DALIBOR JAKAC dipl. ing. stroj.

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IZVJEŠĆE O PROVEDENOM ISPITIVANJU ZRAKOPROPUSNOSTI ZGRADE

Obiteljska kuća

Naručitelj/vlasnik:	FILIP MARO PAVIČIĆ, Pješčana uvala II ogr 5A, Pula 52100, OIB 32079579251
Lokacija građevine:	Čuleti bb, 52000 Pazin k.č. 5876/3 k.o. Lindar
Oznaka izvještaja:	IZ - Čuleti BB
Imenovana osoba:	DALIBOR JAKAC, dipl. ing. stroj.
Mjesto i datum:	BUZET, rujan. 2025.

DALIBOR JAKAC Digitally signed by DALIBOR JAKAC Date: 2025.09.20 12:08:38 +02'00'

Na zahtjev naručitelja, temeljem članka 17. stavka 2. i članka 20. stavka 4. Zakona o gradnji (NN 153/13, 20/17, 39/19 i 125/19) i članak 30., stavak 1. Tehničkog propisa o racionalnoj uporabi energije i toplinskoj zaštiti u zgradama (NN 128/15, 70/18, 73/18, 86/18, 102/20) provedeno je ispitivanje zrakopropusnosti, a rezultati ispitivanja se daju u ovom izvještaju.
Za razliku tlakova između vanjskog i unutarnjeg zraka od 50 Pa izmjereni protok zraka ne smije biti veći od:
n50 = 3,0 h-1 za zgrade s prirodnom ventilacijom,
n50 = 1,5 h-1 za zgrade s mehaničkom ventilacijom,
n50 = 0,6 h-1 kod pasivnih zgrada.
Norma HRN EN ISO 9972:2015 navodi tri metode za ispitivanje:
Metoda 1 – zgrada u uporabi,
Metoda 2 – zgrada u izgradnji,
Metoda 3 – specijalni zahtjevi zgrada.

PRIMJENJENA NORMA	HRN EN ISO 9972:2015: Toplinske značajke zgrada -- Određivanje propusnosti zraka kod zgrada -- Metoda razlike tlakova (ISO 9972:2015; EN ISO 9972:2015)
METODA ISPITIVANJA:	Metoda 1, n50 = 3,0 h-1 za zgrade s prirodnom ventilacijom
VRSTA ISPITIVANJA:	Izvođenje testa s snižavanjem tlaka do - 50 Pa (norma HRN EN ISO 9972-2015) Točka /Clause 5.3 podtlak
	Izvođenje testa s povećanjem tlaka do + 50 Pa (norma HRN EN ISO 9972-2015) Točka /Clause 5.3 nadtlak

Volumetrijski podaci zgrade:

	Objekt I
Unutarnji volumen, V [m3]:	535
Površina ovojnice zgrade, Ae [m2]:	569
Neto podna površina, A [m2]:	168
Izmjena zraka na 50 Pa [h-1]	**2,82**
Protok zraka na 50 Pa [m3/h]	**539**

Rezultati ispitivanja:

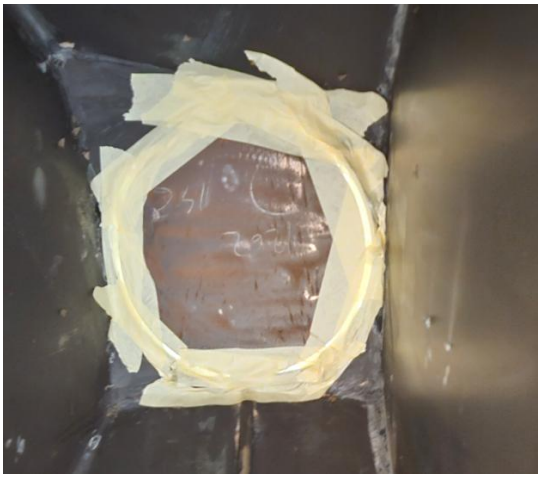
Simbol	**Mjerni podaci**	**Zahtjev HRN EN ISO 9972**	**Izmjereno**	**Proširena mjerna nesigurnost**
n50	Izmjena zraka na 50 Pa [h-1]	3	**2,82**	+/-2,1%
V50	Protok zraka na 50 Pa [m3/h]	3 x V	1507	+/-0,7%

Ispitivanjem zgrade utvrđeno je da ista **ZADOVOLJAVA** zahtjeve propisane u Tehničkom propisu o racionalnoj uporabi energije i toplinskoj zaštiti u zgradama (NN 128/15, 70/18, 73/18, 86/18, 102/20) i zahtjeve norme HRN EN ISO 9972. U nastavku izvještaja su svi podaci i dijagrami iz ispitivanja.

