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Manufacturer: Zystm A/S

Project No.: LAB13-03

Report No.: 1/FC-Z81/P6/06/13

Type testing of bench-type fume cupboard Zystm Zafe 81, W = 900 mm, with VAV-system LabVent LV-VAV/LVVI 250 according to EN 14175-6:2006

Aachen, 19.08.2013

Head of testing station: B. Konrath

Responsible tester: M. Winklehner

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1.0 Introduction

I.F.I. Institut für Industrieaerodynamik GmbH, Institut an der Fachhochschule Aachen, D- 52074 Aachen, has been commissioned by Zystm A/S., DK- 7430 Ikast to test the operational reliability of the bench type fume cupboard type **ZAFE 81 with VAV-system LabVent LV-VAV/LVVI 250** from the manufacturer Lab-Vent Controls, DK- 8361 Hasselager.

The type testing of the **ZAFE 81** fume cupboard **with volume flow controller LabVent LV-VAV/LVVI 250** has been executed in accordance with the test procedure of DIN EN 14 175-6:2006, 5.4.3. which requires additional tests for the VAV cupboard. The additional type testing results according to EN 14175-3:2004 are shown in **report and certificate No. 1/FC-Z81/P3/06/13**.
Further terms and dimensions of testing fume cupboards are given in EN 14 175-1:2003, EN 14 175-2:2003 determines the safety and performance requirements of fume cupboards. These safety and performance requirements are tested and evaluated in accordance with the type testing procedure of part 3 of EN 14 175:2004.

The EN-standard specifies no limit values. The requirements concerning the containment of the fume cupboard of the professional association of the german chemical industry, technical committee chemistry, dated July 29, 2003, of the tested volume flows have been checked and evaluated with regard to the compliance of the valid limit values.

Limit values of professional association of the german chemical industry (BG Chemie), technical committee chemistry, dated 29.07.2003 for testing fume cupboards according to EN 14175-3:2004 (Berufsgenossenschaft der chemischen Industrie, Fachausschuss Chemie)	
Maximum tracergas average value φ_x	**Maximum tracergas peak value**
0,65 ppm	**5 * 0,65 ppm = 3,25 ppm** (Containment: robustness φ_R and sash movement phases φ_3, φ_5 of outer measurement grid test)
	3 * 0,65 ppm = 1,95 ppm (Containment: static sash phases φ_2, φ_4 of outer measurement grid test)

For the measurement values on inner measurement plane, the French NF XPX 15-203 gives a limit value of 0,1 ppm for the average concentration value at each measuring point.

2.0 Description of the test specimen

2.1 Structural design and main dimensions

Figure 1 shows the tested bench-type **ZAFE 81** of nominal width 900 mm. The fume cupboard **ZAFE 81** consists mainly of a steel frame structure carrying the casing and containing the table leaf. A airfoil-profile is installed in front of the desktop. The profile is moveable and separately locked to prohibit the uncontrolled movement (drawing no. Zystmlab 20.iam, denomination: Stinkskab Glasforkant med staenkafskaermning, date 07.03.2012). The glass of the sash is ESG-type.

The main dimensions of the test specimen are:

ZAFE 81	width (mm)	height (mm)	depth (mm)
External	900	2300	850
Internal	850	1110	575-640
Sash opening	850	500	-
Drawing no. of manufacturer	10380003-8100090.iam; ZAFE 81; Birgitte Videbæk Nielsen; 31.01.2013		

The fume cupboard **ZAFE 81** has a one-piece sash with a mechanical stopping device at 480 mm opening. These are resulting in the following test sash opening:

	width (mm)	height (mm)
Sash opening: vertical	850	500
Sash opening: horizontal, right	none	none
Sash opening: horizontal, left	none	none

Figure 1: ZAFE 81 in test room

2.2 Extract air and test volume flow rate

An exhaust air socket of diameter d = 250 mm is fitted to the VAV-system with a connecting flange. The fume cupboard **ZAFE 81 with LabVent LV-VAV/LVVI 250** has been connected to the volume flow measuring system of the testing room via a hose of 1.5 m length and a diameter of d = 250 mm and the extract air has been discharged from the testing room into the atmosphere.

