

Finnish Recovery Boiler Committee

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Content

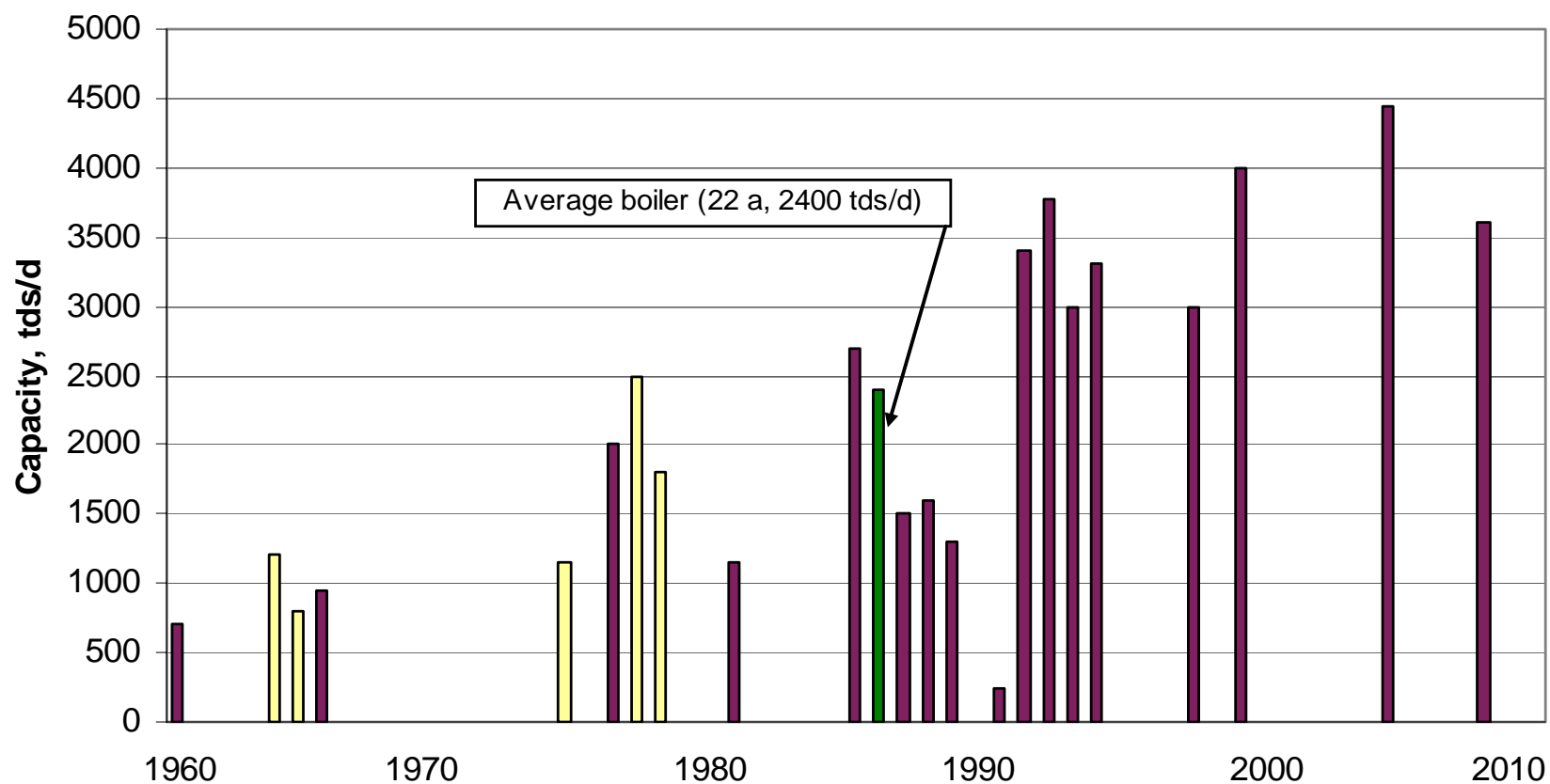
- Overview to finnish recovery boilers
- Incidents in Finland 2009
- Research
 - Tanja Pentinsaari, Master's thesis, Lappeenranta University of Technology: Phenomena of transformation in recovery boiler char bed