Test

In Compliance with ISO9972: 2015 – Europe

Building Address:	Čuleti bb
Performed for:	FILIP MARO PAVIČIĆ
Performed by:	Dalibor
Test date:	17-ruj-25
Associated Test file:	ISO9972EU Culeti Forza



Summary

retrotec **FanTestic**	version: **5.16.99**	licensed to: **Dalibor Jakac**
Test date: **17-ruj-25**	By: **Dalibor**	
Customer:	**FILIP MARO PAVIČIĆ**	
Building Lot Number:		
Building address:	**Čuleti bb**	

Building and Test Information	
Test file name:	**ISO9972EU Culeti Forza**
Building volume [m³]:	**535**
Envelope Area [m²]:	**569**
Floor Area [m²]:	**168**
Building Height (from ground to top) [m]:	**0.5**
Altitude [m]:	**400**
Accuracy of volume measurements:	**2%**
Accuracy of envelope area measurements:	**2%**
Accuracy of floor area measurements:	**1%**
Number of building storeys:	**2**

Results	
Air leakage rate at 50 Pa, q_{50} , [m³/h]	**1507.0**
Air changes at 50 Pa, n_{50} , Pa [/h]	**2.82**
Air leakage rate at 10 Pa, q_{10} , [m³/h]	**539.85**
Specific leakage rate (envelope) at 50 Pa, q_{E50} , [m³/h/m²]	**2.649**
Specific leakage rate (floor) at 50 Pa, q_{F50} , [m³/h/m²]	**8.971**
Effective leakage area at 50 Pa, ELA_{50} , [cm²]	**459.4**
Specific effective leakage area (envelope) at 50 Pa, ELA_{E50} , [cm²/m²]	**0.80738**
Specific effective leakage area (floor) at 50 Pa, ELA_{F50} , [cm²/m²]	**2.73**
Equivalent leakage area at 50 Pa (EqLA), [cm²]	753.1

Compliance

* Set 1 One or more of the test parameters is not valid.

* Set 1 (Difference between flow points too large, must be less than 10 Pa.)

Building Information

Building Measurements

Altitude above sea level [m]: 400

Building Volume [m³]: 535
Volume Measurement Accuracy: 2%

Envelope Area (A_E) [m²]: 569

Floor Area (A_F) [m²]: 168

Floor Area Measurement Accuracy: 1%
Envelope Measurement Accuracy: 2%

Building Height (from ground to top) [m]: 0.5
Building number of storeys: 2

Heating/Ventilation System

HVAC Systems Present:

Pictures

Test Method

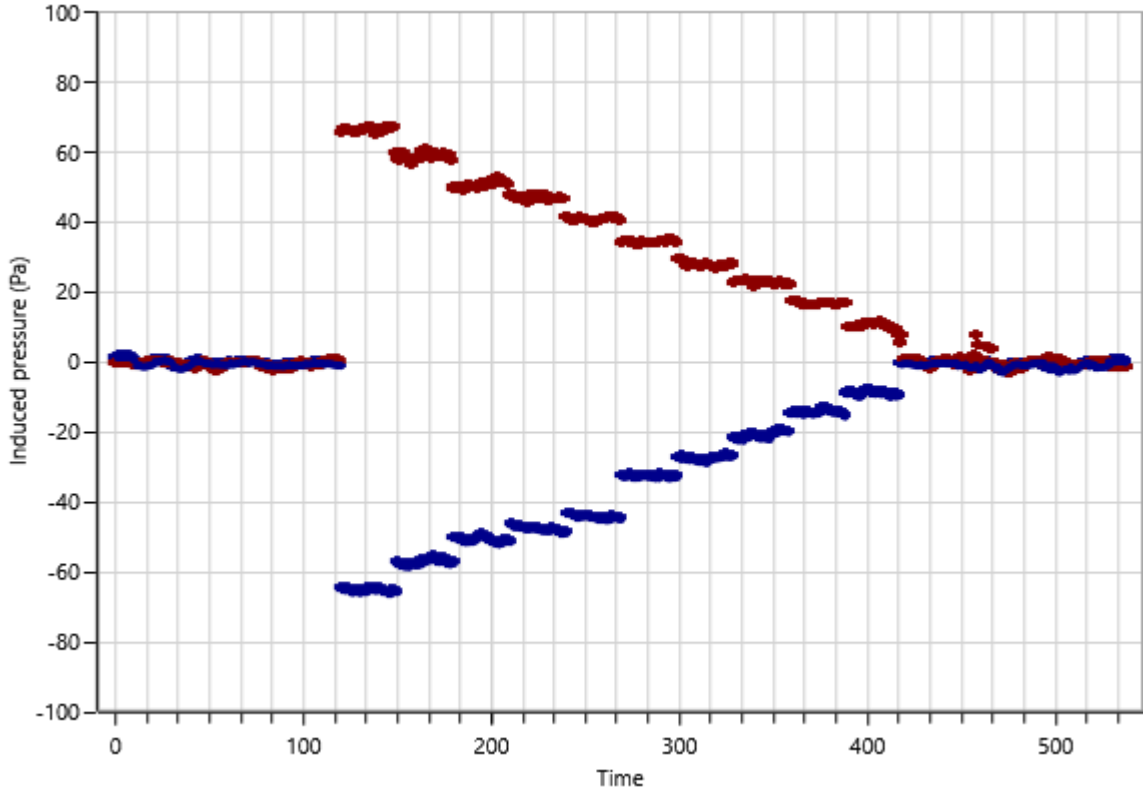
Test Notes:

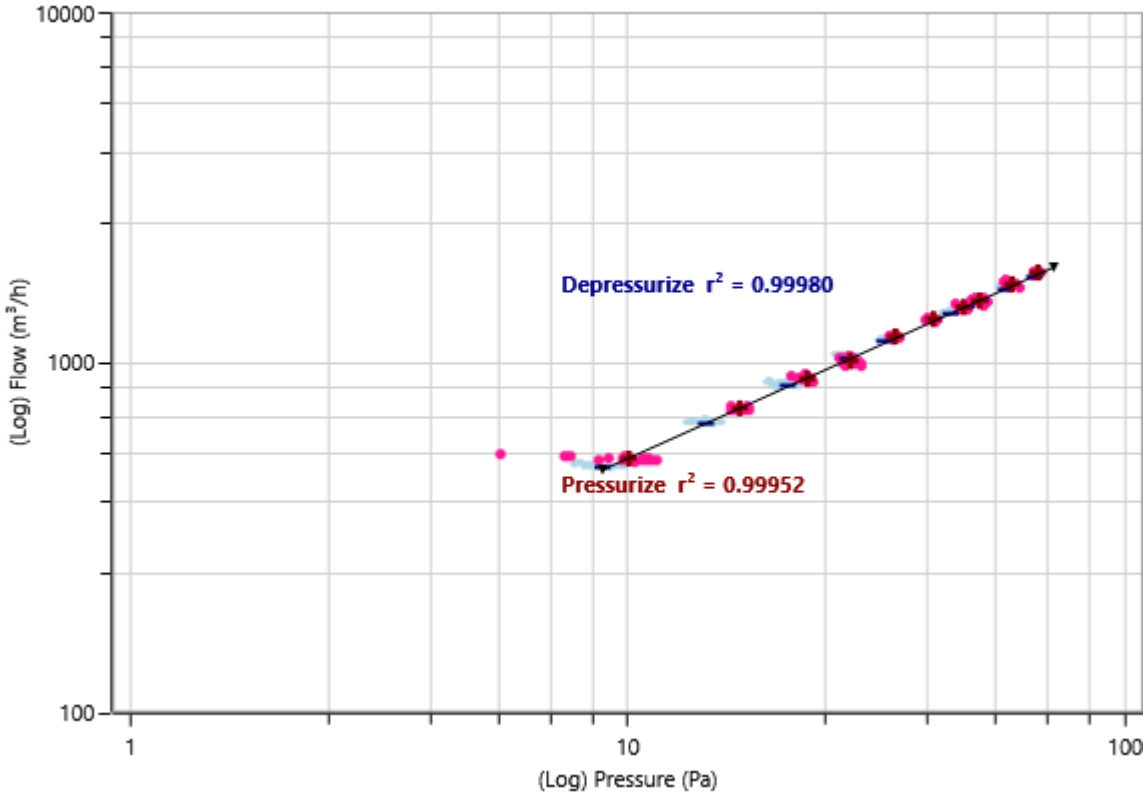
Discussion of Results

Combined Test Data (Average Values)

	Results	95% Confidence Interval		Uncertainty
Air leakage rate at 50 Pa, q_{50} , [m³/h]	1507.0	1497.0	1517.5	+/-0.7%
Air changes at 50 Pa, n_{50} , Pa, n50 [/h]	2.82	2.757	2.877	+/-2.1%
Air leakage rate at 10 Pa, q_{10} , [m³/h]	539.85	533.30	546.50	+/-1.2%
Specific leakage rate (envelope) at 50 Pa, q_{E50} , [m³/h/m²]	2.649	2.593	2.705	+/-2.1%
Specific leakage rate (floor) at 50 Pa, q_{F50} , [m³/h/m²]	8.971	8.862	9.081	+/-1.2%
Effective leakage area at 50 Pa, ELA_{50} , [cm²]	459.4	456.2	456.2	+/-0.7%
Specific effective leakage area (envelope) at 50 Pa, ELA_{E50} , [cm²/m²]	0.80738	0.790	0.825	+/-2.1%
Specific effective leakage area (floor) at 50 Pa, ELA_{F50} , [cm²/m²]	2.73	2.70	2.77	+/-2.1%