The fume cupboard **ZAFE 81** has been tested at the following face velocities and correspondent extract volume flow rates given by the manufacturer:

	Test 1
Nominal face velocity	**0.5 m/s**
Tested face velocity according EN 14175-3:2004	**0.499 m/s**
Correspondent volume flow rates + controller set points: sash 500 mm open-closed	**788-100 m³/h**

2.3 Tested VAV-system

The tested VAV-sytem **LabVent LV-VAVB/LVVI 250** (d = 250 mm) from the manufacurer:

Lab-Vent Controls A/S
Teglbækvej 5
8361 Hasselager
Denmark

was fitted on the connecting socket of the fume cupboard. The lenght w of the connecting length (fig. 2 of EN 14175-6:2006) was 70 mm.

LabVent LV-VAVB/LVVI 250 was equipped with a sash path sensor (LVL-LV-VAVB/LVVI250/937), a velocity sensor (LVF-LV-VAVB/LVVI250/937), electronic unit (LVE-LV-VAVB/LVVI250/937), display/control unit (LVP-LV-VAVB/LVVI250/937-S), motor (LV-913) and the damper LV-VAV-250.

The VAV-system **LabVent LV-VAVB/LVVI250** was tested in a vertical position.

The maximal and minimal difference pressure range given by the manufacturer is: 100 to 400 Pa.

Type: LabVent LV-VAVB/LVVI 250	$\Delta P_{damper\ max.}$ Pa	$\Delta P_{damper\ min.}$ Pa
Manufacturer values	400	100
During test	381	112

2.4 Test room conditions and atmospheric environment

Test room dimensions:		Averaged atmospheric environment:		Place of installation:
Depth	: 5,6 m	Temperature	: 20 - 22 °C	
Width	: 4.6 m	Atmospheric pressure	: 1008 -1019 hPa	centred at a
Height	: 4.0 m	relative humidity	: 38 - 61 %	sound-reflecting rear wall
		air speed in test room	: < 0,1 m/s	
		Room differential pressure	: - 2.2 pa	

2.5 Test procedure

Gas outlets were mounted in the fume cupboard **Zystm ZAFE 81 with LabVent LV-VAV/LVVI 250** in accordance with EN14175-6:2006 and placed in a distance of 200 (+- 5) mm from the sash plane. As stipulated in EN 14175-3 the sash was set on a sash opening of 500 mm height.

A measurement pattern was mounted in front of the fume cupboard in a distance of 50 (+- 5) mm from the sash plane in accordance with EN14175-6:2006, 5.3.4.2.

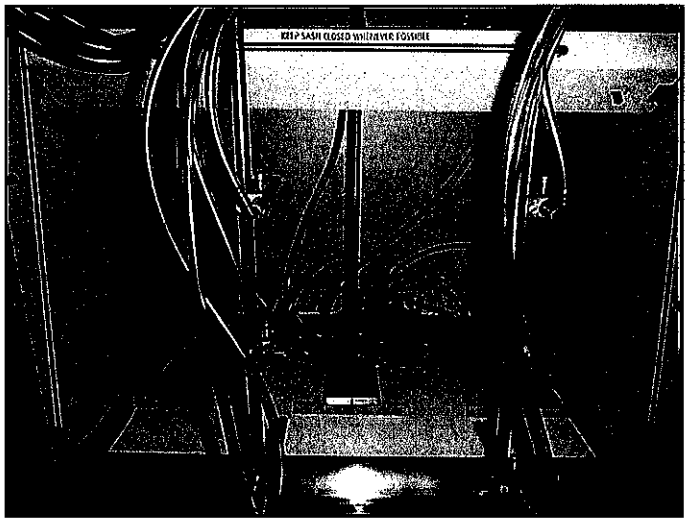


Fig. 2: Set-up of the testing facility in accordance with EN14175-6:2006, 5.4, Outer measurement plane

The test of the **outer measurement plane** was performed in accordance with EN 14175-6:2006, 5.3. The total testing time is 780 seconds, which are subdivided as follows: the first measurement cycle with open sash lasts 360 seconds (average concentration φ_2); after 360 seconds, the sash is closed in 1 second for the period of second 360 to 420 (average concentration φ_3) and remains closed for 240 seconds ((average concentration φ_4), before opening again at second 600 (average concentration φ_5 for the period of second 600 to 780). The test was done twice according to EN 14175-6:2006: with the minimum and maximum pressure difference of the VAV-system.

