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Severe Accident Volatile Iodine Release from Containment vs. Sump Alkalinity

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- Testing of Iodine Pool Model (IPM): Phebus-FP FPT1 TEST
- Full circuit model for VVER-440/213
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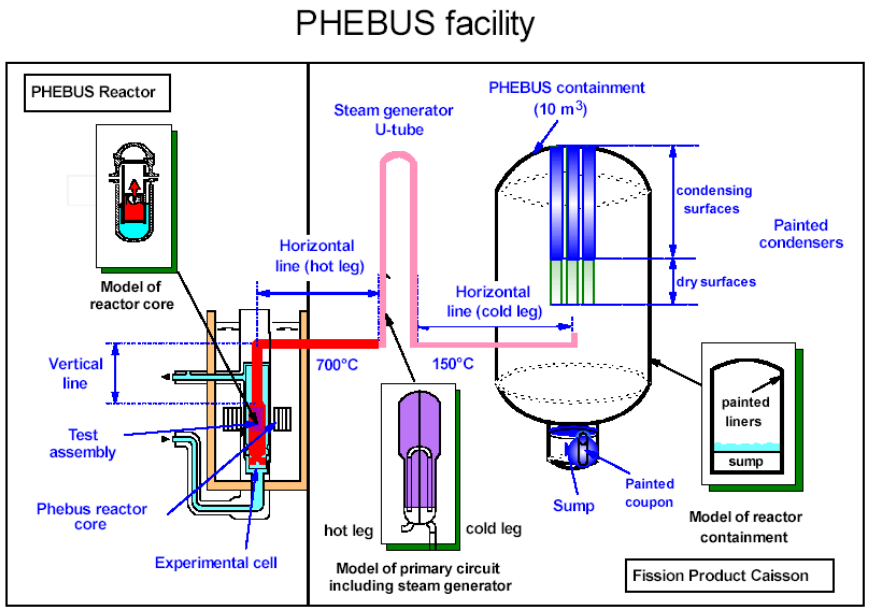
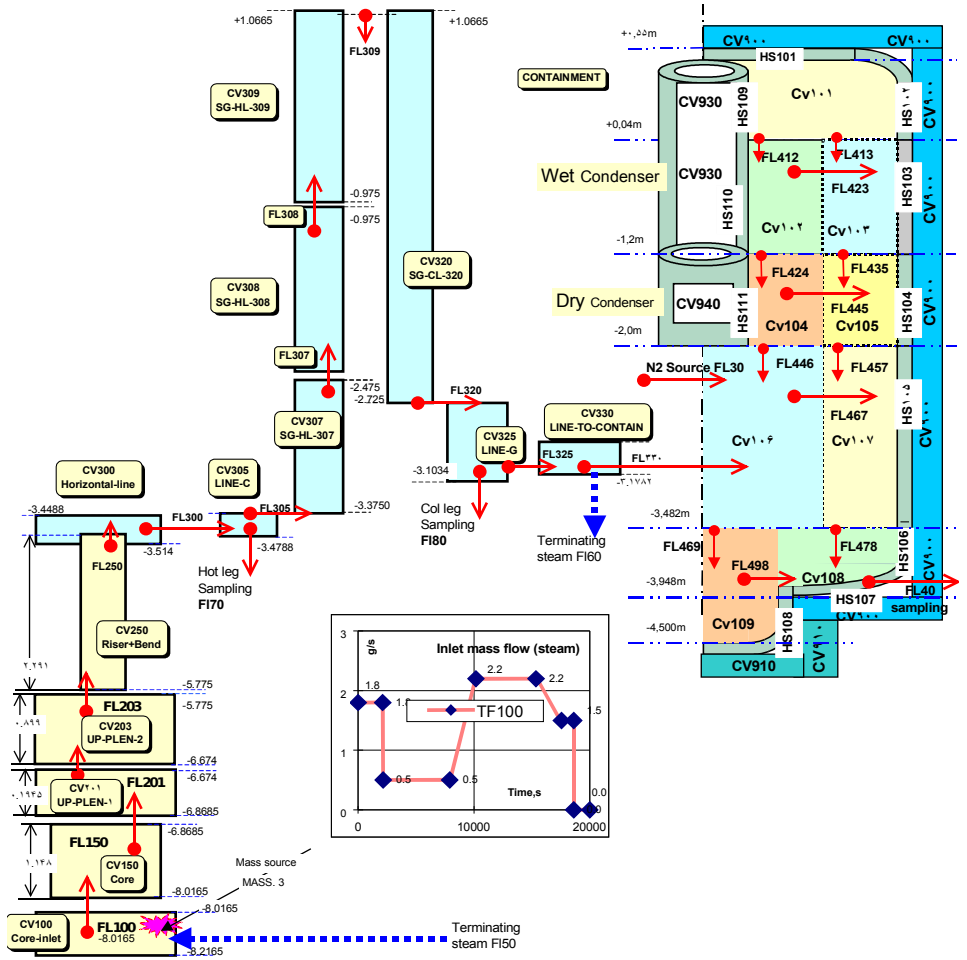
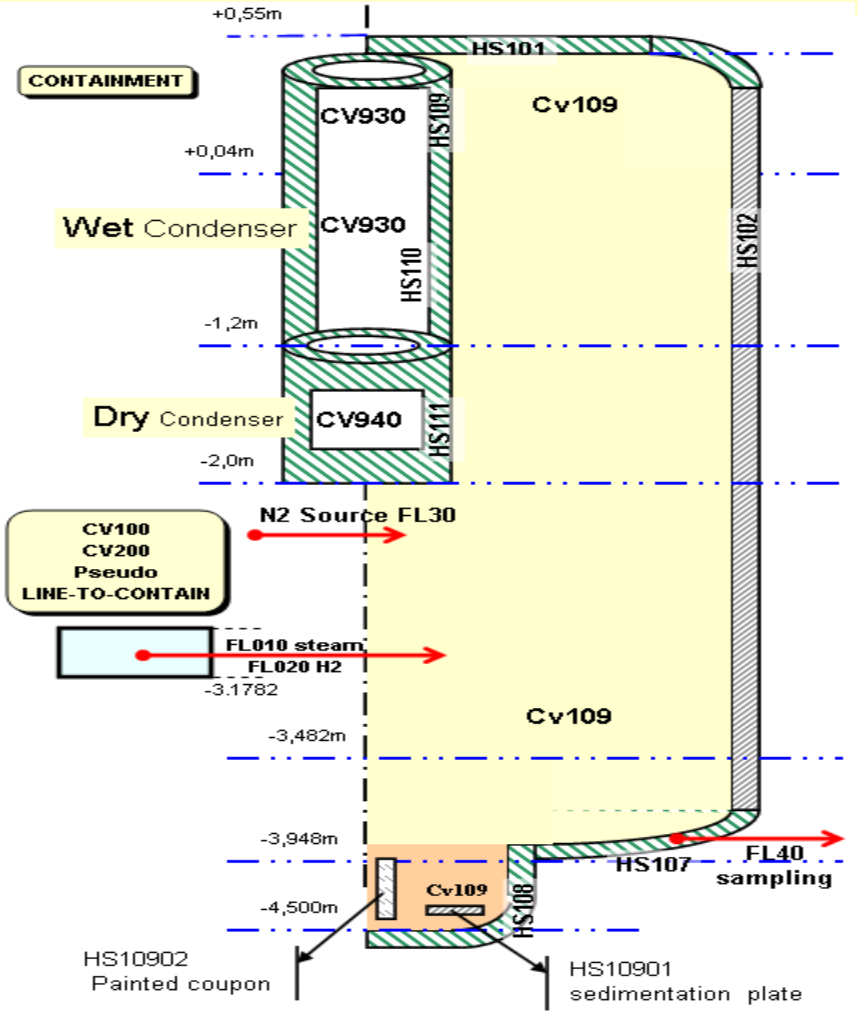
- Stand alone VVER-440/213 containment model
- Stand alone containment model calculations
- Evaluation of VVER-440/213 cases
- Problems in MELCOR 1.8.6

