**Freshwater and Terrestrial Assessment of a proposed new Nuclear Power Plant (NPP)**

In this practical you will undertake an assessment of, and consider the issues involved, in assessing the atmospheric and aquatic radioactive discharges from a nuclear power plant. In this scenario the NPP is located on the banks of a large lake which is used for the supply and discharge of cooling water. Radioactive discharges are released along with the heated water. The assumed discharge rates are given in Table 1.

The practical will give you experience in using the 'SRS-19' models. You will also need to decide how to address radionuclides not included in the ERICA Tool default list.

Table 1: Discharge rates for the NPP to the surface waters and atmosphere

| **Radionuclide released to freshwater** | **Release rate (Bq $s^{-1}$)** |
|---|---|
| $^{60}Co$ | 3.3E2 |

| **Radionuclide released to atmosphere** | **Release rate (Bq $s^{-1}$)** |
|---|---|
| $^{85}Kr$ | 1.3E7 |
| $^{41}Ar$ | 4.0E4 |
| $^{60}Co$ | 1.0E1 |
| $^{134}Cs$ | 2.7E0 |
| $^{131}I$ | 1.4E2 |

Use the default parameters (e.g. concentration ratio etc) present in the appropriate tool and compare all dose rates to the ERICA screening value of 10 $\mu Gyh^{-1}$.

*Part A: Freshwater dispersion modelling*

Using the radionuclide discharge rates to the freshwater environment, model the dispersion of the radionuclides released to estimate the activity concentrations in water at the receptor locations and calculate the dose rate to the most limiting reference organisms using Tier 1 of the ERICA Tool. Assume for this scenario that the receiving lake is large (> 400 $km^2$).

Assume the following:

Water depth – 5m

Distance between the release point and shore (m) 100m

Lake current velocity = 0.1 m/s

Assess all of the following 'distances between the release point and receptor'; the receptor points are in the lake (not on the shore):

a) 100 m
b) 5000 m

Results table – record predicted water activity concentrations and RQs for different source-receptor distances

| | 100 m | | 5000 m | |
|---|---|---|---|---|
| **Radionuclide** | **Bq/l** | **RQ** | **Bq/l** | **RQ** |
| | | | | |

Is the trend in the results between the different assessment points what you expected?

*Part B: Atmospheric dispersion modelling*

Determine which radionuclides may be included in a Tier 1 ERICA Tool dispersion modelling assessment. Identify which radionuclides cannot and determine how to include these in the assessment.

Using the SRS-19 air model determine the activity concentration in air or soil 500m away from the discharge point for each radionuclide identified above for each of the following scenarios:

1. A ground level release
2. A 20m effective stack height
3. A 50 m effective stack height

- Assume the following for other parameters that you may need:
- Wind speed 2.0 m/s
- Fraction of time 0.25
- Dry deposition coefficient 500 m/d
- Wet deposition coefficient 500 m/d
- Surface soil density (kg/m2) 260
- Duration of discharge (y) 50
- In the first instance assume that there are no buildings nearby.

Record the RQ values and the activity concentration in soil or air for each radionuclide included in your assessment in the table below.

Results table

| | Activity concentration in soil (Bq/kg) or air (Bq/m$^3$) | | | | RQ | | |
|---|---|---|---|---|---|---|---|
| | **0m** | **20m** | **50m** | | **0m** | **20m** | **50m** |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | (SUM) | | | |

Compare the findings, are the differences in predictions between assessments for different stack heights as you expected?

*Part C – Dealing with Kr-85 and Ar-41*

You should have recognised above that you could not assess Ar-41 and Kr-85 in the ERICA Tool. You have been provided with the R&D128 spreadsheet tool "Terrestrial ecosystem release version 1.20 - with guidance CFs.xls" and you should use this to estimate the dose rates from Ar-41 and Kr-85.

Using the atmospheric modelling tool R-91 and the discharge rates from table 1 the air concentrations for **Ar-41 and Kr-85 have been estimated as 0.055 and 17 Bq m$^{-3}$ respectively** for a **20 m** stack height.

What are the limiting organisms for Ar-41 and Kr-85?

Do the Ar and Kr results have a significant impact on the overall assessment?

*Atmospheric input to freshwater environment*

Do you need to consider inputs of radionuclides released via the atmospheric route to the freshwater lake in the assessment? The nearest part of the lake is 500 m from the aerial discharge stack.

If yes, how could you do this?