Generic containment simulation using MELCOR 2.1

Juraj Jančovič, Peter Juriš

jancovic@vuje.sk, juris@vuje.sk

5th EMUG

KTH, Stockholm,

2 – 3 May 2013

Motivation

Contribution to verified code matrix for containment phenomena modelling

Application of the latest version of the MELCOR code to develop and validate user skills in the modelling of containment phenomena

Approach

Development of a brand new model of the generic containment for MELCOR 2.1 under the SARNET2 WP7.3 work package

Application of MELCOR PAR model for modelling of hydrogen risk mitigation system

Generic containment - code used – MELCOR 2.1

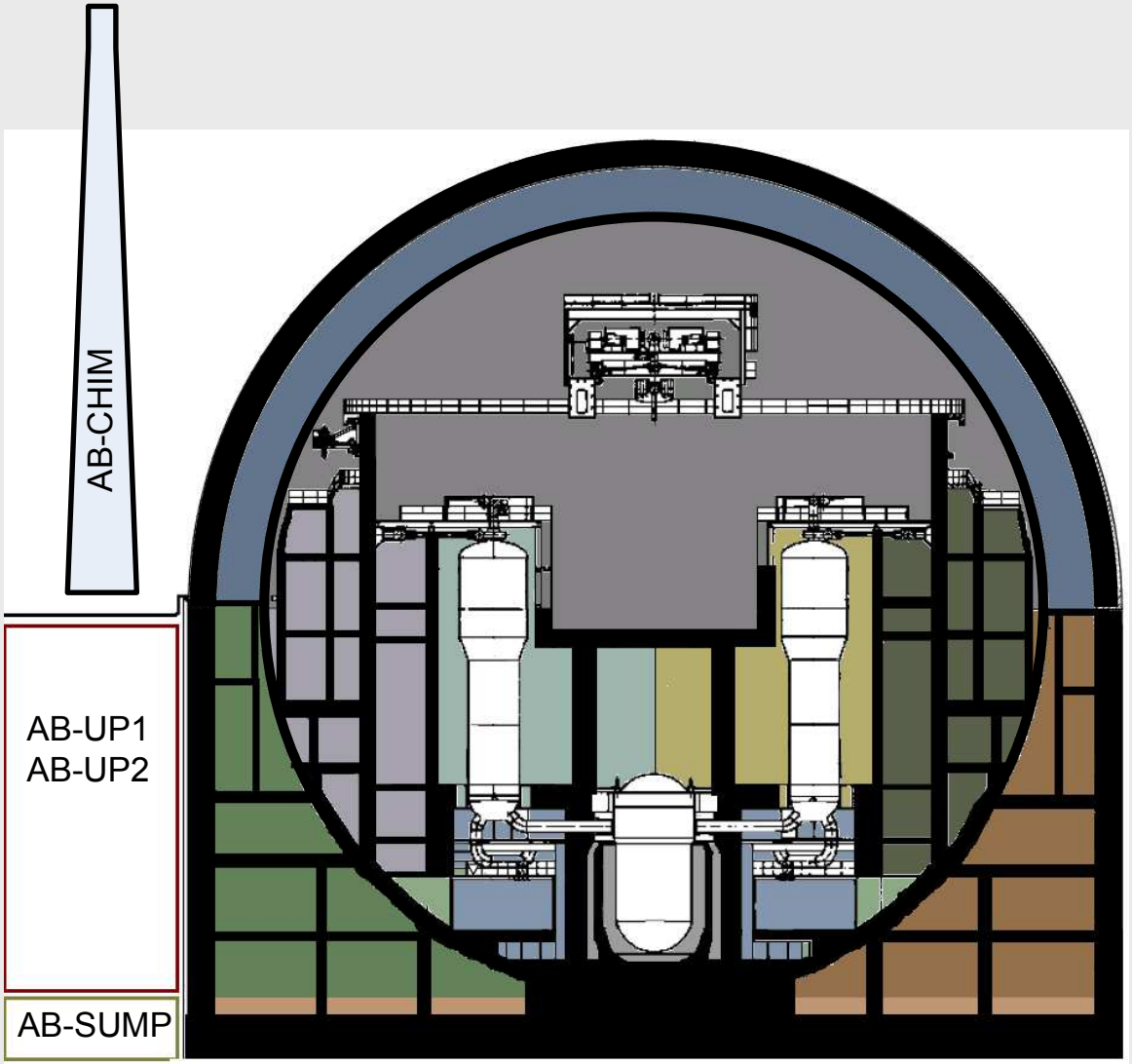
One of outcomes of the OECD/NEA ISP-47 (TOSQAN, MISTRA, THAI) activity was the recommendation to elaborate a 'Generic Containment' including all important components.