Verification of IPM by: Phebus-FP FPT1 TEST
Full circuit model

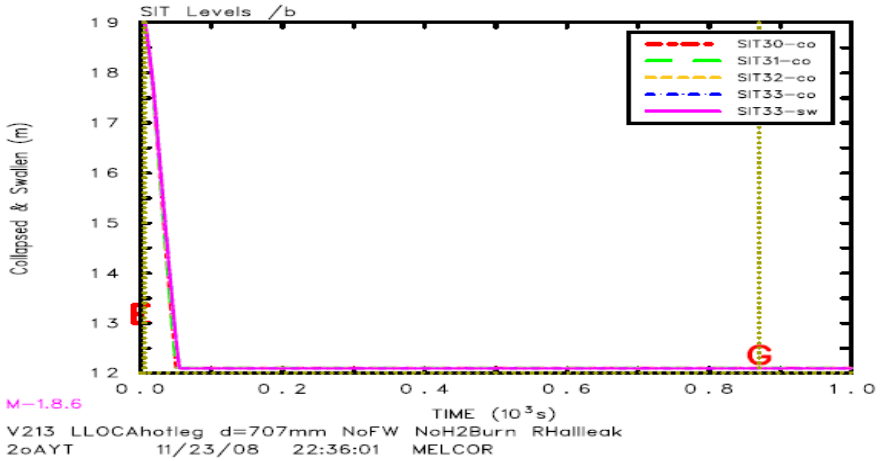


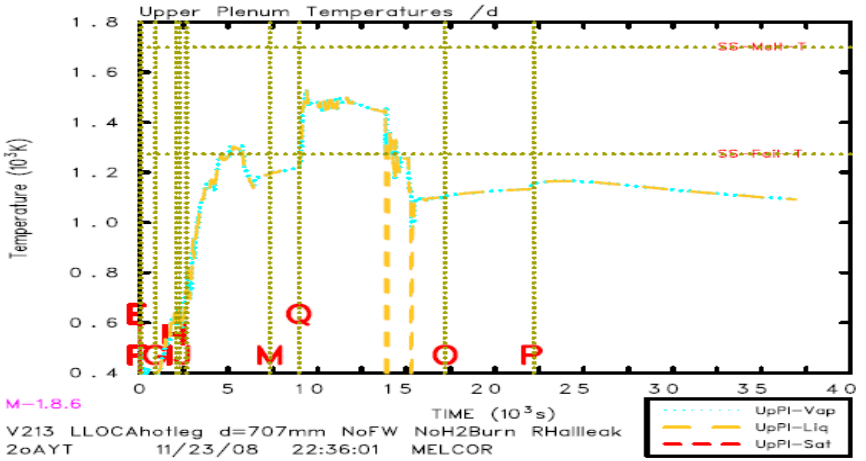


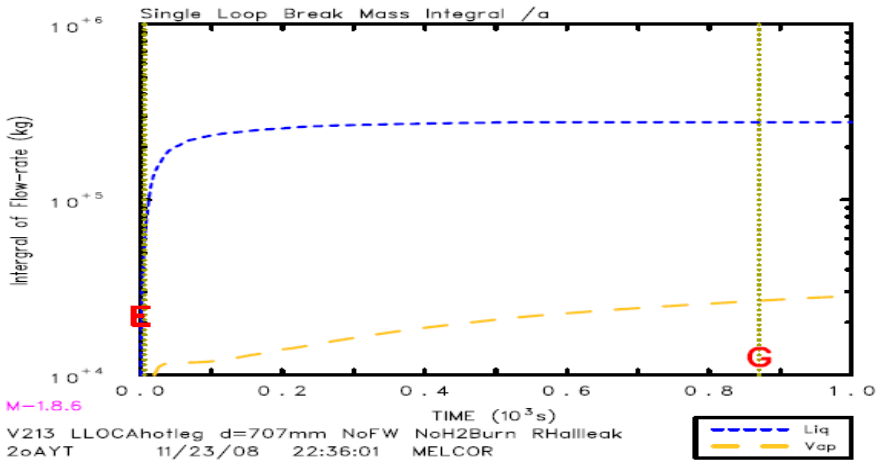
Verification of IPM by: Phebus-FP FPT1 TEST Stand alone containment model

