EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Field Test Experiments and Validation of CEN/TS 1948-4
Dioxin-like PCBs from stationary sources

– CEN/TC 264/WG 1 “Dioxins and PCBs (Emission)“ –

Annex 2

Plant description and sampling conditions at a municipal waste incinerator

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Subject

Report of the CEN WG1 validation measurements 20.6. – 26.6.2007

1. Scope of this report

This report describes the measurements conditions and preparations during the CEN WG1 validation measurements.

This report includes:

- Plant description (chapter 2)
- Review of the I-TEQ levels before validation measurements (chapter 2)
- Selection of the operating conditions (chapter 3)
- Description of the measurement positions (chapter 4)
- Plant data during validation tests from plant system (chapter 5)

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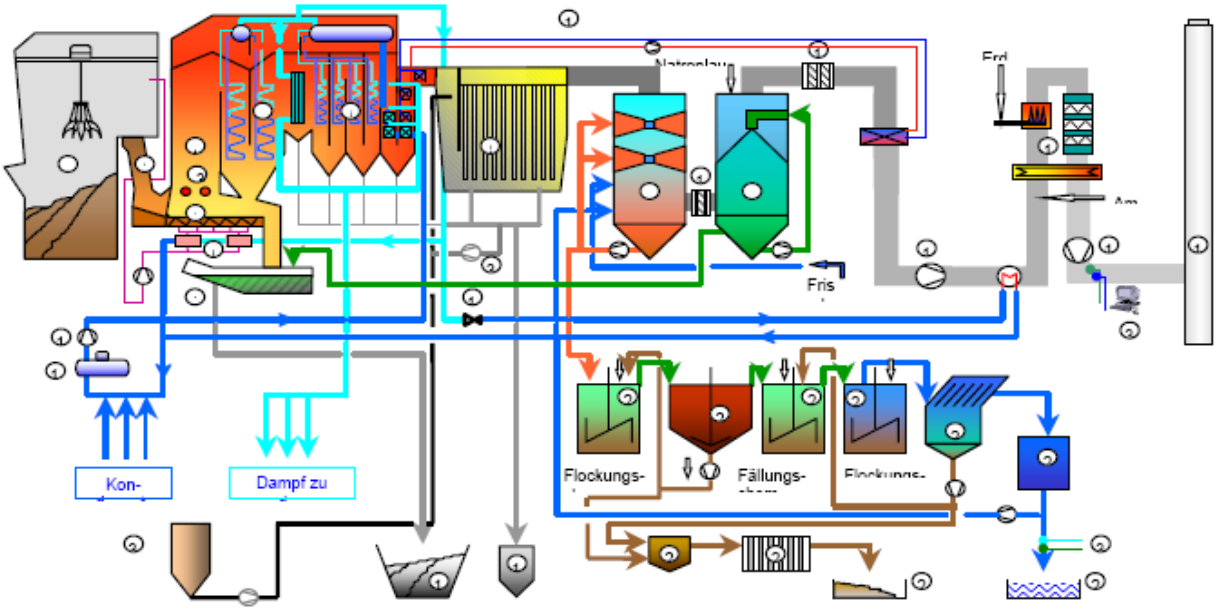
2. Plant description and review of the I-TEQ levels (2004 to 2007)

The selected waste incinerator uses a Martin grate, individual air supply of the sectors. Fire chamber temperature is controlled with a minimum of 900°C (normal plant operation).

The flue gas is cooled in a vessel, with a new heat exchanger, with exit temperature of 420°C, the temperature range of 420°C to 300°C is passed within 1 second.

