From: Patrick Laplante
Sent: Tuesday, May 23, 2006 7:22 PM
To: Timothy McCartin
Cc: Ali Simpkins; James Durham; James Winterle; Paul Bertetti; Roland Benke; Brittain Hill; Christopher Grossman; Keith Compton
Subject: RE: Tc 99 DCF
Attachments: transfer.comp..pdf

Tim,

(you asked!)

Regarding the transfer factor for Tc, I think we are in the ballpark with other sources for the geometric mean given the wide variation in reported values for specific plant types (depending on the type of plant or averaging scheme one can get different mean values...this is because the code uses a summary "leafy vegetables" category and reported values are for specific plant types). I think DOE has done a fairly complete job of summarizing some of the key available references in their AMR on environmental transport parameters and you can delve into the details by clicking the link below if you want to know more. I'm referring to DOE because they have looked at generally the same data sources that we did and then went further into detail in documenting it (WAY further). I've attached a snapshot of the their page regarding Tc leafy vegetable transfer factors which has a comparison chart showing various values they considered (note: some of the values are based on the same source of data but different end users average or select their factors differently). As you can see from the chart, our mean value is not the highest, nor the lowest, its just a tad conservative compared to the others (....dare I say "reasonably conservative"?). ;)

http://www.ocrwm.doe.gov/documents/amr/40792/40792.pdf

Regarding the Kd, P. Bertetti was the last to review the lit to support the soil Kd selection and he looked at recent information. He found it generally supported the ranges provided in the original reference (Sheppard and Thibault, 1990). When we talked earlier today, Paul noted the larger values in the kd range are less common in the literature so there might be a basis for some refinement. (note, the CURRENT max Tc Kd goes to 16 rather than the 37 I noted earlier which was the TPA 5.0 value... but that doesn't change the effect on crop pathway substantially...I recalculated crop/dw ratio of 18.6x vs my previously noted 20x just to be sure).

Regarding the inverse relationship between irrigation duration and dose, this was noted in the CNWRA-97-009 report but more is known about how the model works now than back in 97 when that report was written. The crop irrigation duration is used only for the leaf deposition part of the dose calculation (e.g., irrigation deposition directly to crop surface rather than root uptake). For leaf deposition, the GENII model in GENTPA divides the annual irrigation rate by the irrigation duration to establish an "instantaneous" deposition rate (Ci/m2-sec) that is used along with the growing time of the crop to determine deposition onto crops for the growing period. Thus, if you are applying the same amount of water for a farming season, but the total duration of irrigation period is shortened then the computed (instantaneous) deposition rate will increase, leaf deposition will also increase proportionally, and crop dose will go up.

Given the way irrigation duration is used in the model, it may be better to fix the irrigation durations at a reasonable constant rather than sample them and we can look into that as we check the sampled parameters.

For completeness, the soil concentration calculation (used for root uptake) is not impacted by irrigation duration. Soil concentration is computed from the water concentration and annual irrigation rate adjusted for losses/buildup due to soil sorption/leaching and decay.
Thus, when you change the irrigation duration, you are seeing it impact only the crop surface deposition and not the root uptake. Both crop deposition and root uptake contribute to the crop dose in different proportions depending on the specific parameters selected or sampled.

Pat

-----Original Message-----
From: Timothy McCartin [mailto:TJM3@nrc.gov]
Sent: Tuesday, May 23, 2006 7:55 AM
To: plaplante@cnwra.swri.edu
Cc: 'Ali Simpkins'; jsdurham@cnwra.swri.edu; jwinterle@cnwra.swri.edu; pbertetti@cnwra.swri.edu; rbenke@cnwra.swri.edu; Brittain Hill; Christopher Grossman; Keith Compton
Subject: RE: Tc 99 DCF

Pat:

Sounds very interesting - how extensive is the data supporting this - it does seem odd that Tc99 is so unique? Another interesting aspect of TPA results is that increasing the irrigation time while keeping everything else constant (e.g., annual irrigation rate) the dose drops rather dramatically. It is hard to understand this effect - I put the same amount of water on but when I put it on quickly the dose increases (I would think just the opposite in that irrigation over a shorter period would result in more nuclides being pushed past the root zone due to the higher daily rate - maybe it is an evapotranspiration issue but the amount of radionuclides does not change).

