Organically Bound Tritium (OBT) behaviour and analysis. Outcome of the international workshop held in Balaruc les Bains (France) in 2012.


LSC 2013 Conference

Barcelone 18/03/13
1 Background

2 OBT and tritium fractions
   - why focusing on tritium and particularly OBT,
   - definition,
   - analysis,
   - standardisation, Intercomparison.

3 1\textsuperscript{st} International workshop

4 Conclusion
Background

Past and present tritium releases:
- Atmospheric nuclear weapon testing was the main anthropogenic source in the past up to the 1970s.
- Currently heavy water reactors are the main source of tritium followed by PWR reactors (e.g. Canada, China, Korea and Romania).

Discharges of tritium are forecast to increase:
- New PWR nuclear reactors (EPR) characterized by higher tritium discharge are under construction or planned in several countries (China, Finland, France, UK).
- ITER, the new experimental reactor with high tritium throughput might be in operation by 2025.

Tritium is not found only as tritiated water but also as OBT (tritium incorporated into environmental organic compounds):
- Questions about the impact of the various chemical species of tritium on biological systems.
- High energy deposition along its short track length (LET).
Tritium can exist in several forms:
- Gaseous (HT, HTO, organic molecules).
- Liquid (HTO or organic molecules in solutions).
- OBT which can incorporate into living organisms (vegetables, animals, humans).

Strong debate about RBE (Relative Biological Effectiveness) and \( w_r \) (weighing factor) values:
- Studies\(^*\) indicate that RBE values are "reference radiation" dependent: 1.4 when X rays (200-250 keV) are consigned while 2.2 for \( \gamma \) radiation (\( ^{60}\)Co, \( ^{137}\)Cs).
- A \( w_r \) value of 1 is assigned by ICRP (International Commission on Radiological Protection) while IRSN is of the opinion that a \( w_r \) of 2 rather than 1 would only have a minor significance in routine situations and should only be used in assessing individual risks.
- Ecological associations in France (ACRO and ANCCLI) are arguing for a \( w_r \) of 5 for the sake of precaution.

How will tritium fractions including OBT be distributed within living organism?
OBT and tritium fractions - Definition

- **Exchangeable Tritium**
- **Tissue Free Water Tritium**
- **Exchangeable Organically Bound Tritium**
- **Organically Bound Tritium**
- **Non Exchangeable – Organically Bound Tritium**

Isotopic exchange:

- Atmosphere
- Soil

**ATMOSPHERE**

**SOIL**
OBT and tritium fractions - Analysis

Fresh sample → Overall Tritium measurement

Dehydration

Free water → TFWT measurement

Dry matter → OBT measurement

Immersed in atritiated water to eliminate E-OBT

Solid fraction → E-OBT tentative measurement

Dehydration

Dry solid fraction → NE - OBT measurement
“Domestic” interlaboratory exercises:

- UK: informal intercomparison by the Health Protection Agency (2005) and more recently included in a NPL Programme (2012 Intercomparison Exercise).
- Canada and France: several exercises were organized between 2001 and 2012, focusing on OBT. During this period, the number of participants increased regularly reaching 8 participants in Canada (2012) and 14 in France (2010) for the most recent exercises.

Standardisation and CRM’s (present situation):

- No CRM’s.
- No ISO standard but a French one will be submitted soon to AFNOR.

Increasing interest on OBT measurement worldwide and improve skills since 2001 but some key points are still missing : shared analytical procedures, CRM’s, consolidated experimental data for model improvement…
In discussing tritium, it is essential to state what form (HTO, HT, OBT) and when talking about OBT, it must be clearly specified whether we are talking about the food chain/environmental sample or a molecule that has been labelled for research purposes (Tritiated Organic Molecules).

Different procedures are used by different laboratories participating in inter-comparisons organized in France and Canada.

Variations or bias in analytical data could lead to erroneous dose assessments.

Necessity to validate the analytical procedures and to establish robust international standards.
1\textsuperscript{st} workshop on OBT (Organically Bound Tritium) and its analysis

1\textsuperscript{er} séminaire sur le TOL (Tritium Organiquement Lié) et son analyse

Organizing committee: Nicolas Baglan, Sang Bog Kim

Scientific committee: E. Ansoborlo (CEA/DEN-MAR), N. Baglan (CEA/DAM-DIF), C. Cossonnet (IRSN Orsay), I. W. Croudace (University of Southampton), M. Fournier (ASN), D. Galeriu (IFIN-HH), S. B. Kim (AECL), N. Momoshima (Kyushu University), P. E. Warwick (University of Southampton).

Lieu : Balaruc les Bains, France
Date : 21 au 24 Mai 2012
The 1st workshop organised in may 2012 has gathered about 50 participants.

CEA (Commissariat à l’énergie Atomique) and AECL (Atomic Energy Canada Limited) organized a workshop to bring together experts to debate environmental tritium behaviour (analysis, speciation, migration, etc.).
4 topics were chosen to make a standpoint on OBT and it’s analysis:

- Environmental monitoring
- Tritium sources and modelling
- Analysis
- Inter laboratory exercises

Some important conclusions are:

1. It is time to provide clear definitions on the tritium form to avoid misunderstandings between the various communities.

2. To validate models and to increase the confidence in the results obtained by using them, accurate experimental tritium data are necessary.

3. Validated analytical procedures, summarizing the “knowhow” of the labs performing OBT analysis, need to be published to further improve the performance of OBT analysis.

4. For almost all interlaboratory exercises it is difficult on a yearly basis to provide the samples and to realise the statistical treatment of the results.
At the end of the 1\textsuperscript{st} workshop, it was decided to create a task group led by both AECL and CEA with the support of the scientific committee of the workshop.

Main goal of this group will be to promote OBT analysis through inter-laboratory exercises over a three-year period ending in 2015.

To date, 35 labs from about 9 countries have expressed interest in participating in this group.

The expected benefits are the following: remove or reduce uncertainty in OBT analysis results, provide better OBT model validation data and better public dose results.

At the end of the three years period depending on the conclusions of the first period the exercises might continue either to validate the analytical procedure or as routine exercise.
May 2012: Kickoff meeting in France

February 2013: AECL has provided first intercomparison samples (potatoes)

May 2013 results are submitted to AECL and CEA

September 2013: 2nd meeting in Southampton (results of first trial are discussed)

December 2013:

1. GAU (university of Southampton) provides 2nd intercomparison samples (sediments)

2. CEA provides 3rd intercomparison samples (animal)

April 2014 results are submitted to GAU, CEA and AECL

September 2014: Final meeting in Canada (results of the 2nd and 3rd exercises are discussed),

conclusion of the international intercomparison network