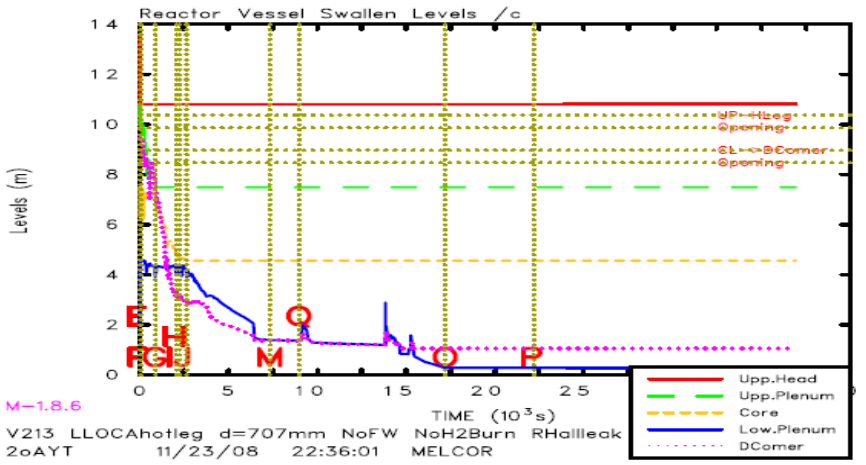


VVER-440/213 Full Circuit model: Hotleg LLOCA.
Results used as input to Stand alone containment model

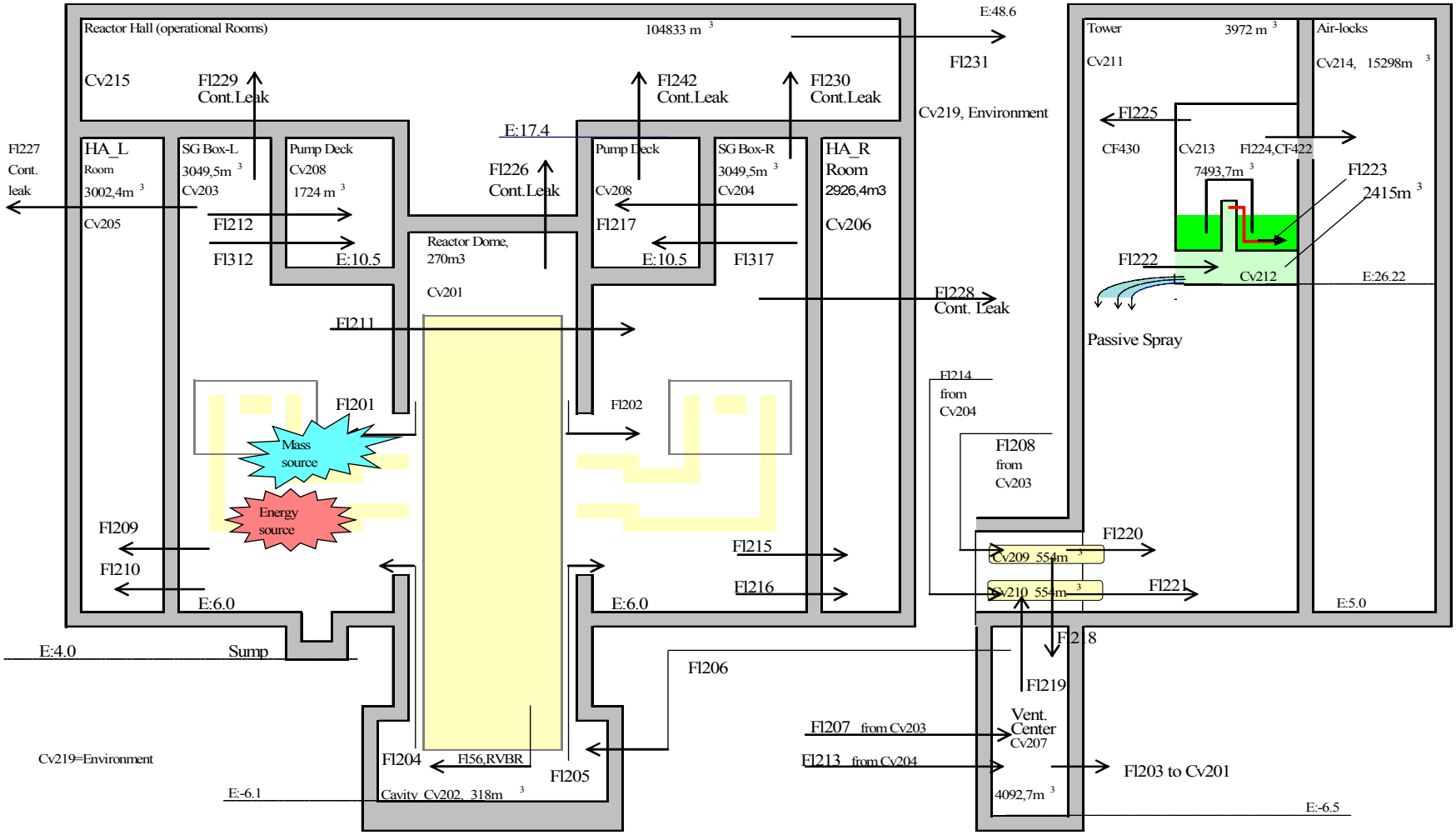








VVER-440 Stand Alone Containment model: Sources: Heat and mass + Aerosols with decay heat



Conditions for VVER-440/213 Stand Alone Containment calculations

	No Alkalizing	Moderate Alkalizing			Assumed max. Alkalizing
Code of Calculation	3oSb	3oSf	3oSg	3oSh	3oSi
Initial pH	6.025	6.225	6.35	6.6	6.9
Potassium K, kg	0	11.8	23.5	58.8	146.2
Equivalent Cs, kg	0	40	80	200	496.9

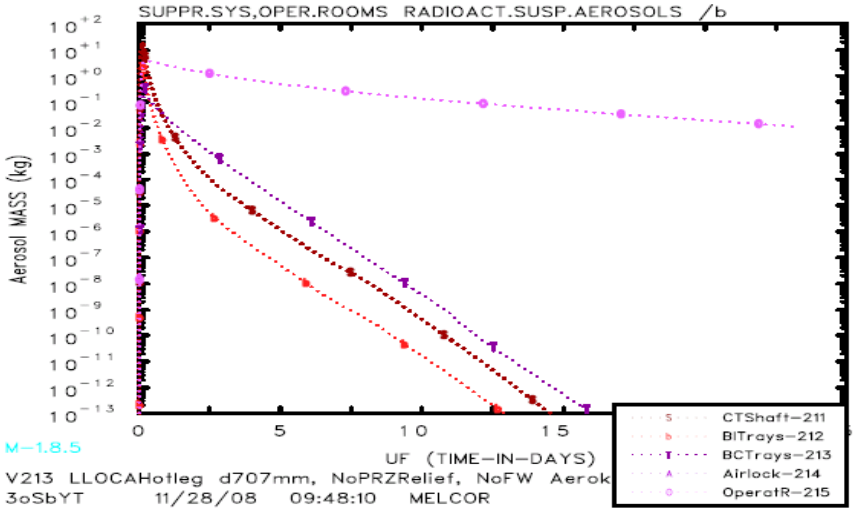
Sources in case of maximal KOH Alkalizing

