Purpose:To quantify the radiological consequences of a release of PET isotopes in gaseous form to the environment, in an urban setting.

Methods:The worst case scenario is identified heuristically and an analytical treatment of the worst case scenario is made using ideas from turbulent hydrodynamics to calculate the minimum dispersion of a cloud of PET isotopes (11C, 13N, 14O, 15O & 18F) in the atmosphere emerging from a ventilation stack, either from the accelerator vault or from a hot cell. A Gaussian plume model is used to calculate the average radiological consequence.

Results:It is shown that 11C production has the worst radiological consequences for an atmospheric release. Whole body and equivalent doses are calculated using Gaussian and uniform radioisotope concentration profiles in the atmosphere for skin, inhalation and external annihilation gamma fields. It is found that the worst case is when there is an atmospheric inversion present, and when the ambient temperature is higher than the stack exhaust temperature as this generates negative buoyancy. The parameters of this model are the stack exhaust velocity, temperature and diameter, the ambient temperature, the released activity, the half-life, and the mean positron range, but not the release height. It is shown that for the Gaussian plume model the mean wind speed and release height are important as well as the release time.

Conclusions:The design features of the ventilation system of a PET facility which can simply and effectively control the radiological consequences of an atmospheric release are identified. The impact of these results on current regulatory thinking on PET isotope production facility design goals and permissible releases in Canada is discussed.