Equivalent leakage area at 50 Pa (EqLA), [cm²]	753.1	747.9	758.3	+/-0.7%





Air Leakage Test Data Appendix–

Depressurize Data Set 1

Test Dataset Date: 17-ruj-25

Start time: 10:38:51 UTC+1
Finish Time: 10:55:09

Environmental Conditions		
Wind speed:		from the
Wind (Beaufort):	4: Moderate breeze	
Operator Location:	Inside the building	
Greatest Baseline Pressure Point	-2.7 Pa	
Initial Bias Pressure:	-0.16 Pa	
Final Bias Pressure:	-0.66 Pa	
Average Bias Pressure:	-0.41 Pa	
Initial Temperature:	indoors: 24 C	outdoors: 20 C
Final Temperature:	indoors: 24 C	outdoors: 20 C
Barometric Pressure	101.325 kPa	from Standard temp/pressure

Depressurize Test Analysis				
Correlation, [%]:	99.980			
Coefficient of Determination, r^2	0.99980			
	Mean	95% confidence limits		Uncertainty
		Lower	Upper	
Slope, n:	0.629	0.621	0.636	
Air leakage coefficient, C_{env} [$m^3/h/Pa^n$]:	128.18	125.0	131.5	
Air leakage coefficient, C_L [$m^3/h/Pa^n$]:	128.19	125.0	131.5	
Air flow at 50 Pa, [m^3/h]	1498.7	1490	1507	+/-0.6%
Air changes at 50 Pa, n_{50} [/h]	2.801	2.743	2.859	+/-2.1%
Specific leakage rate (envelope) at 50 Pa, [$m^3/h/m^2$]	2.6339	2.579	2.689	+/-2.1%
Specific leakage rate (floor) at 50 Pa, [$m^3/h/m^2$]	8.9207	8.8185	9.0230	+/-1.1%
Effective leakage area at 50 Pa, [cm^2]	456.8	454.3	459.4	+/-0.6%
Specific effective leakage area (envelope) at 50 Pa, [cm^2/m^2]	0.80284	0.786	0.820	+/-2.1%
Specific effective leakage area (floor) at 50 Pa, [cm^2/m^2]	2.72	2.69	2.75	+/-1.1%

Measured pressure [Pa]		-65.4	-57.4	-51.0	-47.9	-44.5	-32.9	-27.8	-21.2	-14.6	-9.2		
Induced Pressure [Pa]		-65.0	-57.0	-50.6	-47.5	-44.1	-32.5	-27.4	-20.8	-14.2	-8.8		
#1 [500481], Range	Fan Pressure [Pa]						112.6	91.8	67.2	42.4			

B4													
	Flow [m³/h]						1166	1040	871.7	678.3			
	q_m [m³/h]						1172	1045	875.7	681.5			
	q_{env} [m³/h]						1156	1031	864.0	672.3			
#1 [500481], Range B8	Fan Pressure [Pa]	59.5	51.0	44.3	41.0	37.7							
	Flow [m³/h]	1778	1639	1522	1461	1397							
	q_m [m³/h]	1786	1646	1529	1468	1404							
	q_{env} [m³/h]	1762	1624	1508	1448	1385							
#1 [500481], Range B2	Fan Pressure [Pa]										102.7		
	Flow [m³/h]										509.0		
	q_m [m³/h]										511.3		
	q_{env} [m³/h]										504.4		
Total Flow, q_r [m³/h]		1778.23	1638.65	1521.87	1460.80	1397.28	1166.14	1040.29	871.705	678.317	508.961		
Measured Flow, q_m [m³/h]		1786.47	1646.25	1528.93	1467.57	1403.75	1171.55	1045.12	875.747	681.462	511.321		
Flow through envelope, q_{env} [m³/h]		1762.4	1624.1	1508.3	1447.8	1384.9	1155.8	1031.1	863.96	672.29	504.44		
Error [%]		-0.3%	-0.2%	-0.1%	-0.3%	-0.1%	1.1%	0.5%	0.2%	-1.1%	0.2%		

10 induced pressures each taken for 30 s. Settings are to take 10 points for 30 seconds each.

Total of 108 baseline readings taken before test, over 96 s of the 120 s that was set. 12 average baseline pressures are shown, each taken for 10 s.

Total of 108 baseline readings taken after test, over 97 s of the 120 s that was set. 12 average baseline pressures are shown, each taken for 10 s.

