WEATHERING OF FISSION PRODUCTS DEPOSITED ON ASPHALT

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Introduction

The exposure rate level from radioactive materials deposited on outdoor surfaces will diminish not only with the physical half-life of the nuclei but also because of movements of the materials.

What can happen on a road is either that the materials penetrate into the road surface or it can be removed alltogether by going into a sewage with rainwater.

The dose rate's variation in time, D(t), can be described as:

$$D(t) = D(o)\ W(t)\ \exp(-\lambda t)$$

where W(t) can be splitted up into a part with short weathering halflife and one with a long halflife:

$$W(t) = A \cdot \exp(-\lambda_{w1} t) + (1-A)\exp(-\lambda_{w2} t)$$

λ : the decay constant corresponding to the physical halflife of the radionuclide.
λ_{w1} : the decay constant for the short term weathering.
λ_{w2} : the decay constant for the long term weathering.
A : the part that disappears with short term halflife.

The parameters that influences the weathering is:

1) The contaminating material (nuclide, chemical compound, concentration).
2) The surface (chemical compound, roughness porosity).
3) The way of deposition (wet or dry).
4) The history of the contaminated area since deposition (weather, traffic).

Road Experiments

At Risø we have contaminated asphalt areas with three different fission product nuclides and then followed the dose rate at 1 m above the road surface. The contamination was allways done with the radionuclide dissolved in water.

The amount of experiments done is not sufficient to give any clear indication on how the weathering depends on the different parameters involved. But at Fig. 1 it can be seen that there is a correlation between the short term weathering halflife and the part removed: when we have a very short halflife, up to 70% gets removed and when the short-term halflife, is long, almost nothing gets removed.

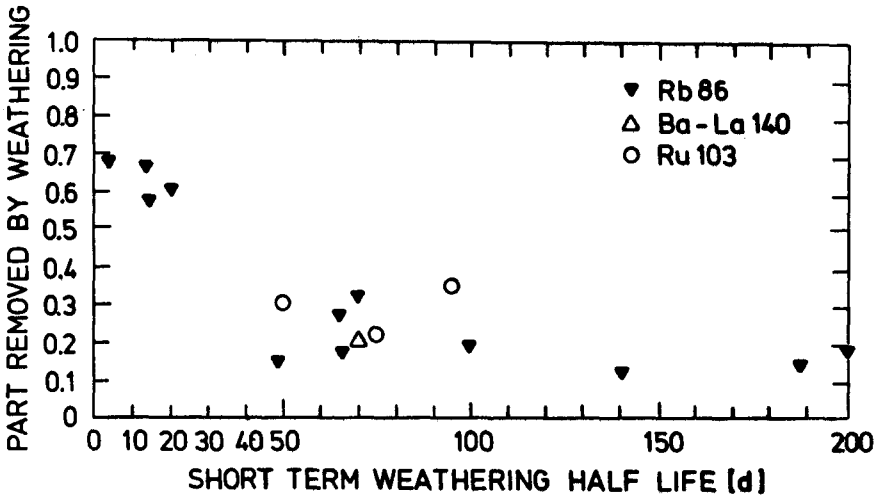

Fig. 1.: Weathering efficiency plotted against the weathering half-life.

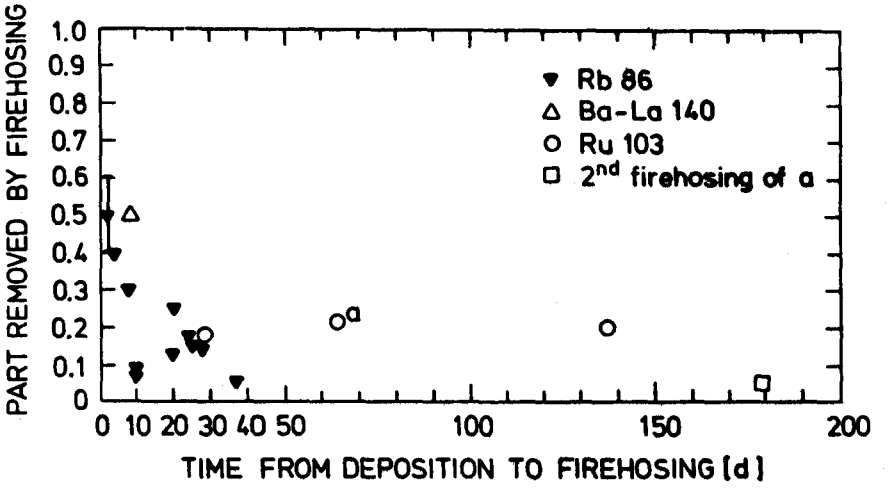

Fig. 2.: Efficiency of fire-hosing plotted against age of contamination.

Forced Decontamination

Several decontamination attempt were made, the most successfull being fire-hosing. On Fig. 2 is shown the results of the fire-hosings against the time at which it was done. It is clearly seen that about half of the Rb86 (representing Cs134 and Cs137) can be removed if the fire-hosing takes place very soon after deposition. Whereas it has no meaning to try removing Rb86 by fire-hosing after about 30 days.

The two other nuclides Ba-La140 and Ru103 seem to have a different behaviour. For Ru103 there is no time dependence to be seen, it allways seems possible to remove about 20%.

Conclusion

The results of the experiments vary a lot, but to get a general idea (and a mumber to use in consequence models) the linear average of the halflifes and removed part have been calculated and for model purpose we then get the dose rate time dependence to be

$$D(t) = D(o)\ \exp(-\lambda t)\cdot (0.3\cdot\exp(-3.2y^{-1}\ t) + 0.7\cdot\exp(-7.5\cdot10^{-3}y^{-1}\ t))$$

($\lambda_{w2} = 7.5\cdot10^{-3}y^{-1}$ is taken over from Gale, 1963-AERE-R4241).

The results indicate that Rubidium/Cesium after some weeks are fairely well bound to the asphalt surface, whereas Barium/Lanthanum and Ruthenium do not appear to react chemically with the surface and they are therefore more mobile.