AMCA 210 Series
Wind Tunnel Introduction

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Content

Long Win – Taiwan

Long Win **Introduction**

Expert in:

1. Electronics **thermal management.**
2. Mechanics and manufacture engineering.
3. Control field technologies.
4. More than **600 system design experiences**.
5. More than **2000 m^2 fluid and thermal lab.**

AMCA 210 Standard

Lab. Methods of Testing Fans for Aerodynamic Performance Rating

Published by

ANSI/AMCA 210-07
ANSI/ASHRAE 51-2007

Air **M**ovement and **C**ontrol **A**ssociation

American **N**ational **S**tandard **I**nstitute

American **S**ociety of **H**eating, **R**efrigerating and **A**ir Conditioning **E**ngineers

Long Win Wind Tunnel Compliance

ISO 5801- 2007

Industrial fans -- Performance testing using standardized airways

AMCA 210- 07 ASHRAE 51- 07

Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

GB/T 1236- 2000

IEC 61591-2005

Household Range Hoods - Methods for Measuring Performance

JIS B 8330

Long Win

AMCA 210-07 Series Wind Tunnel

Introduction | Principle | Operation | Calibration | Features | Model

Application

AMCA 210-99 Wind Tunnel Introduction

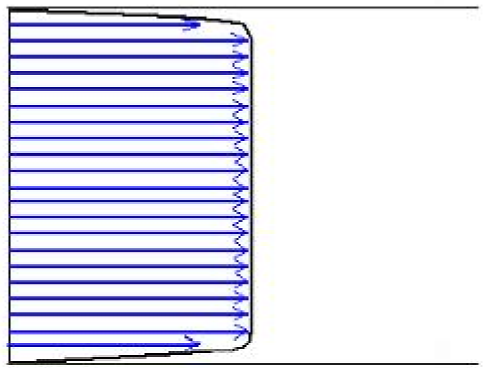
Wind Tunnel with
Flow / Pressure Measuring Mode

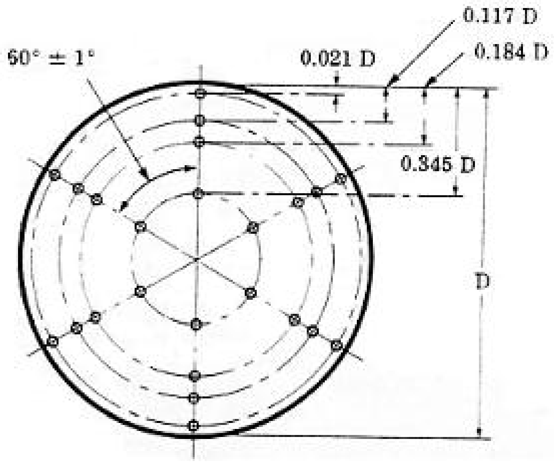
A. Flow Measuring Mode:
Low Cost.
Large Uncertainty.

B. Pressure Measuring Mode:
Higher Cost to Compare with A Mode.
Higher Accuracy and Repeatability.

A. Flow Measuring Ducts

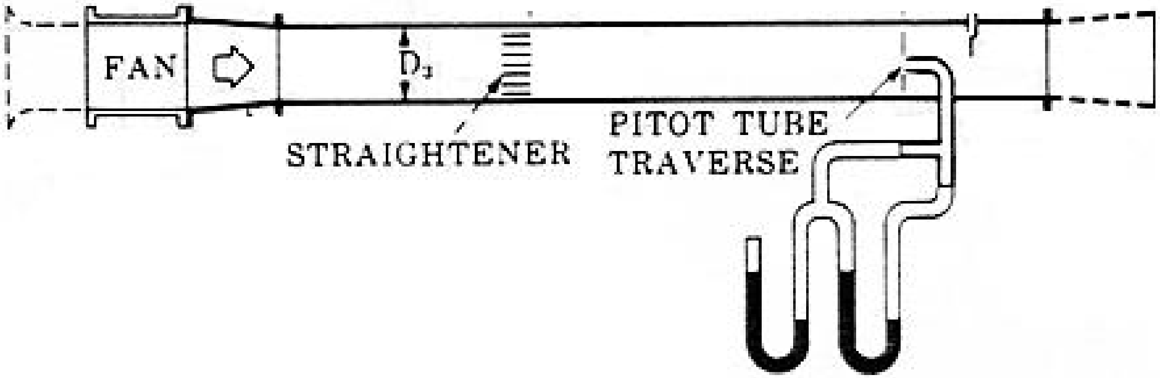
Circular Cross-section, 24 Points Measuring.
AMCA 210-99 Fig.7、13、16 Structure.





$$Q = U_{duct} \times A_{duct}$$

Uduct : Average Velocity.
Aduct : Cross-section .
Q : Volume Flow rate.



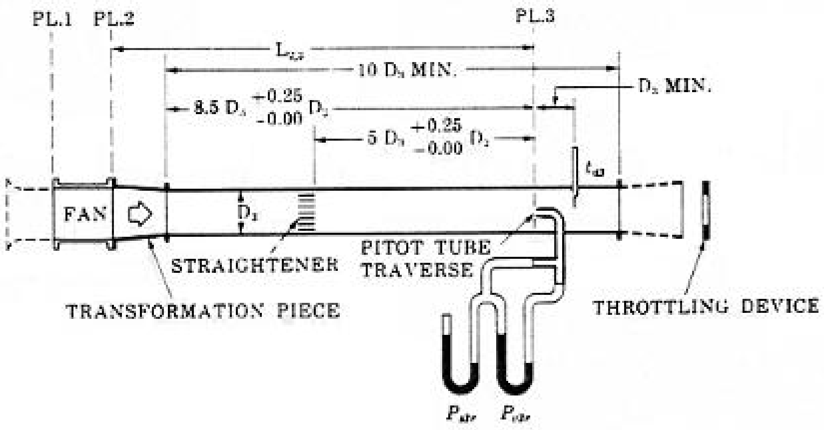


Figure 7 Outlet Duct
ANSI/AMCA STANDARD 210-85

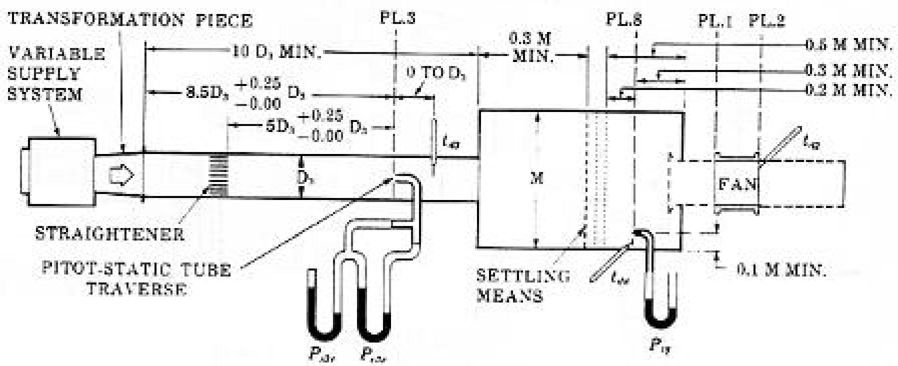


Figure 13 Inlet Chamber
ANSI/AMCA STANDARD 210-85

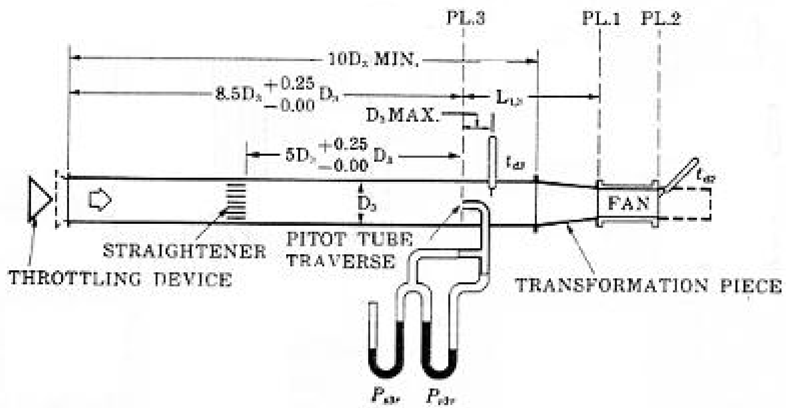


Figure 16 Inlet Duct
ANSI/AMCA STANDARD 210-85

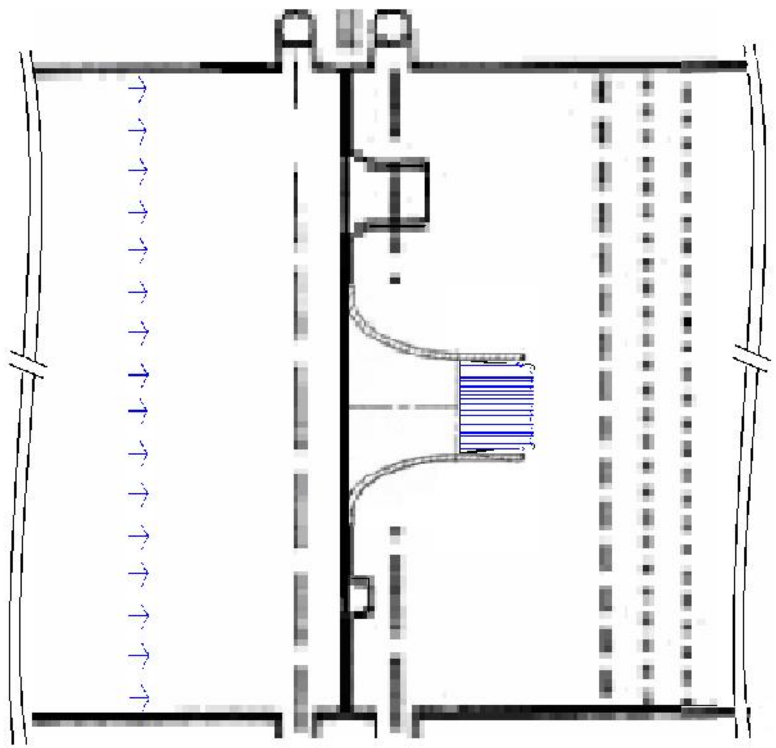
1985 Long Win
Fundamental, Forward & First

B. Pressure Measuring Mode:

Duct & Chamber to Measuring the Pressure Difference Across the Nozzle(△P56) to Calculate the Air Flow Rate.
Fig.8～12，14，15 Structure.

$Q_N = C_d \times U_n \times A_n$ single nozzle
$Q_T = \Sigma\ Q_N$ multi-nozzle

Cd : Discharge Coefficient.
Un : Velocity at Nozzle Throttle.
An : Nozzle Throttle Cross-section.
QN : Single Nozzle Air Flow Rate
QT : Multi Nozzle Air Flow Rate.