This waste incinerator is a plant with new state of the art flue gas cleaning system, which consists of

1. Fabric filter with addition of activated carbon operated at 180°C
2. 2 stage wet scrubber operated at 60°C
3. 4 layer low temperature SCR (Selective Catalytic Reduction unit) operated at 180°C



Picture 1: Plant flow diagram

3 ..... grate	11 ..... catalyst box
8 ..... bag house filter	14 ..... stack
9 ..... wet scrubber	33 ..... measurement of pollutants

Picture 1: schematics of the plant

This combination of flue gas cleaning components ensures to fulfil the legal limit during all the operation time. During normal operation the emission values of PCDD/F are described with 10% of the legal limit. PCDD/PCDF and dioxinlike PCB´s are removed in 2 steps:

Step 1: Bag house filter with addition of 1kg activated carbon/hour,
Step 2: Catalyst box with a temperature of 180°C,

The adsorbtion of PCB on activated carbon at 180°C has an efficiency of 90%.
The catalytic destruction of PCB´s at the catalyst has an efficiency of 75% per layer, which is 99,6% for all 4 layers.

Until 2007, I-TEQ emissions of 0,037 ng/m3 were published in the Technical description of this waste incinerator.

In May 2006, I-TEQ values of 0,010 ng I-TEQ were measured. In December 2006, I-TEQ values of 0,013 ng I-TEQ were measured.

Table 1 shows the changes in the mean values of the measured I-TEQ.

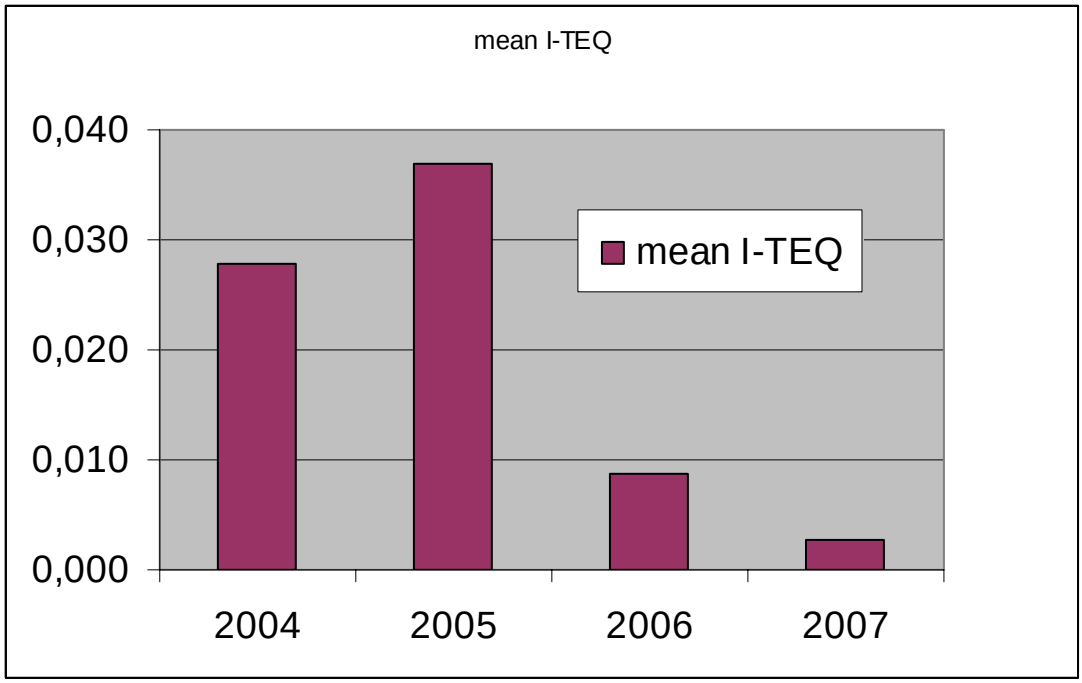


Table 1: mean values of the measured I-TEQ values

In June 2006 the electrostatic precipitator was substituted by a bag house filter with activated carbon addition and ash recirculation system.

The measurement value of 2007, describes the mean value during the validation measurements.

3. Selection of the operation conditions

On the 18th of June, the plant manager informed the validation team, that it was necessary to stop grate No. 2 and to clean it, start up of grate 2 was scheduled with June 23rd.