Overview to finnish recovery boilers

Finnish recovery boilers

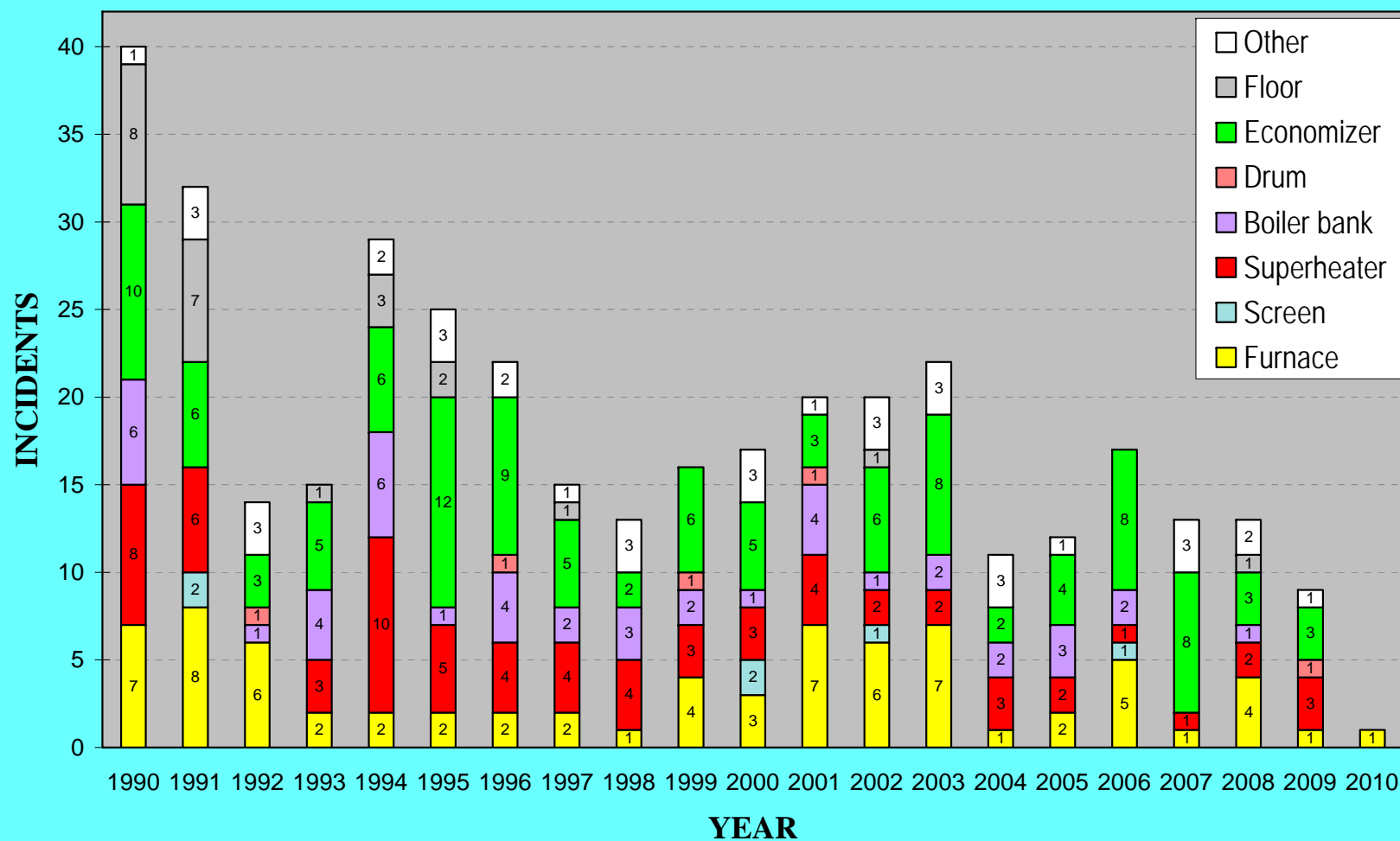
- 5 recovery boilers has been shut down during 2008-2009
 - 3 pulp mills were closed down
 - 1 new boiler was built replacing 2 old boilers from the 1960s and 1970s
- By the end of year 2010 one pulp mill will be shut down unless uncoated fine paper demand supply balance and pricing clearly recover