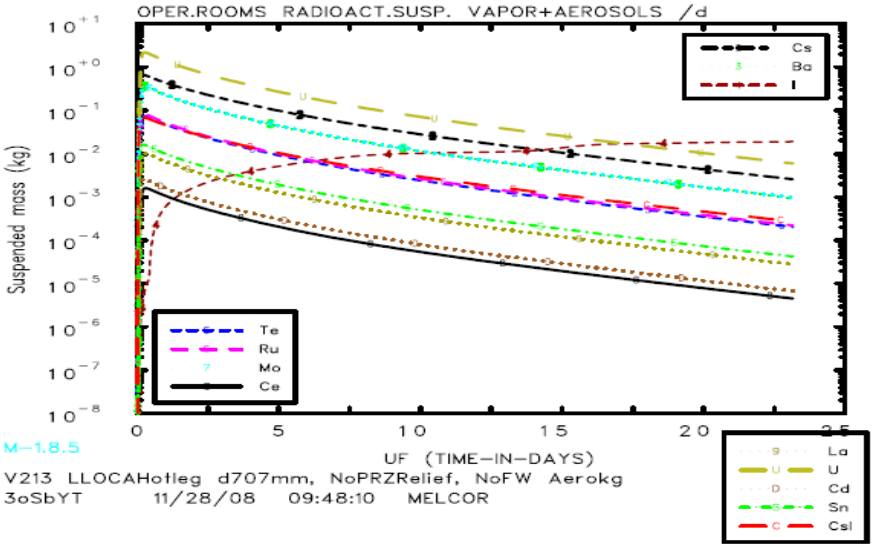
- Water from Suppression Pool Trays (Bubbler condenser) 12g H3BO3/kg, KOH=100.0 mg/kg (acc. to SIT tanks)
- Primary circuit H3BO3 added to this source (7 gH3BO3/kg and 10mgK/kg)
- Water from SIT tanks (12g H3BO3/kg, KOH=100.0 mg/kg)

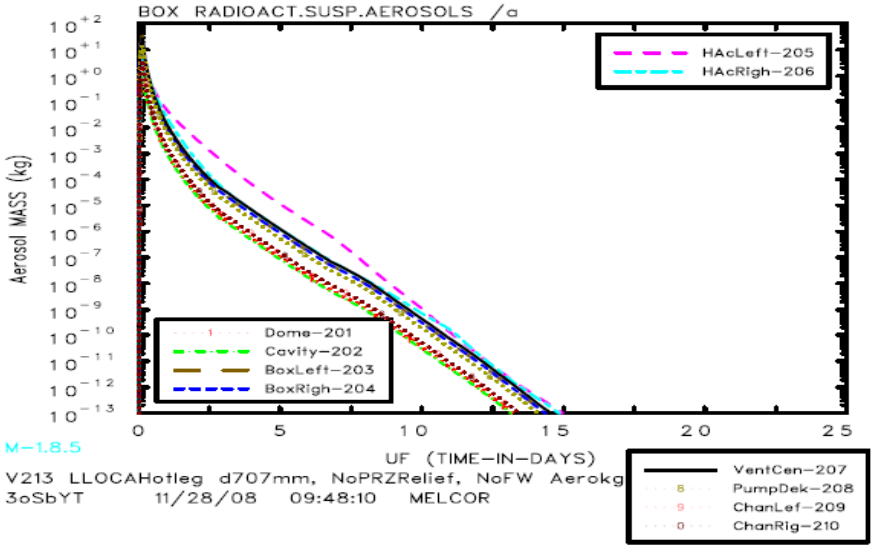
Other Conditions:

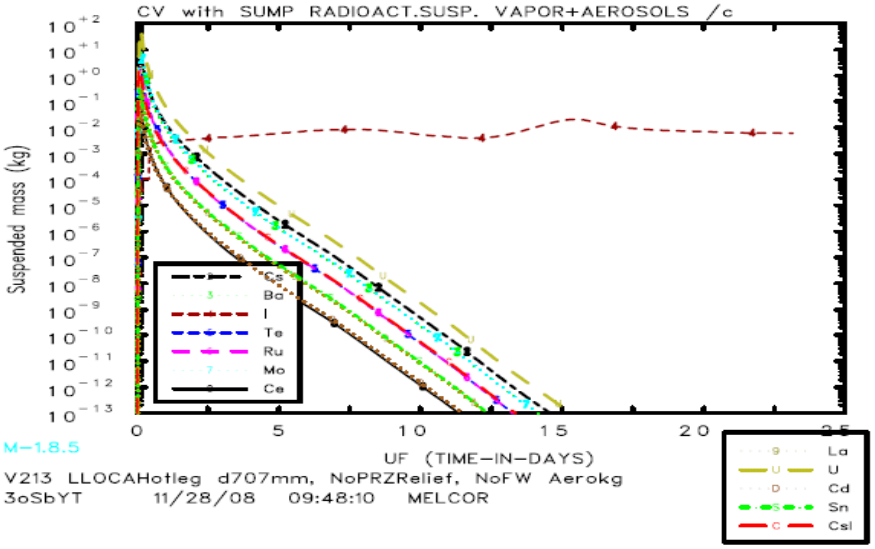
- Not all the water gets discharged from the primary circuit and from the Bubbler Condenser.
- Vessel failure was not considered in Stand Alone Containment Model
- Alkalising effect of Fission product Cs has been calculated by the MELCOR itself.

