Type testing according EN 14175-3
on

fume cupboard bench type 1500
(EURO-II-Tischabzug T150)

of the company

Renggli AG
Industrie-Ost
Birkenstrasse 31
CH 6343 Rotkreuz, Switzerland

report with measurement data

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Abstract

The present investigation was done on the model EURO –II Tischabzug T150 , a 1500 mm bench type fume cupboard of the Renggli AG . Thereby all tests according the norm of EN 14175, part 3, state February 2004 have been executed. The results of the particular tests will be presented in this report and found the base for the documentation according to part 2 of the same norm, which should be delivered to the user with the hand over of the fume cupboard.

NOTE OF THE TEST HOUSE:

The testing of fume cupboards according EN 14175, part 3 is a type testing, which will be done in a test laboratory under comparable and ideal conditions – uniform inflow with low air velocity and turbulence, no person in the surrounding area of the fume cupboard, etc. The exhaust air volume flow sets the testing results, under the abovementioned conditions, presented in these report. However in practise it might be possible that, due to negative influences on the site and operation in and on the fume cupboard, potentially relevant more exhaust air volume flow is needed. For the setup of the amount of exhaust air for the fume cupboard, in addition the fluctuations of the volume flow of the ventilation system has to be taken into account.

Introduction

The subsequent described investigations applied for the testing process correspond to the new European norm, which was already available as the final version at the time point of the investigations. The new type testing of fume cupboards differs from former European national standards primal thereby, that the opening of the sash vertical as well as horizontal is limited to maximal 500 mm. Further differences with regard to test gas injection and sampling probe pattern lead to an incomparability of the results from the measurements according to DIN, BS, DS or NF and the measurements of the future norm. The new norm includes additionally a testing scheme, which simulates difficult circumstances by means of defined flow conditions in the front area of the fume cupboard. In contrast to nowadays no limits will be specified in the norm. Those limits shall be determined by security authorities and operating associations. In Germany a temporary average limit of maximal 0.65 ppm for the outer grid and robustness measurements is given by the subject committee of chemistry of the BGZ. For the measurements on the inner grid at present no limit exists. Further details can be obtained form the norm EN 14175, part 1, 2 and 3.

Breadboard construction

The measurement systems described in this report, used for the measurements represent the overall experimental installation for the quantitative investigation of fume cupboards. The installation consists of a test laboratory with separately regulated incoming and outgoing air, as well as the measurement systems, which are used to test and quantify the functionality of the fume cupboards. The measurement data will be electronically recorded, stored and archived during the testing.

Test laboratory

The test laboratory has a base of 5 times 5 square meters and a height of 3.80 meters. The test laboratory is build as a room in room concept. This means that it is a stand-alone construction in the technical hall of FC²S GmbH in Baiersdorf. The walls and the ceiling are smooth and no beam overhangs. The entrance to the test laboratory was closed during the measurements.

Before starting a measurement the concentration of SF_6 has to be determined in the test laboratory. It has to be beneath the detection limit of the concentration measurement device, and has not to exceed 10 % of the smallest measured value,

At the beginning of every test gas measurement on the fume cupboard the SF_6 – concentration in the room was reviewed. The device - depending detection limit was beneath 0.01 ppm during the measurements.

Ventilation system

The ventilation system in the test laboratory consist of two exhaust air and one inlet air systems with corresponding piping form plastics. The particular air flow will be determined by the pressure drop of a volume flow measurement aperture and if necessary corrected by the speed control of the fan, resp. the position of the dampers in the duct.

Exhaust air of the fume cupboard

The exhaust air volume flow can be varied between 100 and 2400 m³/h with this system. The connection of the fume cupboard happens by courtesy of a straight pipe and if necessary a restricted fitting on the socket designated by the manufacturer. Thus the subsequent connection to the domestic technique will be simulated. The exhaust air will be blown out over the roof of the technical hall.

Exhaust air of the room

In case of low fume cupboard air flow additional air will be exhausted over two sockets on the ceiling symmetrically positioned beside the fume cupboard to guarantee an air exchange in the room of minimum eight times per hour. For this the exhaust air volume flow can be varied between 50 and 1000 m³/h. This exhaust air will be also blown out over the roof.