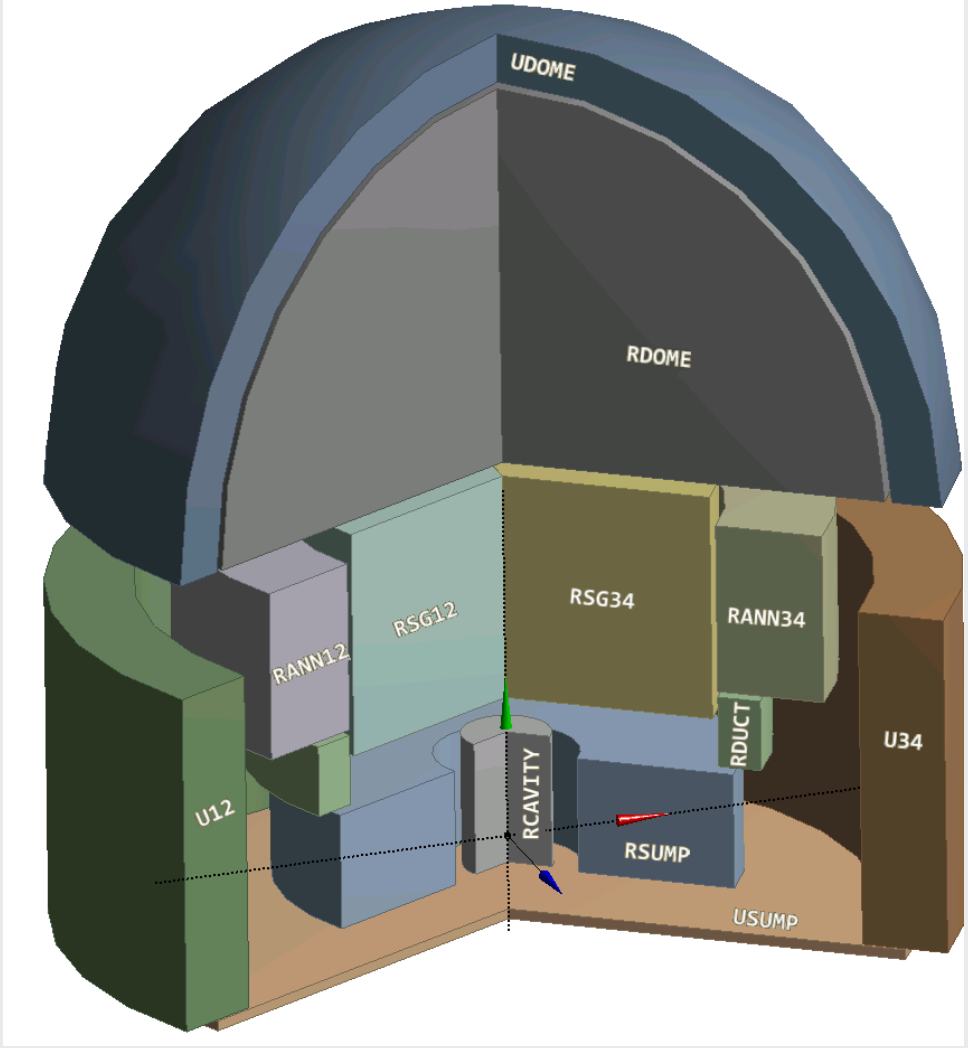
Within the SARNET2 Network of Excellence, such a Generic Containment nodalisation, based on a German PWR (1300 MWe), was developed.

Generic containment run1 – thermal-hydraulics with hydrogen distribution modelling, run2 – modelling of hydrogen risk mitigation systems,

Passive autocatalytic recombiners – AREVA/Siemens type modelled,

Generic containment





Generic containment - participants

Organisation		Code (Version)
1.	AREVA	GOTHIC (v7.2b) WAVCO(2009_1)
2.	ENEA	MELCOR (v1.8.6YV)
3.	GRS	ASTEC (v2.0) COCOSYS (v2.4dev)
4.	JSI	ASTEC (v2.0)
5.	IRSN	ASTEC (v2.0)
6.	JÜLICH	COCOSYS (v2.4)
7.	NRG	MELCOR (v1.8.6) SPECTRA (v3.6)
8.	NUBIKI	ASTEC (v2.0)
9.	RSE	MELCOR (v1.8.6YN) ECART (v.4W0Q)
10.	RUB	COCOSYS (v2.4)
11.	UJV	COCOSYS (v2.4) MELCOR (v1.8.6YV)
12.	UNIPI	MELCOR (v1.8.6) FUMO
13.	VTT	APROS (v5.09)
14.	VUJE	MELCOR (v2.1)

