Handläggare
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Strålsäkerhetsmyndigheten
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Svar till SSM på begäran om förtydligande information angående ”Distributed LDF”

Strålsäkerhetsmyndigheten, SSM, har i sin skrivelse till Svensk Kärnbränslehantering AB, SKB, daterad 2012-04-04 begärt att SKB tillhandahåller fullständig dokumentation om ”Distributed LDF”.

I SKB:s rapport Radionuclide transport report for the safety assessment SR-Site (TR-10-50), Tabell 3-7 anges tre olika typer av LDF värden; Basic LDF, LDF pulse och Distributed LDF. Tabell 3-7 har SKB rapport Landscape dose conversion factors used in the safety assessment SR-Site (TR-10-06) som referens men den innehåller inte någon information om Distributed LDF. SSM vill veta hur Distributed LDF härleds.

SKB:s svar

Nedanstående svar har delats upp i en beskrivning av vad riskkriteriet baserar sig på (avsnitt 1.1), en beskrivning av var ”distributed” LDF finns i dokumentationen av SR-Site (avsnitt 1.2), samt en förtydligande dokumentation av beräkningen av ”distributed” LDF (avsnitt 1.3).

1.1 Riskkriteriet och ”distributed LDF”

SKB vill understryka att ”distributed LDF” inte har använts för att demonstrera uppfyllelse av riskkriteriet, utan de ingår i SR-Site som illustration av olika restscenarier, vilket framgår i TR-10-50, s. 40:

“Distributed LDF
There are also a few cases, calculated for illustrative purposes, see Section 6.2.3 and Section 6.5, where a large number of canisters are assumed to fail. In such cases, LDF values calculated for a release spread over the landscape objects according to the distribution of release locations over time during the modelled interglacial period are applied, rather than the basic LDF values where the landscape object yielding the highest dose is pessimistically used to represent the biosphere. These LDF values are referred to as distributed LDF.”

Detta återfinns också i avsnitt 13.2.3 av huvudrapporten SR-Site, TR-11-01:

“The radionuclide model was also used to illustrate the consequences of a number of hypothetical release scenarios where losses of barrier functions of the repository are assumed already at deposition (see Section 13.7.3). For these simulations, which are described in more detail in /Avila et al. 2010/, two approaches were taken.

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1. *Releases were multiplied by the LDFs obtained with a constant release rate distributed to the biosphere objects in accordance with the time dependent distribution of release points over an interglacial. This is more appropriate than the use of the basic LDFs for these release scenarios, since they concern situations where all deposition positions are affected by a hypothetical barrier loss and hence cause releases.*
2. *...”*

Det är också tydligt i nedan citerade stycke från TR-10-06 och TR-10-09 att ”distributed” LDF inte är den konverteringsfaktor som används för att beräkna risk, utan en illustration för att jämföra olika säkerhetsanalyser eller illustrerande fall.

1.2 Befintlig dokumentation av ”distributed” LDF

Rapporten TR-10-50 hänvisar till TR-10-06, men vare sig ”basic LDF”, ”distributed LDF” eller ”LDF pulse” används som begrepp i biosfärsarbetet. I biosfärsrapporterna, (tex. TR-10-05, TR-10-06, TR-10-09) beskrivs hur olika LDF räknats fram i olika sammanhang, utan att använda de ovanstående tre begreppen. Beräkningen av ”distributed” LDF beskrivs i rapporten TR-10-06 i diskussionen med en jämförelse av andra beräkningar i stycket *5.5 Comparison with early studies* s. 85-86.....

