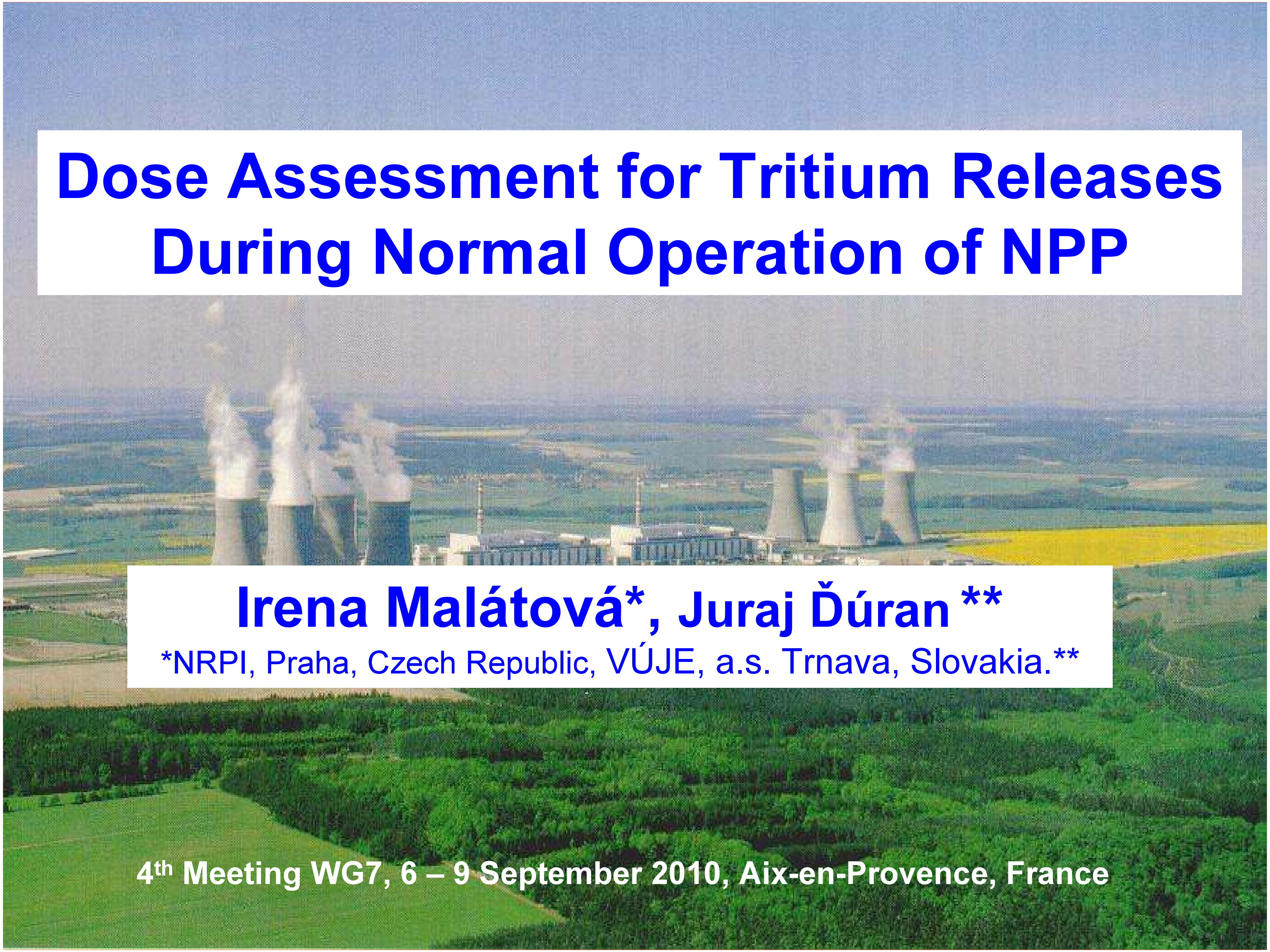
Dose Assessment for Tritium Releases During Normal Operation of NPP



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Main source of tritium in the Czech republic are NPPs Dukovany and Temelín, both PWR Type.

Doses to population from tritium and other radionuclides in the discharges from NPPs are very low, much lower than authorized limits

However, calculation of doses from tritium has some problems from the point of view of its RBE and therefore, often it is a target of anti-nuclear activists.

Aim of this work was to find out how realistic are the estimation of doses to public, and if too conservative, to suggest more realistic approach.

Dose constraint and authorized limits for discharges of radionuclides into environment in the Czech Republic

Dose constraint for total discharge of radionuclides – 250μSv per year for a representative individual from public (200μSv for airborne discharges, 50μSv for liquid discharges)

On the basis of optimization process, site specific authorized limits are set for NPP