1	GRS_ASTEC
2	IRSN_ASTEC
3	JSI_ASTEC
4	NUBIKI_ASTEC
5	RSE_ASTEC
6	FZJ_COCOSYS
7	GRS_COCOSYS
8	RUB_COCOSYS
9	UJV_COCOSYS
10	AREVA_GOTHIC
11	AREVA_GOTHIC2
12	AREVA_WAVCO
13	NRG_SPECTRA
14	RSE_ECART
15	VTT_APROS
16	ENEA_MELCOR
17	NRG_MELCOR
18	RSE_MELCOR
19	UJV_MELCOR
20	VUJE_MELCOR

Generic containment – flow pattern

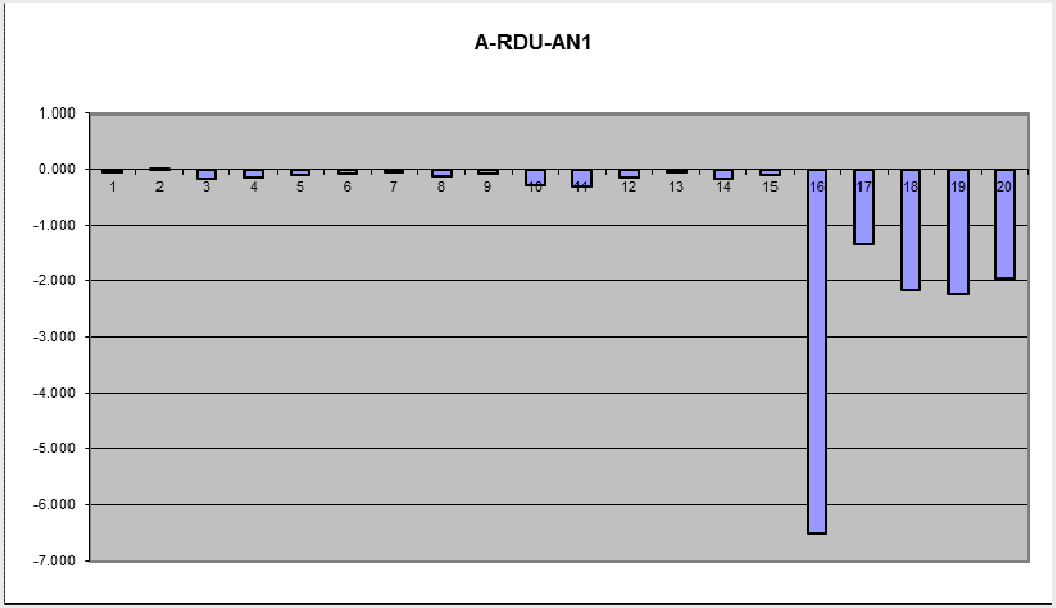
Compare qualitatively the atmosphere circulation (“flow pattern”) in the containment at specific times,

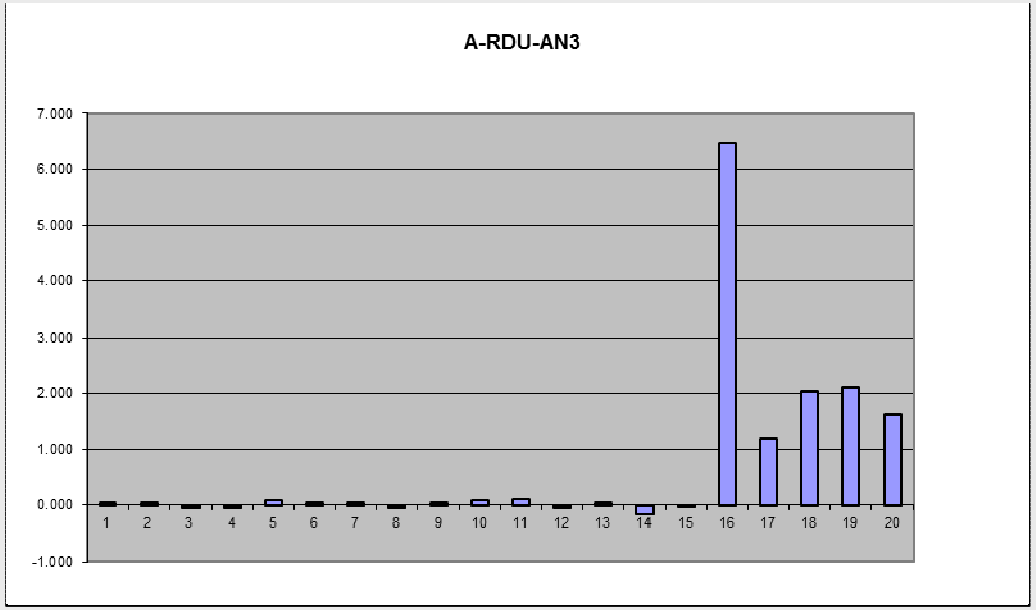
For Run1, flow pattern was compared by JSI (Slovenia) at:

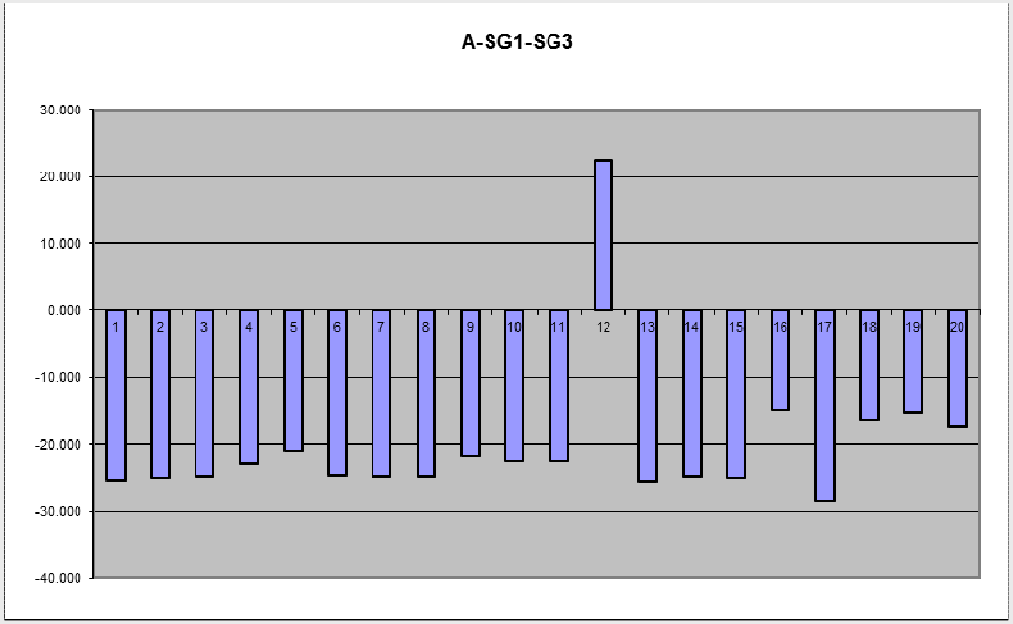
- before start of hydrogen injection (2 040 s),

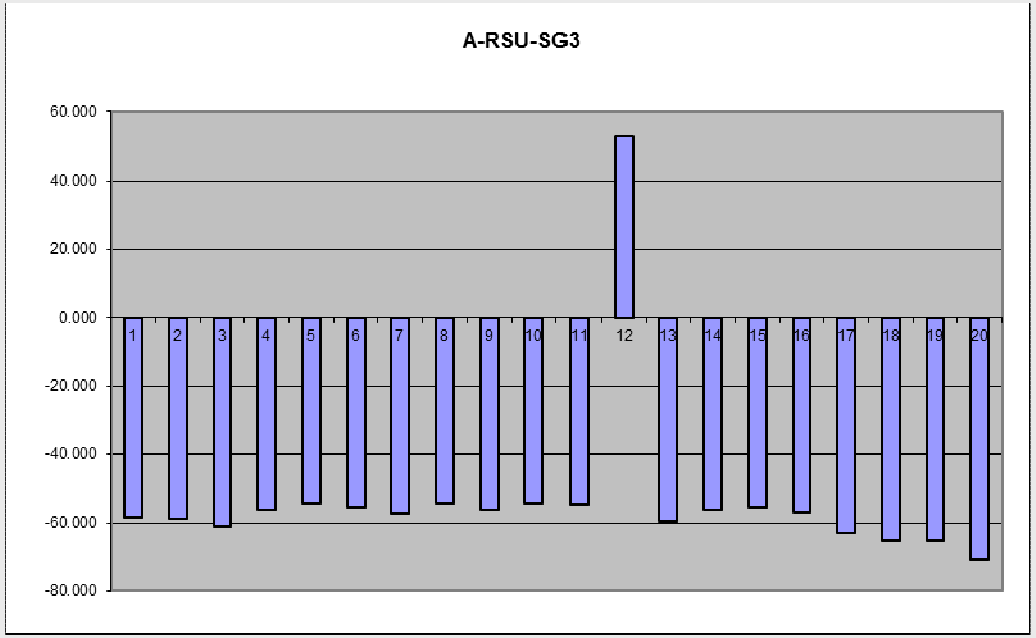
- after major part of hydrogen has been injected (12 290s).