Incoming air in the room

The inlet air system consists of a controlled air conditioning unit which includes a controllable fan for adjustment of the air flow, a piping and two outlets in the test laboratory positioned symmetrically on the floor and across from the fume cupboard. The air conditioner sucks the required air from the front part of the technical hall. The tracking of the air happens passively through the existing openings in the hall. The system is able to control the airflow in a range of 500 to 1500 m³/h within a temperature range of 15 to 30 °C with an accuracy of ±0.5 °C.

Atmospheric conditions

The temperature in the test room was kept within the allowed tolerance range during the measurements to guarantee similar test conditions for the fume cupboards. For the actual type testing the following values were measured, which are located in the usual range of conditions in laboratories.

	demanded	measured
room temperature T_r:	20 – 26°C	22,1 ± 1°C
incoming air temperature (room):	20 – 26°C	22,3 ± 1°C
rel. humidity :		40 ± 15%
air pressure:		1010-1019 hPa

General prescription of the fume cupboard

The investigated fume cupboard is a bench type fume cupboard, type EURO-Tischabzug T150 of the manufacturer Renggli AG. with a table top height of 900 mm. The fume cupboard is a serial model, this means, that the used parts and fluid dynamic details correspond to the serial manufacturing. A fume cupboard monitoring system was mounted on the cupboard, but not in operation. A mechanical stop on the right side of the side panel must be pressed if the sash should be raised higher than 500 mm opening.

The investigated fume cupboard had only a vertical moveable sash.

An airflow indicator was not installed at the investigated fume cupboard.

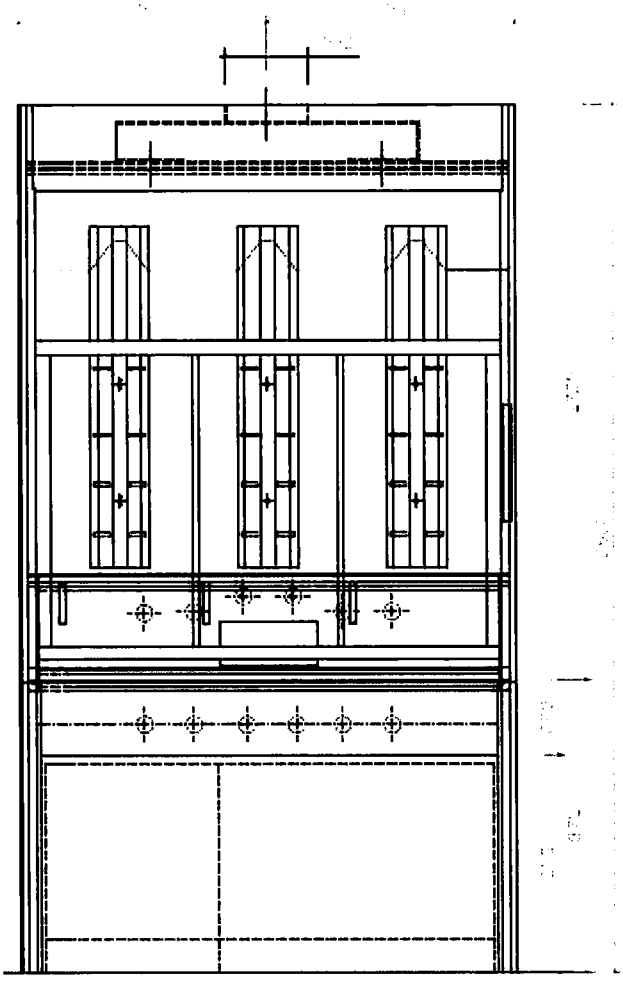


Figure 1: The investigated fume cupboard

Prescription of the particular measurements

Determination of the face velocity

The air velocity was determined perpendicular to the measurement plane in the sash opening of the fume cupboard with a multi sensor velocity measurement device. The device is a net depending device on which one can connect up to 24 sensors. The sensors are distributed over the sash opening according to the guidelines of the norm and are mounted on a pattern which is fixed on a tripod. The device sends the data to a computer where they are stored.