The test gas was a mixture of 10% (per cent by volume) sulphur hexafluoride (SF6) in air. The tracer gas flow to test the fume cupboard was realized with a volume flow rate of 4,5 l/min (in accordance with EN14175-3:2004, 5.3.1.3).

The concentrations were measured using a Foxboro gas-infrared-absorption-spectrometer, Type MIRAN 1A. The measuring system was calibrated from 0 to 10 ppm. The measured values were entered and analyzed using a PC with a built-in A/D-converter, type DASH 16 of Keithley Instruments Inc..

The test gas coming from the fume cupboard was sucked by the probe samplers built in accordance with EN14175-3:2004 and conducted to the measurement instrument through 2 m long hoses and the probe collector also described in the Standard. The analog concentration signal was entered 5 times in the second, digitized, converted to a concentration value, then summarized to an average value and saved for further analysis.

If a test results in values above 0.01 ppm, EN 14175-3:2004 stipulates that 2 repeated measurements of this test are performed. However for the analysis, the measured values of the first 60 seconds are not taken into consideration in EN14175-6:2006 to realize balanced conditions.

The data and results were analyzed in accordance with EN14175-6:2006, 5.4.5.

3.0 Measuring equipment used

Gas absorption spectrometer MIRAN 1 A CVF Ser. No. 4431 Foxboro; calibrated on: 03.12.2012

Propeller anemometer, MODEL 27106 , Young; calibrated on: 03.12.2012

Gas outlet in accordance with EN 14 175-3:2004

Personal Computer Pentium 333

BROOKS mass flow controller, Type 5850 E, Ser. Nr.: T20466

BROOKS controller, Type 5875

TSI-air velocity probe, Type 8475 , 0-2 m/s, Ser. no.: 0204211; calibrated on: 08.11.2012

Hygro-Thermo-Barograph, Type 8070 Nr. HK 4688 G. Lufft

A/D-Converter DAS16 Keithley

Test and evaluation software DIGISTO2, I.F.I. GmbH

ISEL tooth belt feeder BL1, No. 232101 0155

Testo Luxmeter 545, Ser.No.: 00711097/206

Spring balance Pesola, 0-5 kg, No. kra-002

Halstrup Multur, 0- 1000 Pa, Ser. No: 11970207, calibrated: 10-2012

Smoke tube, I.F.I. Gmbh

3.1 Averaged concentration detection limit of the measuring instrument chain

Date of tests: 14.-21.06.2013	**ppm**
Detection limit (2 x σ)	< 0,005
Time constant	< 15 sec.

4.0 Results of testing the VAV fume cupboard: containment of the outer measurement plane according to EN 14175-6:2006

4.1 Average concentrations of tracer gas φ_{2-5} and containment factors C_{F2-5} according to EN 14 175-3:2004, 5.3.5.3. and 5.4. at minimum pressure difference

$\Delta P_{minimal}$ = 112 Pa	Containment: Outer measurement plane							
	φ_2	Containment factor	φ_3	Containment factor	φ_4	Containment factor	φ_5	Containment factor
	ppm	C_{F2}	ppm	C_{F3}	ppm	C_{F4}	ppm	C_{F5}
Test 1	<0.01	>3426	<0.01	>3426	<0.01	>3426	<0.01	>3426
Test 2	-	-	-	-	-	-	-	-
Test 3	-	-	-	-	-	-	-	-

Measurement values < 0.01 ppm are below the minimum detection level of the test system used (<0.005 ppm)