As described in many publications, the I-TEQ values normally will increase dramatically during stop and restart of an incinerator. I-$TEQ_{PCDD/f}$ of 6,0 ng/m3, I-TEQ_{PCB} of 0,6 ng/m3 are reported in the literature during start up of the incinerator.

The increase of the I-TEQ values can be caused by:

- Incomplete combustion
- Cold surfaces at the grate
- Bypass of the catalyst box

Therefore an increase of the I-TEQ by a factor 20 can be expected caused by the start up.

Considering the changed conditions and considering the obligation not to exceed the legal limit of 0,1 ng I-TEQ/m3, following measurement plan was agreed during the start up meeting on 19rd of June.

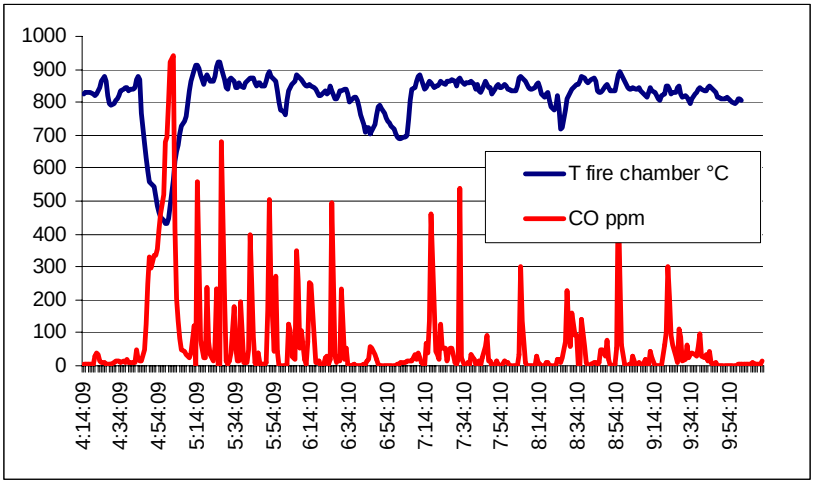
day	Operation condition of grates	Operation condtion of baghouse filter	Operation condition of catalyst box
1	Line 1, 3 in normal operation, Line 2 only fan	180°C, 1 kg/h activated carbon	180°C
2	Line 1, 3 in normal operation, Line 2 only fan	180°C No activated carbon addition,but still recirculation	180°C
3	Line 1, 3 in normal operation, Line 2 only fan	180°C No activated carbon	180°C
4	Line 1, 3 in normal operation, Line 2 start up	180°C No activated carbon	180°C
5	Line 1,2,3 in normal operation	180°C No activated carbon	180°C
6	Line 1,2,3 in normal operation	180°C No activated carbon	180°C

In the preparation measurements, the influence of the activated carbon addition was checked. Short stop of the activated carbon addition showed no difference (because of the flyash recirculation).
Therefore the activated carbon addition was stopped on day 2 until day 6 completely.

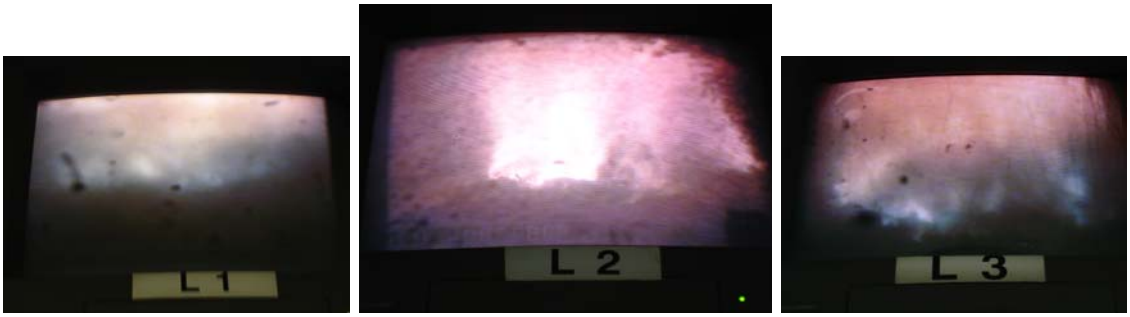
During start up, the fire chamber temperature was reduced sometimes to temperatures below 500°C. Below this temperature, the PCB´s are not destroyed, they are evaporated. Considering 99% destruction efficiency at 900°C, 0% destruction efficiency below 500°C, Start up of line 2 shall increase the PCB concentrations by a factor of 5. No addition of activated carbon shall increase the PCB concentrations by a factor of 3 (factor 2 with recirculation). Lower NH3 concentration shall decrease the PCB concentrations by a factor of 2.