NPP Dukovany: 40μSv airborne and 6μSv liquid discharges

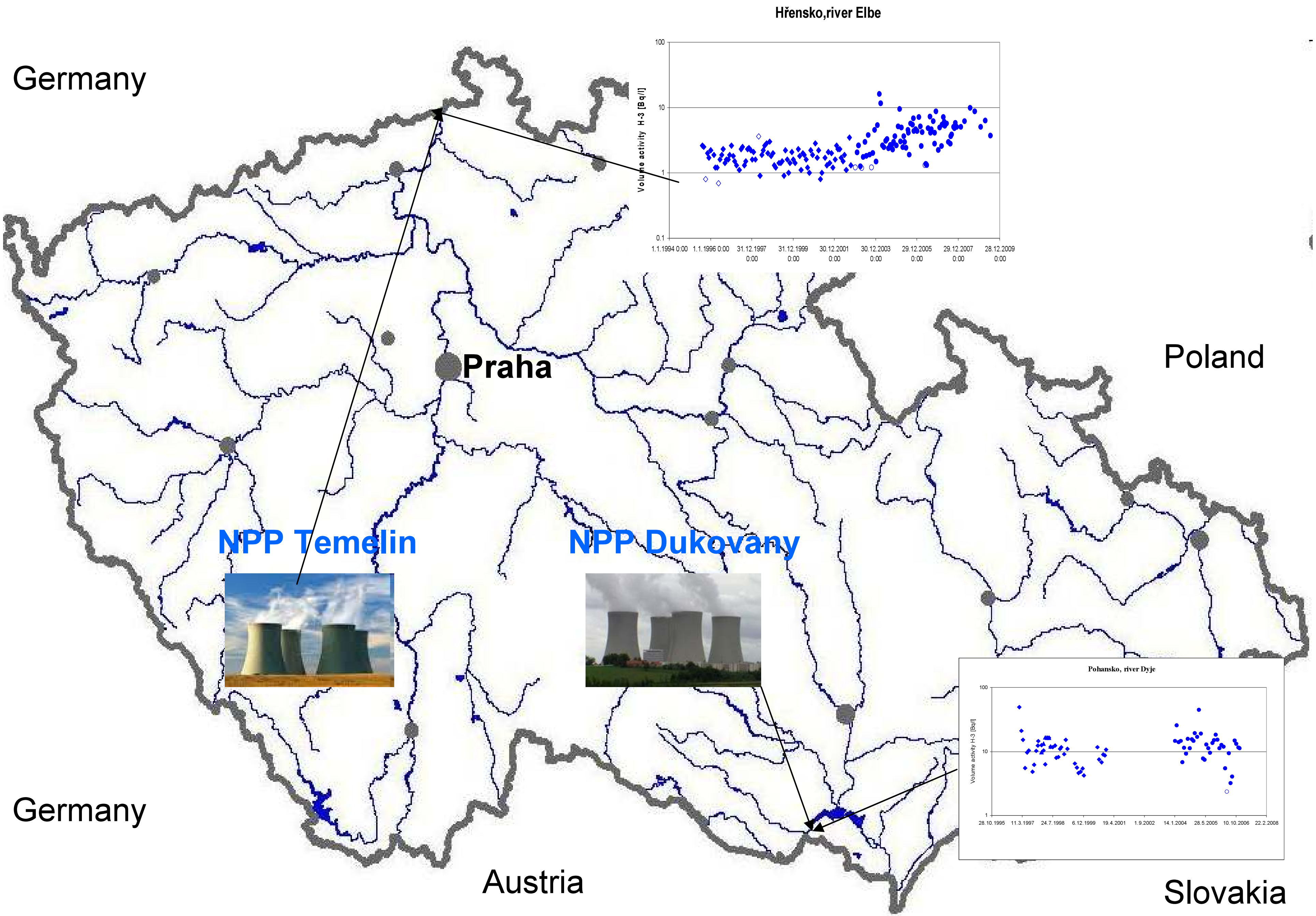
NPP Temelín: 40μSv airborne and 3μSv liquid discharges