△P Across the Nozzle

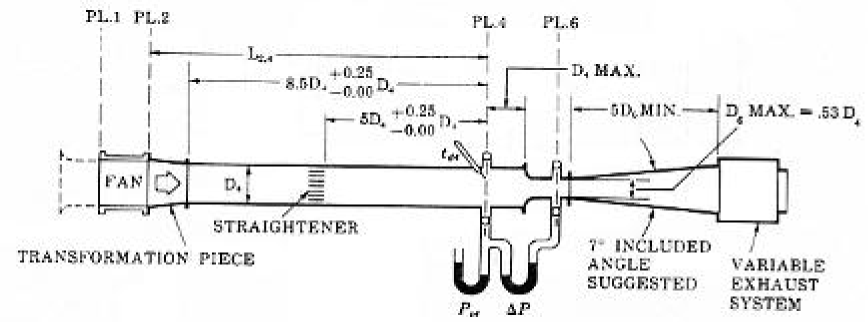


Figure 8 Outlet Duct
ANSI/AMCA STANDARD 210-85

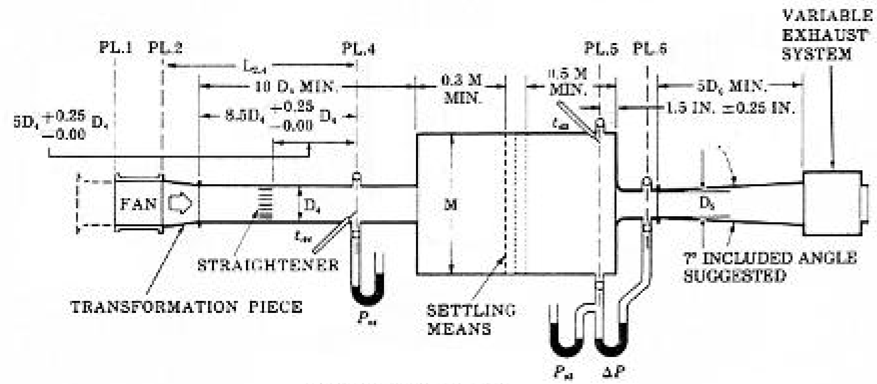


Figure 9 Outlet Duct
ANSI/AMCA STANDARD 210-85

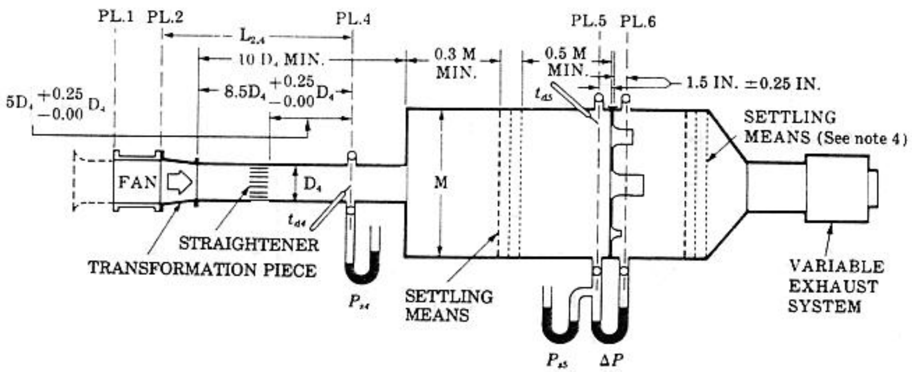


Figure 10 Outlet Duct
ANSI/AMCA STANDARD 210-85

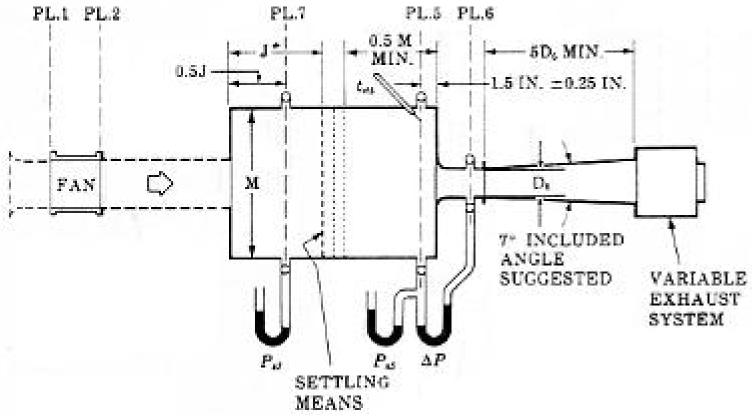


Figure 11 Outlet Chamber
ANSI/AMCA STANDARD 210-85

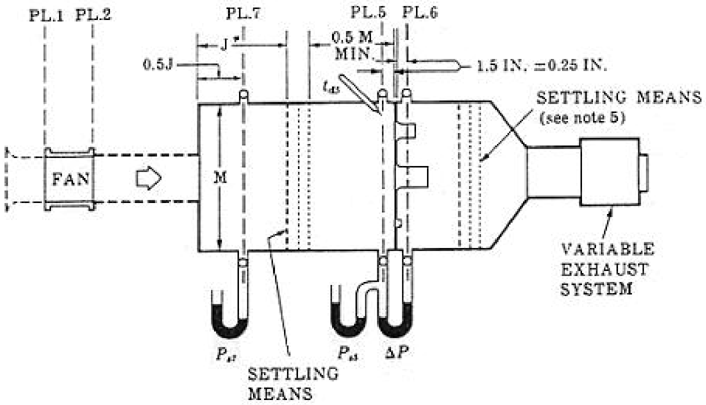


Figure 12 Outlet Chamber
ANSI/AMCA STANDARD 210-85

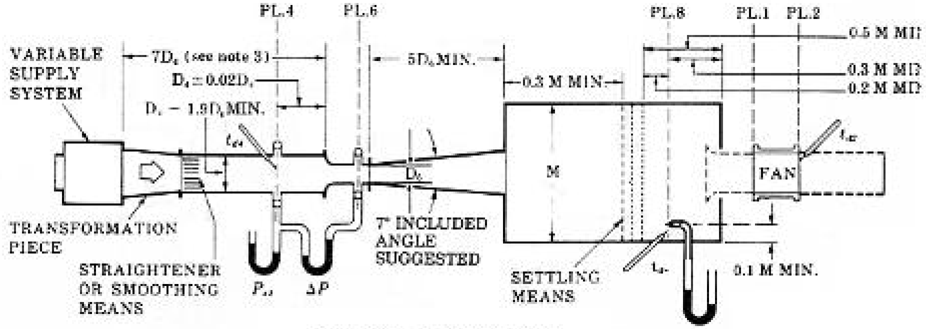


Figure 14 Inlet Chamber
ANSI/AMCA STANDARD 210-85

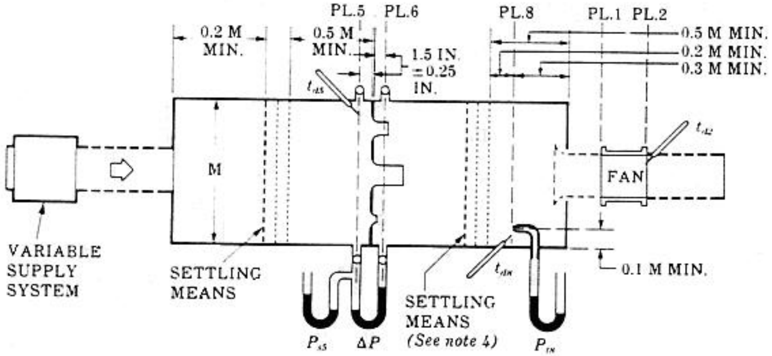
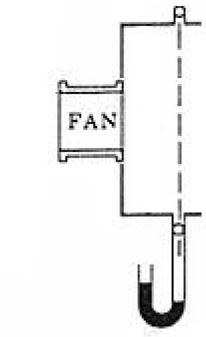
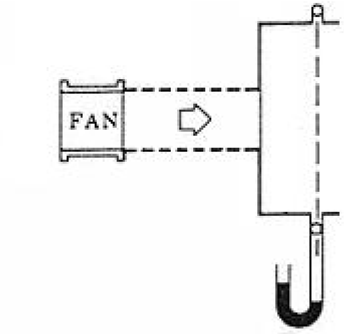
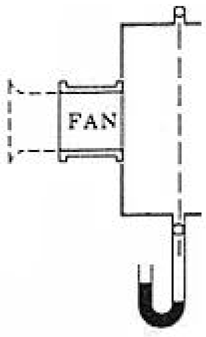
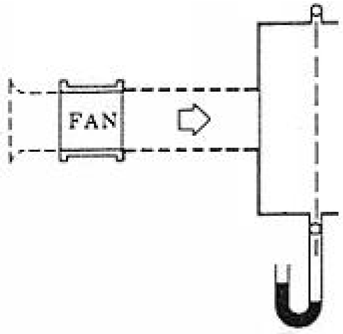