4.2 Measured average volume flow rates at minimum pressure difference

Nominal volume flow rate sash open-closed m³/h	Time period: 60-360 sec; Sash 500 mm open m³/h	Time period: 361-420 sec; Sash dynamic closed m³/h	Time period: 421-600 sec; Sash closed m³/h	Time period: 601-780 sec; Sash 500 mm opend m³/h
788-100	796	142	102	795

4.3 Average concentrations of tracer gas φ_{2-5} and containment factors C_{F2-5} according to EN 14 175-3:2004, 5.3.5.3. and 5.4. at maximum pressure difference

$\Delta P_{maximal}$ = 381 Pa	Containment: Outer measurement plane							
	φ_2	Containment factor	φ_3	Containment factor	φ_4	Containment factor	φ_5	Containment factor
	ppm	C_{F2}	ppm	C_{F3}	ppm	C_{F4}	ppm	C_{F5}
Test 1	<0.01	>3426	<0.01	>3426	<0.01	>3426	<0.01	>3426
Test 2	-	-	-	-	-	-	-	-
Test 3	-	-	-	-	-	-	-	-

Measurement values < 0.01 ppm are below the minimum detection level of the test system used (<0.005 ppm)

4.4 Measured average volume flow rates at maximum pressure difference

Nominal volume flow rate sash open-closed m³/h	Time period: 60-360 sec; Sash 500 mm open m³/h	Time period: 361-420 sec; Sash dynamic closed m³/h	Time period: 421-600 sec; Sash closed m³/h	Time period: 601-780 sec; Sash 500 mm opend m³/h
788-100	826	151	104	823

4.5 Testing of reaction time in accordance with EN 14 175-6:2006

Testing of reaction time at:	Type VAV system	Nominal volume flow rate: sash open m³/h	Nominal volume flow rate: sash closed m³/h	Reaction time: step up/ sec	Reaction time: step down/ sec
Minimal pressure difference $\Delta P_{minimal}$ = 112 Pa	LabVent LV-VAVB/ LVVI250	788	100	2.7	7.2
Maximal pressure difference $\Delta P_{maximal}$ = 381Pa				2.5	9.6

4.6 Test of the air exchange efficiency in accordance with EN 14 175-3, 5.5.

Volume flow rate: sash closed	Internal volume V_{fc} m^3	Air exchange rate N 1/s	Air exchange efficiency ε %
100 m³/h	0.6	0.03	**61.6**

4.7 Tracer gas peak values C_{max} (SF_6-peak value), 0.5 m/s

Sash opening	φ_5 ppm	Containment factor C_5	C_{max} ppm	Tracergas peak maximum (Berufsgenossenschaft der chemischen Industrie, Fachausschuss Chemie, 29.07.03)
500 mm vertical	<0.01	>3426	**0.01**	**5 * 0,65 ppm = 3.25 ppm**

4.8 Setpoint values according EN 14175-6:2006, 5.3.3.

Sash opening	Setpoint extract volume flow rate/ m³/h	Extract volume flow rate / m³/h	Difference extract volume flow rate Δq_v/ m³/h	Difference extract volume flow rate Δq_v/ %
500 mm open	788	809	21	2.7
250 mm open	390	398	8	2.1
closed	100	104	4	4.0

5.0 Results

The fume cupboard **ZAFE 81 with LabVent LV-VAV/LVVI 250** has been tested in accordance with the type testing procedure for fume cupboards with VAV-system of EN 14 175-6: 2006. The requirements to the containment of the fume cupboard of the professional association of the german chemical industry (BG RCI), technical committee chemistry, dated 29.07.2003, were fulfilled at the tested volume flow rates and the values measured were below the required limit values.
The test results and conditions at the tested face velocities are given in short form in the "Certificate No. 1/FC-Z81/P6/06/13" and the amendment to the certificate "Results of the type testing of a fume cupboard in accordance with EN 14 175-6:2006, No. 1/FC-Z81/P6/06/13

The place of installation and the operation in and at the fume cupboard can lead to negative influence on the safe operation of the fume cupboard. Therefore, in practice substantially larger extract volume flow rates can be necessary for a safe operation of the fume cupboard than the extract volume flow rates adjusted for the tests.