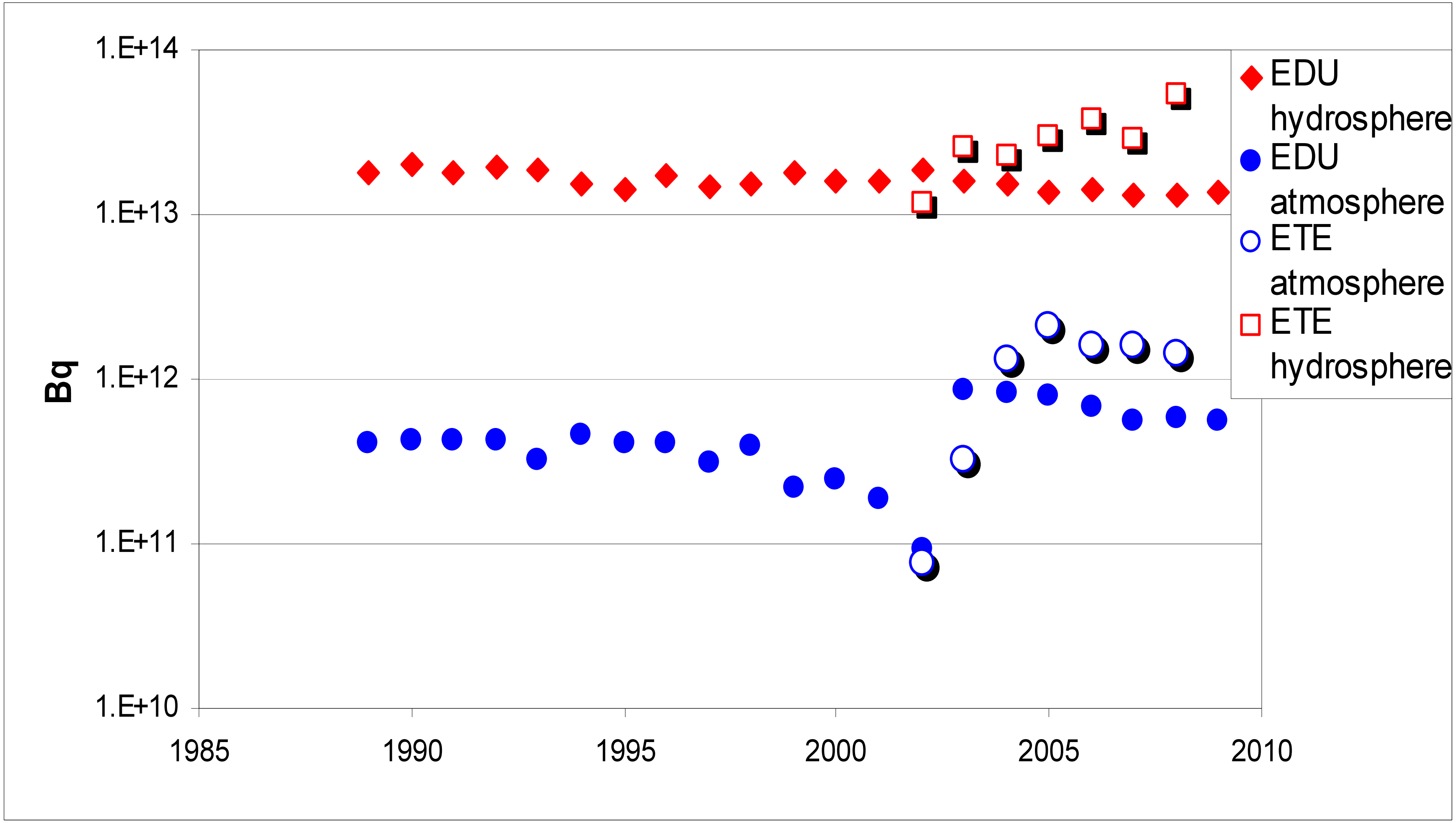
Characteristics of the NPPs in the Czech republic and doses to public from their releases.

Nuclear Power Plant	**Dukovany**	**Temelín**
Power output	4x440MW	2X1000MW
Releases to atmosphere (Sv)	1.6E-08	8.0E-09
Releases of tritium (Sv)	3.20E-10	6.40E-11
Releases to hydrosphere (Sv)	1.80E-06	1.10E-06
Releases of tritium (Sv)	1.80E-06	1.10E-06

Doses from liquid releases during normal operation are 2 to 3 order of magnitude higher than from airborne releases. In liquid effluents and therefore in overall dose to population, dose from tritium is dominant. Tritium is the only one radionuclide measurable in the environment (in the rivers)

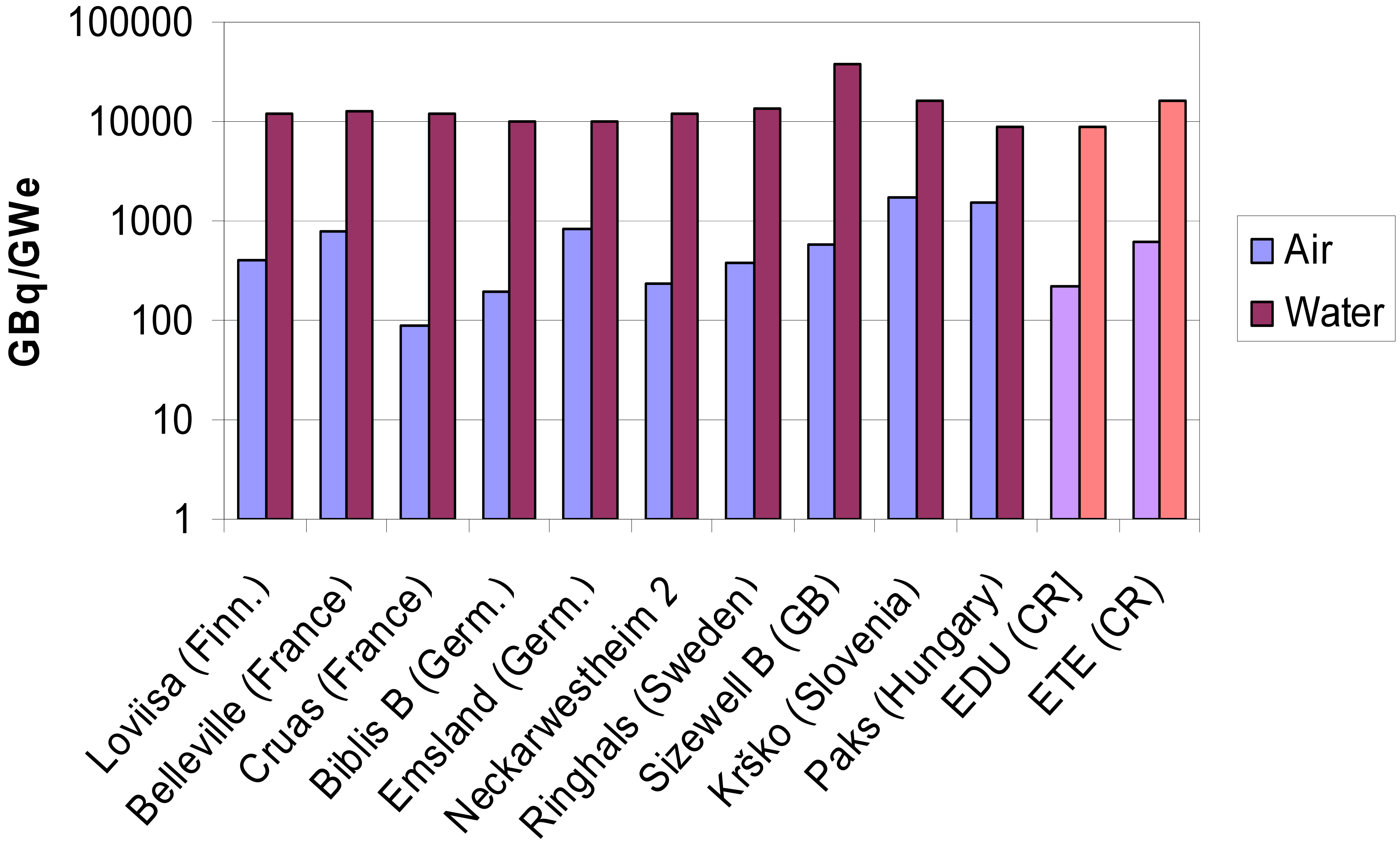
Doses to public are calculated using models of transport of radionuclides in environment in combination with measured released activity of radionuclides into air and water.