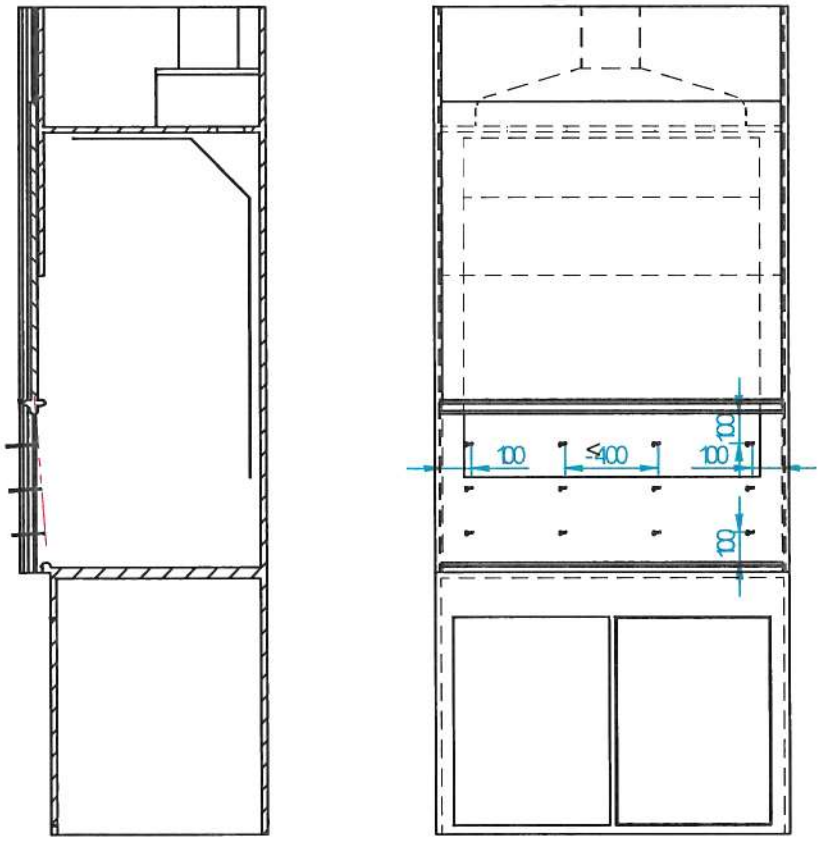


Figure 2: Distribution of the sensors in the measurement plane

Measurement of the containment

According to the guidelines in the new norm for type testing for the outer measurement plane nine test gas injectors are uniformly distributed in the interior of the fume cupboard. The distance to the sash opening is 200 mm. For the measurements in the inner measurement plane one test gas injector is placed 150 mm in front of the middle sampling probe. The test gas itself consist of a mixture of 10 % SF_6 (Tracer) and nitrogen. The amount of test gas is fixed to 4.5 litres per minute for the outer measurement plane and 2.0 litre per minute for the inner measurement plane. For the sampling two different measurement patterns are applied, which are placed either directly in the sash opening or in a distance of 50 mm to from the sash opening.

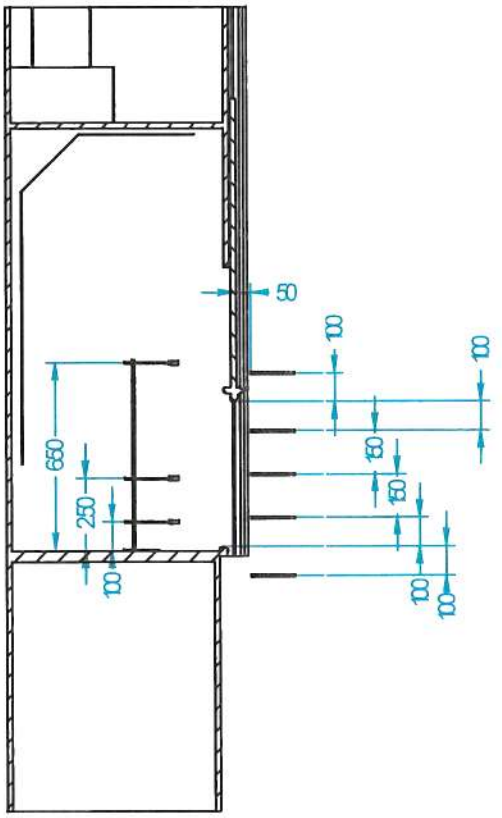


Figure 3: Distribution of test gas injectors for the outer measurement plane

Inner measurement plane (Inner Grid)

The measurement pattern for the testing of the front opening (inner grid) consists of 3x3 tubes with a distance of respectively 30 mm to the vertical and to the horizontal border of the measurement plane. The outbreak potential will be measured on 6 different positions (figure 4). On each of the positions the concentration of tracer gas is measured for a time period of 360 sec and the data are stored.