Figure 15 Inlet Chamber
ANSI/AMCA STANDARD 210









Type A
Free Inlet,
Free Outlet

Type B
Free Inlet,
Ducted Outlet

Type C
Ducted Inlet,
Free Outlet

Type D
Ducted Inlet,
Ducted Outlet

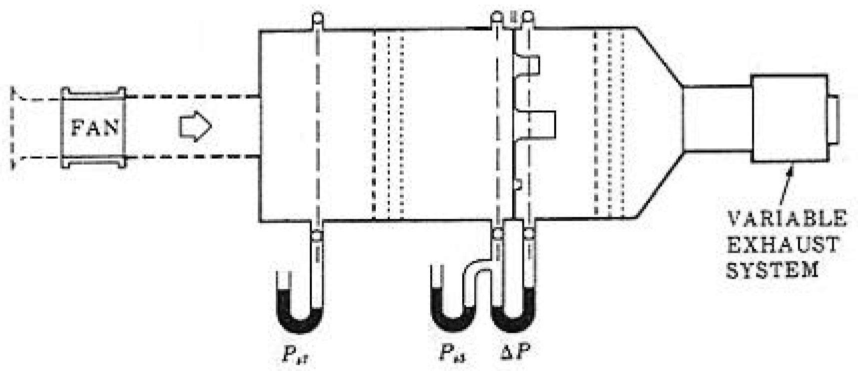


Fig.12 12025 DC12V with Different Type

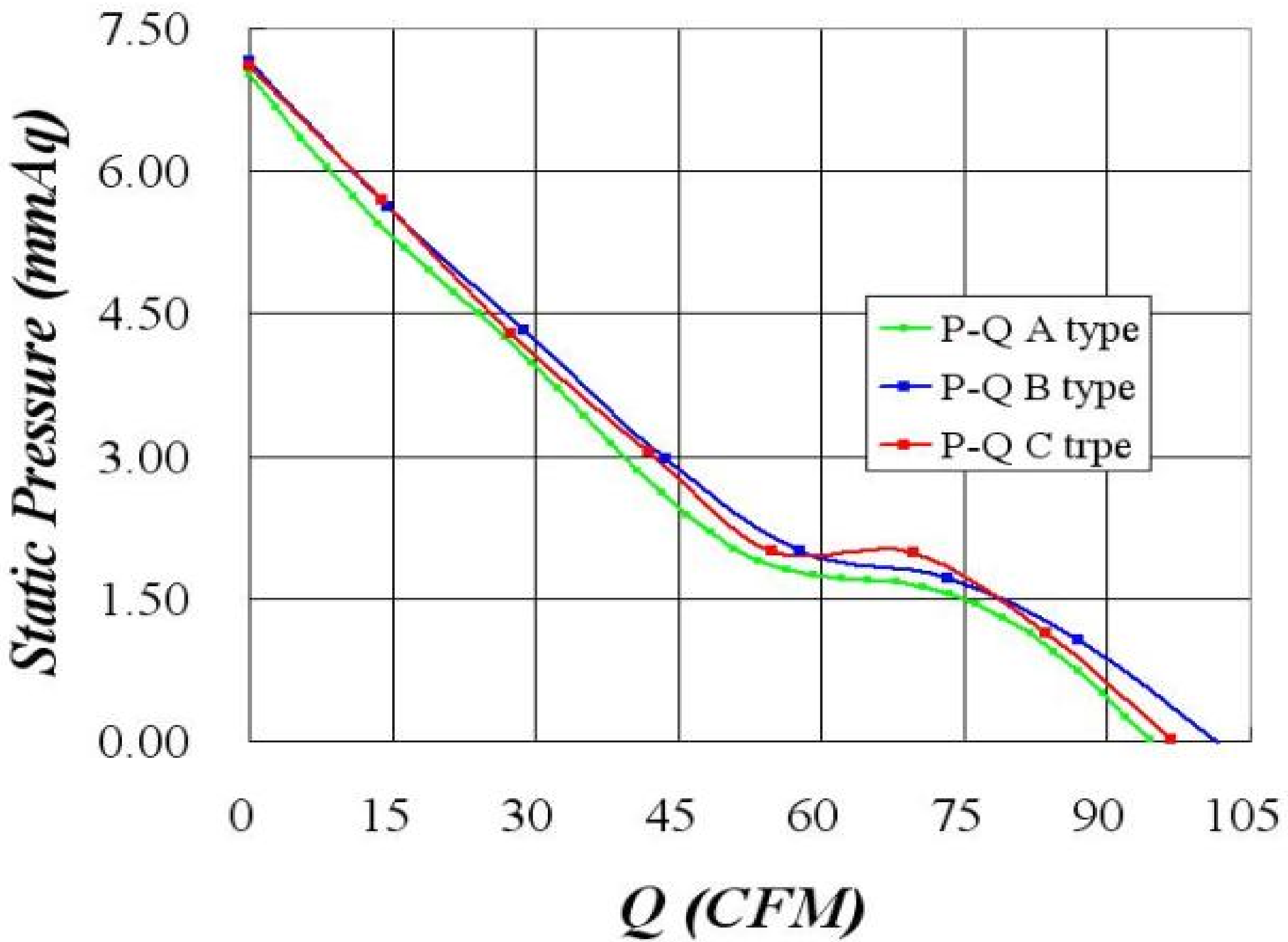


Fig.12/15 8038 DC12V with Different Type

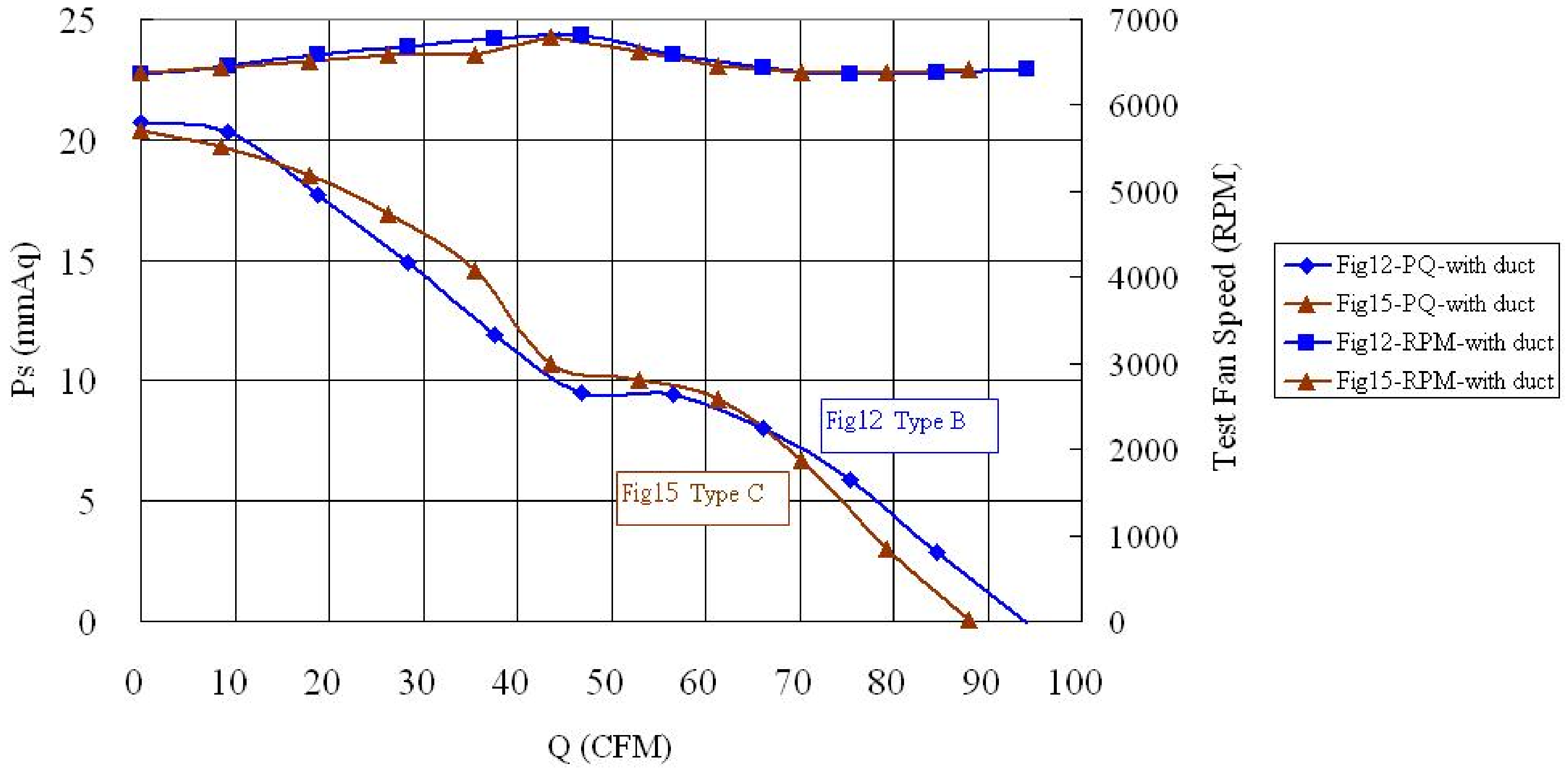


Fig.12/15 8038 DC12V with Type A

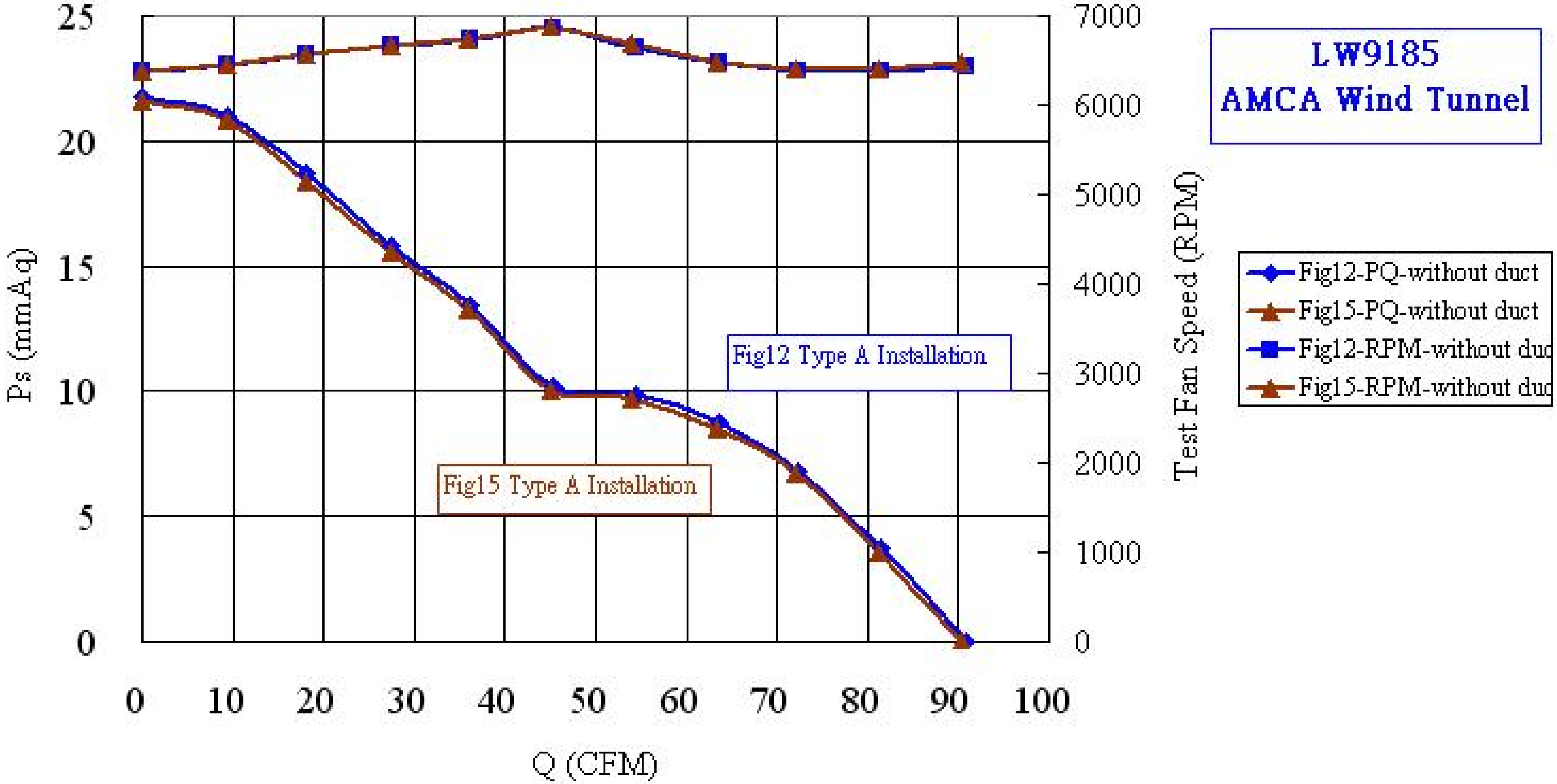
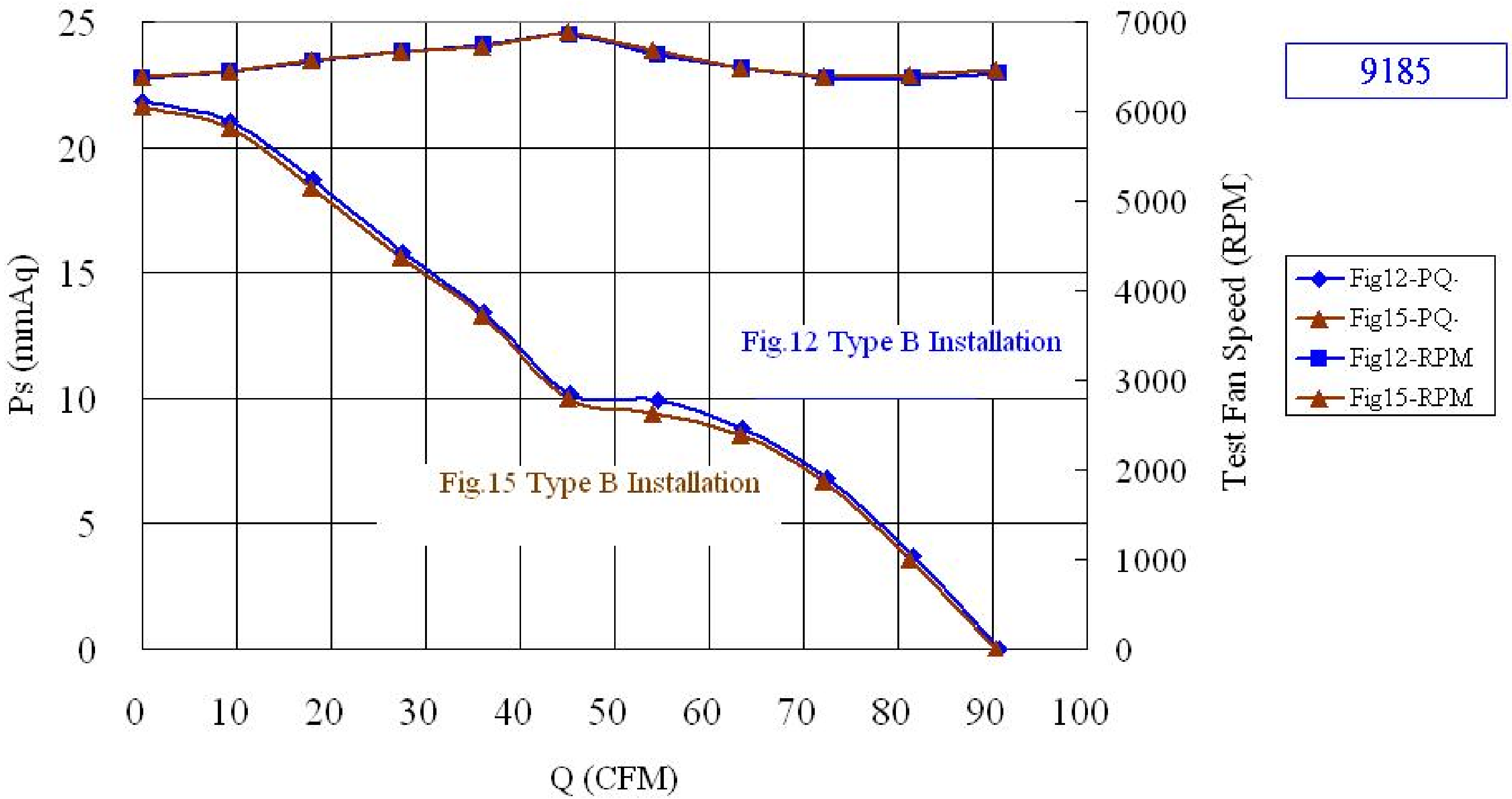
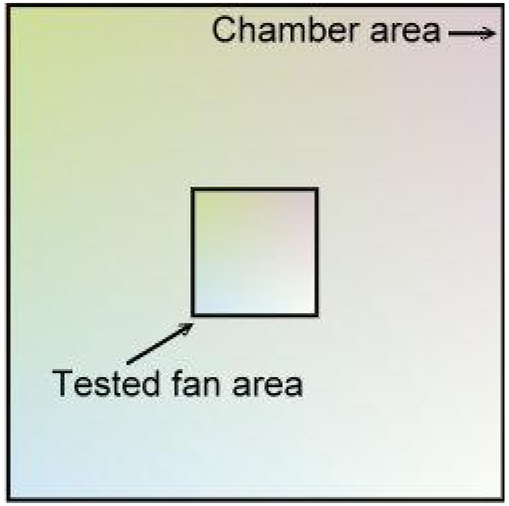


Fig.12/15 8038 DC12V with Type B





Outlet Chambers

An outlet chamber (Figure 11 or 12) shall have a cross-sectional area at least **nine times** the area of the fan outlet or outlet duct for fans with axis of rotation perpendicular to the discharge flow and a cross-sectional area at least **sixteen times** the area of the fan outlet or outlet duct for fans with axis of rotation parallel to the discharge flow.