Germany
Hřensko,river Elbe
100
10
1
0.1
Volume activity H-3 [Bq/l]
1.1.1994 0:00
1.1.1996 0:00
31.12.1997 0:00
31.12.1999 0:00
30.12.2001 0:00
30.12.2003 0:00
29.12.2005 0:00
29.12.2007 0:00
28.12.2009 0:00
Praha
Poland
NPP Temelin
NPP Dukovany
Pohansko, river Dyje
100
10
1
Volume activity H-3 [Bq/l]
28.10.1995
11.3.1997
24.7.1998
6.12.1999
19.4.2001
1.9.2002
14.1.2004
28.5.2005
10.10.2006
22.2.2008
Germany
Austria
Slovakia



Annual releases to atmosphere and hydrosphere from the Czech Nuclear Power Plants Dukovany and Temelín

Annual releases of tritium, normalized to power output, from NPP PWR to air and water (geom.mean)

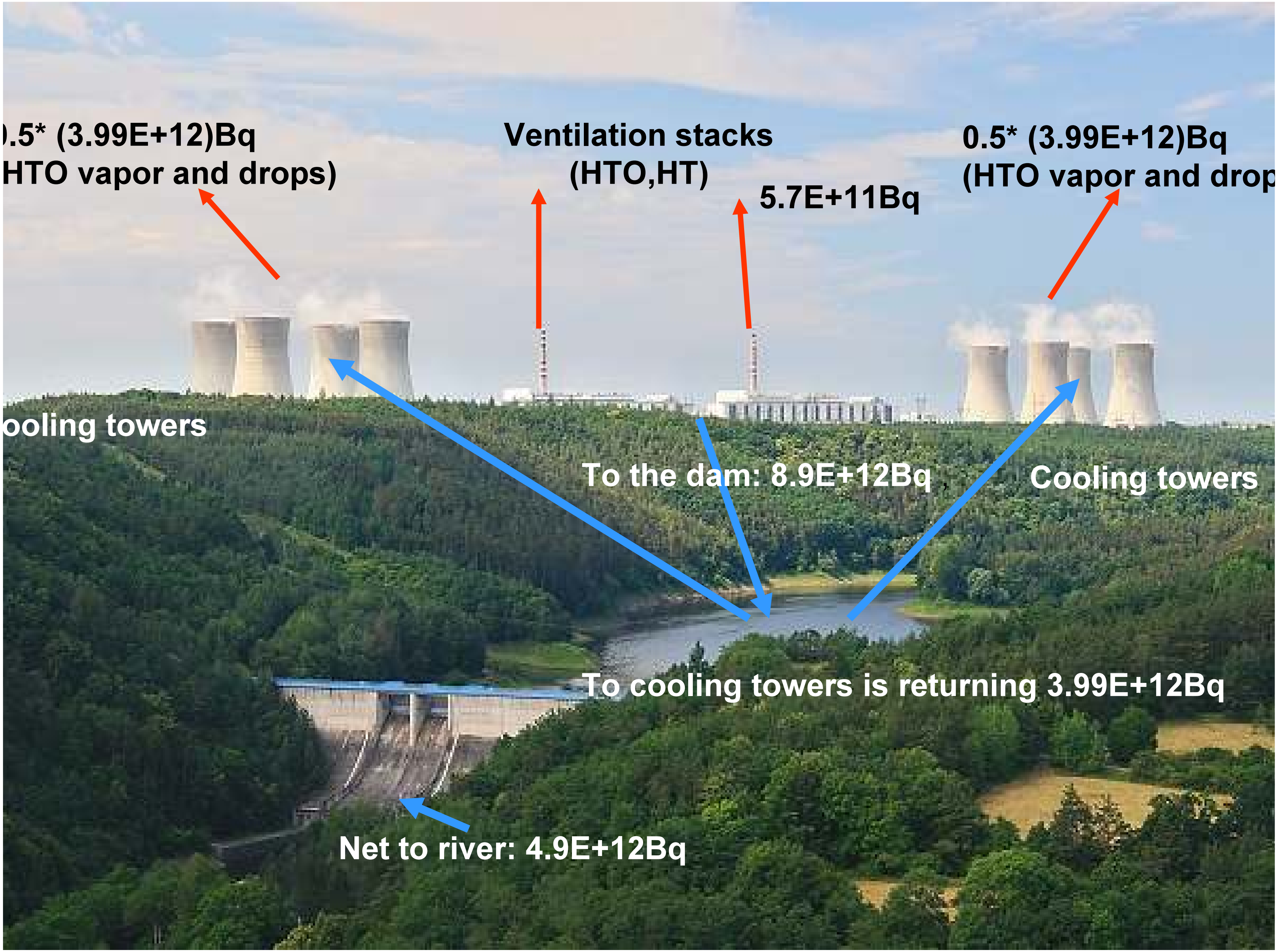


Old model for calculation of doses to the public

The old model calculation of population doses took into account releases through ventilation stacks into atmosphere and liquid effluents into hydrosphere only.