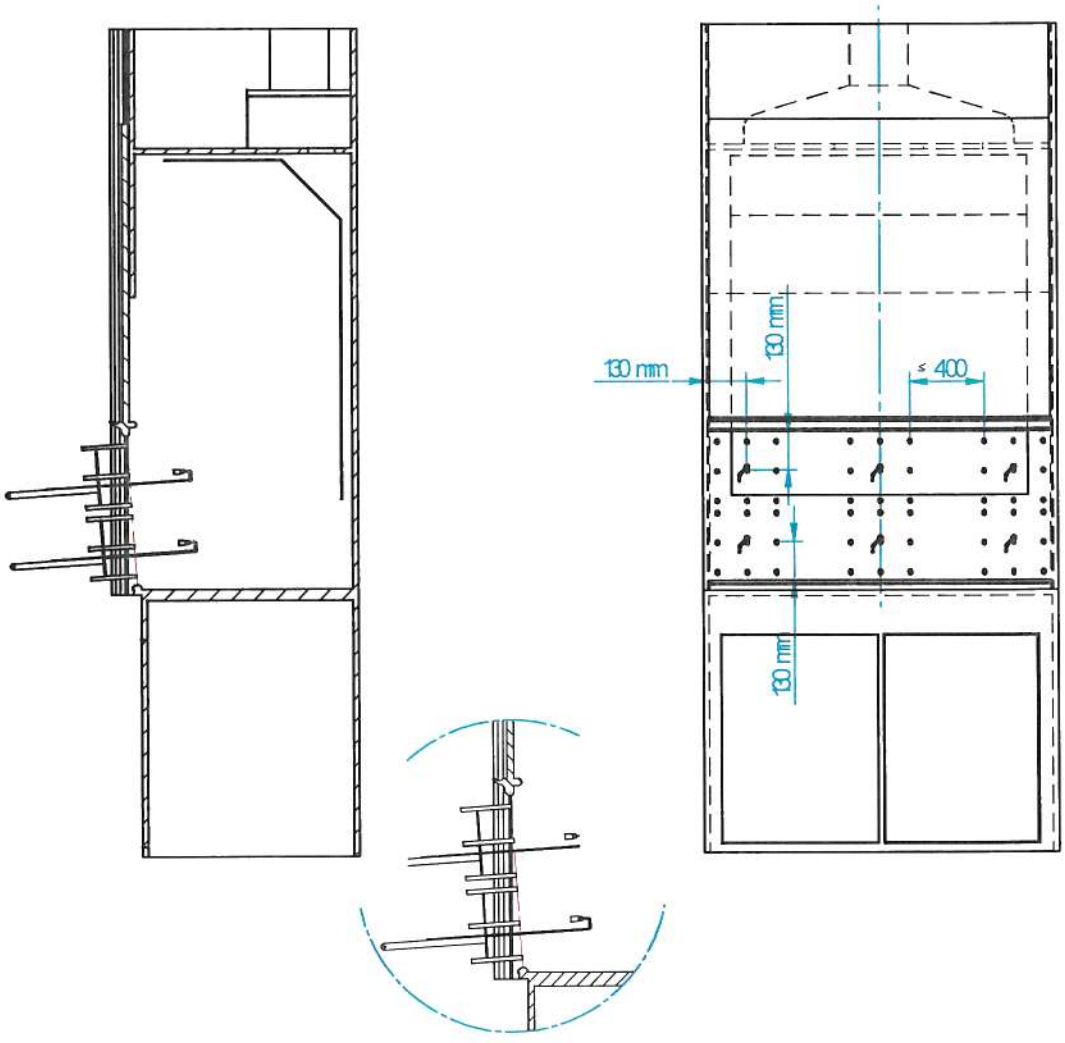


Figure 4: Measurement pattern „inner grid“

Outer measurement plane (Outer Grid)

This test measures the outbreak of tracer gas for the whole sash opening (clear width x 500 mm height of opening) with a measurement pattern with several, respectively 5 vertical arranged tubes placed in front of the fume cupboard (figure 5).