Inlet Chambers

Inlet chambers (Figure 13, 14, or 15) shall have a cross- sectional area at least **five times** the fan inlet area.

From AMCA 210-99 page10

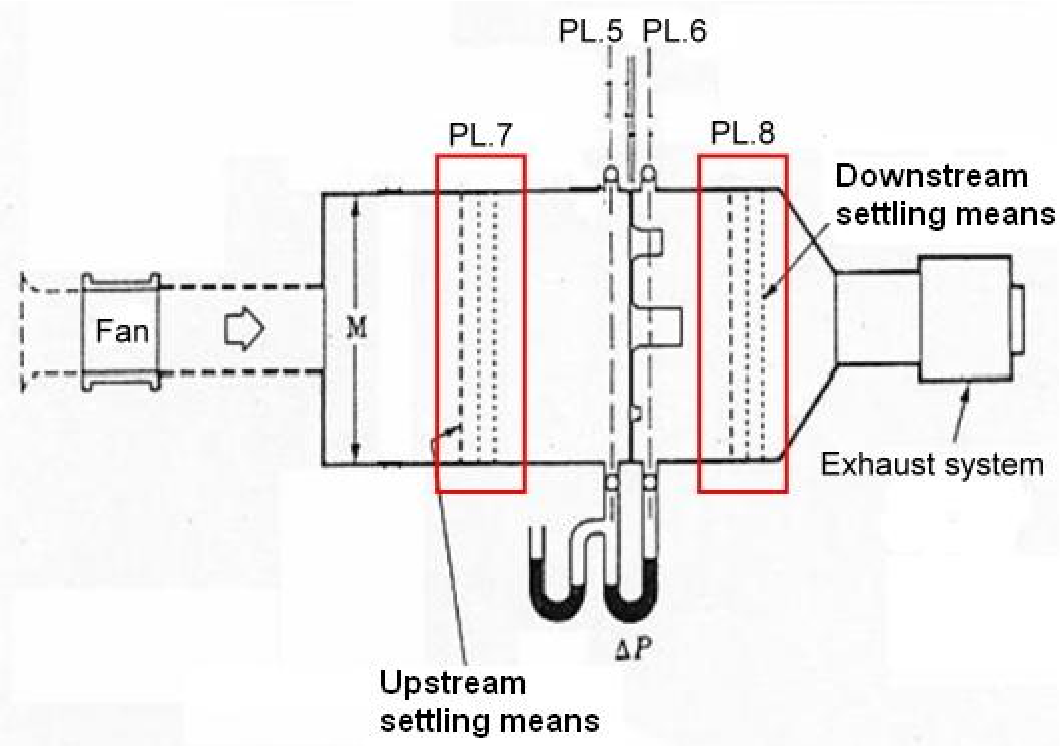
different chamber shapes

A chamber may have a **circular** or **rectangular** cross-sectional shape.

The dimension M in the test setup diagram is the inside diameter of a circular chamber or the equivalent diameter of dimensions a and b where

$$M = \sqrt{\frac{4ab}{\pi}}$$

From AMCA 210-99 Page10

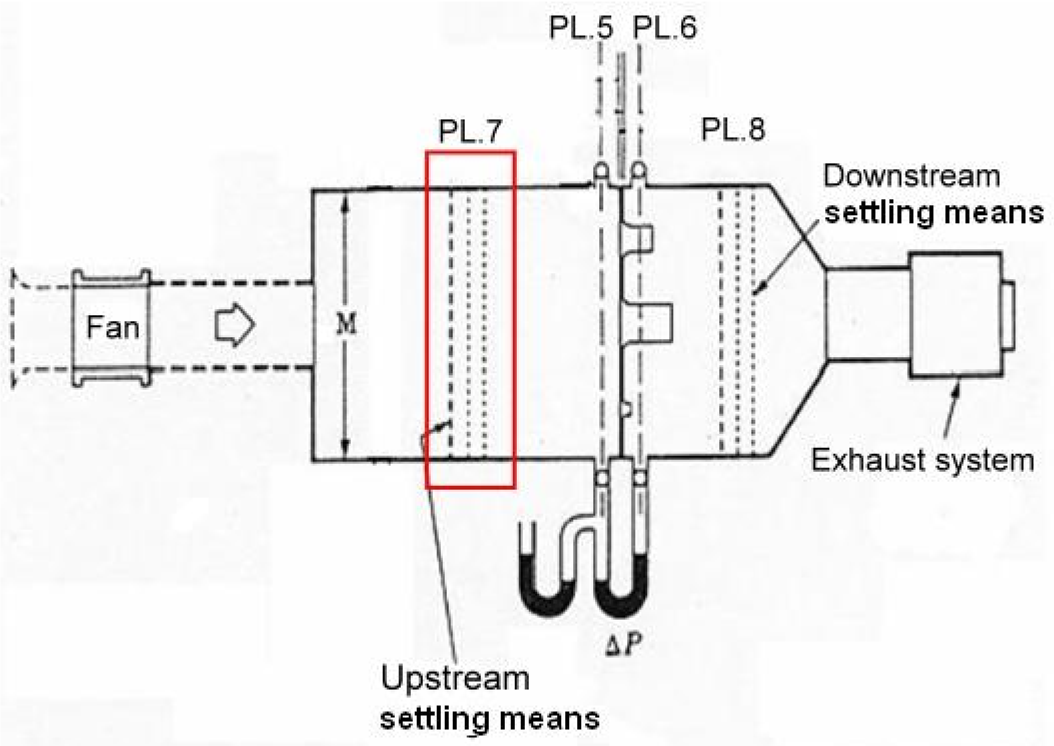


Any combinations of screens or perforated plates that will meet these requirements may be used, but in general a reasonable chamber length for the settling means is necessary to meet both requirements.