Annex

1.0 Containment of the outer measurement plane in accordance with EN 14 175-6:2006

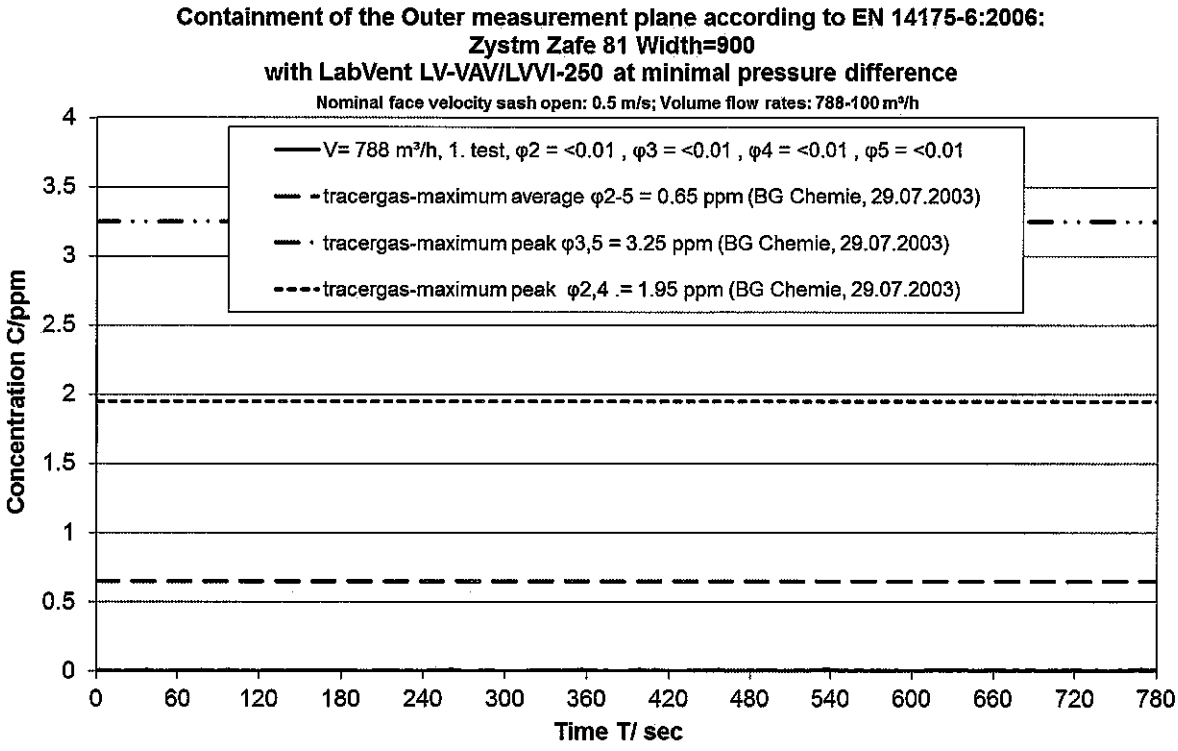


Diagram 1: 788 - 100 m³/h (sash 500 mm open- closed), minimal pressure difference