Flow pattern – 12 290 s









PAR modelling

PAR volumetric flow, recombination rate.

$$Q = a\,C_H^b \qquad R_H = \eta\ \rho_H\ Q\ f(t)$$

f(t) = $\left[1 - e^{-\left[\frac{t-t_0}{\tau}\right]}\right]$

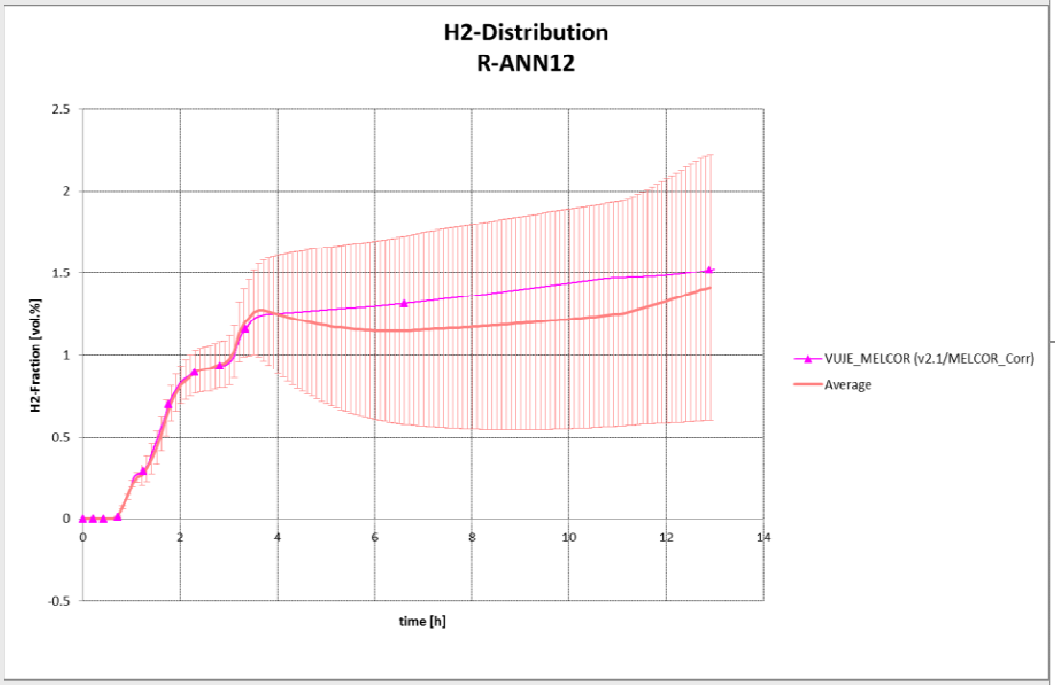
with following values of constants:

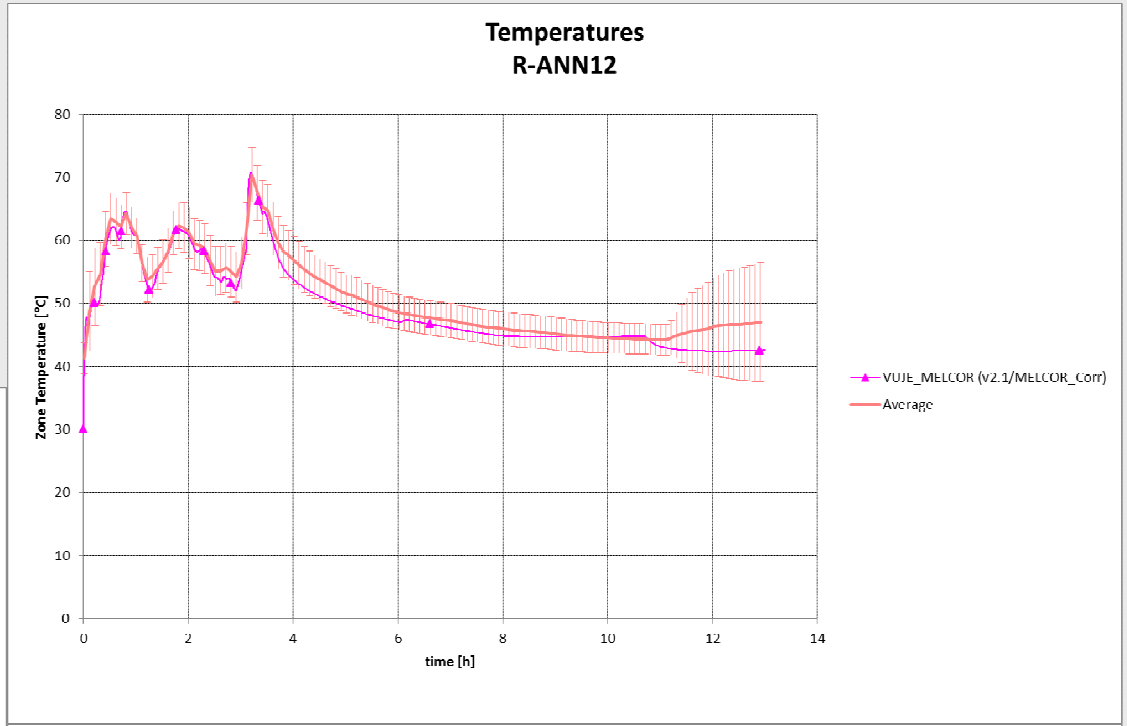
a = 0.170, b = 0, η = 1, τ = 15

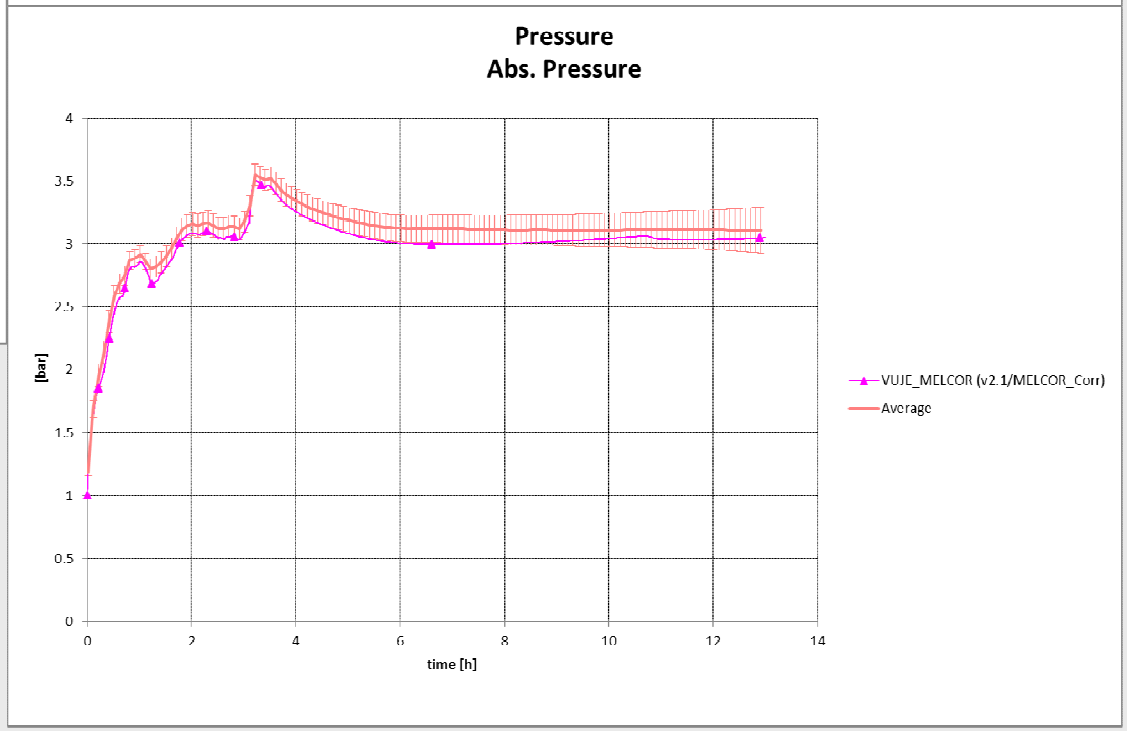
Depletion rate for FR90/1-750T PAR is 0.667 g/s at 4% hydrogen concentration and 150 kPa; recombination capacity = f(c(h2)) – linear,