“Figure 5-49 shows a comparison between the SR-Can LDFs values with values obtained from simulations with the SR-Site Radionuclide Model for the biosphere. In these simulations it has been assumed, as in SR-Can, that the radionuclide releases are distributed between biosphere objects in the landscape in proportion to estimated release fractions to different objects at different time points. No general tendency can be observed in Figure 5-49 of the LDFs from SR-Can being higher or lower than the LDF obtained from these simulations. The most likely reason for this is that for some radionuclides the use of updated Kd and CR values has led to increases and for other to decreases in LDFs. So, comparison of numerical values of the LDFs from SR-Site and SR-Can is not very meaningful. However, a general pattern observed is that for those radionuclides for which consumption of contaminated food is the dominant pathway of exposure, the SR-Site LDFs are typically an order of magnitude higher than the SR-Can LDFs. However, the activity concentration in well water was calculated in a similar way in the two assessments (though the exposure from the well was not combined with other pathways in SR-Can), and consequently LDF values for radionuclides where drinking water is the dominant pathway are similar in the two assessments.

A main conceptual difference between SR-Can and SR-Site approaches for derivation of the LDFs is that in SR-Can it was assumed that the releases were distributed over the whole landscape, whereas in SR-Site it is assumed that all releases will reach the discharge area (biosphere object), where they will cause maximum exposure. The impact of this difference in approaches has been indirectly addressed by the analysis of uncertainties associated with the localization of potential releases in the landscape presented in Section 5.1.1. From this analysis it can be inferred that SR-Site LDFs should be higher or similar to SR-Can LDFs, everything else being equal apart from this difference in approaches.”

Följande kortfattade beskrivning finns i figurtexten till fig. 5-49:

“Figure 5‑49. *LDF values for different radionuclides reported in SR-Can compared with the corresponding LDF values derived in the SR-Site project with a similar method to that used in SR-Can, but applying updated models and parameter values. The solid line represents a 1:1 relationship between the baseline LDFs and the EDFs.”*

Vidare nämns i syntesrapporten för biosfären (TR-10-09) på s. 119ff:

“10.3.3 Residual scenarios to illustrate barrier functions

The radionuclide model has also been applied to illustrate the barrier function of the repository for a number of hypothetical release scenarios, where losses of barrier function are assumed already at deposition (see Section 13.7 in SR-Site main report for details). These hypothetical residual scenarios include one failure mode where an initial defect in the canister copper shell of each canister grows into a larger defect, and also calculation cases where there is a large opening in the copper shell of all canisters.

In the above scenarios all canisters contribute to the release of radionuclides to the biosphere and the assumption that the entire release will reach one biosphere object (as in the LDF calculations) is clearly not valid. For these scenarios it was instead assumed that the release of radionuclides would be distributed over all identified discharge areas in the landscape, and that each biosphere object would get a release proportional to the fraction of release points in the object, at each point in time.

To assess consequences in the period directly after closing the repository, the release was used as a time dependent input parameter to the radionuclide model (see above). Dose curves were generated for each biosphere object. By selecting the maximum dose over all biosphere objects for each point in time a dose curve representing the landscape was generated for each nuclide.

To assess periods far into the future, when the release is expected to vary little within time spans of 10,000 years, a constant unit release was distributed over the Forsmark landscape. LDFs were then calculated in accordance with the methods described in Chapter 8. That is, the LDF for each radionuclide was defined as the maximum dose over all biosphere objects and time points during a full interglacial."

1.3 Förtydligande dokumentation

Som framgår av ovan citerade stycken användes liknande metodik som i SR-Can. Det betyder att:

1. För antal utströmningspunkter per objekt och tidsperiod utnyttjades informationen som finns i TR-10-05 kapitel 7 (Excelark bifogas som bilaga 1).
2. Totalt 1 Bq/y fördelades över alla objekt i proportion till antalet utströmningspunkter till respektive objekt.
3. Modellen beräknade för hela landskapet doskonverteringsfaktorn (LDF) i varje objekt över hela tidsperioden av en interglacial.
4. Det betyder att totala ackumulationen och eventuella nedströmsanrikningar tas hänsyn till.
5. För varje nuklid beräknas sedan den maximala LDF under hela denna tidsperiod.
6. Detta värde tabulerades i tabellen 3-7 i TR-10-50.

De erhållna värdena användes som nämnts ovan inte för riskberäkningarna utan för illustration och som jämförelse med resultat från SR-Can.

Med vänlig hälsning

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Bilagor

1. Discharge points, SKBdoc id 1341101