Containment and Operating rooms: Radioactive aerosols and vapors – Hotleg LLOCA – Stand Alone Containment – No Alkalizing

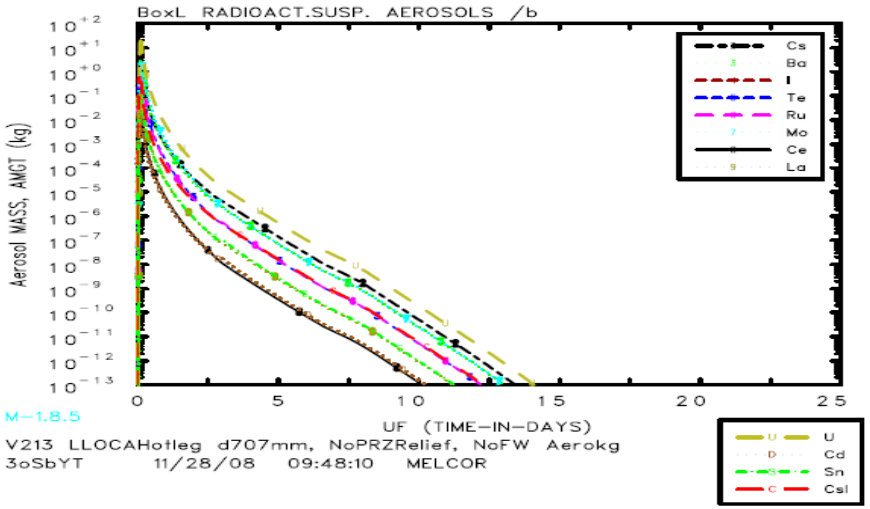


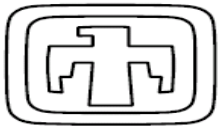






Containment and Environment: Radioactive aerosols and vapors – Hotleg LLOCA – Stand Alone Containment – No Alkalizing





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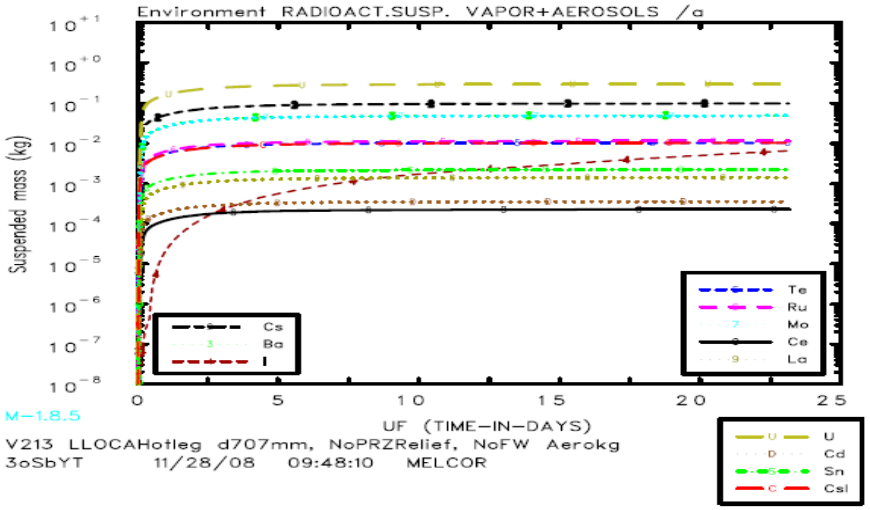
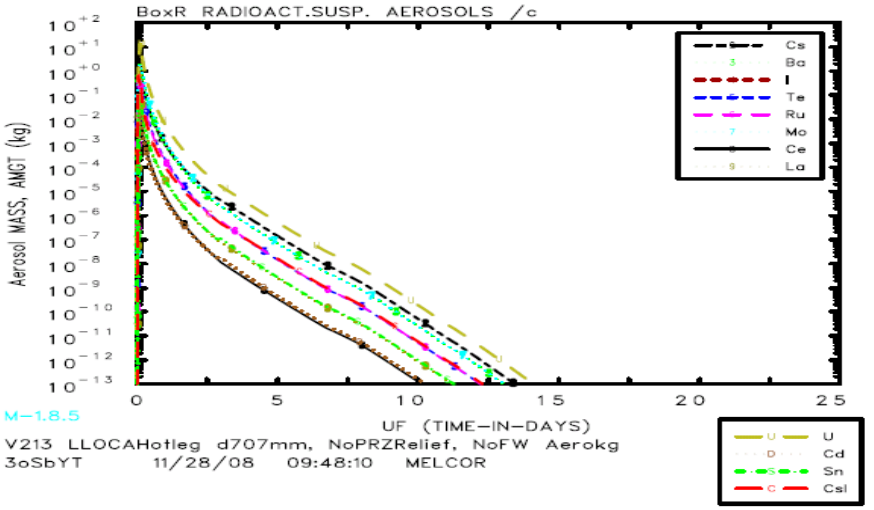




Stand Alone Containment – Hotleg LLOCA – No Alkalizing
Summary

Containment *after 15-25 days*

Suspended aerosols decrease to zero

Airborne Volatile Iodine stays constant

Operating rooms (OpR)

Suspended aerosols decrease 1000 times after 23 days

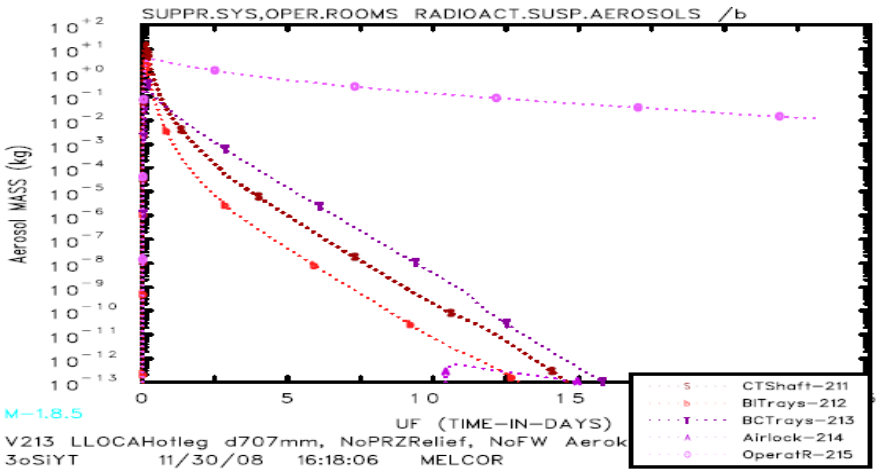
Airborne Volatile Iodine increases. After 5-6 days exceeds that of the airborne aerosol iodine (CsI)