Finnish recovery boilers

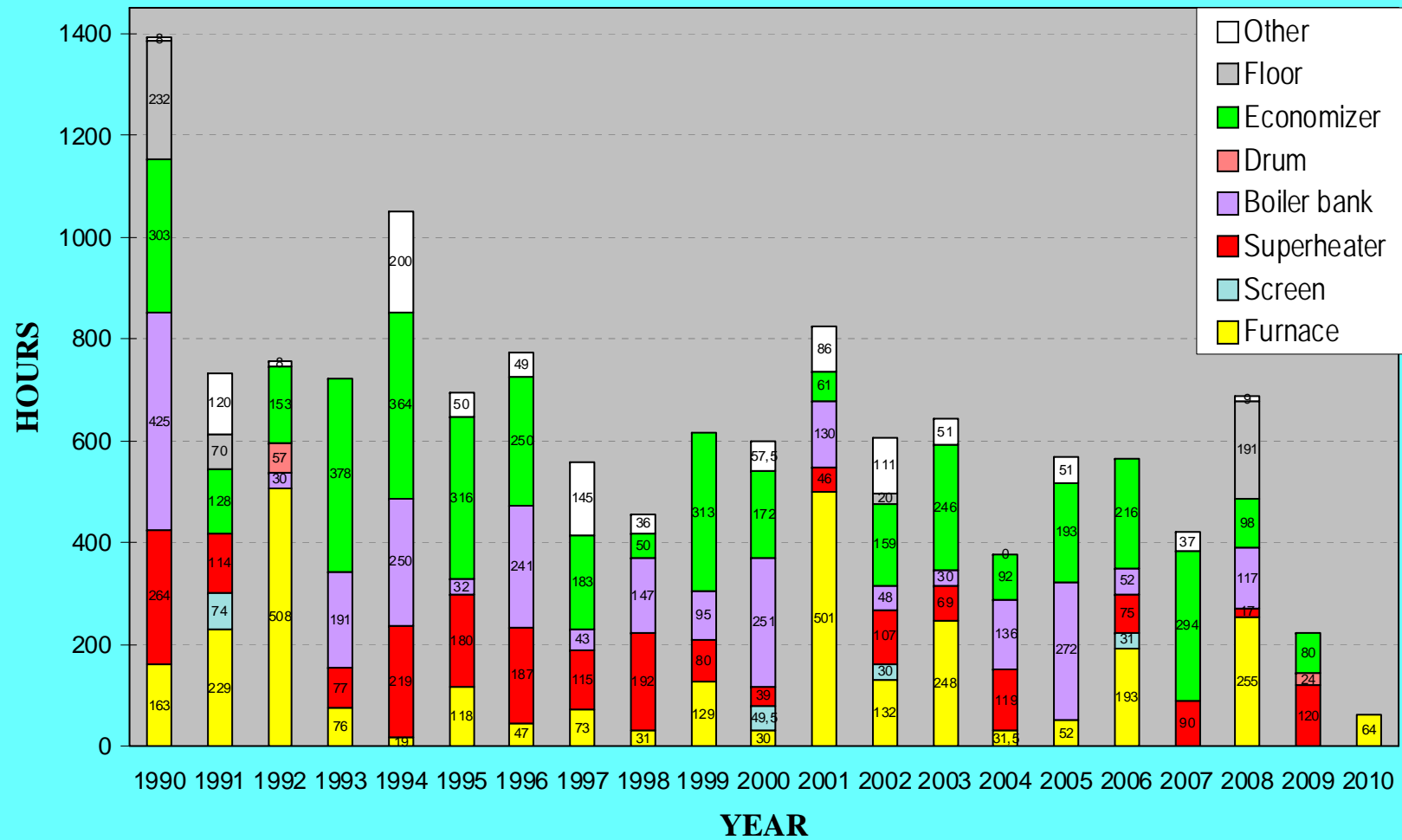


Incidents in Finland 2009

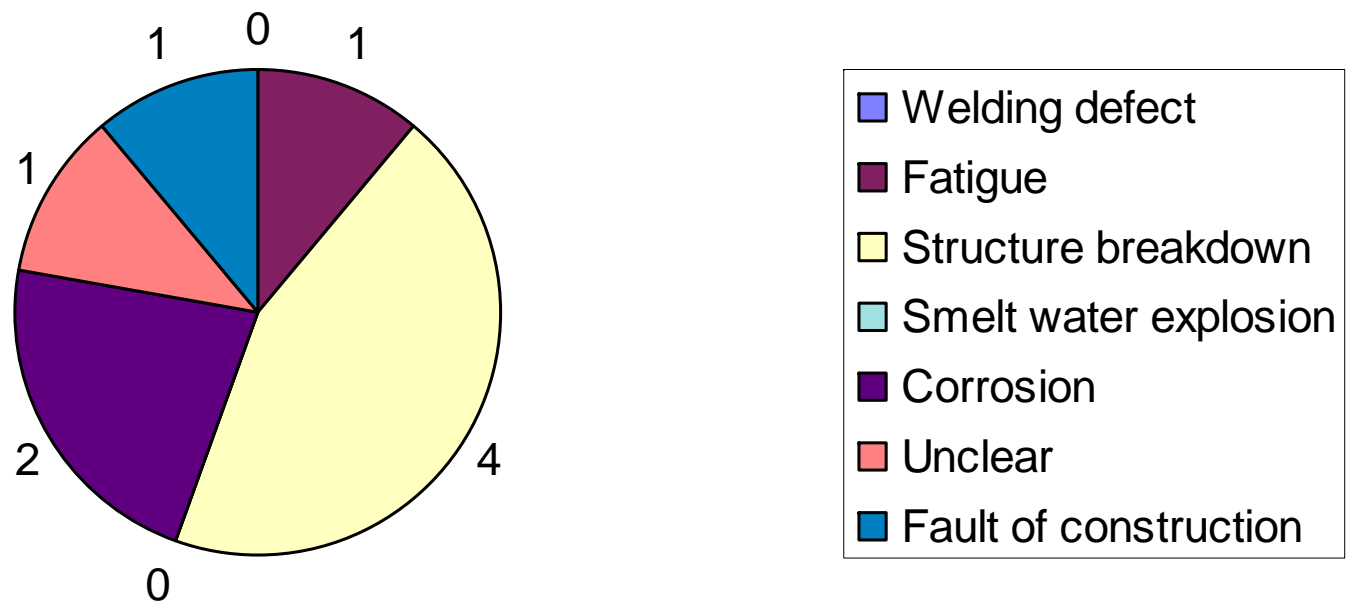
NUMBER OF INCIDENTS BETWEEN 1990-2010



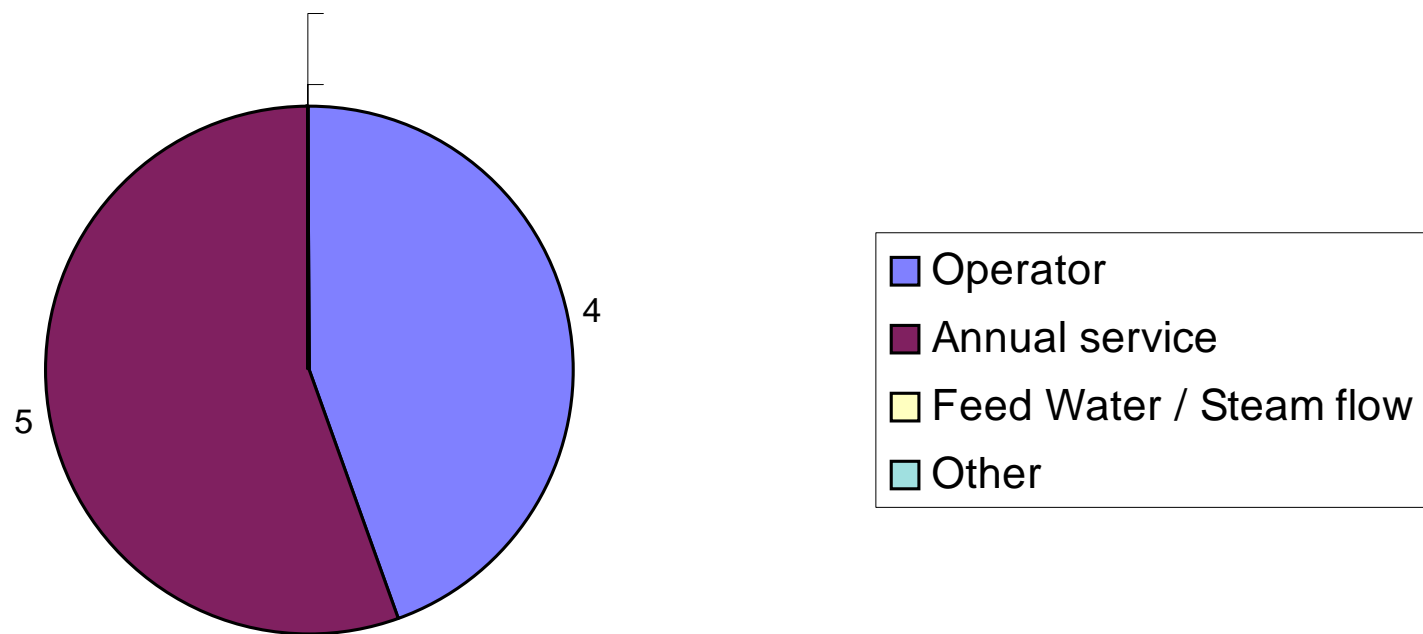
DOWN TIME HOURS 1990-2010



Incident reasons 2009



Incident detection 2009



Research

Cooling of the char bed 1/6

- The overall shape and composition of char bed is well defined
- The char bed consist of active layer on top and beneath it a passive unreacting bed. Close to the bottom is the solid smelt layer.
- Both passive and active parts of the char bed are relatively porous and light.
- The heat capacity per volume is much less than e.g. rocks.
- Thermal conductivity of char bed is close to insulating materials.
- The heat stored in the char bed is about 4200MJ/m² and the heat stored in smelt is 340MJ/m².

Table 1, Thermal properties of char bed, Adams and Frederick, 1988.

Material	Density	Heat capacity	Heat conductivity	Diffusivity
	kg/m ³	J/kg°C	W/m°C	10 ⁹ m ² /s
Passive bed	400-1330	1254	0.078	50-75
Active bed	290-460	1254	0.28-0.38	500-1000
Smelt, liquid	1923	1338	0.450	181
Smelt, solid	2163	1421	0.882	284

Cooling of the char bed 2/6

- Water washing of secondary superheater after 17 ½ h stopping of the liquor firing
- Salt cakes fell down and cracked the surface of the frozen smelt bed
- Smelt-water reaction
- Weak corner opened 100mm
- Down time 144 hours



