Surface contamination activity reconstruction based on measurements of ambient dose equivalent

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Software tools EasyRAD and Andreeva Planner were developed and implemented in the Northwest Center for Radioactive Waste Management (SevRAO), a branch of the Federal State Unitary Enterprise "Enterprise for Radioactive Waste Management" RosRAO to improve the level of radiation safety. This work was done as a result of scientific cooperation between the Kingdom of Norway and the Russian Federation. EasyRAD calculations are based on measurements of ambient equivalent dose rate. Andreeva Planner is used for dynamic simulation of the radiation situation based on activity, radionuclide composition and geometry of sources. But to get information on these parameters is significantly more difficult, than to get dose rate measurements. Furthermore such information is not sufficient for modeling the radiation environment. This problem could be solved by finding a method for transition from the dose rate grid to the surface contamination grid. Generally accepted method is the method of conversion coefficients. This method is based on knowledge of the dose-rate factors for kerma (DRFK): the transition coefficients from the surface activity to the Air kerma rate. However, this method is applicable only if the surface activity is a constant. This paper presents a more efficient method of transition from Air kerma rate (ambient equivalent dose rate) to the specific surface activity, in cases where the method of conversion coefficients is not good enough. As known, ambient equivalent dose rate $\dot{H}^*(d)$ and surface contamination A are connected through the following expression:

$$\dot{K}_{air}(x,y) = \int\int Q(x,y,\acute{x},\acute{y}) \cdot A(\acute{x},\acute{y})\, d\acute{x}d\acute{y} \qquad (1)$$

In eq. (1) the value Q (equation core) is a contribution to the ambient equivalent dose rate in a point with coordinates $(\acute{x},\acute{y})$ from a point source activity localized at coordinates (x, y). Equation (1) is a Fredholm equation of the first kind. It is an incorrect mathematical problem that needs appropriate mathematical methods. In this paper the Fredholm equation is solved by a method of ridge regression (Computer code is created in the language R). This paper presents solutions for model examples, which verify the proposed method. Results are presented for real ambient equivalent dose rate grids for different areas of the industrial site at Andreeva Bay. The proposed method shows significant advantages in comparison with the method of conversion coefficients. Contaminated area is calculated more accurate. The method allows finding contaminated areas that are 2-4 times less than that area identified by the method of conversion coefficients.