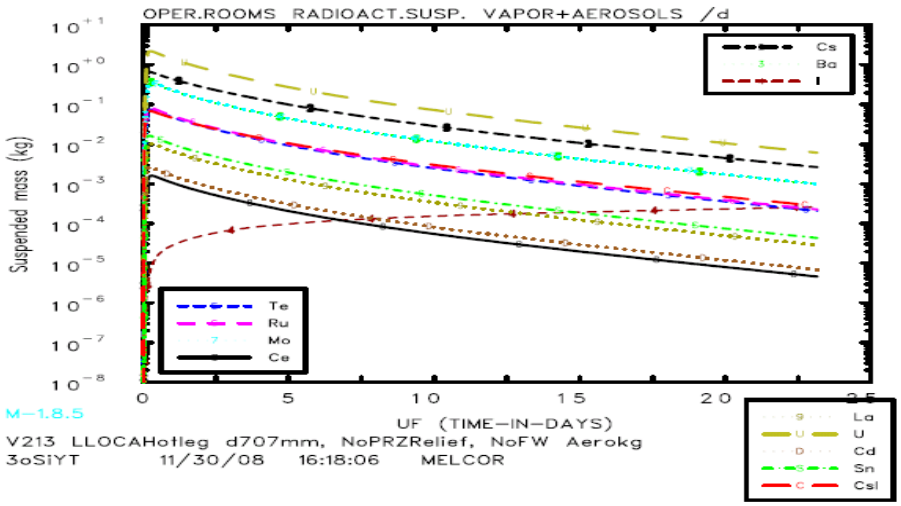
Environment *after 15-25 days*

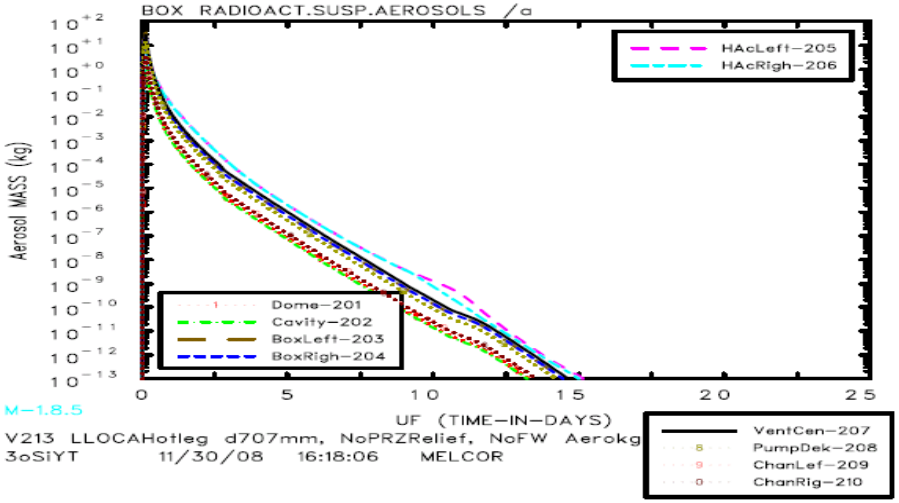
Aerosol Iodine release ceases after 2-3 days

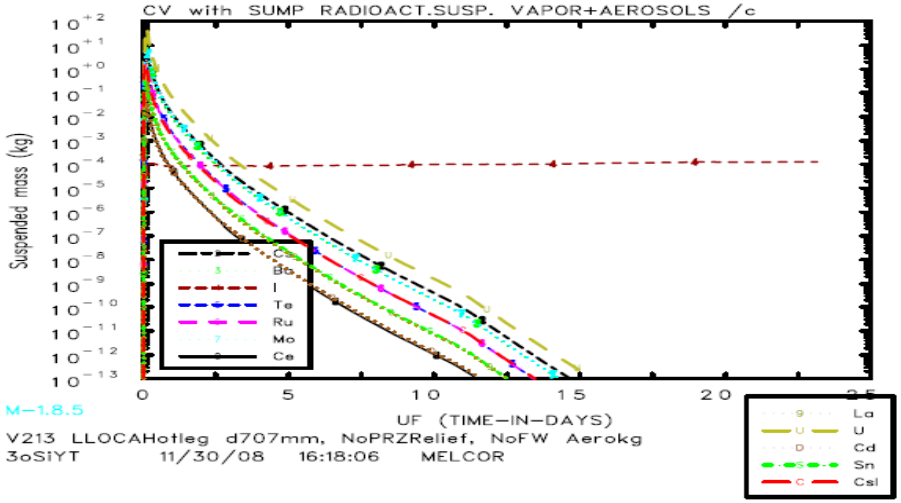
Volatile Iodine release is continuous.
After 23 days reaches the level released during the 1st 2-3 days by aerosol Iodine (CsI).

Containment and Operating rooms: Radioactive aerosols and vapors – Hotleg LLOCA – Stand Alone Containment – Max. Alkalizing