So following concentrations should be expected:

day	Expected increase of PCB concentrations
1	1 x 1 x 0,5 = 0,5x
2	1 x 2 x 0,5 = 1x
3	1 x 3 x 0,5 = 1,5x
4	5 x 6 x 1 = 30x
5	1 x 6 x 1 = 6x
6	1 x 6 x 1 = 6x



Start up condition 4th day (23.6.2007)



Firechamber line 1 Firechamber Line 2 after cleaning Firechamber line 3

4. Measurement positions

The measurement positions were discussed during the start up meeting on the 19th of June.

Line 1,2 and 3 have separate baghouse filters, separate scrubber. They are combined in the gas/gas heat exchanger before the catalyst box.

Due to the changed conditions, line 2 out of operation, only fan was in operation, it was agreed to sample only in one sector of the flue gas channel., to minimise the impact of inhomogen PCB distribution over the channel.

The filter cooler method was able to sample at all flanges, the cooled prope method, needed horizontal flanges (because of the condensate in the probe), Ec- the dilution method needed the bigger flanges.

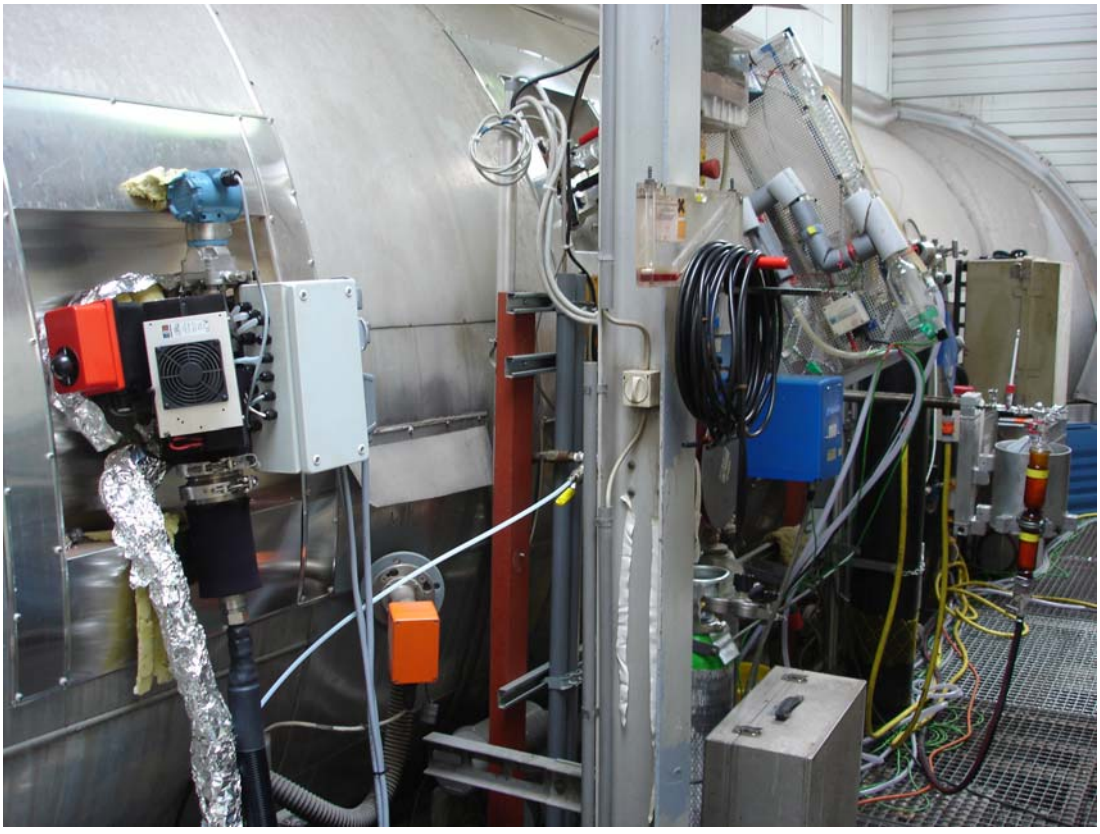
Considering these requirements, the flanges were selected according following schedule:

Flange	Method	Probe length	Team
C D1	Cooled probe method	Long probe Long probe	1
E B	Filter cooler method	Short probe Long probe	2
F A	Dilution method	2 short probes Long probe	3

Measurement positions in the stack

Flange	Method	Probe length In stack	X (mm)	Y (mm)	Z (mm)
C D1	Cooled probe	1750 mm 700 mm	700 900	0 0	2150 2150
E B	Filter cooler	570 mm 1750 mm	570 900	+300 - 400	4300 1800
F A	Dilution	400 mm + 600 mm 1750 mm	400,600 600	0 0	5500 0
B2	Oxygen	600 mm	600	0	2150

Overview of measurement on east side



Overview of measurements on the west side

5. Measured flue gas parameter

Flue gas parameters are downloaded from the measurement system of the plant.

The dust fractions (dependent on particle size) were measured from the diluted gas stream with a laser photometer.

Due to the hot season, the Ambient temperautes were:

Day	Time	Air temperature
20.6.2007	11:10 to 17:10	30,4°C
21.6.2007	9:50 to 15:50	30,3°C
22.6.2007	9:35 to 15:35	23,8°C
23.6.2007	4:10 to 10:10	16,8°C
25.6.2007	9:45 to 15:45	27,3°C
26.6.2007	8:50 to 14:50	17,5°C

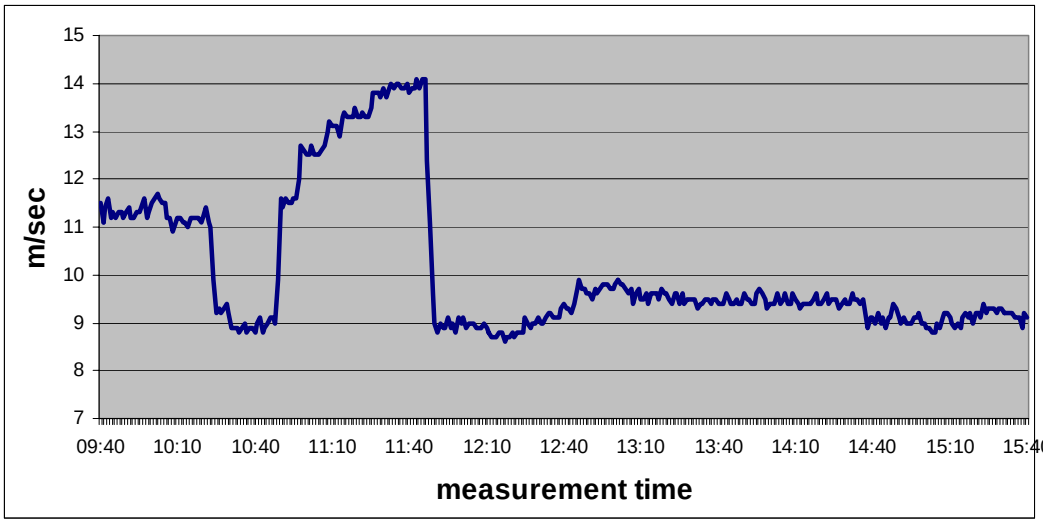
Day	Time	Flue gas temperature
20.6.2007	11:10 to 17:10	128,8°C
21.6.2007	9:50 to 15:50	127,7°C
22.6.2007	9:35 to 15:35	125,6°C
23.6.2007	4:10 to 10:10	129,5°C
25.6.2007	9:45 to 15:45	130,0°C
26.6.2007	8:50 to 14:50	130,9°c