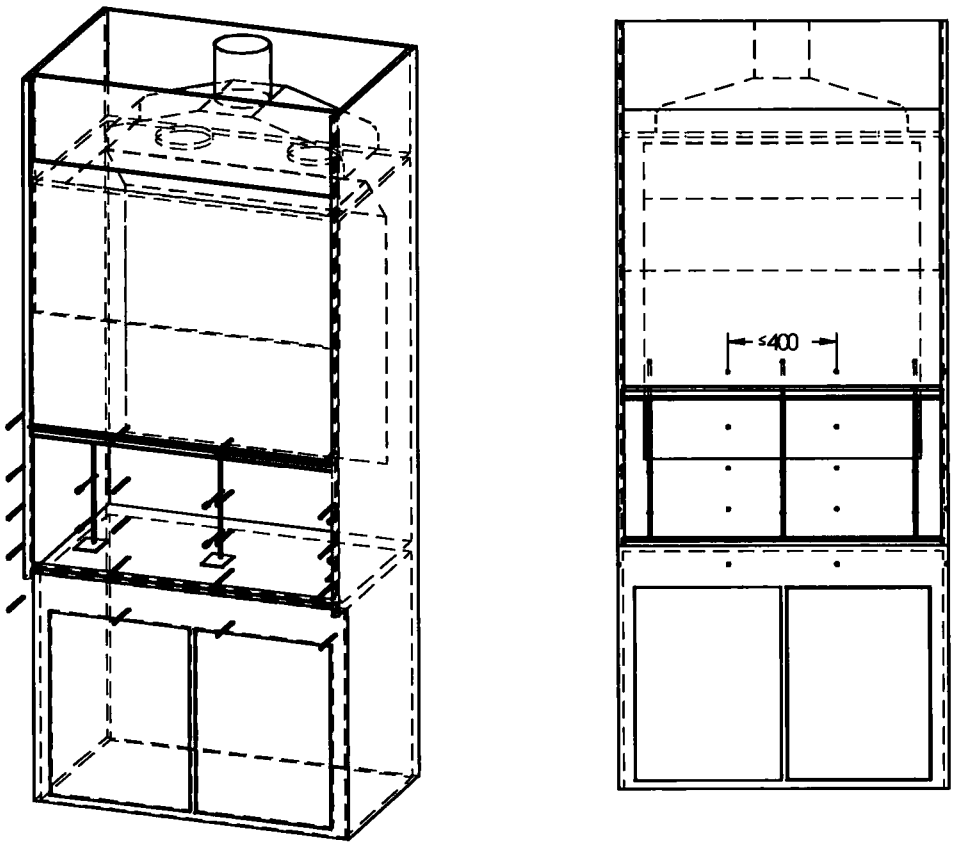


Figure 5: Measurement pattern „outer grid“

The measurement takes in this case 780 sec. After 380 sec the front opening will be closed, after additional 240 sec the sash will be opened to maximum 500 mm. Thereby the dynamic effect of closing and opening will be investigated.

Robustness of containment

The robustness test uses the installations of the "outer grid". However a flat rectangular plate with the dimensions 0,4 x 1,9 m moves cross to the front part of the fume cupboard with a velocity of 1 m/s. With overall 6 crossings a defined perturbation in the front area is simulated. This gives a hint to the sensitivity of the fume cupboard to outside influences (figure 6)