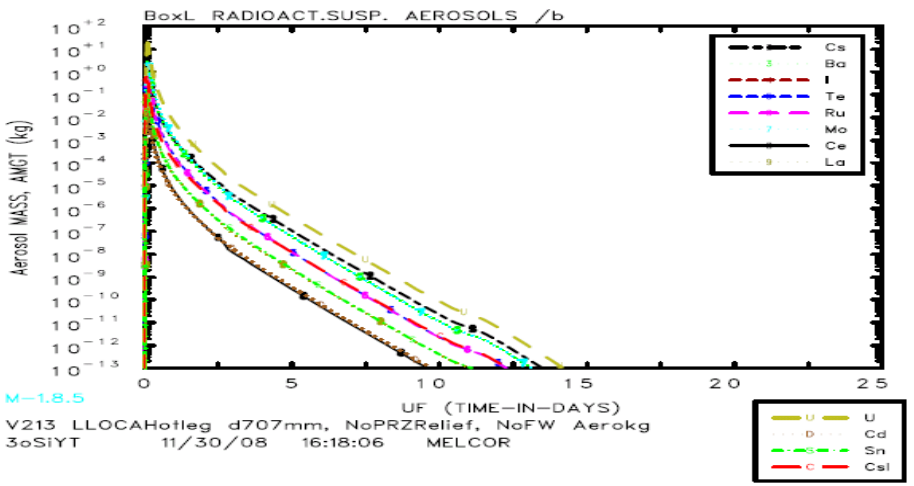


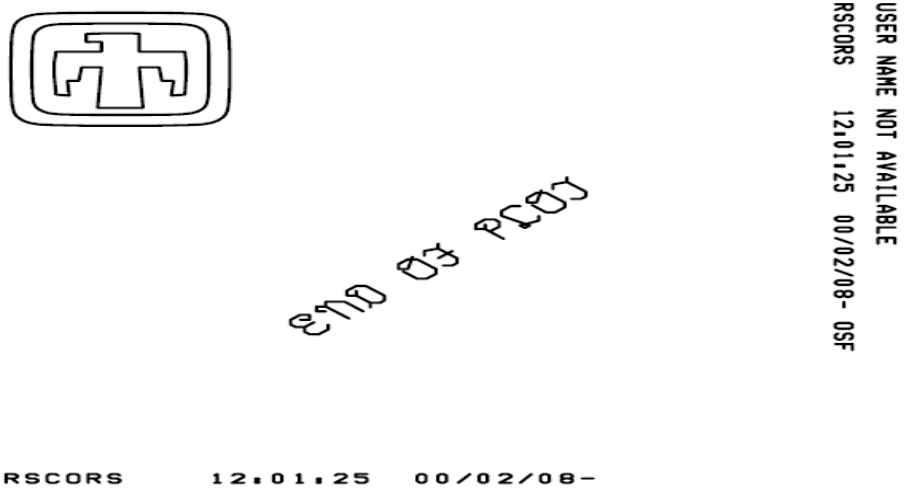


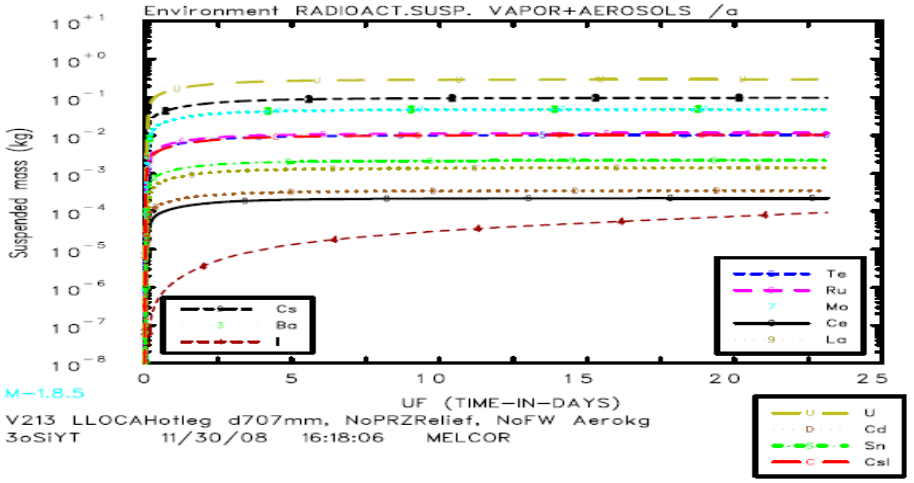




Containment and Environment: Radioactive aerosols and vapors – Hotleg LLOCA – Stand Alone Containment – Max. Alkalizing







Stand Alone Containment – Hotleg LLOCA – Max. Alkalizing
Summary

Containment *after 15-25 days*

Suspended aerosols decrease to zero

Airborne Volatile Iodine stays constant but 10-100 times smaller

Operating rooms (OpR)

Suspended aerosols decrease 1000 times after 23 days

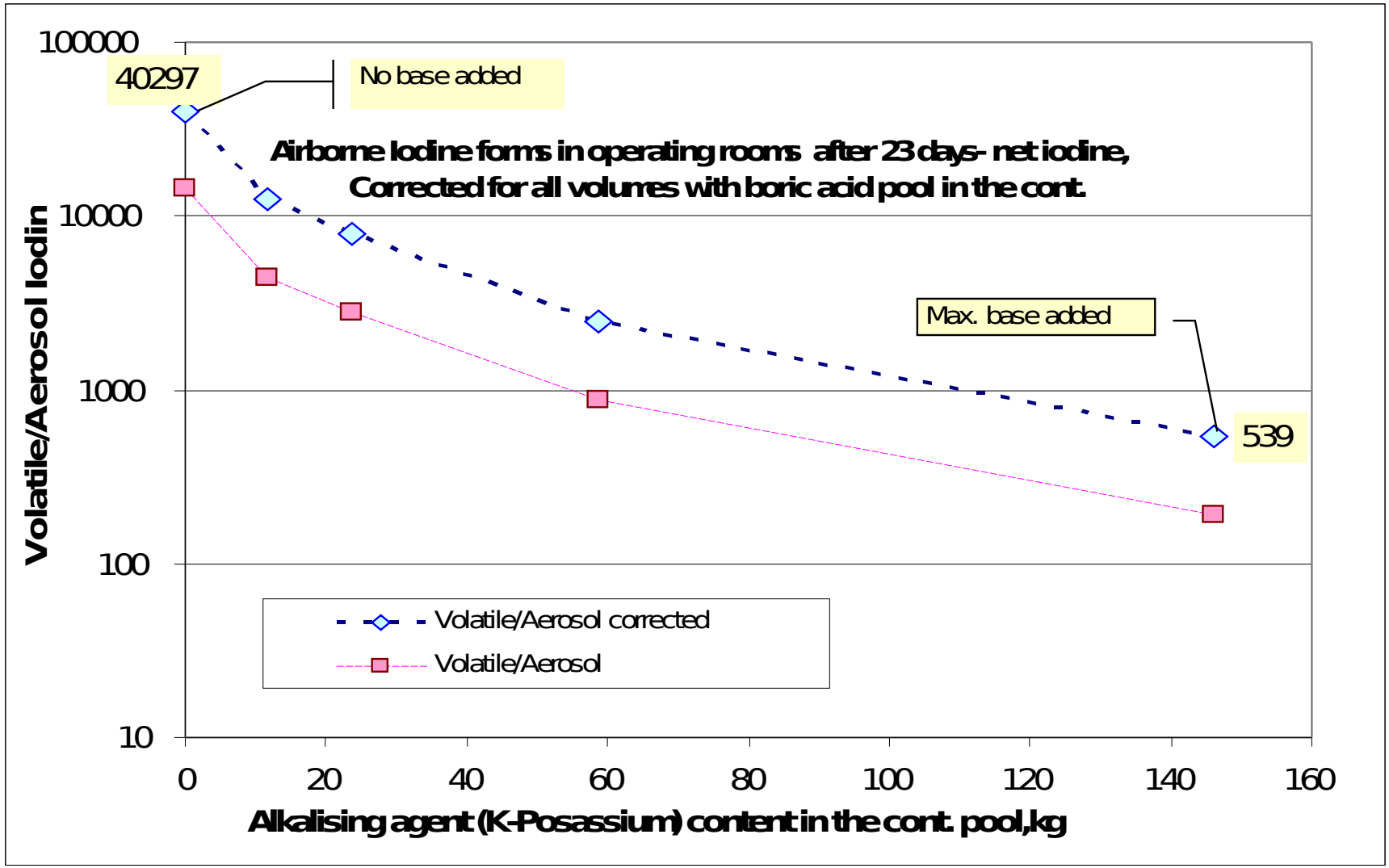
Airborne Volatile Iodine increases. But instead of After 5-6 days it exceeds that of the airborne aerosol iodine (CsI) only after 20-22 days