Cold water with a temperature below 15°C was provided to cool the Cooled probes of the Cooled probe method and the condenser of the filter condenser method. The dilution method used a Peltier cooler on the mixing chamber for the cooling.

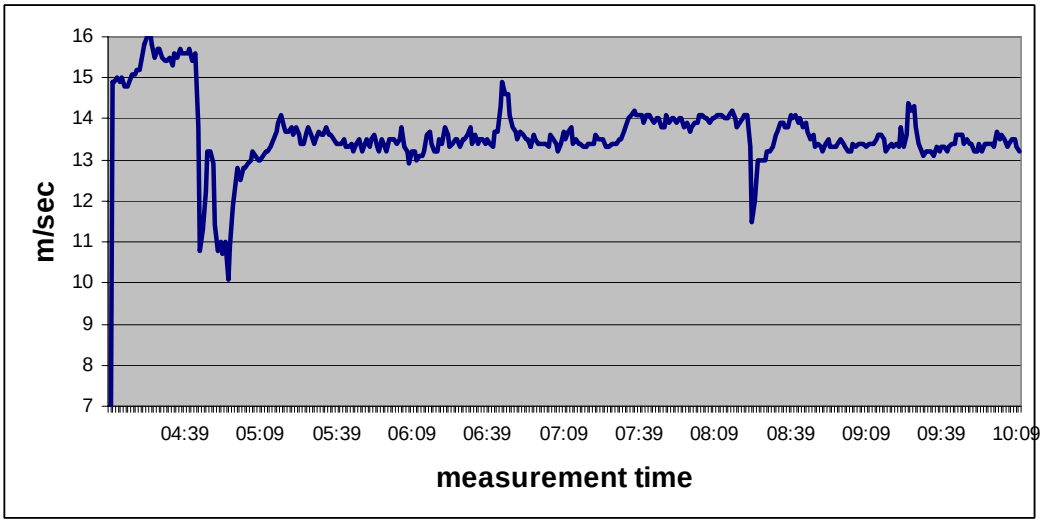
The Measurement positions at the west side had approx. 10°C higher temperature in the container, the measurement position in the East side +5°C more.

Day	Time	Barometric pressure	Stack pressure	Velocity
20.6.2007	11:10 to 17:10	980 mbar	+ 0,44 mbar	15,1 m/sec
21.6.2007	9:50 to 15:50	979 mbar	+ 0,35 mbar	15,3 m/sec
22.6.2007	9:35 to 15:35	979 mbar	- 1,10 mbar	10,1 m/sec
23.6.2007	4:10 to 10:10	980 mbar	- 0,58 mbar	13,6 m/sec
25.6.2007	9:45 to 15:45	976 mbar	- 0,22 mbar	13,6 m/sec
26.6.2007	8:50 to 14:50	973 mbar	- 0,62 mbar	13,5 m/sec