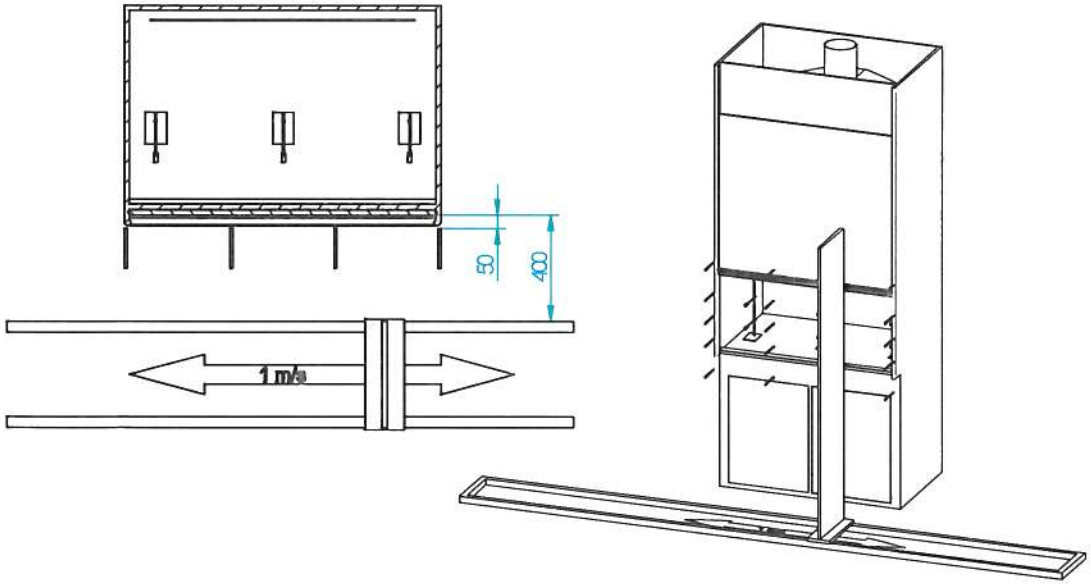


Figure 6: Test installation for robustness test

Force to move the sash

For the measurement of the force, necessary to move the vertical sash into one direction, a small holding device was fixed on the handle. Here the spring balance with maximum indicator was attached to three points: left, centre and right .the force for opening and closing must be not higher than 30 N (50 N for combination sashes).

Remark: the values of 30N, resp. 50 N are the only limits given in the standard en14175, part 2

Illumination

The luminance and equability on the table surface has to measured according to EN 12665.

Applied measurement devices

Pressure measurement device

The measuring of the pressure drop as well as the determination of volume flows is done with a precision manometer of Halstrup Walcher, Typ KAL 84 with an range of 0 - 1000 Pa, The device has a valid calibration from the manufacturer from February 2005.

Air velocity sensors

Omni - directional measurements

The review of the ambient conditions is carried out with a thermal anemometer of the type LVFA with an omni - directional spherical sensor of DANTEC Dynamics, Denmark. The sensor had a calibration of June 2001 for the range of 0.1-1.0 m/s, resp. 1.0–5.0 m/s, with the last internal verification in September 2005.

Uni - directional measurements

For the measurement of the air velocity in the opening a multiple sensor measurement device, type FVA 2400 of Cambridge Accusense, USA, is applied. The used Sensors are of type AVS 100 and were calibrated in the range of 0.15–0.75 m/s in August 2006.

Measurement of test gas

Gases

The applied test gas (10% SF_6 in 90% N_2) was delivered by Rießner Gase. The manufacturer certificate gives a concentration of exactly 10,03 % SF_6. The bottle with the test gas was placed the whole time during the type testing in the test laboratory and didn't feel any thermal fluctuations.

Test gas flow regulator

The dosage of the test gas is done with an electronic mass flow regulator of the manufacturer Fischer-Rosemount. The real flow regulator is calibrated especially for the test gas in the range of 0–5 l/min. The calibration was done by the manufacturer in February 2006.

Gas analyser

The concentrations are measured with an IR – gas - absorption spectrometer, type VIVO Trigas of the manufacturer Dantec Dynamics, Denmark. The device was calibrated by manufacturer in February 2005. Before the type testing starts the measurement system (measurement device – measurement line – A/D-converter) was approved according to chapter 5.3.1.1. of the EN 14 175, part 3 for SF6 in the range 0.0 – 5.0 ppm.

Further instruments

I luminance

The luminance on the table was measured with a lux-meter, having a range from 0-200, resp. 200-20000 Lux, According to the manufacturers specifications is the accuracy ±(5%rdg+10dgt) at the color temperature of 2856K..

Air pressure

The actual barometric data came from the weather station of the nearby airport Nuremberg (NUE).

Measurement results

The following tables summaries the measurement results. The numbering of the tables is according the draft norm. The measurements were done for two different volume flow rates, which were not varied during the measurements.

Measurement of the face velocity according chapter 5.2 (all values in m/s)

Exhaust volume flow rate 600 m³/h

Measurement plane front sash 500 mm vertical open (15 measurement points in 5 columns and 3 rows)

	column 1	column 2	column 3	column 4	column 5
row 1	0,31	0,28	0,31	0,31	0,30
row 2	0,30	0,23	0,25	0,24	0,26
row 3	0,27	0,21	0,25	0,22	0,27
mean value :	0.27				
standard deviation					
row 1	0,01	0,01	0,02	0,01	0,01
row 2	0,01	0,02	0,02	0,03	0,03
row 3	0,02	0,01	0,02	0,02	0,04

Testing of containment according chapter 5.3

All shown values are mean values in ppm.