However, in Dukovany NPP the source of cooling water is water from the river dam with the outfall of liquid effluents from NPP. Significant activity of tritium is escaping into air by the way of the cooling towers, contributing thus to the dose from air releases and diminishing dose from hydrosphere.

Activity of radionuclides in cooling water is measured periodically in NPP, amount of water vapours is calculated from flow rate above and below NPP.



).5* (3.99E+12)Bq
HTO vapor and drops)
Ventilation stacks
(HTO,HT)
5.7E+11Bq
0.5* (3.99E+12)Bq
(HTO vapor and drop
ooling towers
To the dam: 8.9E+12Bq
Cooling towers
To cooling towers is returning 3.99E+12Bq
Net to river: 4.9E+12Bq

Modifications in the new model

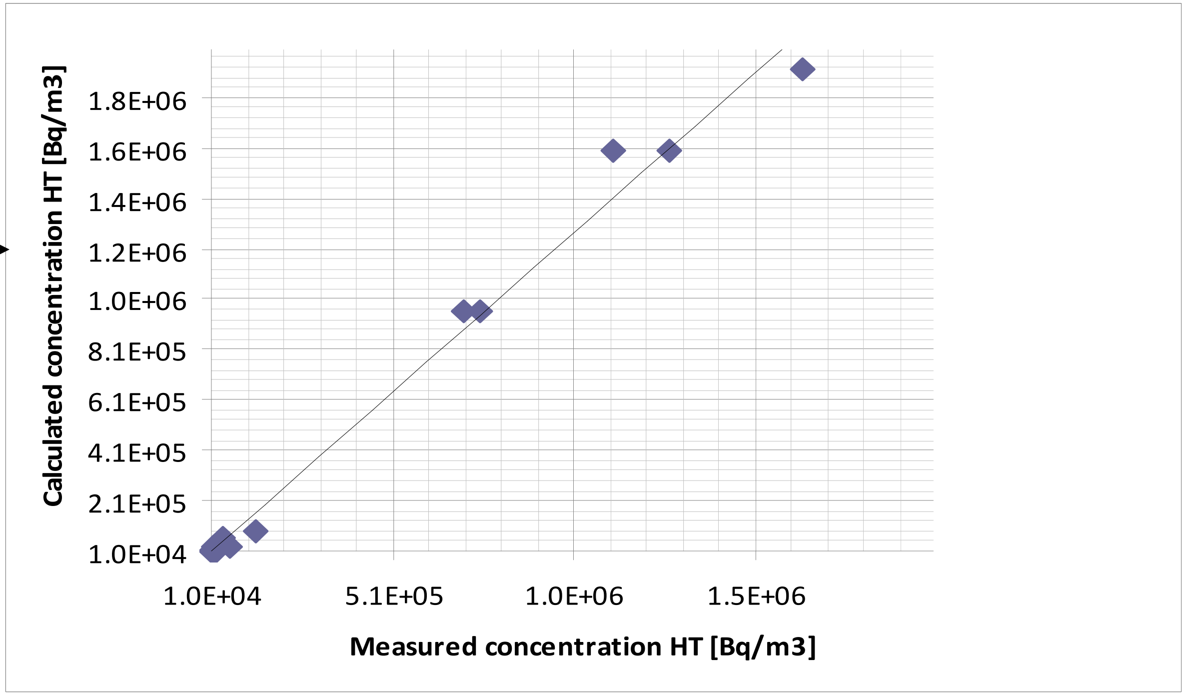
A computer code PTM_HTO has been developed to assess the dose to general public. It takes into account HTO, HT and water drops (1 – 3 % of the released activity of ^{3}H). Oxidation of HT to HTO and reemission of HTO from soil to the atmosphere are included too.

Organically bound tritium (OBT) in vegetations, milk and beef is taken into account.

