Radiation
(nuclear or major radiological emergencies)

Overview

Prevailing weather conditions play an important part in the consequences of an accident or other event resulting in a release of radioactive substances to the atmosphere. Airborne radioactive releases are transported by the wind, spread and diluted by turbulent atmospheric processes and deposited onto the ground by dry and wet scavenging.

Meteorological situation partly determines the initial elevation of a buoyant plume. A release plume may also initially rise very high and move with the wind without causing any observable concentrations at the ground level till the mixing conditions change and the plume quite suddenly touches the ground (or a heavy rain shower occurs). Rain increases deposition and consequently also dose rates at the ground level (see Fig. 1). Furthermore, in the worst case bad weather (stormy wind, heavy rain, fog) might completely prevent performing of certain measurements, such as airborne fallout mapping.

In case of transboundary releases of radioactive material, or if a national authority is assumed to give assistance to a foreign sister institute, it is essential to have access to international meteorological data.

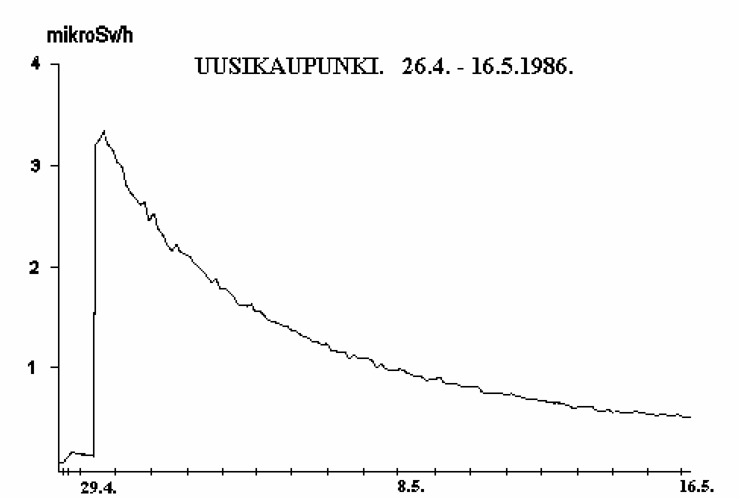

Fig. 1. Example of the effect of rain on observed external dose rates during the Chernobyl accident (Uusikaupunki, Finland).

Data usefulness

From the viewpoint of a radiation protection authority, rain data can be utilized in three ways:

– As input to dispersion and dose calculation models. Although the meteorological institutes normally maintain and further develop national state-of-the-art dispersion models, the radiation protection authorities often have at their disposal also other systems, some of which are quite sophisticated like the RODOS system (Erhardt and Weiss, 2000; Raskob, 2008) while some are simple yet versatile like HOTSPOT (HOTSPOT, 2009); the latter, for example, has been used in many published “dirty bomb” studies. In addition, there may be other programs in use that are of value in certain cases. Common to most of these models is that they accept as input rain information in one form or another (intensity or washout/rainout coefficient, possibly precipitation type, sometimes also duration and areas of rain occurrence instead of assuming rainy conditions during the whole release period in the whole transport area).

– To help to plan and carry out proper and timely measurements in different geographical areas without e.g. exposing mobile measurement teams or equipment to excessive radiation or contamination levels caused by wet scavenging or to extremely strong showers that could hinder measurement activities. After the passage of a release cloud all stored rain data is invaluable when planning and conducting large-scale airborne contamination mappings because it helps to focus expensive measurement campaigns on the geographical areas of interest.
– To help to explain and interpret measured radiological data (cf. Fig. 1). Comparison of radiation data and rain data is useful also in routine conditions because rain brings down naturally occurring radionuclides (^{7}Be, radon’s progenies) that may increase measured dose rates (Paatero, 2000; Mercier et al., 2009) and even cause exceedings of alarm levels.

About data quality and format

The main tasks of a radiation protection authority in nuclear or radiological emergencies are performing situational analyses and preparing recommendations on possible countermeasures. Pre-defined action plans and strategies, model predictions and real radiation measurements as well as other relevant data (e.g. population and land-use data) provide the basis for a proper management of the situation at hand.

There are several potential sources of error and uncertainty that are reflected in the situational analyses and thus possibly to some extent in the countermeasure recommendations (see Lahtinen et al., 2007). Some of these sources are associated with radiation measurements (e.g. equipment malfunctions, variations in natural background radiation, general statistical uncertainties of radioactive decay, effects of natural or man-made structures on the measured quantities) and some with calculated predictions (such as generic weaknesses and limitations of different models, and incorrectness, scarcity or unrepresentativeness of meteorological data). Of course, in a nuclear accident the biggest source of uncertainty in calculations – at least in the early phases – is likely to be that of the source term, i.e. radionuclides released to the atmosphere, their amounts and physico-chemical characteristics.

One can argue that there is a third distinct category of uncertainties, comprising those of the interface between model calculations and measurement data (data assimilation and related interpolations, approximations and averagings) and the way of presenting and comparing various results (e.g. number of details shown, choice of colours on the screen and in printouts).

It is clear that in order to decrease the amount of overall uncertainty all meteorological data – including rainfall data (intensity, precipitation type etc.) – should be as reliable as possible and provided in a format (numeric, graphical) that is easily linked with the calculation and presentation systems used by radiation protection authorities. An index describing the degree of data uncertainty should also be given when feasible. It is also foreseen that radiation protection authorities do not need radar data from abroad continuously nor from all countries. Therefore a pull system with a possibility to freely define the time and geographical area seems a good choice.

Literature

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