Tim

>>> Pat LaPlante <plaplante@cnwra.swri.edu> 05/22/2006 8:28:54 PM >>>
Tim,

Tc has the highest plant transfer factor (highest plant uptake) of any of the elements we model. This is consistent with the supporting data.
Thus, when the soil Kd is high, soil retention is increased and then this contributes to far more plant uptake relative to other elements (there is wide variation in plant uptake depending on the plant and the element). Tc *concentrates* in most plant categories included in the IAEA compendium (plant concentration is higher than soil) and they report values for some plants that are much higher than the extreme of our range (e.g., their 95% value for lettuce is 2000 and our leafy vegetable value max's at around 760).

I can reproduce your 20x crop to drinking water pathway ratio by changing only the Tc99 soil kd to the max of the range (37) in a mean value base case run. The crop to dw factor decreases to 1.7x when the geometric mean of the Tc Kd distribution (0.1) is run for the same problem (thus suggesting the Kd as the driver of your results). This last case (1.7x) represents 63% of the total DCF (vs 37% water) which is still a bit higher than expectation but not by much.

Note also that the plant uptake scale factor is the means by which plant uptake is varied in the model so that parameter (which is based on IAEA/IUR literature compendium) can add or subtract another 10x to the crop pathway (from your results I'm guessing you didn't perturb that one). If I max both the Tc99 kd AND the plant uptake scale factor the difference between crop and dw pathway is increased to 200x.

Thus, so far, the results you are getting appear to match the parameter changes you are making and my general understanding of how the model works. Keep in mind that once the parameters are sampled the average results should be closer to expectations. We should probably generate the DCF distributions as part of the validation work to check for reasonableness. We will also continue to look into the model and parameters and make adjustments if necessary.

Pat

-----Original Message-----
From: Timothy McCartin [mailto:TJM3@nrc.gov]
Sent: Monday, May 15, 2006 9:08 AM

To: plaplante@cnwra.swri.edu
Cc: Ali Simpkins; jsdurham@cnwra.swri.edu; jwinterle@cnwra.swri.edu; pbertetti@cnwra.swri.edu; rbenke@cnwra.swri.edu; Brittain Hill; Christopher Grossman; Keith Compton
Subject: RE: Tc 99 DCF

Pat:

Thanks for the info - we can talk when you get back but what I did was run a test case with the DCAGW parameters set at the maximum to see what happens and what is odd is that the DCF for TC 99 is 20 times higher for crops than the drinking water whereas it is just about the same for all other radionuclides - thus Tc99 is dramatically different in the biosphere than every other radionuclide and was wondering what is the reason for this (it is not the soil Kd as no other nuclide had this effect with some extremely large Kds) - it may be something with solubility but I think this should be looked into. I am trying some test runs with TPA41jbeta4 to see if a similar effect is observed.

Tim

>>> Pat LaPlante <plaplante@cnwra.swri.edu> 05/12/2006 9:29:52 PM >>>
Tim,

I did some checking into your question and was going to send a note with an initial reply to your question, however, it was getting a bit long winded and instead I have copied my reply onto the CNWRA/NRC shared drive in a directory called PLaPlante. That directory contains an e-mail style response, an excel file containing groundwater pathway fractions from a TPA51betaA (PC version) mean value run, the tpa.inp file used for the calcs, and DCF output file. I'm going to be out next week so I wanted to at least provide some initial information before I left so you and perhaps others could continue looking into this if necessary. I will be back in the office on 5/22.

The bottom line from my checking is that the changes to the soil kd distributions used in GENTPA biosphere calculations when compared to the prior distributions in 5.0 are the likely explanation for an increase in crop pathway in 51betaA for Tc99 in certain types of runs and perhaps for a full stochastic base case (that would need further testing...unless that's what you did), however, the magnitude of the impact may not be as great as your results suggest (this is one area where you can see different results depending on how and where you look...so its important to be certain we fully understand the true impact before making conclusions on the impact of the parameter changes on the total system results). Because you didn't provide details of the run you did, I'm not sure how you arrived at the 20x drinking water factor mentioned in your e-mail (I got 4x for a mean value run) but I'm sure we can eventually figure it out.

The details are in my note on the shared drive. For what its worth, work on soil Kd's for the biosphere calculations falls under DOSE2 ISI.