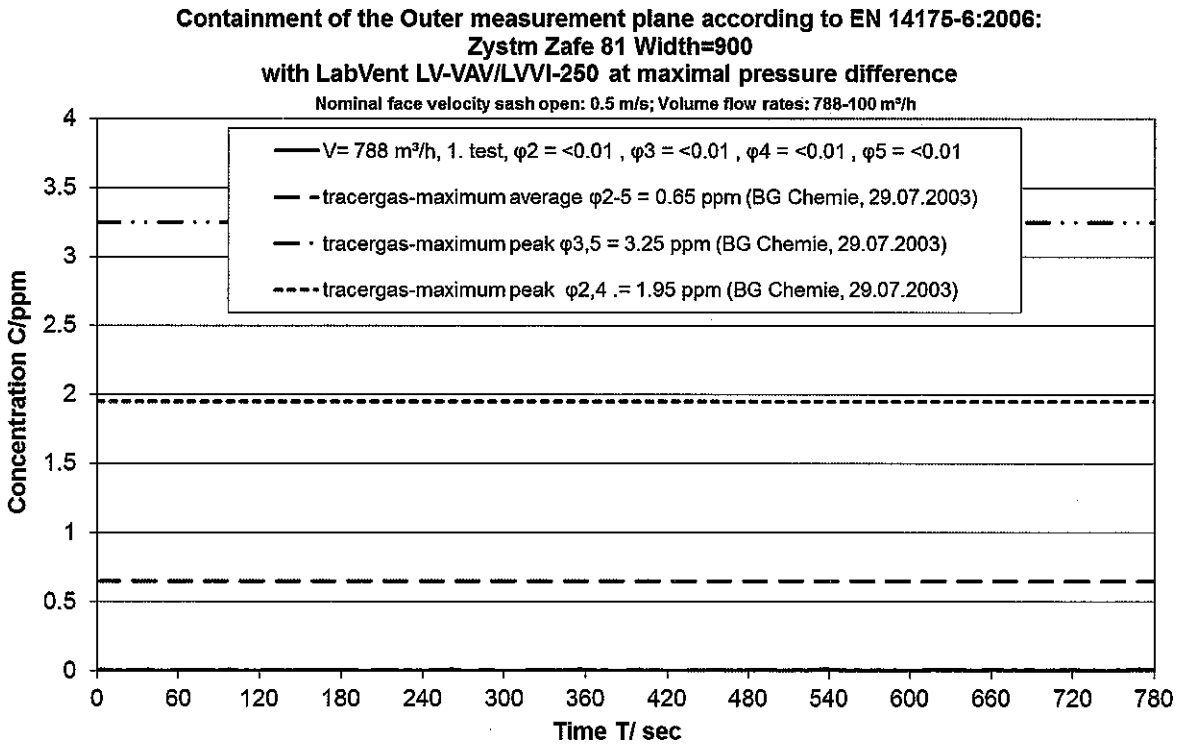


Diagram 2: 788 - 100 m³/h (sash 500 mm open- closed), maximal pressure difference