In the same way as in the old model local consumption is assumed (e.g. that all products consumed are locally produced – very conservative approach)

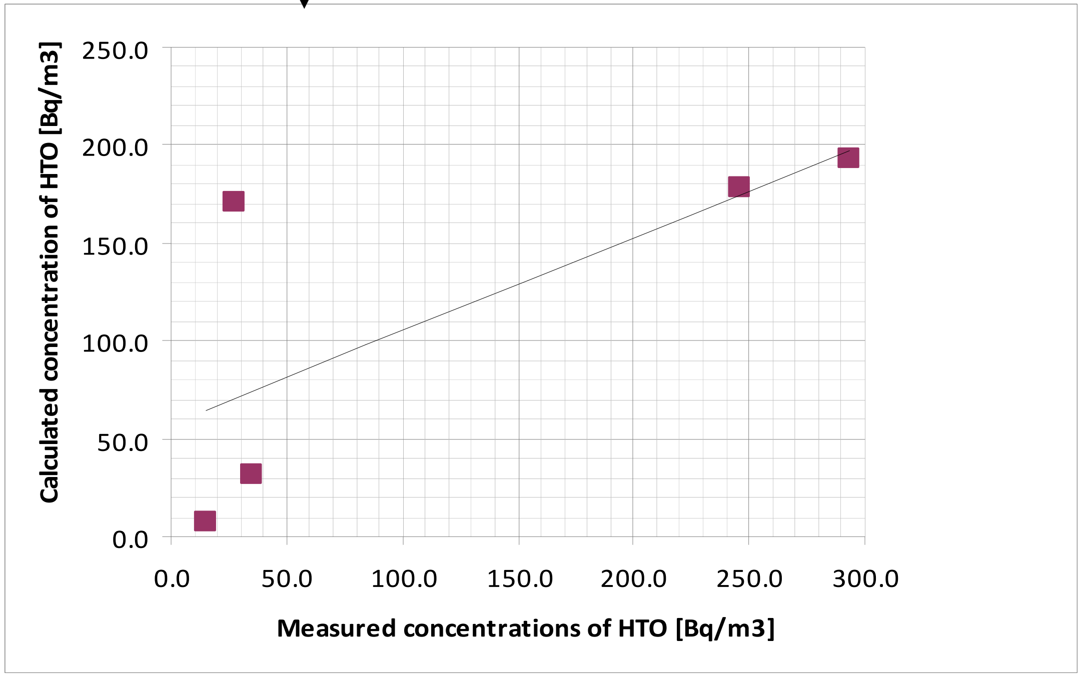
Validation of PTM_HTO Model on the data from field experiment