Screens of square mesh round wire with **open areas of 50% to 60% are suggested** and several will usually be needed to meet the above performance specifications.

A performance check will be necessary to verify the flow settling means are providing proper flow patterns.

From AMCA 210-99

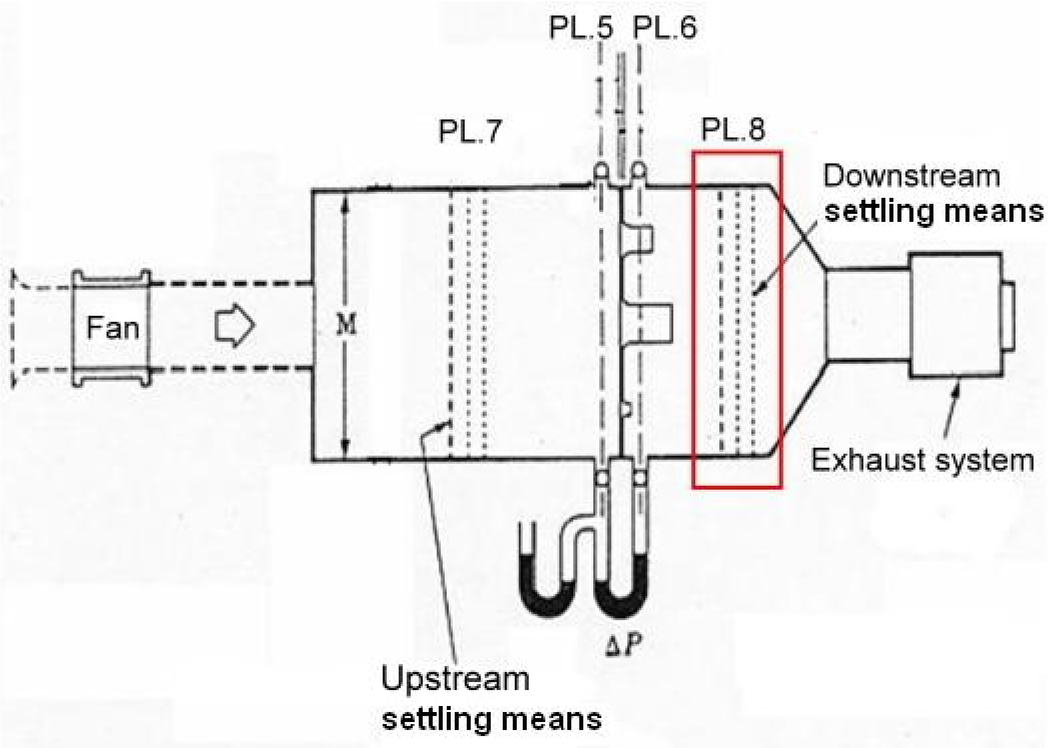


Upstream Settling Means

Where a measuring plane is located upstream of the settling means, the purpose of the settling screen is to absorb the kinetic energy of the upstream jet. and allow its normal expansion as if in an unconfined space.

This requires some backflow to supply the air to mix at the jet boundaries, but the maximum reverse velocity shall not exceed 10% of the calculated Plane 2 or Plane 6 mean jet velocity.

From AMCA 210-99



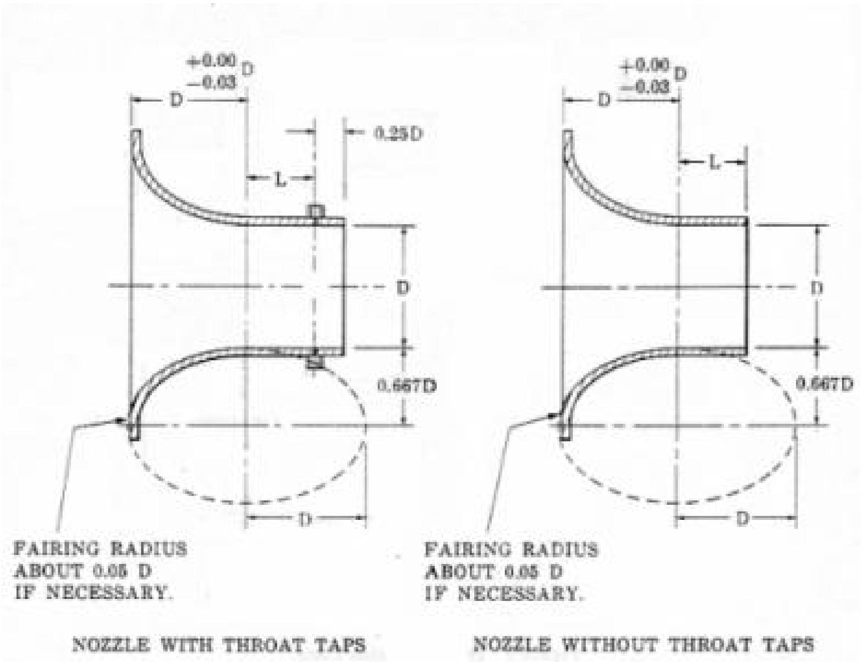
Downstream Settling Means

Flow settling means shall be installed in chambers where indicated on the test setup figures to provide proper airflow patterns.

Where a measuring plane is located downstream of the settling means, the settling means is provided to ensure a substantially uniform airflow ahead of the measuring plane.

In this case, the maximum local velocity at a distance 0.1 M downstream of the screen shall not exceed the average velocity by more than 25% unless the maximum local velocity is less than 2 m/s (400 fpm).

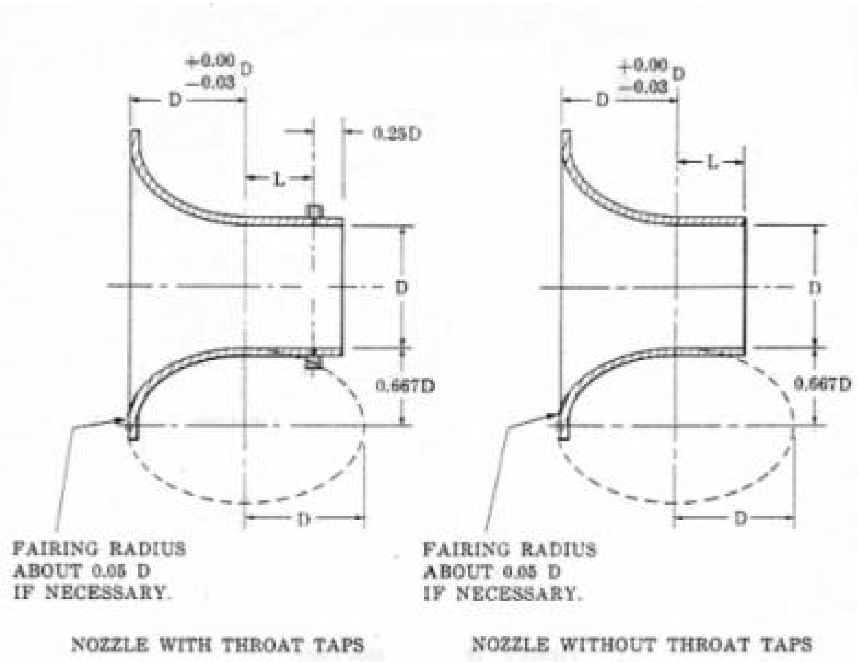
From AMCA 210-99



Notes

1. Nozzle throat dimension L shall be either 0.6D±0.005D (recommended) or 0.5D±0.005D.
2. Nozzle shall have elliptical section as shown. Two and three radii approximations to the elliptical form that do not differ at any point in the normal direction more than 1.5% D from the elliptical form may be used. The outlet edge of the nozzle shall be square, sharp, and free from burrs, nicks or roundings.
3. The nozzle throat shall be measured (to an accuracy of 0.001 D) at the minor axis of the ellipse and the nozzle exit. At each place, four diameters—approximately 45° apart must be within ±0.002 D of the mean. At the entrance to the throat the mean may be 0.002 D greater, but no less than the mean at the nozzle exit.

>> Next Page



Notes

4. The nozzle surface shall fair smoothly so that a straight-edge may be rocked over the surface without clicking and the surface waves shall not be greater than 0.001 D peak to peak.

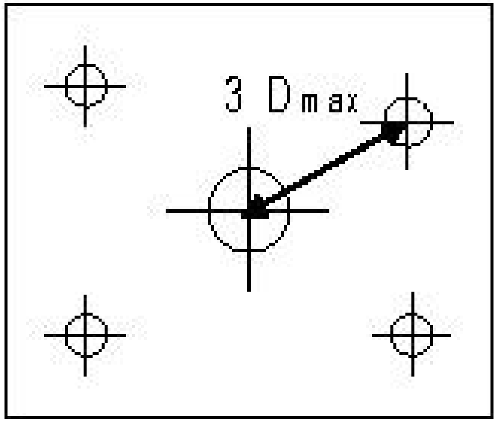
5. When nozzles are used in a chamber, either of the types shown above may be used. Where a nozzle discharges directly to a duct, nozzles with throat taps shall be used, and the nozzle outlet should be flanged.

6. Throat tap nozzles shall have four static pressure taps 90° apart connected to a piezometer ring.

From AMCA210-99

<< Previous Page

6.3.4 Multiple Nozzles.



Multiple nozzles shall be located as symmetrically as possible.The centerline of each nozzle shall be at least 1.5 nozzle throat diameters from the chamber wall.

The minimum distance between centers of any two nozzles in simultaneous use shall be three times the throat diameter of the larger nozzle.

The uncertainty of the airflow rate measurement can be reduced by changing to a smaller nozzle or combination of nozzles for the lower airflow rate range of the fan.

