the truck to the reception points were the cause of the high dose recorded.

Investigation by the Regulatory Authority

During the course of the investigation by the Regulatory Authority, a series of measurements were undertaken on similar technetium-99 generators, to reconstruct the dose received by the driver.

Using dose rate meters and dosimeters, a series of measurements were made around the generators, and also at the driver's seat (in the front of the vehicle) in order to estimate the dose received by the driver during the transport of the complete consignment of the six generators stowed in the rear of the vehicle (a Ford Transit).

Other measurements were also carried out at approximately 5 cm from the load in order to simulate the generators being loaded directly behind the driver's seat.

Results

The dose rate was about 600 $\mu\text{Sv/hr}$. at the level of the generator's lid and around 500 $\mu\text{Sv/hr}$. along the side walls.

When the generators were loaded in the rear of the car, the dose rate at the level of the driver's seat varied between 5 and 10 $\mu\text{Sv/hr}$. The dose rate at to approximately 5 cm of the load was close to 500 $\mu\text{Sv/h}$.

Discussion

The driver of the van explained that he placed his dosimeter in the pocket of his trousers or on his belt, and that he carried the generators with his arms along his body. Each Saturday, at the end of his rounds, he left his dosimeter in the van, which remained there until the following Saturday. The rest of the week, the vehicle was not assigned to other transports of radioactive materials.

"Typical Saturday rounds" for the driver consisted of delivering three generators to hospitals of city B, then three generators to hospitals of city C. This involves three hours of driving with six generators, then three additional hours with three generators. The van was empty during the drive back to city A.

On the basis of information provided by the driver and measurements carried out, the manual transportation of generators by the driver led to a maximum dose of 1 to 1.5 mSv. Moreover, the exposure related to the travel time provides an additional dose of 0.4 mSv. In total, it appears that the maximum dose likely to have been received by the driver is evaluated at 2 mSv over the exposure period. This dose is not compatible with the dose of 11.3 mSv registered by the dosimeter.

During more detailed discussion with the driver, it appeared, in fact, that he placed the generators directly behind his seat to facilitate handling. Under these circumstances, the driver was exposed to significant dose rates for several hours each Saturday. On the basis of three hours at 500 $\mu\text{Sv/hr}$. then three additional hours at 250 $\mu\text{Sv/hr}$, the driver could have, thus, received a dose to the order of 2.25 mSv each week. Over the period that the dosimeter was worn (between four and six weeks), a dose included between 9 and 13.5 mSv could therefore have been received during the transportation of the generators. Added to the dose due to the manual handling of the generators by the driver (1 to 1.5 mSv), these doses are compatible with the recorded value.

Conclusions and actions

The Regulatory Department have concluded that this incident resulted from a lack of appreciation of the risk of irradiation associated with the products that he was carrying by the driver, and therefore a training and follow-up failure by the distributor. Loading the generators in the front of the vehicle is not compliant with "Instructions to Drivers" drafted by the Regulatory Department, and was also an obvious offense to the working procedures established by the distributor.

The distributor was asked to update and amend his "Radiation Protection Procedures" and to reinforce the training of his staff in order to emphasize the following points:

- The technetium generators must be loaded in the rear of the transport vehicle in order to guarantee dose rates of less than 20 $\mu\text{Sv/hr}$ at the driver position.
- Once unloaded from the vehicle, the technetium generators must never be transported other than on a dedicated cart, provided by the employer. The drivers must not, under any pretext, carry the generators themselves between the vehicle and the point of reception.

This incident reveals:

1. The importance of wearing the dosimeter which, in this case, allowed for the detection of an abnormal exposure situation. The provision of an operational rate meter or dosimeter, positioned behind the seat, could have allowed for the display of the real dose rate.
2. The effectiveness of the dose reconstruction methods.
3. The need to include controls relative to the modes of transportation during the investigations of the approved distributors of radioactive sources by regulatory authorities.