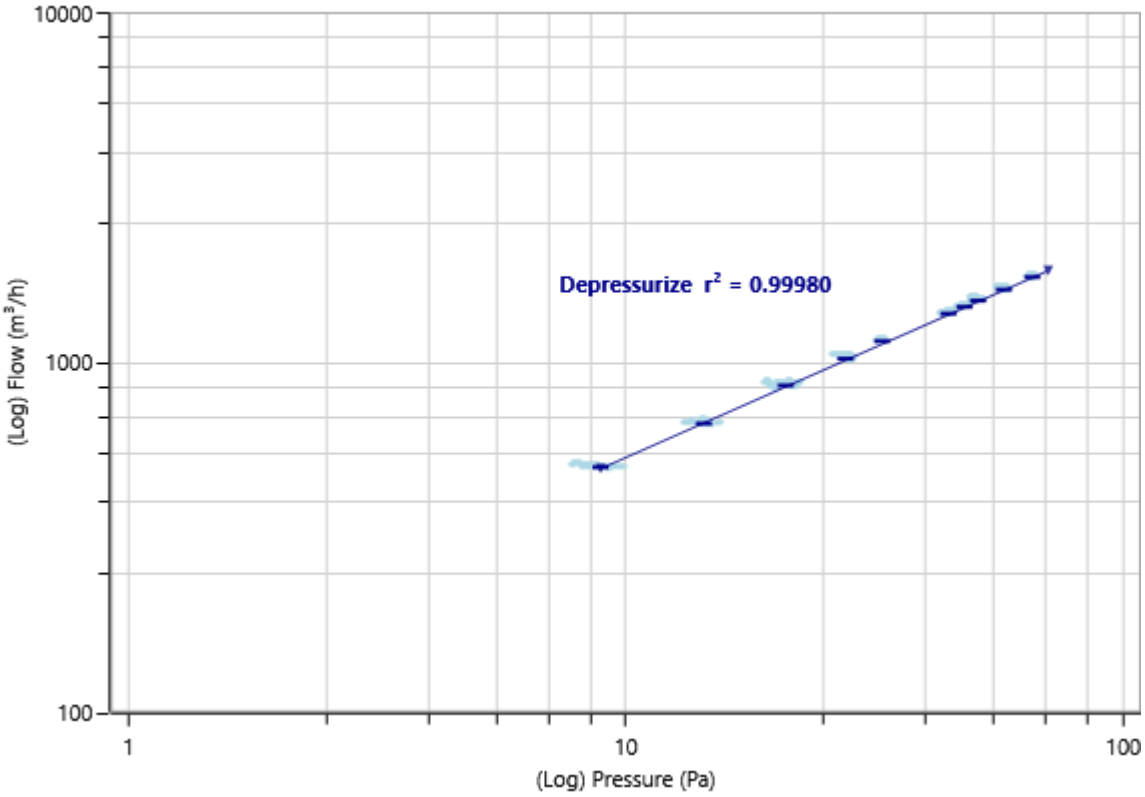
Baseline settings are to take 12 points for 10 seconds per point to make up the total duration.

Average Baseline, ΔP: -0.41 Pa
Greatest Baseline Pressure Point: -2.7 Pa

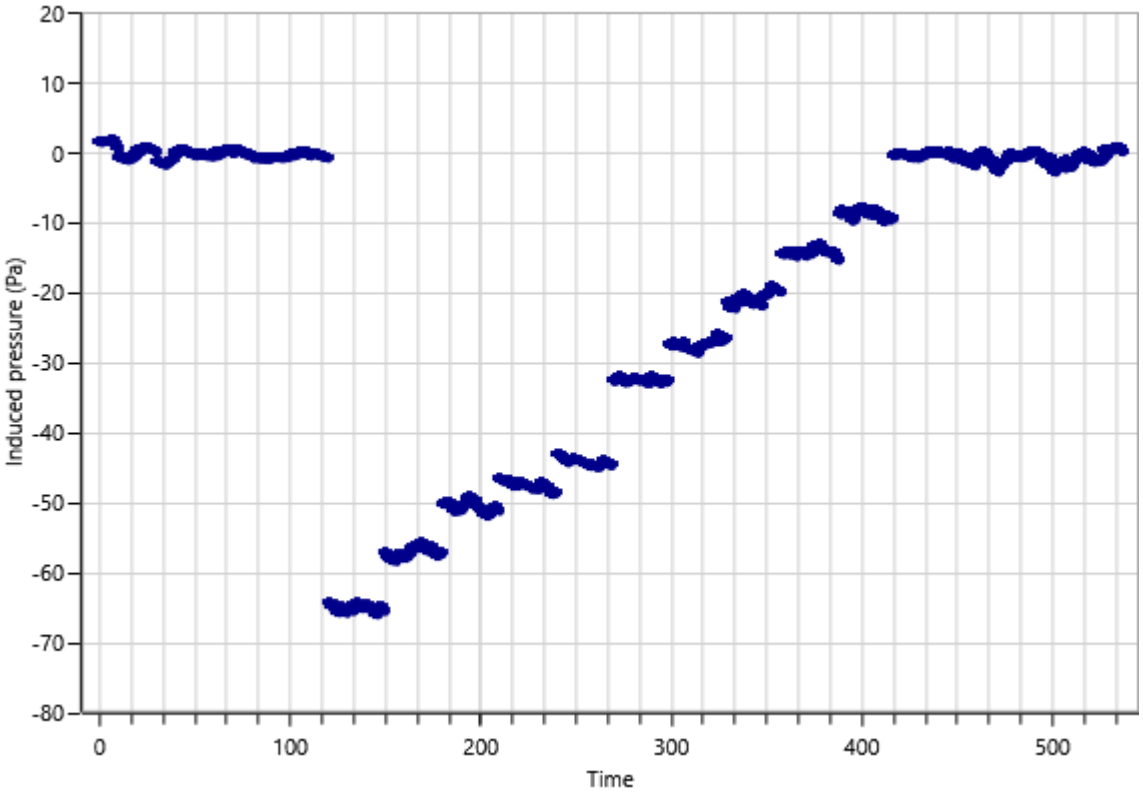
Static Pressure Averages:			
Average Baseline [Pa]	ΔP -0.41	Number of initial readings (108)	Number of final readings (108)
initial [Pa]	ΔP01 -0.16	ΔP01- -0.58	ΔP01+ 0.60
final [Pa]	ΔP02 -0.66	ΔP02- -0.91	ΔP02+ 0.19