2.0 Testing of the reaction time in accordance with EN 14 175-6:2006

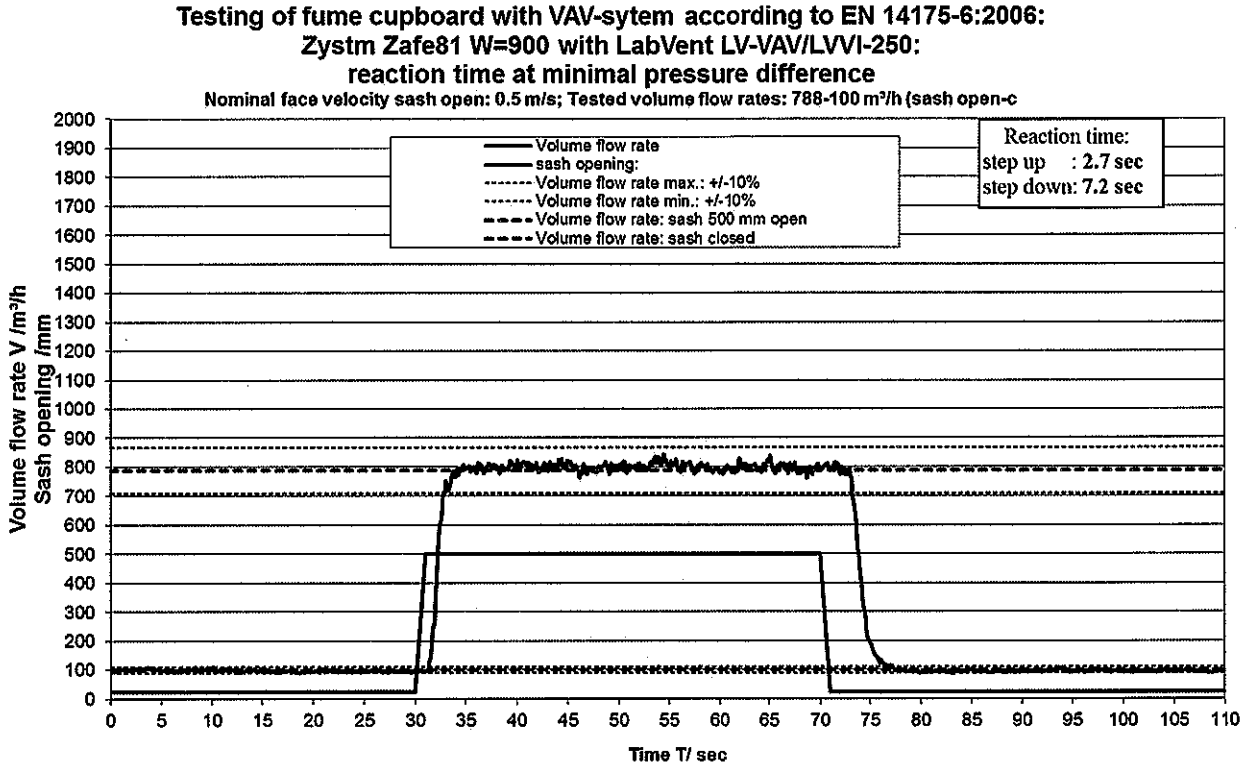


Diagram 3: reaction time, minimal pressure difference