From AMCA210-99

Pressure Measuring Mode

Single Nozzle：**QN = Cd x Un x An**

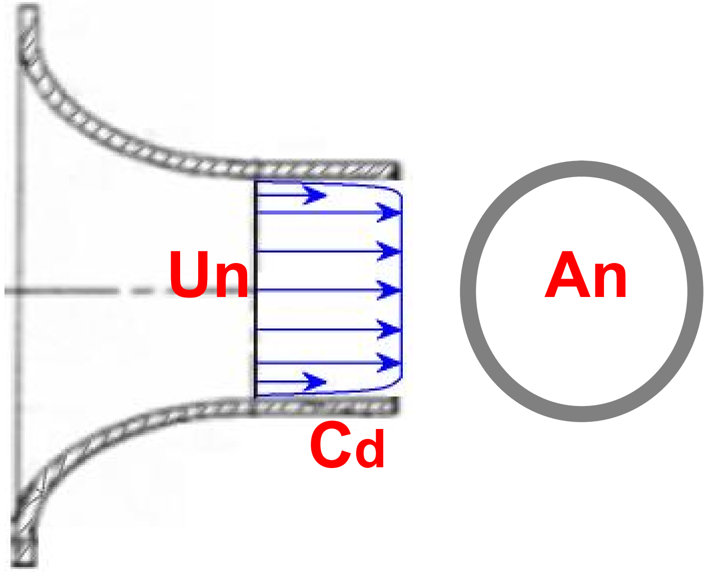
Multi-Nozzle：**QT = ∑ QN**

Where

Cd = Discharge Coefficient

Un = Throat Velocity

An = Throat Cross Section



How to get Cd

How to get Un

Nozzle Cd

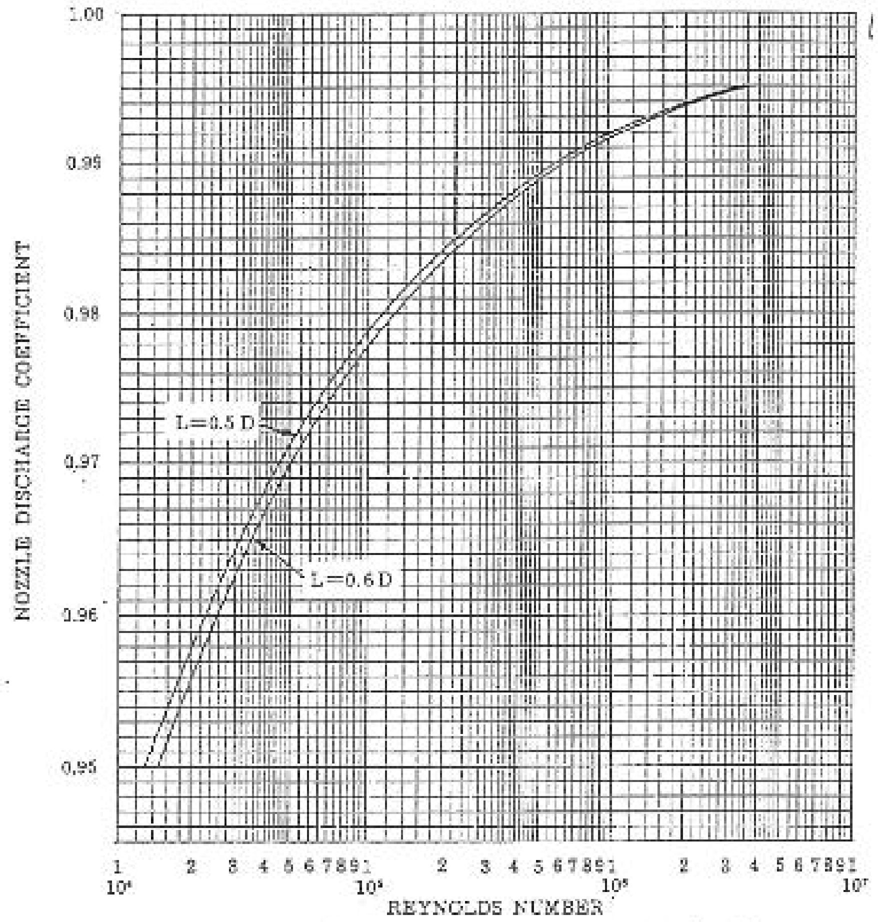


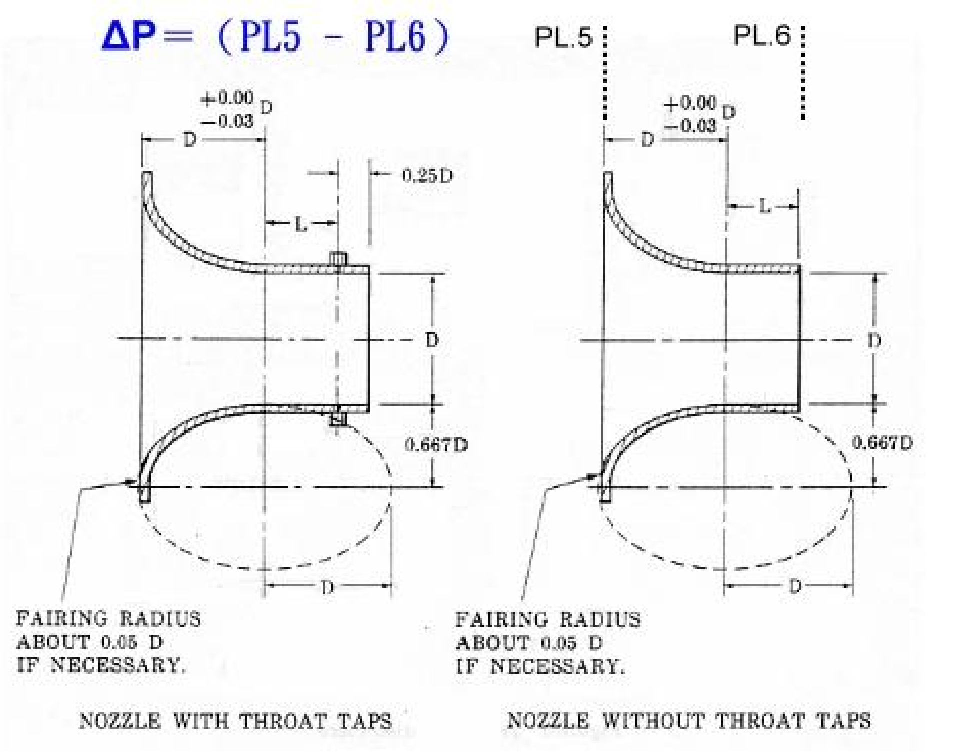
Figure 18 Coefficients of Discharge For Flow Nozzles

From AMCA 210-85 Page 38

$$C_d = 0.9986 - \frac{7.006}{\sqrt{Re}} + \frac{134.6}{Re}$$

$$Re = \frac{D_n \cdot U_n}{\nu}$$

Back to Nozzle Flow Rate



From AMCA210-99

$$Un = \sqrt{\frac{2 \times \Delta Pn}{\rho}}$$

Where

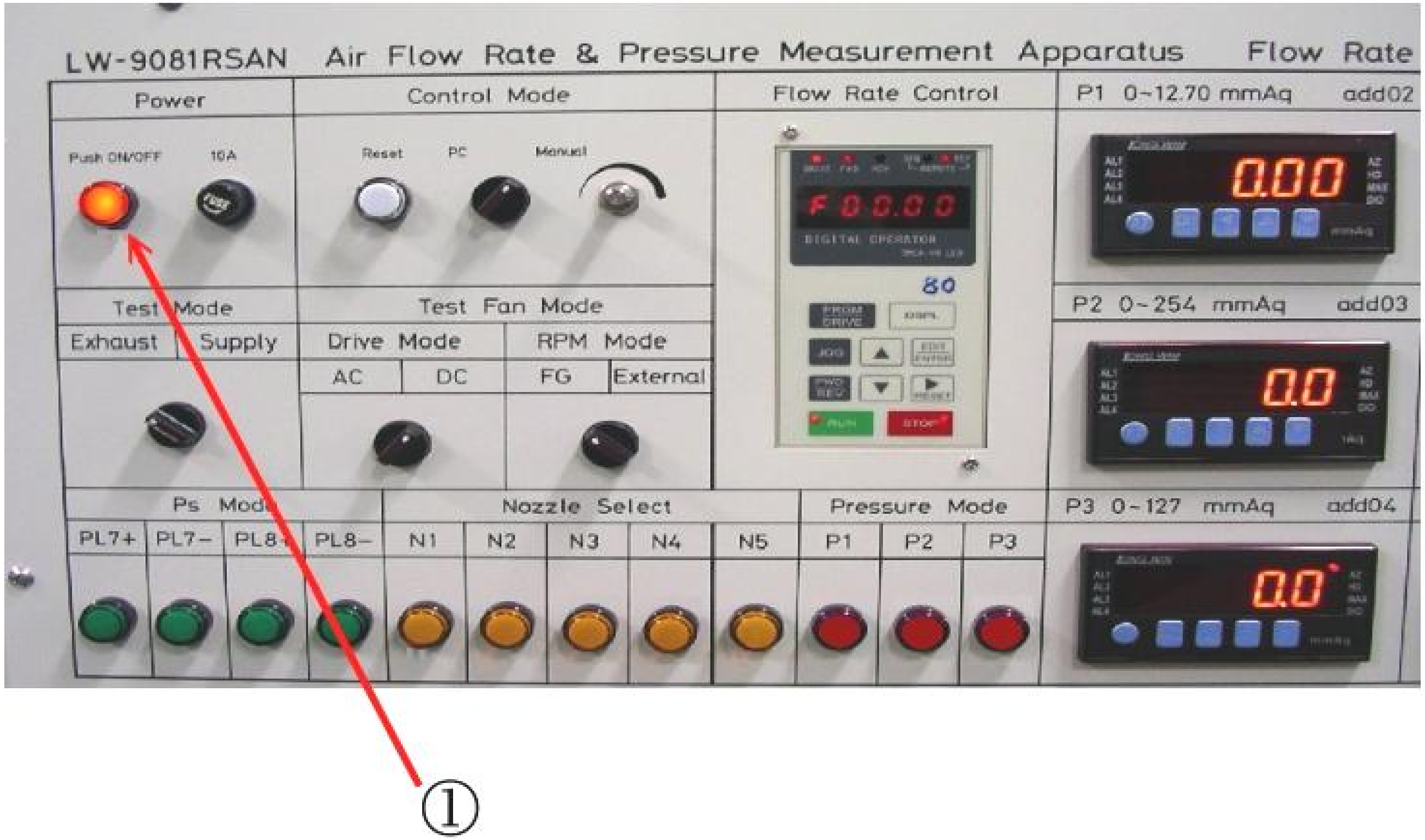
Un = Throat velocity ΔPn = Pressure difference between PL5 and PL6