Inner measurement plane (5.3.6.1)

Average concentration in ppm from 60-360s

Measurement plane front sash 500 mm vertical open

upper left	upper middle	upper right
< dl	< dl	< dl
lower left	lower middle	lower right
0.04	< dl	< dl
0.07		
0.05		

Containment factor Cf_i from 286 to 2000 (partly limited by the instrument's detection limit)

Outer measurement plane (5.3.6.2)

Measurement plane front sash 500 mm vertical open

mean concentration in ppm of:			
60s - 360s	**361s – 420s**	**421s – 600s**	**601s - 780s**
0.02	**0.02**	**< dl**	**0.03**
0.04	**0.01**	**< dl**	**0.03**
0.07	**< dl**	**< dl**	**0.03**

Containment factor Cf_o: from 643 to 4500 (partly limited by detection limit)

Testing of robustness of containment according chapter 5.4

(Mean concentration in ppm from 60-240s)

Measurement plane front sash 500 mm vertical open

measurement 1	**0.32**
measurement 2	**0.26**
measurement 3	**0.29**

Containment factor CF_r: 125 to 140

Testing of air exchange efficiency according chapter 5.5

(Air exchange efficiency ε in %)

600 m³/h	**ε = 42**

Testing of pressure drop according chapter 5.6

Diameter of the duct connection:	250 mm
Exhaust air flow	600 m³/h
Pressure drop for 500 mm open front sash:	59 Pa
Pressure drop for closed front sash:	80 Pa

Measurement of the illumination according to chapter 9

(Illumination on the table surface in Lux)