Baseline, initial [Pa]	1.56	-0.70	0.50	-1.23	0.19	-0.38	0.10	-0.03	-0.78	-0.62	-0.11	-0.38
Baseline, final [Pa]	-0.33	-0.31	-0.02	-0.79	-0.69	-1.60	-0.44	-0.33	-1.87	-0.99	-0.91	0.39

Flow vs Induced Pressure (Depressurize Set)



Building Gauge Pressure (Depressurize Set)



Pressurize Data Set 2

Test Dataset Date: 17-ruj-25
Start time: 10:58:58 UTC+1
Finish Time: 11:12:51

Environmental Conditions		
Wind speed:		from the
Wind (Beaufort):	4: Moderate breeze	
Operator Location:	Inside the building	
Greatest Baseline Pressure Point:	7.4 Pa	
Initial Bias Pressure:	-0.66 Pa	
Final Bias Pressure:	-0.21 Pa	
Average Bias Pressure:	-0.43 Pa	
Initial Temperature:	indoors: 24 C	outdoors: 19 C
Final Temperature:	indoors: 24 C	outdoors: 19 C
Barometric Pressure:	101.325 kPa	from Standard temp/pressure

Pressurize Test Analysis				
Correlation, r [%]:	99.952			
Coefficient of Determination, r^2	0.99952			
	Mean	95% confidence limits		Uncertainty
		Lower	Upper	
Slope, n:	0.647	0.636	0.659	

Air leakage coefficient, C_{env} [m³/h/Pa^n]:	121.00	116.2	126.0	
Air leakage coefficient, C_L [m³/h/Pa^n]:	120.43	115.6	125.4	
Air flow at 50 Pa, [m³/h]	1515.7	1503	1528	+/-0.8%
Air changes at 50 Pa, n_{50} [/h]	2.833	2.772	2.894	+/-2.2%
Specific leakage rate (envelope) at 50 Pa, [m³/h/m²]	2.6637	2.606	2.721	+/-2.2%
Specific leakage rate (floor) at 50 Pa, [m³/h/m²]	9.0218	8.9049	9.1386	+/-1.3%
Effective leakage area at 50 Pa, [cm²]	462.0	458.2	465.8	+/-0.8%
Specific effective leakage area (envelope) at 50 Pa, [cm²/m²]	0.81193	0.794	0.829	+/-2.2%
Specific effective leakage area (floor) at 50 Pa, [cm²/m²]	2.75	2.71	2.79	+/-1.3%

Measured pressure [Pa]		65.7	58.3	50.1	46.5	40.3	33.7	27.3	22.3	16.2	9.5		
Induced Pressure [Pa]		66.1	58.7	50.5	46.9	40.8	34.2	27.7	22.8	16.6	10.0		
#1 [500481], Range B2	Fan Pressure [Pa]										119.5		
	Flow [m³/h]										531.3		
	q_m [m³/h]							1045			529.2		
	q_{env} [m³/h]										538.3		
#1 [500481], Range B8	Fan Pressure [Pa]	127.1	111.2	93.2	86.3								
	Flow [m³/h]	1808	1672	1500	1440								
	q_m [m³/h]	1801	1666	1495	1434								
	q_{env} [m³/h]	1831	1694	1520	1458								
#1 [500481], Range B4	Fan Pressure [Pa]					184.2	149.9	114.4	93.1	66.0			
	Flow [m³/h]					1330	1186	1009	897.5	738.8			
	q_m [m³/h]					1325	1181	1005	894.1	735.9			

	q_{env} [m³/h]					1347	1202	1022	909.4	748.5			
Total Flow, q_r [m³/h]		1807.69	1672.25	1500.38	1439.51	1329.90	1186.08	1008.93	897.537	738.807	531.271		
Measured Flow, q_m [m³/h]		1800.68	1665.76	1494.56	1433.92	1324.73	1181.48	1005.01	894.054	735.939	529.209		
Flow through envelope, q_{env} [m³/h]		1831.5	1694.3	1520.1	1458.5	1347.4	1201.7	1022.2	909.36	748.53	538.27		
Error [%]		0.3%	0.3%	-0.8%	-0.2%	1.0%	1.0%	-1.7%	-0.6%	0.2%	0.5%		

10 induced pressures each taken for 30 s. Settings are to take 10 points for 30 seconds each.