ρ = Air flow density

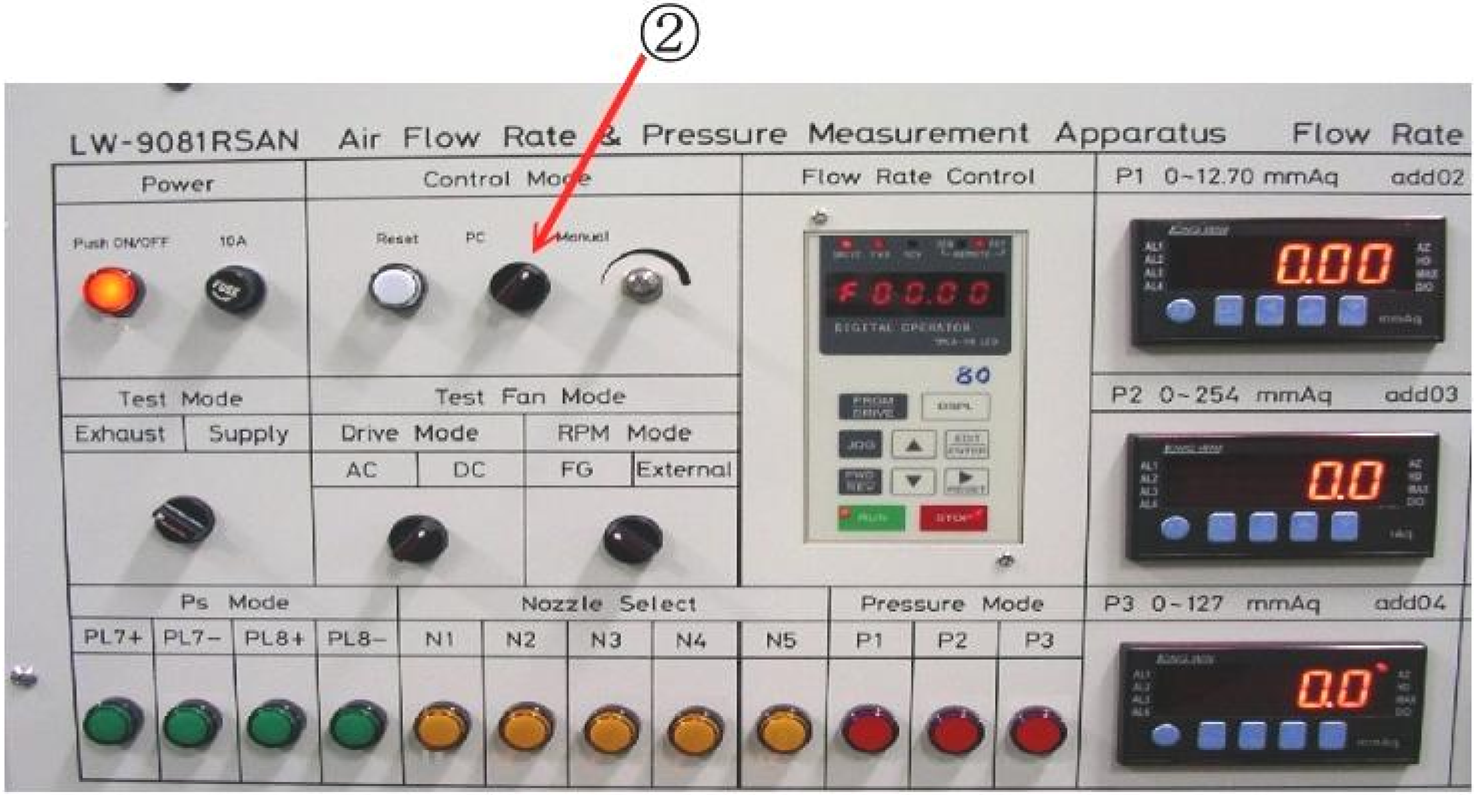
Back to Nozzle Flow Rate

Step 1 : Power ON. (Push ON/OFF button)

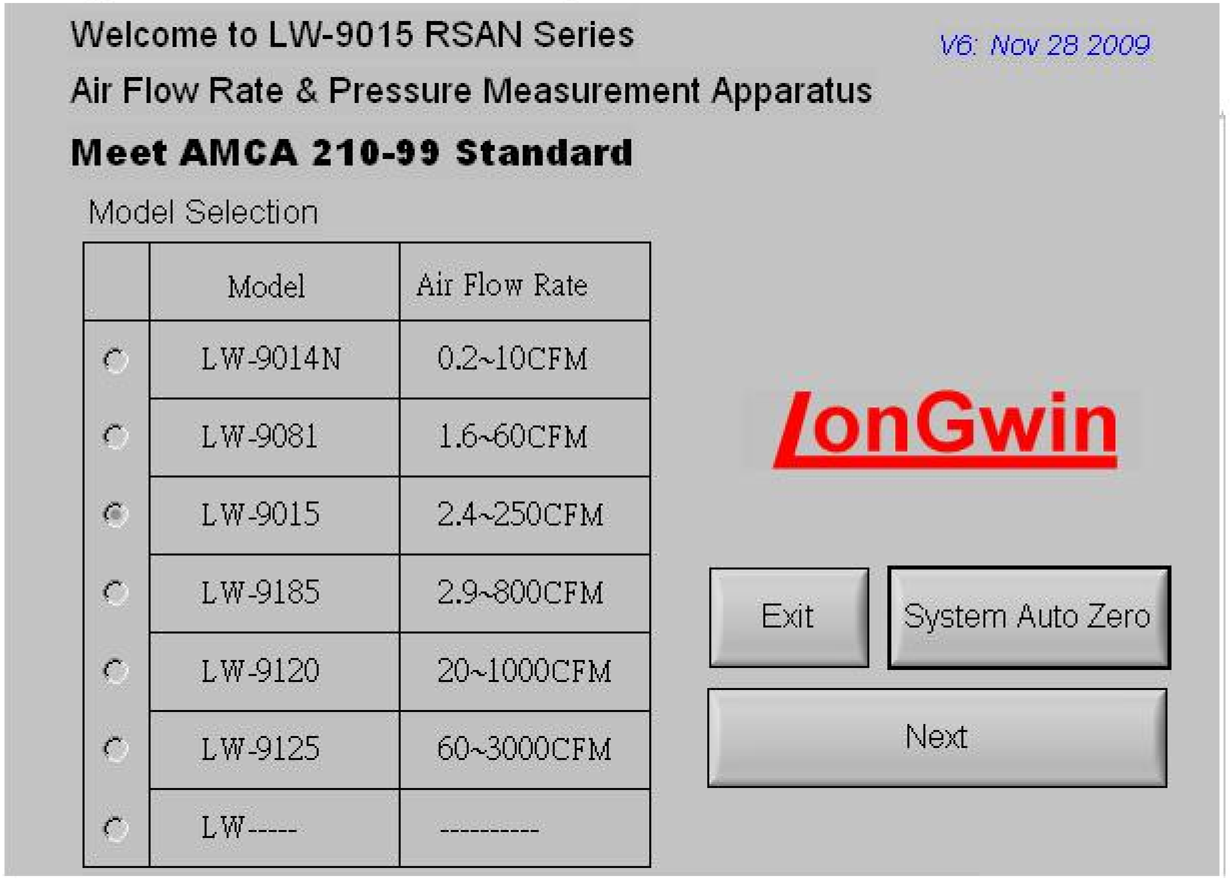
(equipment will warm up 3 minutes)



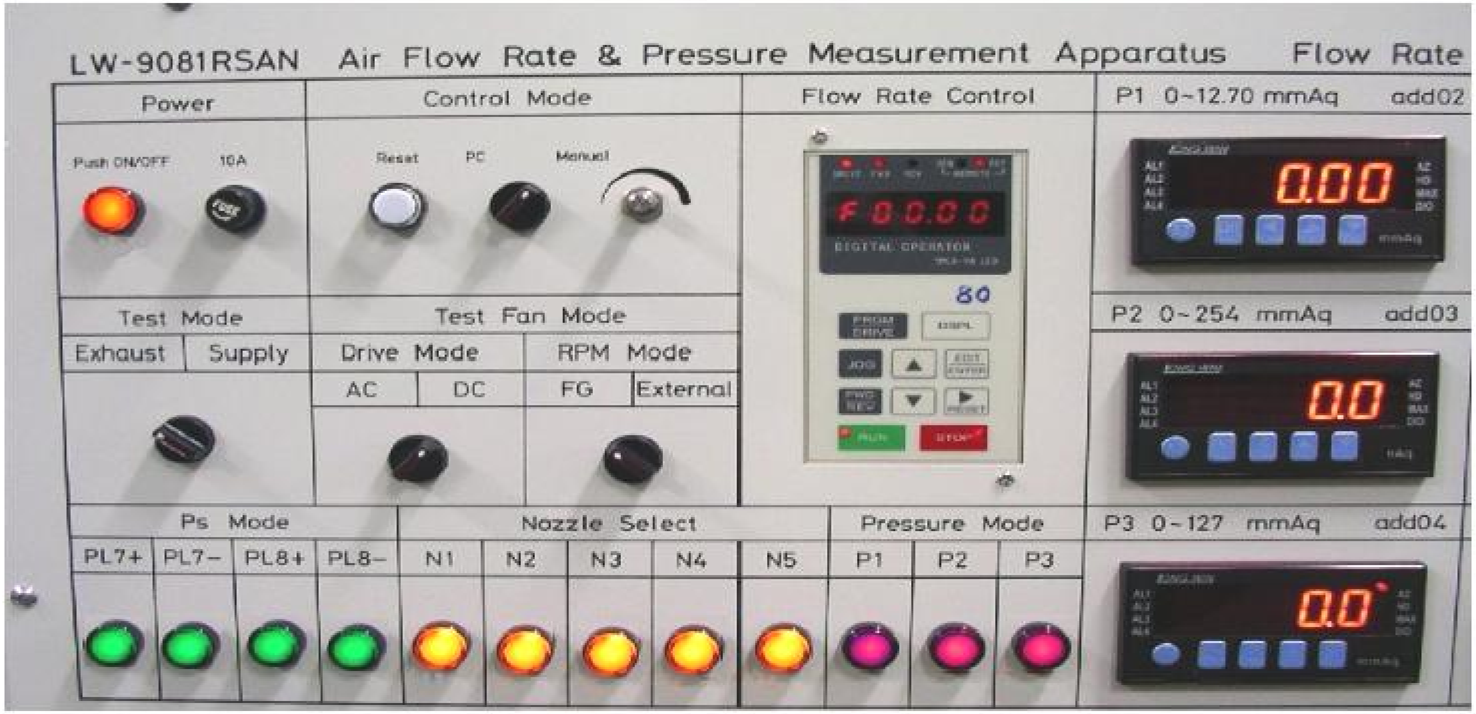
Step 2 : Check Control Mode at PC position