630	730		740	630
		750		
680	730		750	700

Data according to EN 12665: Average value: 704 Lux
Symmetry factor: 89 %

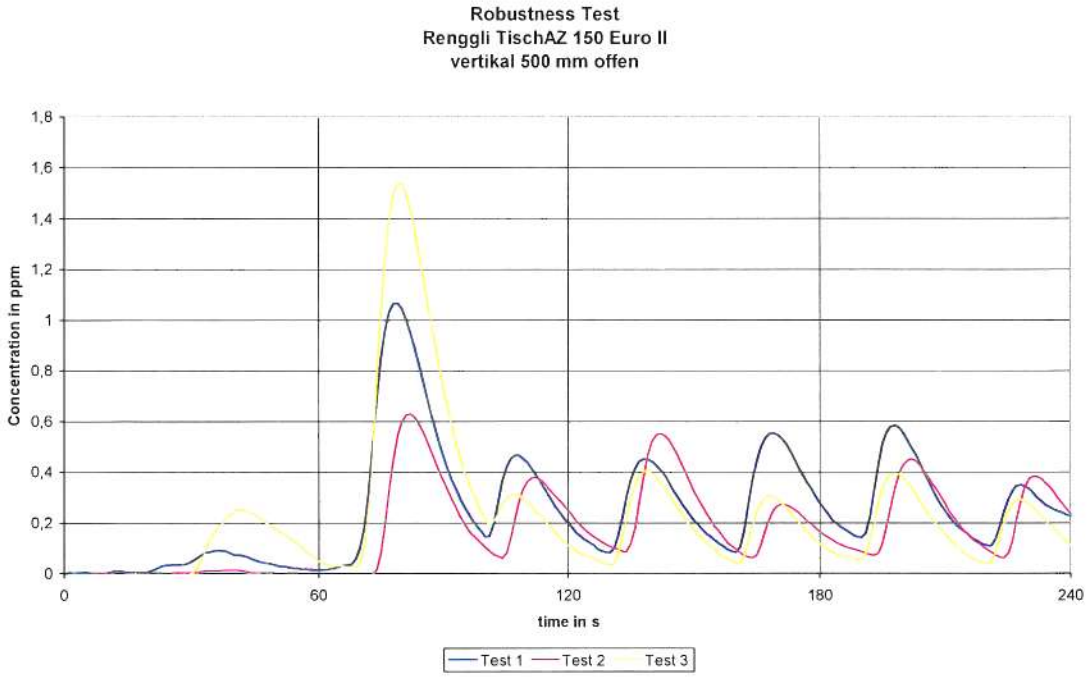
Baiersdorf, November 14th, 2006

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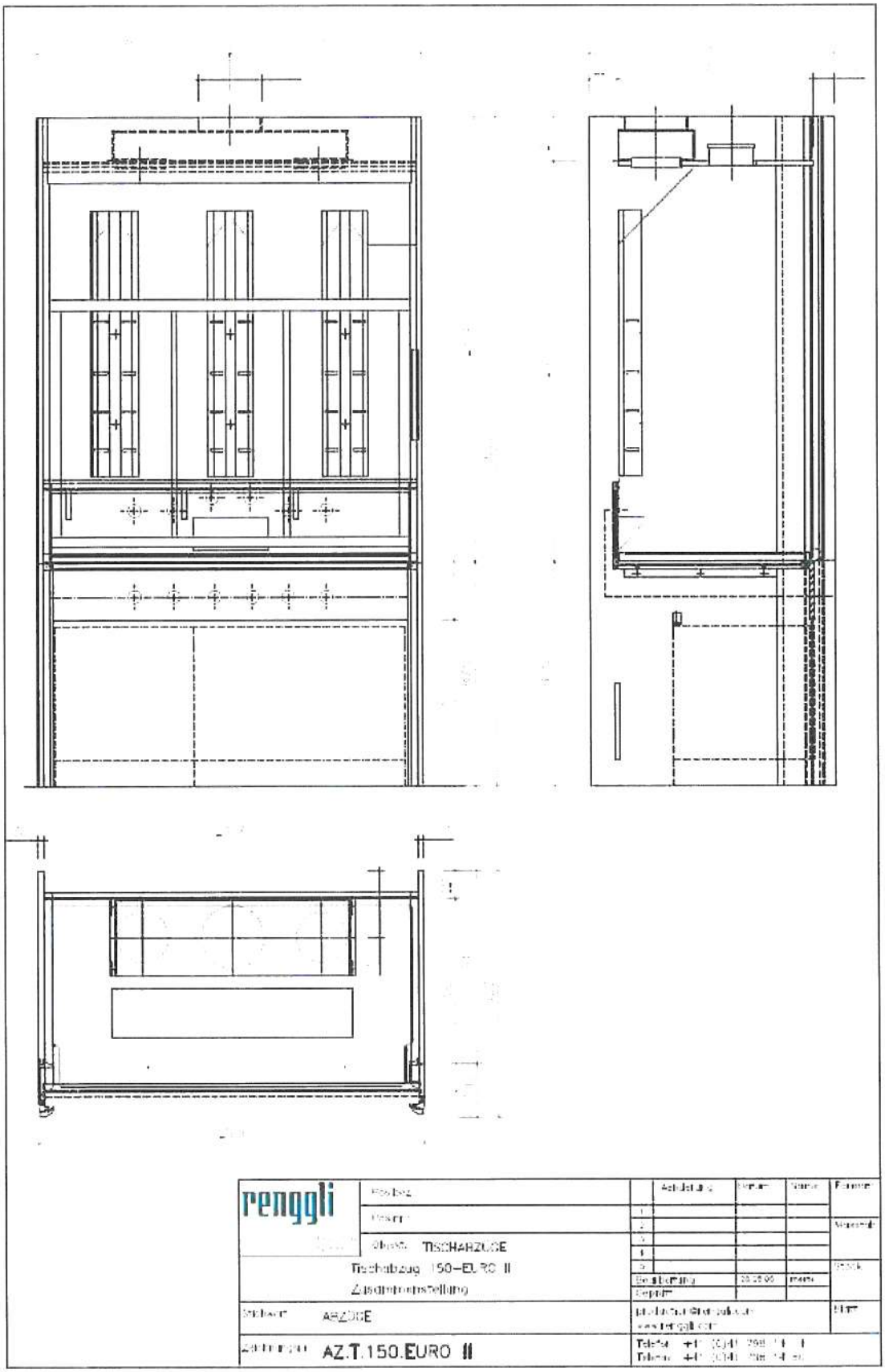
Annex:

Robustness tests, measurement data



Pressure drop




renggli
TISCHARZUGE
Tischabzug 150-EURO II
Zusammenstellung
AZ.T.150.EURO II