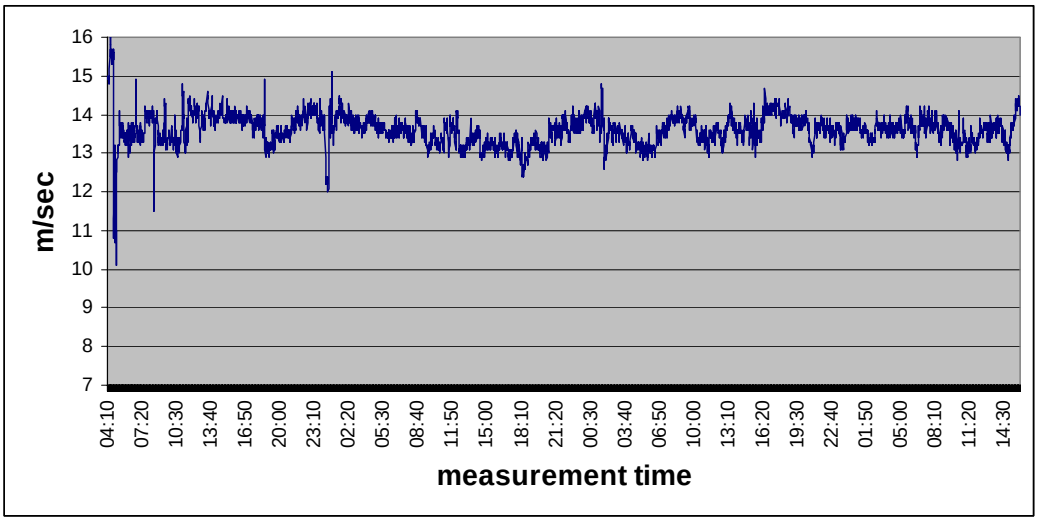
At the first 2 days, the pressure in the stack was higher than the barometric pressure, the other days lower. Velocity changed, due to shut down of line 2.



Velocity changes at measurement day 3 (22.6.2007)



Velocity changes during start up day 4 (23.6.2007)



Velocity from 20.6.2007 to 26.7.2007

Day	Time	Oxygen*	Humidity
20.6.2007	11:10 to 17:10	14,3 %	16,0 %
21.6.2007	9:50 to 15:50	14,4 %	15,8 %
22.6.2007	9:35 to 15:35	11,3 %	18,8 %
23.6.2007	4:10 to 10:10	9,7%	19,9 %
25.6.2007	9:45 to 15:45	9,3%	21,7 %
26.6.2007	8:50 to 14:50	9,1%	20,8 %

*measurement of FORCE

Day 1 to 3 showed higher oxygen levels and lower humidity levels, because at line 2 only the fan was in operation,

An important part of the validation, was the periodic check of the dust concentrations. The baghouse filter showed very good precipitation of the dust particulates.

Day	Time	Dust mg/m3
20.6.2007	11:10 to 17:10	0,5
21.6.2007	9:50 to 15:50	1,3
22.6.2007	9:35 to 15:35	0,4
23.6.2007	4:10 to 10:10	1,4
25.6.2007	9:45 to 15:45	0,8
26.6.2007	8:50 to 14:50	1,5

On day 5 the patricle size spectrum of the dust emissions was measured, using the dilution method and dilution 1:9 with clean air.

	flange F		Flange A	
Fraction µm	mass in 1:9 diluted flue gas µg/m3	Mass corrected to dilution µg/m3	mass in 1:9 diluted flue gas µg/m3	Mass corrected to dilution µg/m3
>0,23	26,94	242,46	30,02	270,18
>0,3	21,36	192,24	23,56	212,04
>0,4	15,33	137,97	16,83	151,47
>0,5	9,43	84,87	10,52	94,68
>0,65	4,91	44,19	5,78	52,02
>0,8	3,37	30,33	4,04	36,36
>0,9	2,26	20,34	2,96	26,64
>1	1,48	13,32	1,84	16,56
>2	1,13	10,17	0,92	8,28
>3	1,1	9,9	0,13	1,17
>4	0,97	8,73	0,13	1,17
>5	0,71	6,39	0,71	6,39
>7,5	0	0	0	0
>10	0	0	0	0
>20	0	0	0	0
total dust (mg/m3):		0,8		0,9

The differences of the dust concentrations between flange A and F are below 10%.