Environment *after 15-25 days*

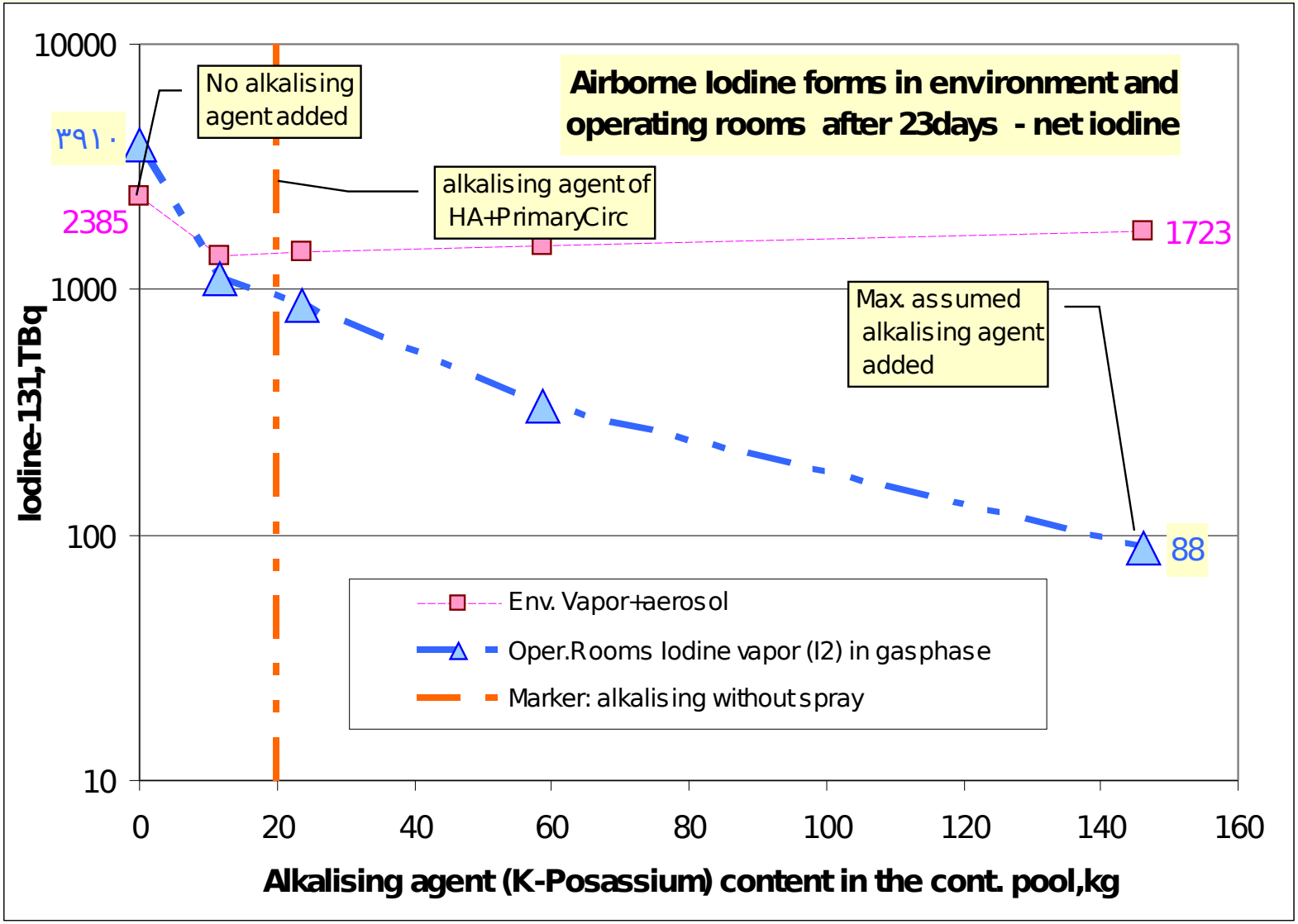
Aerosol Iodine release ceases after 2-3 days

Volatile Iodine release is continuous.
After 23 days it reaches only 1/100th of the level released during the 1st 2-3 days by aerosol Iodine (CsI).

Release characteristics vs. alkalizing in percent: OPERATING ROOMS



Release characteristics vs. Alkalizing as I-131 activity:
ENVIRONMENT AND OPERATING ROOMS



Summary

KOH content in the pressure suppression trays should be with pH-9-9.5 as prescribed

MELCOR 1.8.6 calculated I-131 TBq (Large break LOCA - hot leg)	*No KOH*	*Max. KOH*
CsI deposited in operating rooms	*7389*	*12202*
CsI released to environment	*1040*	*1692*
Volatile I released to environment	*1345*	*32*
Volatile I suspended in operating rooms	*3910*	*88*

Volatile iodine does not pose a problem with proper alkalizing compared to aerosol iodine.

Problems, Shortcomings in MELCOR 1.8.6 IPM application

a) Effect of hydrazine N2H4 is included

b) Only 2 CVs with IPM could be calculated at the same time (more volumes may have unbuffered water pools and films due to condensation generating volatile I)

c) No methyl iodine was generated as all the surfaces were wet

d) Mass balance of iodine was with a large error

e) Effect of acid generation from different sources can be evaluated only with sensitivity studies

f) MELCOR 1.8.5 and 1.8.6 gives results for CH3I. However the UG says that equations are not included

g) Some chapters of UG are with typing errors

h) Some output variables are not explained

i) It is not clear if RN classes are hard wired or have to be defined by the user