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Environmental characterisation of a major radioxenon source in Europe

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Abstract

In the framework of the verification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) the atmospheric background of environmental radioxenon has been studied. It was recently shown that radiopharmaceutical facilities (RPF) have a major contribution to the general background of ^{133}Xe and other xenon isotopes both in the northern and southern hemisphere. The daily International Monitoring System (IMS) noble gas measurements around the globe are influenced from such anthropogenic sources that could hide relevant radioxenon signals.

To distinguish a nuclear explosion from releases from civil nuclear facilities, not only the activity concentration but also the ratio of different radioxenon isotopes (^{131m}Xe, ^{133m}Xe, ^{133}Xe and ^{135}Xe) plays a crucial role, since the ratios can be used to discriminate source types.

Theoretical release and ratio studies were recently published, but no high-sensitive measurements in and close to radiopharmaceutical facilities have ever been performed.

During the summer of 2008, a three week field campaign was carried out in the region around the Belgian radiopharmaceutical facility IRE in Fleurus, the world third largest one. The scope was to obtain the activity concentration of the releases and the isotopic composition. Two 6-hour noble gas measurements, using mobile SAUNA sampling equipment were collected each day at different distances from the facility (1 – 100 km). The sampling locations were guided by atmospheric dispersion model results. Three samples from the stack itself were also collected. All 38 samples were shipped after collection to and measured with a SAUNA at the laboratory in Stockholm, Sweden.

The environmental concentrations of ^{133}Xe were measured and found to be in the range between 0.7 – 4 10^5 mBq/m^3. Nine samples contained all four CTBT relevant radioxenon isotopes. The concentrations of the stack spike samples were in the range 2 10^9 – 4 10^{10} mBq/m^3. This corresponds to a daily release of around 1 TBq. This is consistent with literature and is well below exposure guidelines and therefore not dangerous to the public, but high enough to increase radioxenon background in wide regions around such facilities especially given the high sensitivity of the CTBT monitoring systems.

In a simple model the measured concentrations are fitted versus the distance from IRE and the resulting source term agrees reasonably well with the concentration of the measured stack samples.

This paper further compares the environmental field measurements made with reported stack releases from the facility, with measurements from the Belgian national Telerad network as well with long distance measurements at the Schauinsland Mountain near Freiburg, Germany and at Bruyères-le-Châtel, near Paris, France.

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Disclaimer

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