HT



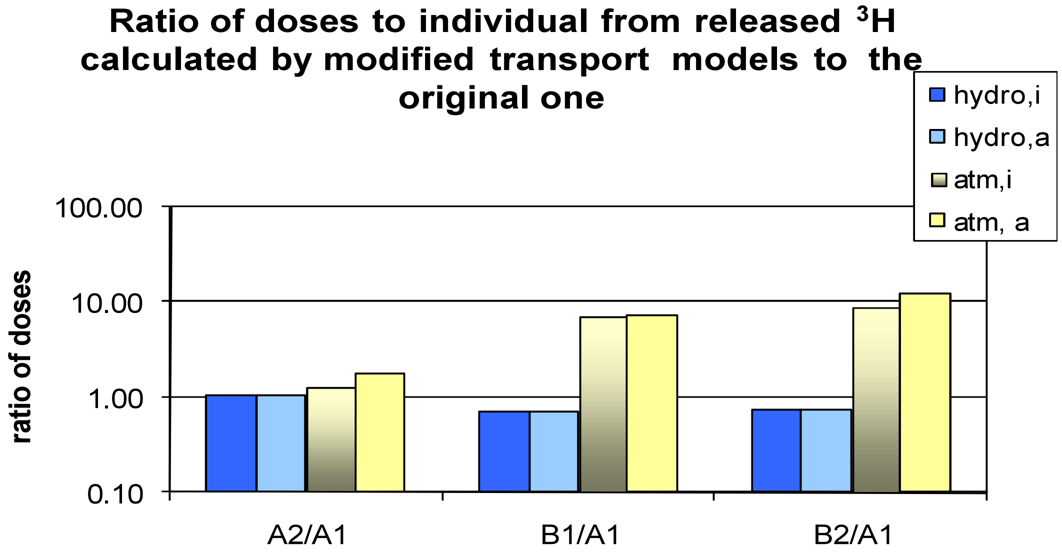
Experimental vs. Theoretical Data

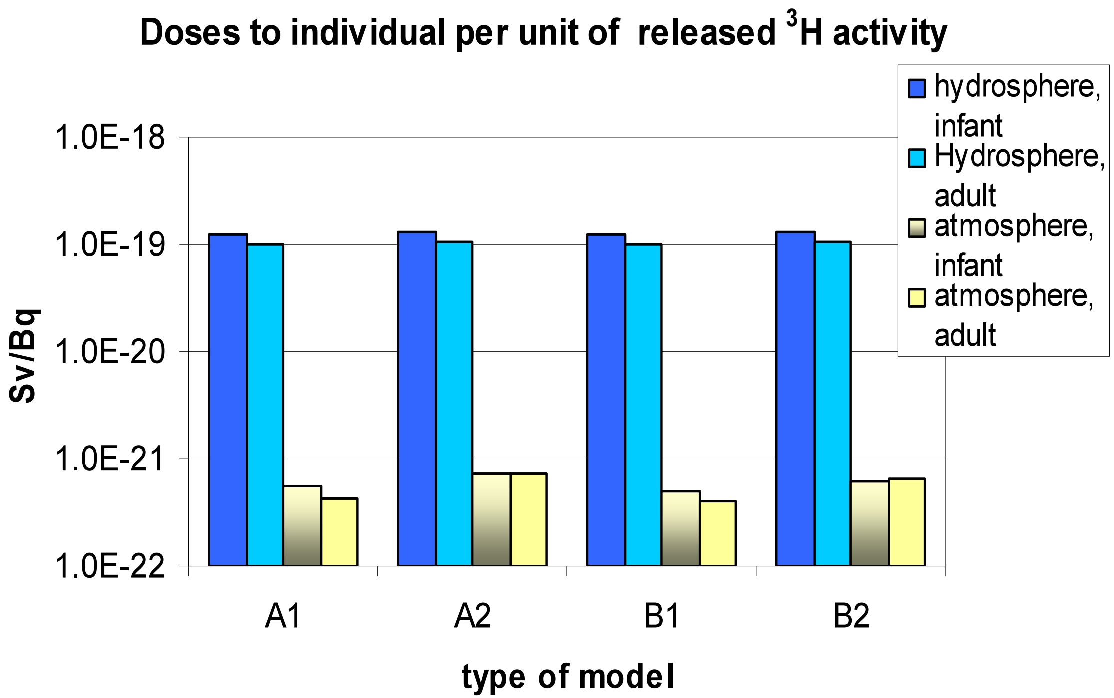
HTO



R.M.Brown,G.L.Ogram And F.S.Spencer: Field Studies of HT Oxidation and Dispersion in the Experiment II, the 1987 June experiment at Chalk River, Canadian Fusion Fuels Techn. Project. CFFTP Report No CFFTP – G – 88007, October 1988