Thanks
Pat

-----Original Message-----
From: Timothy McCartin [mailto:TJM3@nrc.gov]
Sent: Thursday, May 11, 2006 9:25 AM
To: plaplante@cnwra.swri.edu
Cc: rbenke@cnwra.swri.edu; Brittain Hill; Christopher Grossman; JWINTERLE.CNWRA.Internet@nrc.gov; Keith Compton
Subject: Tc 99 DCF

Pat:

I have noticed that Tc-99 has a dramatically higer crop ingestion DCF (~ 20 times higher) than the drinking water DCF - this is dramatically different than the rest of the 42 radionuclides (crop about the same or less than the drinking water DCF) - with the exception of Cl-36 which is about 7 times higher. I know there are some peculiarities in the treatment of Tc-99 in GENII but it seems a bit odd based on all the other nuclides (especially I-129) - what is the basis for the treatment? - is this a conservative approach?

Tim

Hearing Identifier: HLW_YuccaMountain_Hold_EX
Email Number: 427

Mail Envelope Properties (008201c67ebf$b1ab3a80$45c9a281)

Subject: RE: Tc 99 DCF
Sent Date: 5/23/2006 7:21:59 PM
Received Date: 5/23/2006 7:22:05 PM
From: Patrick Laplante

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Priority: Standard
Return Notification: No
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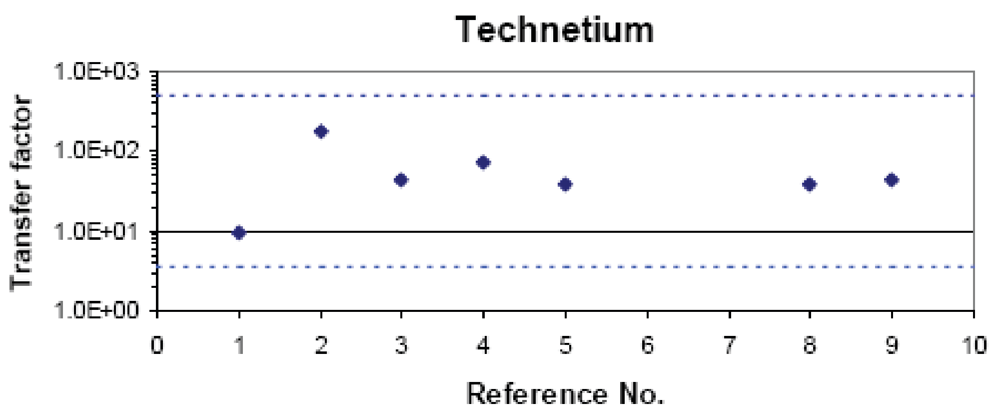
Table 6-2. Technetium Soil-to-Plant Transfer Factors for Leafy Vegetables

No.	Reference	Transfer Factor, dimensionless	
		Best Estimate	Range and Distribution
1	Baes et al. 1984 [DIRS 103766], p. 10	9.5E+00 [a]	–
2	IAEA 1994 [DIRS 100458], pp. 17 to 25	1.8E+02 [b]	1.0E+01 – 7.8E+03 (95-% confidence range)
3	Kennedy and Strenge 1992 [DIRS 103776], pp. 6.25 to 6.27	4.4E+01	–
4	LaPlante and Poor 1997 [DIRS 101079], p. 2-13	7.6E+01 [c]	lognormal, GSD = 2
5	Rittmann 1993 [DIRS 107744], pp. 35 to 36	4.0E+01 [d]	–
6	Sheppard 1995 [DIRS 103789], pp. 55 to 57	–	–
7	Peterson 1983 [DIRS 167077], pp. 5-50 to 5-51	–	–
8	Wang et al. 1993 [DIRS 103839], pp. 25 to 26	4.0E+01 [e]	–
9	This analysis - recommendation	–	lognormal, GM = 4.6E+01[f], GSD = 2.6 truncation: low = 3.8E+00; high = 5.5E+02



NOTES: TFs are in units of Bq/kg dry-weight crop per Bq/kg dry-weight soil.
Truncation limits shown in graph as dashed lines.

[a] The value is not specific to leafy vegetables but rather it was developed for plant parts usually associated with vegetative functions (leaves, stems, straw)

[b] Best estimate is the GM of the values for cabbage, lettuce, and spinach.

[c] Input values for the GENII-S code used in biosphere modeling for Yucca Mountain.

[d] GENII-S default

[e] RESRAD default value

[f] For the references listed in this table, GM = 4.6E+01; GSD = 2.6