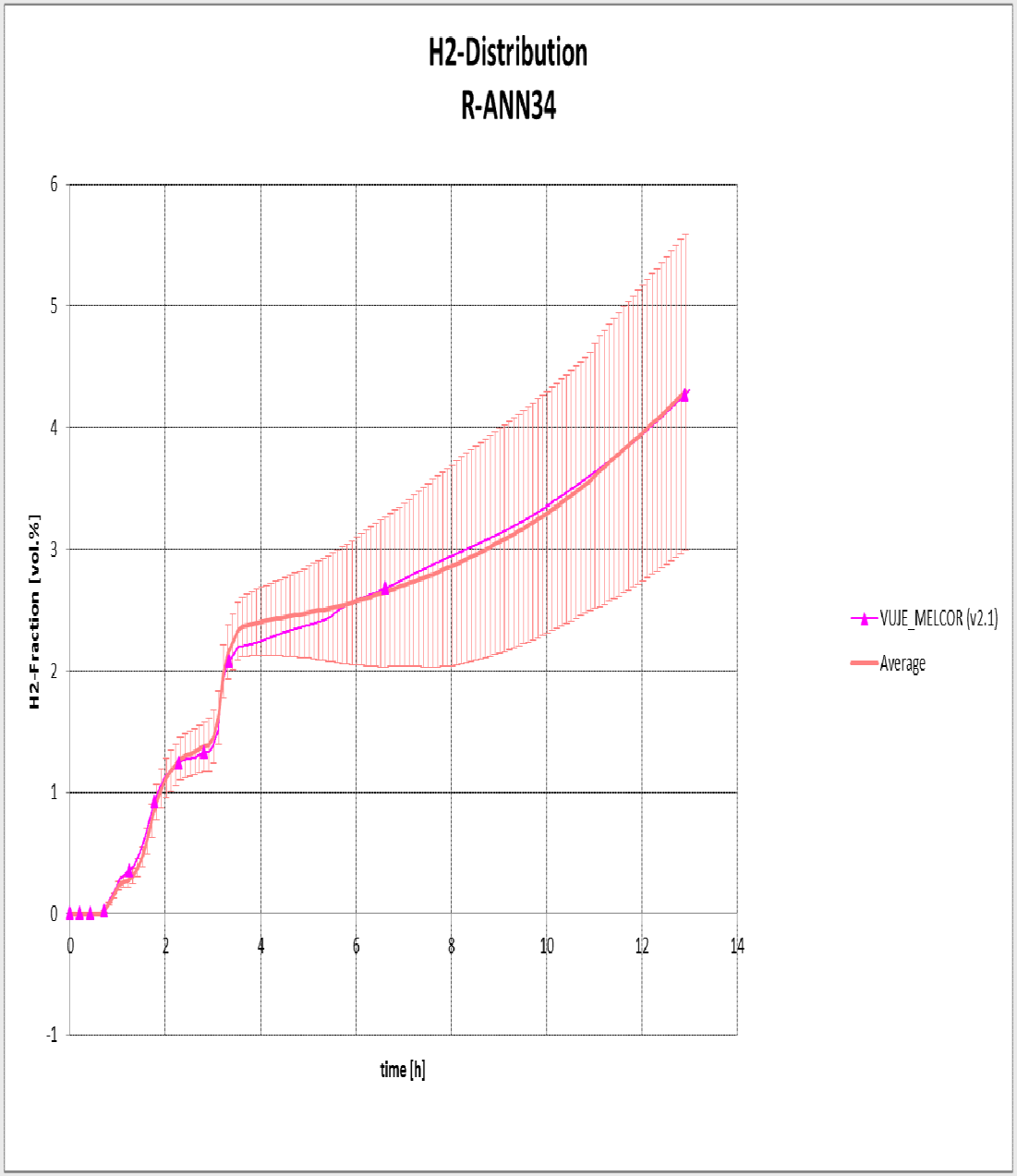
Depletion rate of used modelling of "FR90/1-750T PAR equivalent" is in the following table for pressure 150 kPa, temperature 100 degC, humidity 0.5.