Total of 108 baseline readings taken before test, over 97 s of the 120 s that was set. 12 average baseline pressures are shown, each taken for 10 s.

Total of 107 baseline readings taken after test, over 98 s of the 120 s that was set. 12 average baseline pressures are shown, each taken for 10 s.

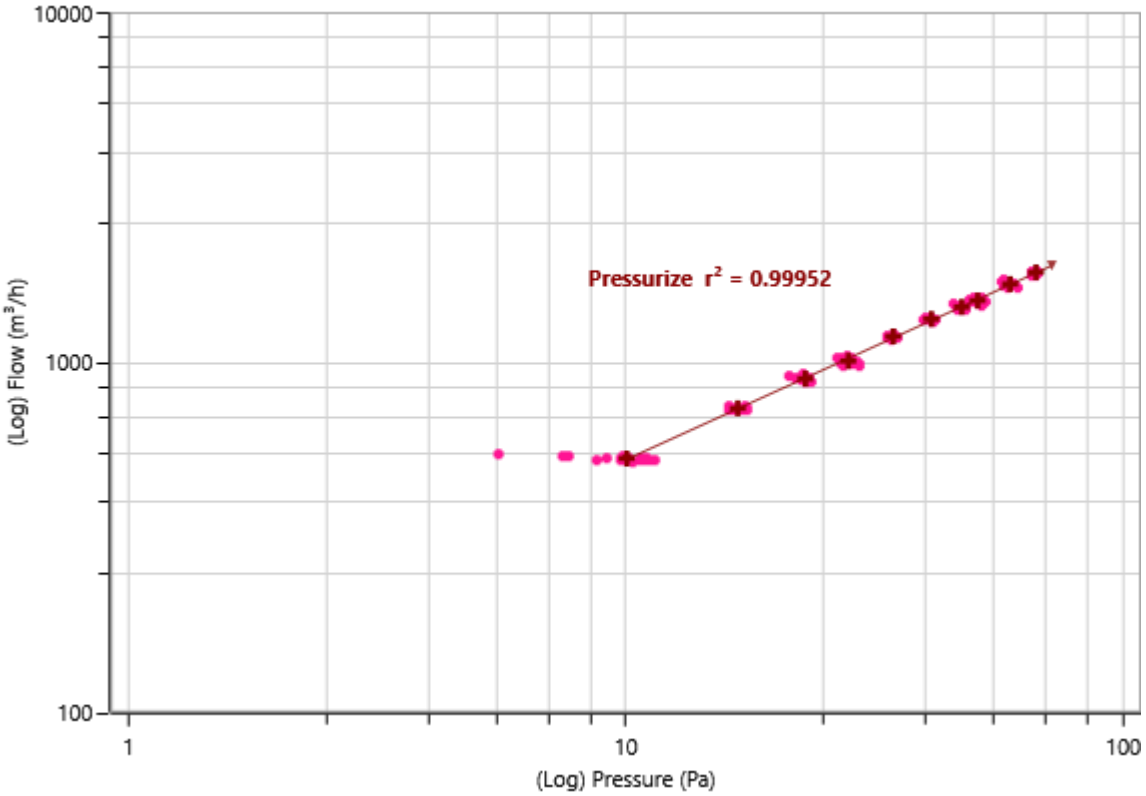
Static settings are to take 12 points for 10 seconds per point to make up the total duration.