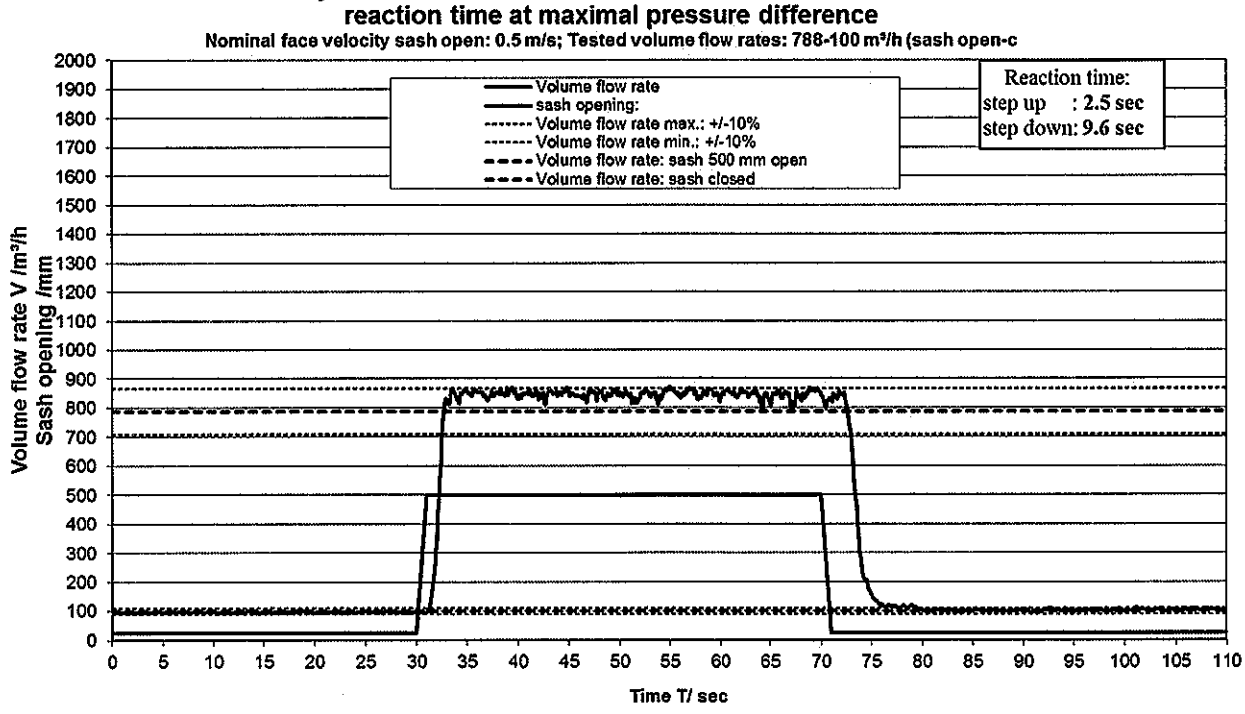
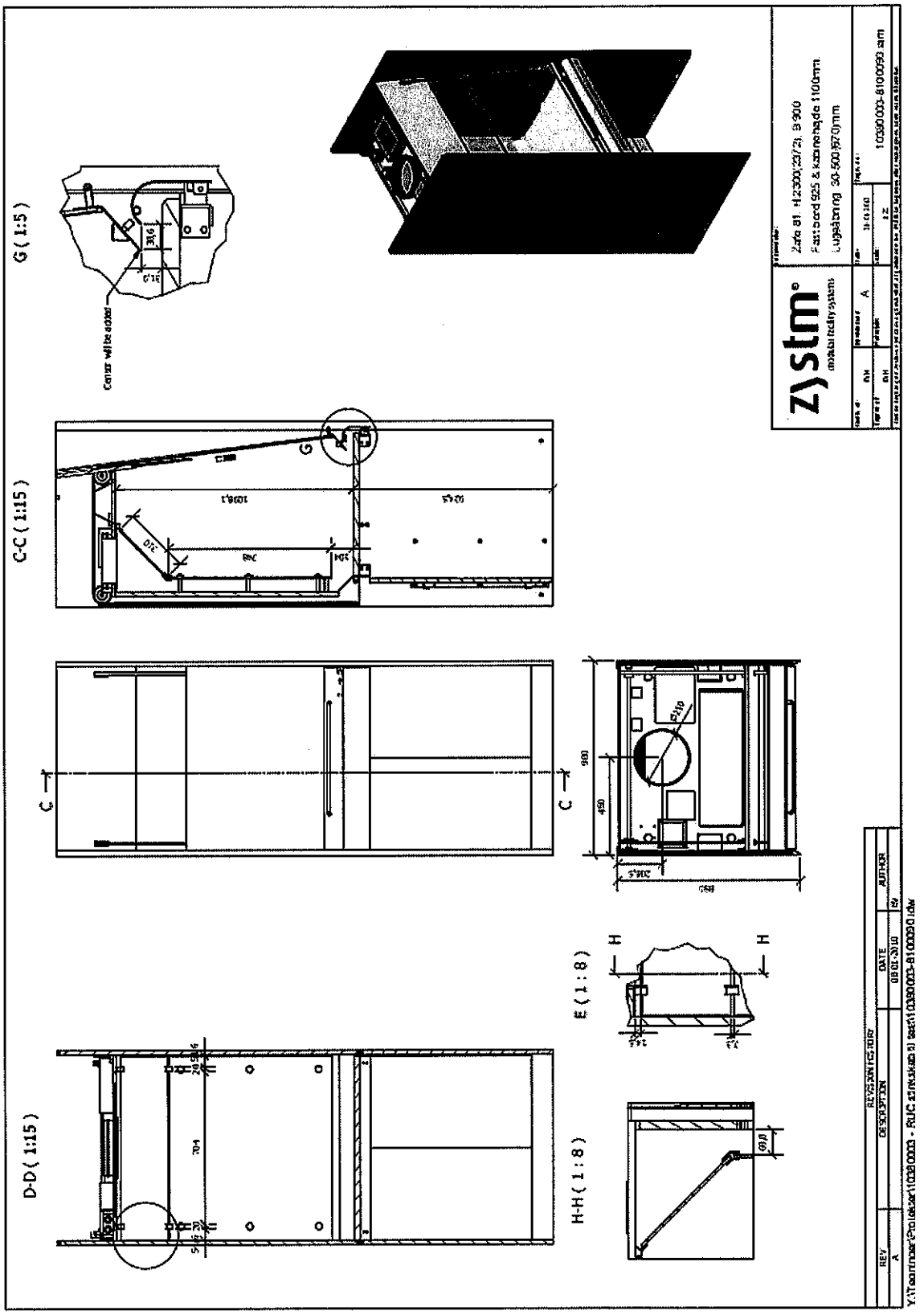


Diagram 4: reaction time, maximal pressure difference



Manufacturer drawing: Zystm ZAFE 81