3rd Working Group Meeting EMRAS II Working Group 7 “Tritium” Accidents

2nd EMRAS II Technical Meeting IAEA Headquarters, Vienna 25–29 January 2010

Final Report

29 January 2010

Enlarged interest

- INDIA- start large program for experiment and models- need assistance for OBT measurement technique
- BRAZIL- prepare for new nuclear plants- tritium in coastal water (tropical)- need cooperation
- UK (Scotland) have problems with tritium at MAGNOX- cooperation, rainy climate
- Kazakhstan, SemiPalatinsk, tritium in the environment- can do experiments, will cooperate
- >22 participants, 10 active

Key ideas

- Decrease uncertainty in assessing committed dose for public (deterministic, probabilistic),
  We need dose coefficients and time integrated intake (HTO,OBT)
- Needs of indicators (early monitoring) for accident management (countermeasures)
- Needs of sub-model test>>>time dependent prediction of concentration in food and feed
- Processes which should be included in models and their status as defined in the early 90th but no progress in operational models
- Ongoing work within the IAEA supported EMRAS II working programme: “Development of a state of the art tritium model”
- Tritium is a very dynamic radionuclide which cannot be modelled with the same approaches as other radionuclides
- In the first days, tritium dynamics depend strongly on the environmental characteristics, therefore a simple compartment model might not be appropriate
- Definition of a worst case different, as physical dependencies should not be ignored – otherwise too conservative

Regulatory requirements for a model

- Relatively simple
- Transparent
- Easy to program
- Results should be conservative (but not too much)
- Deterministic calculations possible (worst case assessments)
- Probabilistic calculations possible (95% percentile as worst case)
- Is this possible for Tritium?
- Problems detected: operational models used for licensing have no provision for robustness and control of uncertainty
- Models for accident management are to complex and user non friendly

Proposed Vision (Raskob)

- Develop a new model
- Take an advanced dispersion model (particle model)
- Add subroutines for the key processes specific to tritium
  - Dry and wet deposition
  - Movement in soil
  - Root uptake
  - Behaviour in crops (transpiration) with OBT build up
  - Secondary plume from reemission if HT is of interest
- Agree in the WG on these processes and the modelling approach
- Program these processes in subroutines that can be integrated into a dispersion model
- Derive from this a simple model for regulatory purposes

Achievements up to now

- Comparison between CERES and UFOTRI codes for ITER: problems with atmospheric transport and with CERES tritium **P Cortez**

But what is the truth?

- Key process revised (terrestrial), proposed VISION for WG7 **W.Raskob**
- Excellent review on AECL results on OBT production, data and model and fish experiments, *a gap in previous knowledge* **Sang Bog Kim**
- Process level animal model, how to use, suggestion for parsimonious modelling (derivation of simple but robust model) **A. Melintescu** IFIN Animal data base available upon request
- Interaction matrix for tritium- guidance for modeling and personal questions **S Le Dizes** First young modeler asking advice, will have
- Briefing of soil water models as used in a different project **L Marang**, helpful to decrease our efforts
- Development of a complex model to help simplifying **H Nagai** Japan
- Presentation of the simple model for plant in Ourson **F Siclet**, excelent for further derivation of simple but robust models
- Review on HTO washout (**L Patryl** CEA+IFIN using also Atanassov, Golubev)
- Update of AQUATRiT, user approach, **IFIN**
- **Disclosure of unpublished work- air-plant interaction, OBT formation IFIN**

Tritium WET DEPOSITION

•Washout process too complex to be described by comprehensively by simple washout coefficient;
•Experimental data miss and lead to the uncertainty in the washout assessment;
•Too few studies about washout during snow (= 2 × 10−5s−1) or fog (deposition more important than rain ?);
•Improvements have to be done on inputs but which ?
-Better knowledge of cloud and rain process on HTO scavenging
-Taking account of local conditions (topography)
-Taking account of time evolution for rain process
-Select parameters which influence washout
-Chose typical rainfall conditions and give their representative washout rates ?
-Uncertainty on assumptions
•Improvements have to be done on computed of washout
-Washout rate or washout coefficient
-Drop model better or simple model (with)
-Uncertainty of model
-Atmospheric dispersion models (gaussian, lagrangian, ...)

Aquatic pathway :WHAT ARE THE MAIN TROPICAL ISSUES

- The main concern about Tritium in tropical environments is related with the possible role of DOC high concentra-tion in river or coastal waters for quick formation of DOT from potential accidental releases of high activity HTO or HT.
- If organic colloids could assimilate tritium from water in its exchangeable positions, it would be readily uptake by organisms in the form of OBT (buried tritium)
- As organic colloids have high stability with large residence times in water column this process could lead to tritium biomagnification
- If biomagnification possibility were confirmed for tropical aquatic environments, in accident scenario, it would give place to tritium issues, perhaps worse than Cardiff Case.
- Customization of aquatic pathway models (AQUATRIT, OURSON) with tropical parameters and species (we have no experimental data available for tritium)

Modeling strategy (Steps for MAGENTC)

- Step 1: Collect relevant experimental data;
- Step 2: Basic understanding of metabolism and nutrition;
  Reviews of the past experience (STAR, TRIF,
  OURSON, UFOTRI, PSA etc);
- Step 3: Formulate basic working hypothesis;
- Step 4: Using the rat (very good experimental data base thanks to H. Takeda, NIRS Japan) for exercise;
- Step 5: Understanding the animal nutrition from literature and make a standardization;
- Step 6: Developing the conceptual and mathematical model;
- Step 7: Test the model with experimental data;
- Step 8: Make prediction for the cases without experimental data;
- Step 9: Trials for simplify without losing the predictive power.

Next steps

working pre-drafts circulated before summer holiday,
meeting in September Aix en Provence

- Washout rate for typical rain patterns (CEA IFIN)
- Review of aquatic pathway and recommended models (IEN Brazil, IFIN, EDF)
- Upgrade fish experiments (AECL Canada)
- Derivation of simple models for transfer in farm animals, uncertainty analysis (VÚJE Slovakia, IFIN)
- Optimisation of modelling soil-plant transfer of HTO (IFIN, EDF?)
- Tritium interaction matrix and associated processes (IRSN)
- OBT formation in night, data and modelling trials (AECL, IFIN +?)

Working Document (IAEA)

- Introduction, general tritium and aim in EMRAS (briefing recent lit)
- Wet deposition (rain and snow)-status, models, experimental and modeling comparison and improvements needed (CEA draft practical, IFIN help) draft in september 2010
- Aquatic pathway- briefing of experimental data,, main processes, recommended models, associate hydrological model (only ref)- EMRAS mussel and AECL experiments

  IFIN will submit for publication AQUATRIT update (until end march), available to interested people, EDF draft OURSON, AECL draft doc fish experiments >>september 2010

- September- decision for final draft working material
- Decision of Cardiff case

- Terrestrial pathway
- Update of processes

  _Dry dep (after recent results)

  Wet dep to soil plant – to elaborate pre-draft IFIN-september

  Foggy deposition ?

  reemission

Uptake of HTO and OBT formation Day Night

Reuse doc fom each (CEA start)

DAY (PLANT GROwTH – POTOSYNtHESIS)

experimental data briefing, hypothesis for moddeling

NIGHT , briefing AECL

Building the state of art Added Value general

- Recommended models for farm animals (simple and process level), experimental database
- Recommended models for crops (simple and process level), classes of crops, experimental database
- Sources of uncertainties

HOW TO DERIVE SIMPLE< TRANSPARENT AND ROBUST MODELS (low conservatism)

- Recommendation to users-site adaptation