Average Baseline, ΔP: -0.43 Pa
Greatest Initial Baseline Pressure: 7.4 Pa

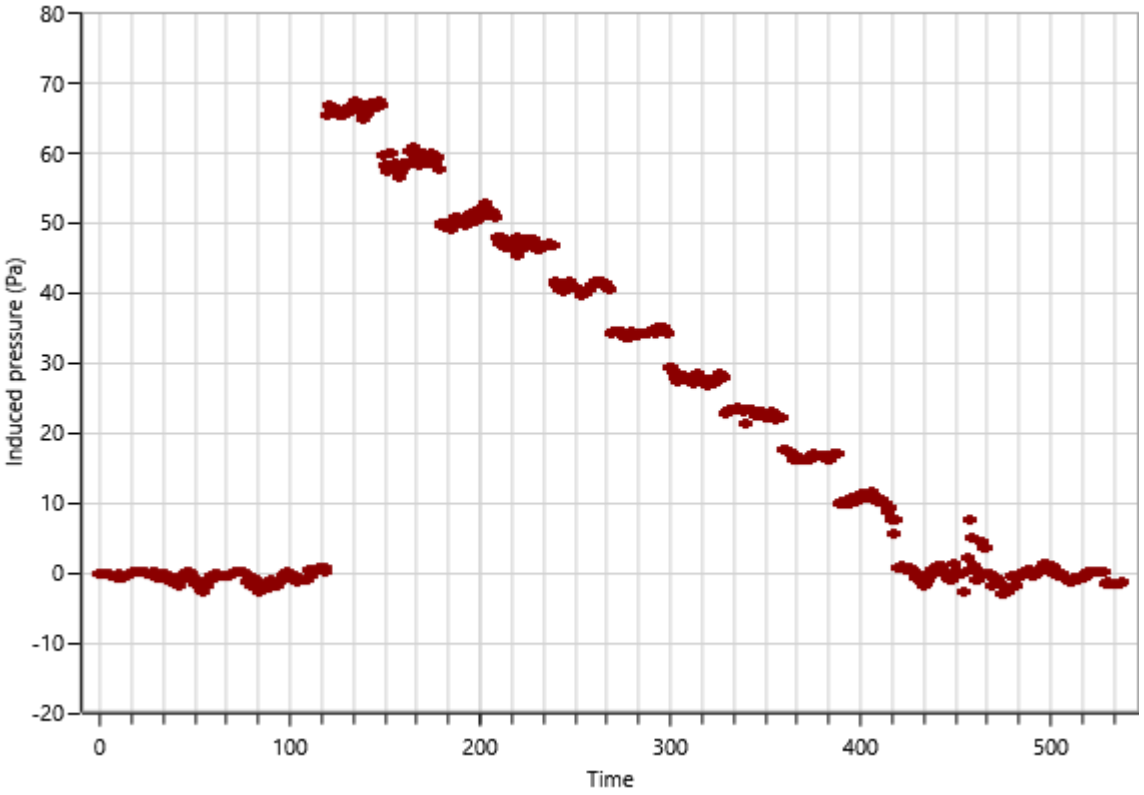
Static Pressure Averages:			
Average [Pa]	ΔP -0.43	Number of initial readings (108)	Number of final readings (107)
initial [Pa]	ΔP01 -0.66	ΔP01- -0.91	ΔP01+ 0.19
final [Pa]	ΔP02 -0.21	ΔP02- -1.09	ΔP02+ 0.95

Baseline, initial [Pa]	-0.33	-0.31	-0.02	-0.79	-0.69	-1.60	-0.44	-0.33	-1.87	-0.99	-0.91	0.39
Baseline, final [Pa]	0.59	-0.71	-0.01	1.24	0.86	-2.04	-0.57	0.38	-0.01	-0.97	0.07	-1.50

Flow vs Induced Pressure (Pressurize Set)



Building Gauge Pressure (Pressurize Set)



Test Equipment

The following test equipment was used in the performance of the air leakage tests.

	Fan	Fan serial	Fan location	Gauge	Gauge serial	Gauge Calibration
#1	Retrotec 5000			DM32X	500481	

Fan Calibration Certificate Retrotec 5000:

Retrotec 5000 Fan last calibrated: (Flow Equation Parameters - D1) . . CFM							
Range	**n**	**K**	**K1**	**K2**	**K3**	**K4**	**MF**
Open	0.499	555.2	0	0.3	0	1	10
A	0.503	290.9	0	0.4	0	1	20
B8	0.527	121.5	0	0.7	0	1	35

Polynomial Range	**g**	**f**	**a**	**b**	**c**	**d**	**K2**	**MF**
B4	50	0.589	0.0000177	-0.0153	6.274	138.4	0.8	40
B2	50	0.918	0.00000253	-0.004662	2.754	25.71	1	50
B1	50	0.447	0.00000274	-0.003137	1.489	10.71	1	60
B74	30	0.129	0.00000165	-0.001495	0.6592	15.95	0.8	55
B47	30	0.0235	0.00000083	-0.0007298	0.3072	7.946	1	25
B29	30	0.0177	0.000000144	-0.0001854	0.1001	2.978	0.6	50

Fan Pressure (FP) is the measured fan pressure when using a self-referenced fan or when Room Pressure (RP) is negative. If using a fan which is not self-referenced, and Room Pressure is positive, Fan Pressure is calculated by subtracting the measured Room Pressure from the Absolute Value of the Fan Pressure.

If PrA>0 and fan is not self-referencing: FP = |PrB|-PrA
If PrA<0 or fan is self-referencing: FP = PrB

Flow calculations are not valid if Fan Pressure is less than either MF or (K2 x |RP|).

Flow in CFM using the above coefficients is calculated as follows for standard Ranges:

$$flow = (FP - (|RP| \times K1))^N \times (K + (K3 \times FP))$$

Flow in CFM using the above polynomial coefficients is calculated as follows:

$$flow = (a \times FP^3) + (b \times FP^2) + (c \times FP) + d + ((g - |RP|) \times f)$$