Cooling of the char bed 3/6

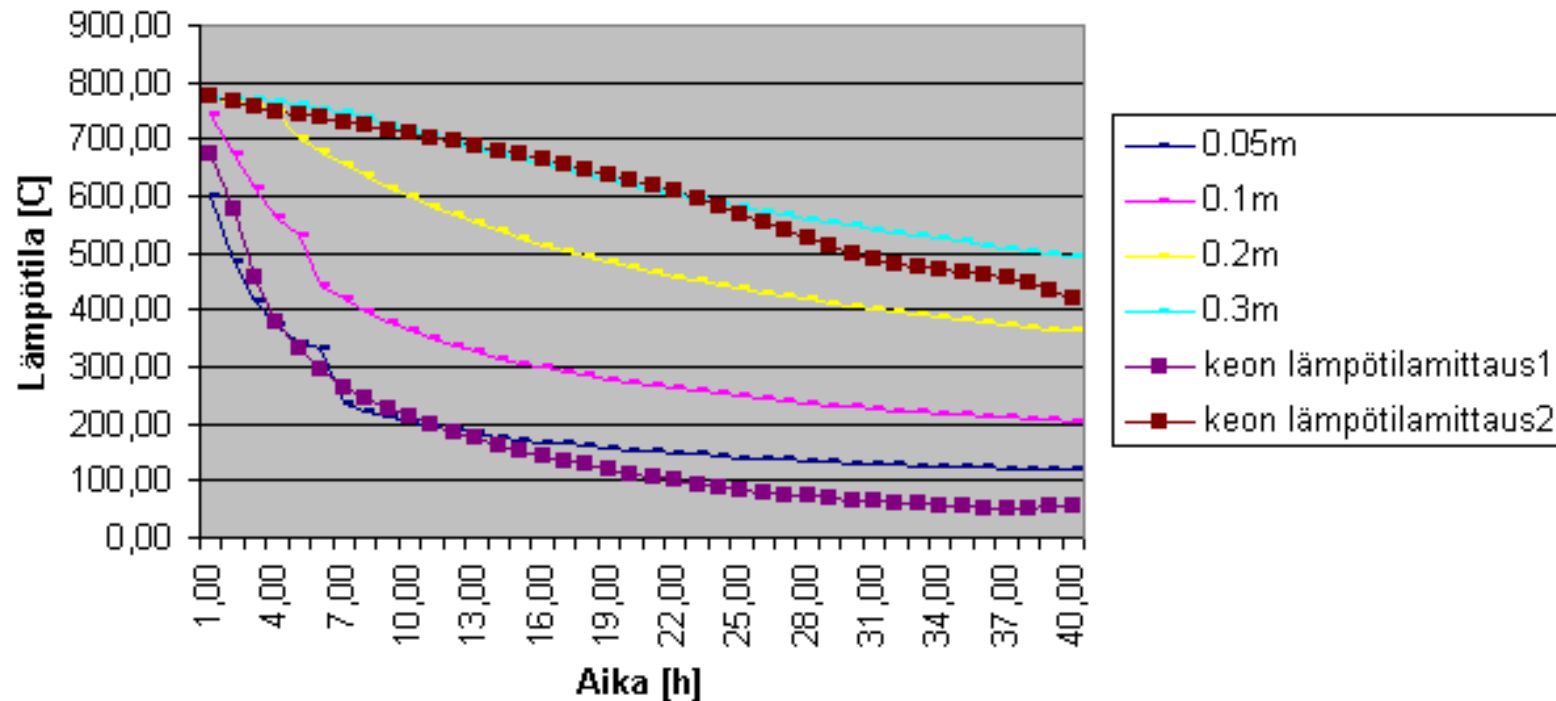


26.3.2010 Markus Nieminen, Finnish Recovery Boiler Committee
SKOG 2010 Sundsvall

Cooling of the char bed 4/6

- Cooling of the char bed has been problematic especially when the boiler has been stopped though emergency shutdown.
- Cooling time is affected by the char bed height and composition.
- The cooling increase from additional cooling agents remains unproven.
- The inside of the char bed and its processes are not yet known
- Temperature profile at char bed can be modeled using the so called ADL-model.
 - One dimensional conduction of heat in a solid, when one side starts cooling.
 - Char bed is though as a flat surface where heat is only conducted in vertical direction
 - Some parameters needs to be estimated

Cooling of the char bed 5/6



- We assume the char bed to be 0.6 meters high and symmetrical.
- No heat releasing nor utilizing reactions take place inside the char bed.
- Model was compared to bed cooling measurement report, which was done during annual shutdown.

Cooling of the char bed 6/6

Table 2, Total required time to cool charbed to less than 500°C.

Bed height [m]	Cooling time [h]
0.1	2.5
0.2	6.5
0.4	19
0.6	39
0.8	69
1	108
1.2	154
1.4	202
1.6	255
1.8	313
2	382

TACK!