Example for releases in 2008



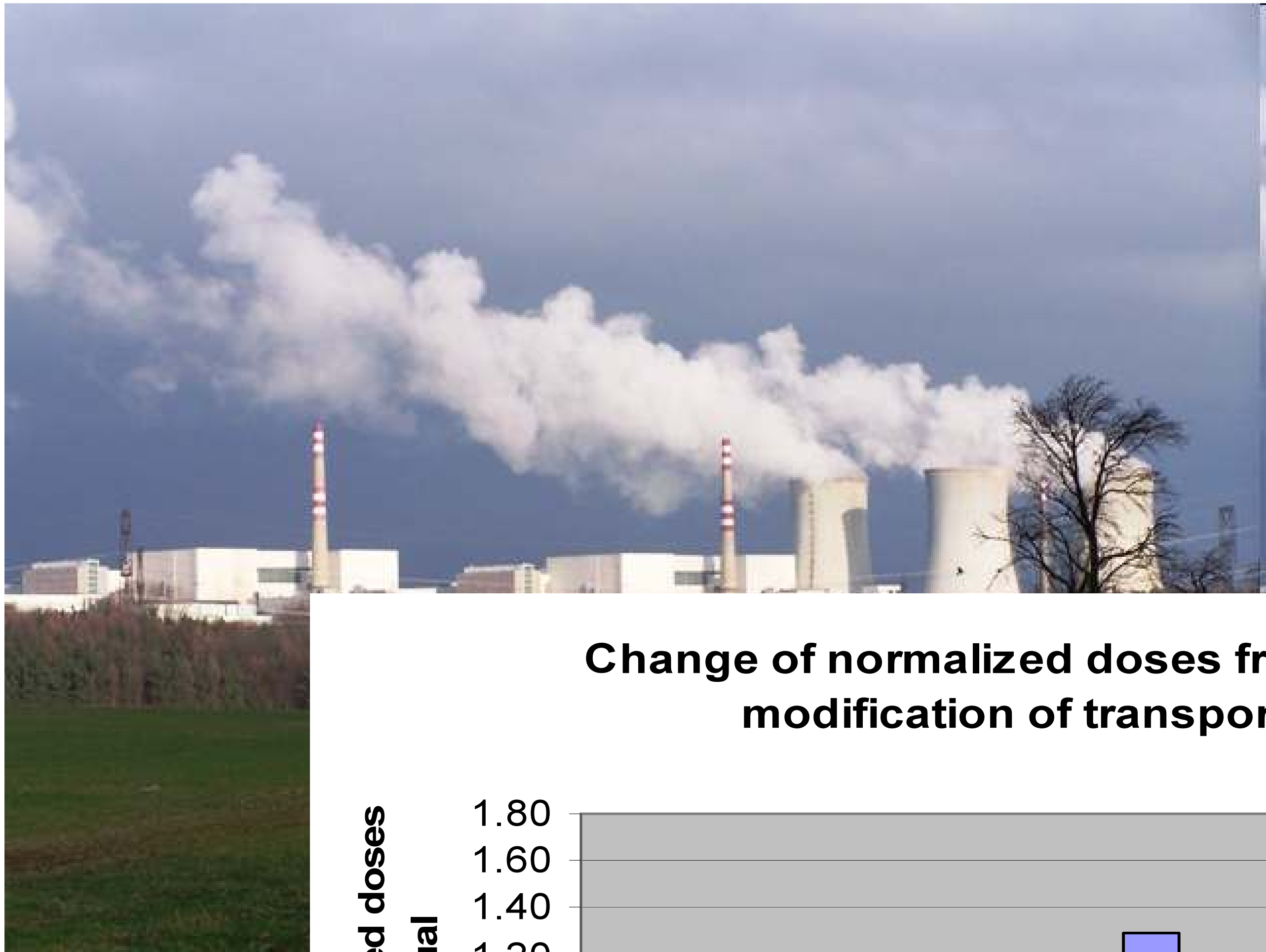


A1 – without OBT, without releases through cooling towers

A2 – with OBT, without releases through cooling towers

B1 – without OBT, with releases through cooling towers

B2 – with OBT, with releases through cooling towers

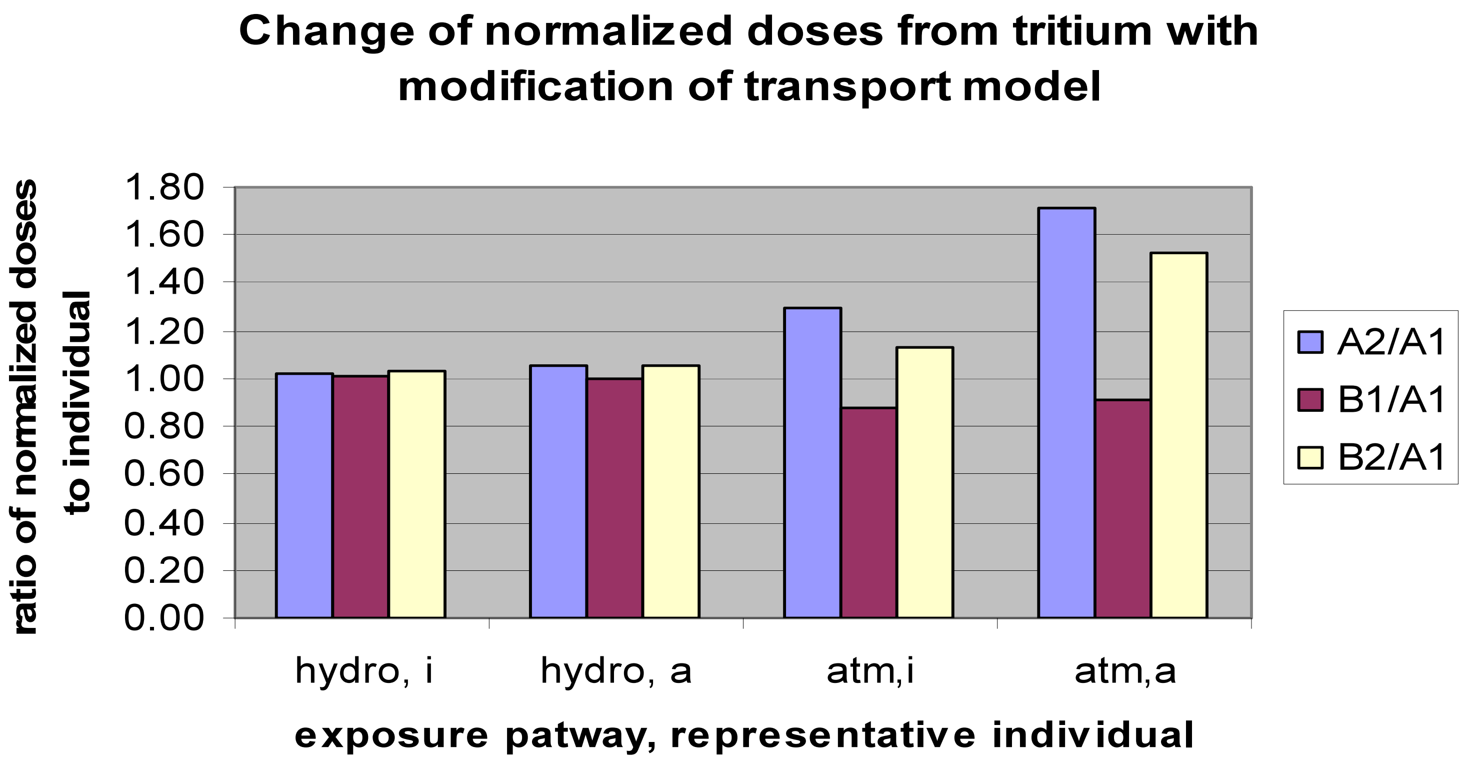


A1 – without OBT, without releases through cooling towers

A2 – with OBT, without releases through cooling towers

B1 – without OBT, with releases through cooling towers

B2 – with OBT, with releases through cooling towers



Conclusions.

Doses from tritium to population from the Czech NPP are very low (below 2μSv),

When OBT is included, doses from airborne discharges increase by about 30 %. Increase of doses from water discharges, which are dominant, is less than 10%

Taking into account recirculation of cooling water, overall doses from tritium from NPP Dukovany decreased about 50%.

Such approach would be not practical for limitation purposes as the amount of water evaporated through cooling towers is known ex post only. However, for reporting annual doses, a realistic approach would be appropriate.