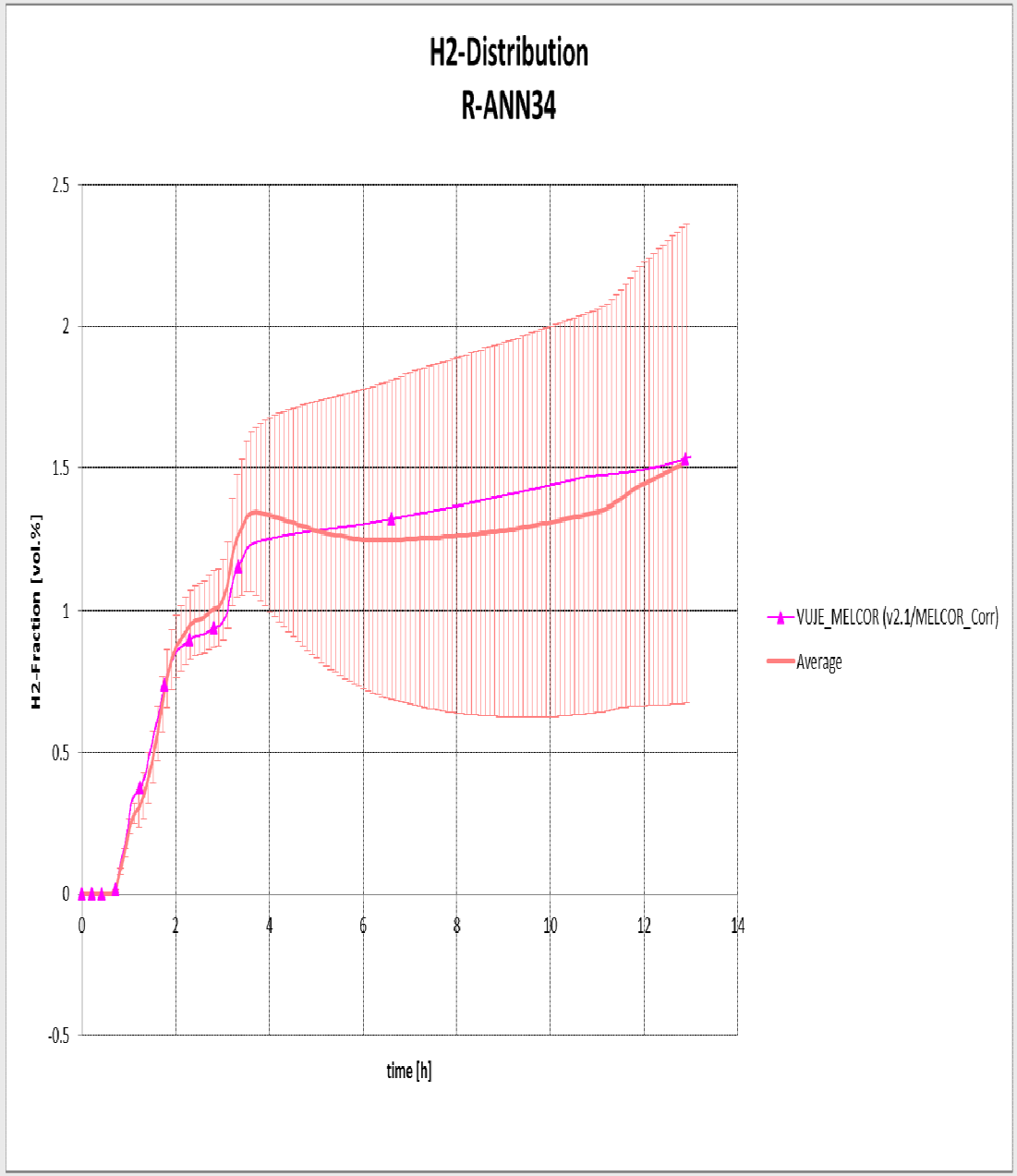
Hydrogen concentration (%)	Depletion rate (g/s)
0	0
2.01	0.334
4.02	0.668
6.03	0.1


H2-Distribution
R-ANN12
H2-Fraction [vol.%]
time [h]
VUJE_MELCOR (v2.1/MELCOR_Corr)
Average


Temperatures
R-ANN12
Zone Temperature [°C]
time [h]
VUJE_MELCOR (v2.1/MELCOR_Corr)
Average


Pressure
Abs. Pressure
[bar]
time [h]
VUJE_MELCOR (v2.1/MELCOR_Corr)
Average


H2-Distribution
R-ANN34
H2-Fraction [vol.%]
time [h]
VUJE_MELCOR (v2.1)
Average


H2-Distribution
R-ANN34
H2-Fraction [vol.%]
time [h]
VUJE_MELCOR (v2.1/MELCOR_Corr)
Average

Conclusions on Generic containment

Higher flow into „blind“ volumes for MELCOR, when compared to other codes.

PAR model tweaked to follow AREVA correlation.

Participants preferred MELCOR 1.8.X

MELCOR experience

Spray recirculation – mass flow through sprays needed to correctly model recirculation,

CVH_INPUT, FL_INPUT, CVH_INPUT...

FL_VLV – all valves packed together; better to have a valve with the flow path,

If no MP_INPUT – crash without any message,

Core definition better in 2.1 for cells with the same content...