Step 3 : Software click system auto zero



Step 4 : System turn on all valves, warm up 180 sec,
P1 / P2 / P3 auto zero



Step 5 : System auto zero completed
Click Stop for next step

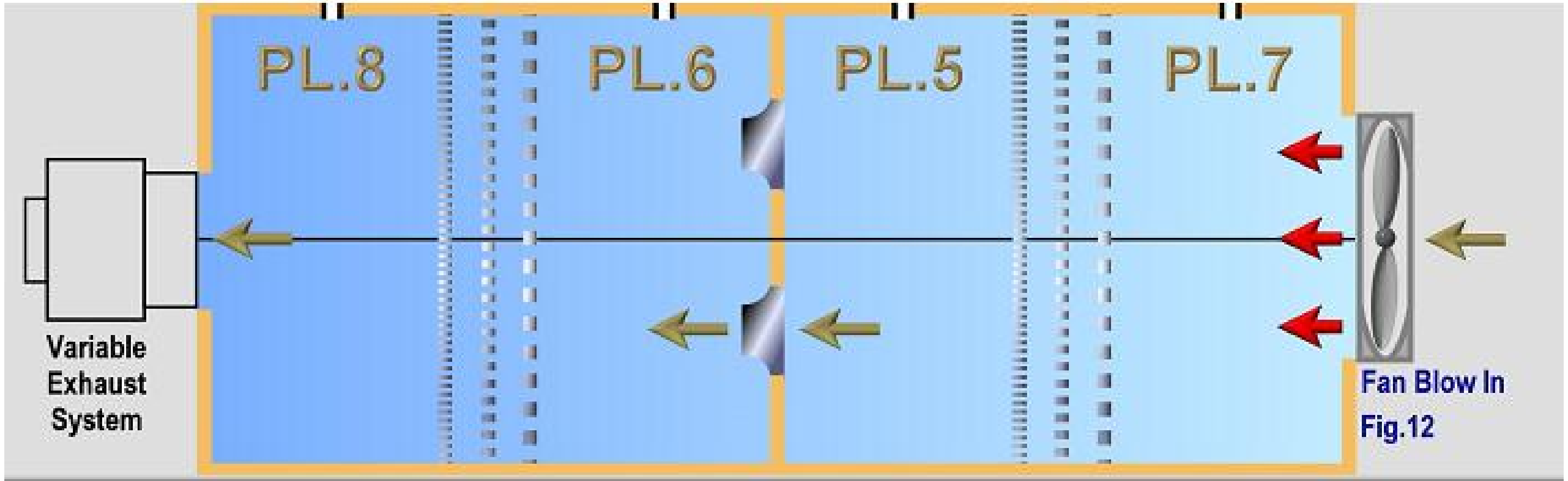


Fig.15 Inlet Chamber

D. Fan Performance Curve - FPC

E. System Resistance Curve - SRC

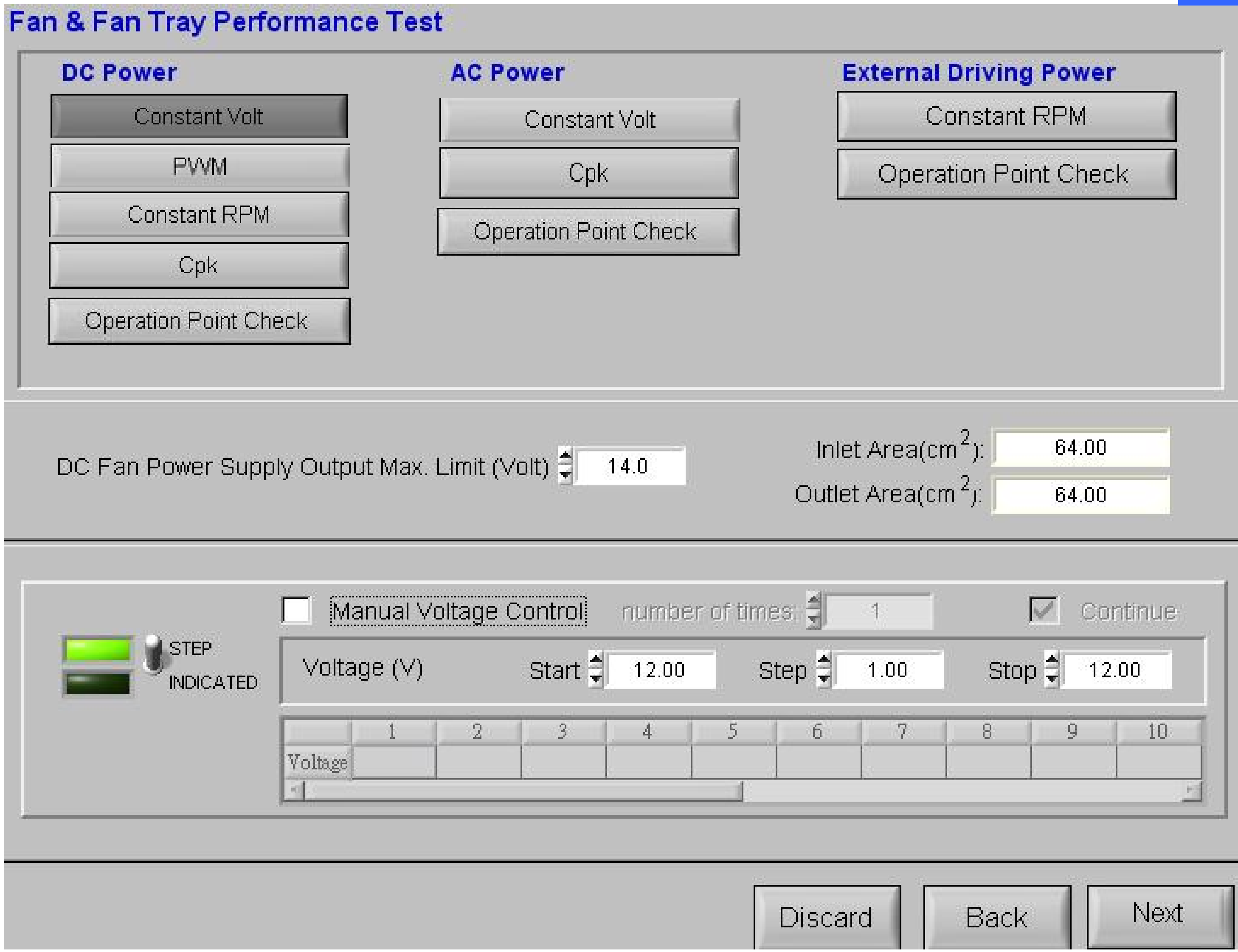
F. Airflow / Thermal Resistance - TRC

Fig.12 Outlet Chamber

A. Fan Performance Curve - FPC

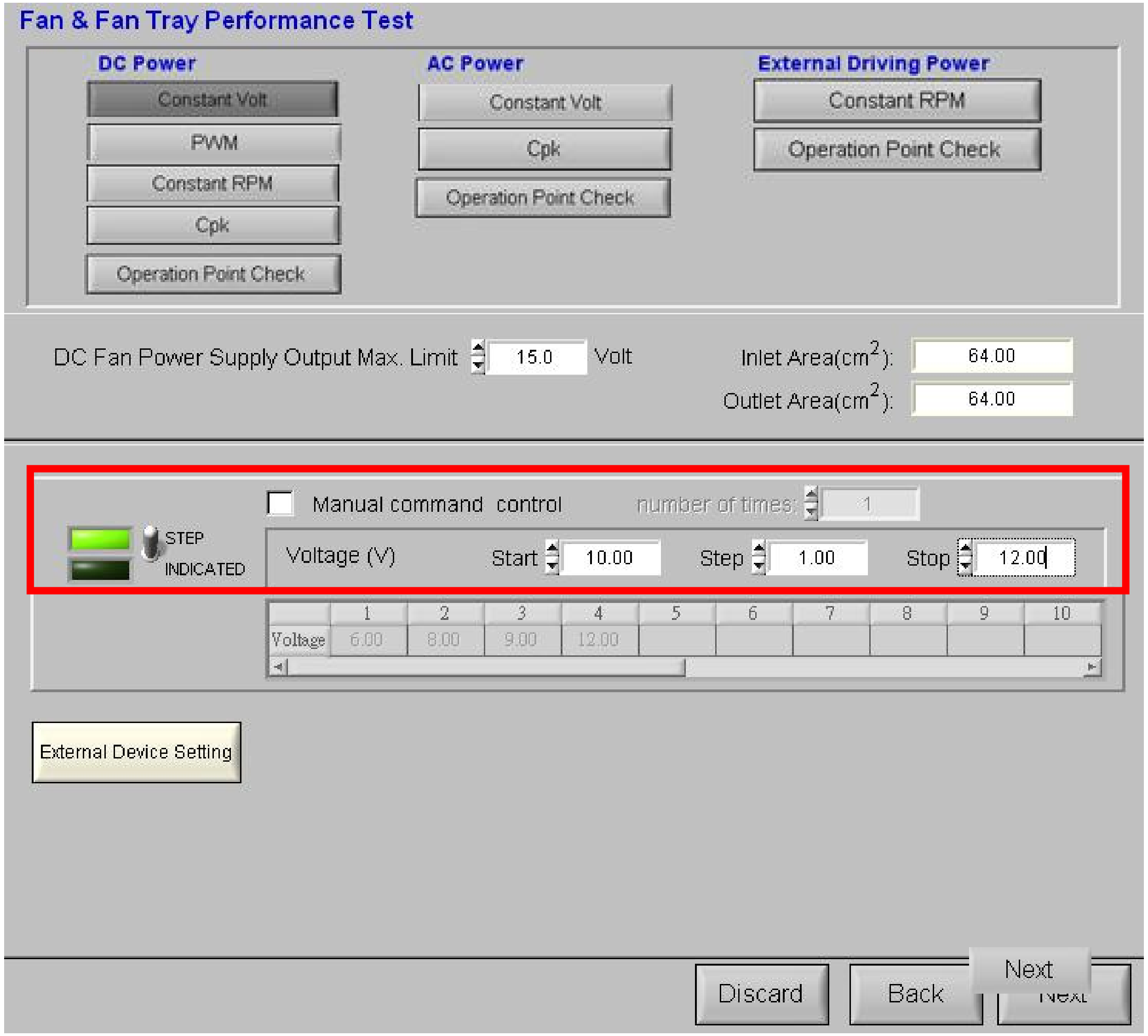
B. System Resistance Curve - SRC

C. Airflow / Thermal Resistance - TRC


Fan & Fan Tray Performance Test
DC Power
Constant Volt
PWM
Constant RPM
Cpk
Operation Point Check
AC Power
Constant Volt
Cpk
Operation Point Check
External Driving Power
Constant RPM
Operation Point Check
DC Fan Power Supply Output Max. Limit (Volt) 14.0
Inlet Area(cm 2): 64.00
Outlet Area(cm 2): 64.00
STEP
INDICATED
Manual Voltage Control
number of times: 1
Continue
Voltage (V)
Start 12.00
Step 1.00
Stop 12.00
1 2 3 4 5 6 7 8 9 10
Voltage
Discard
Back
Next

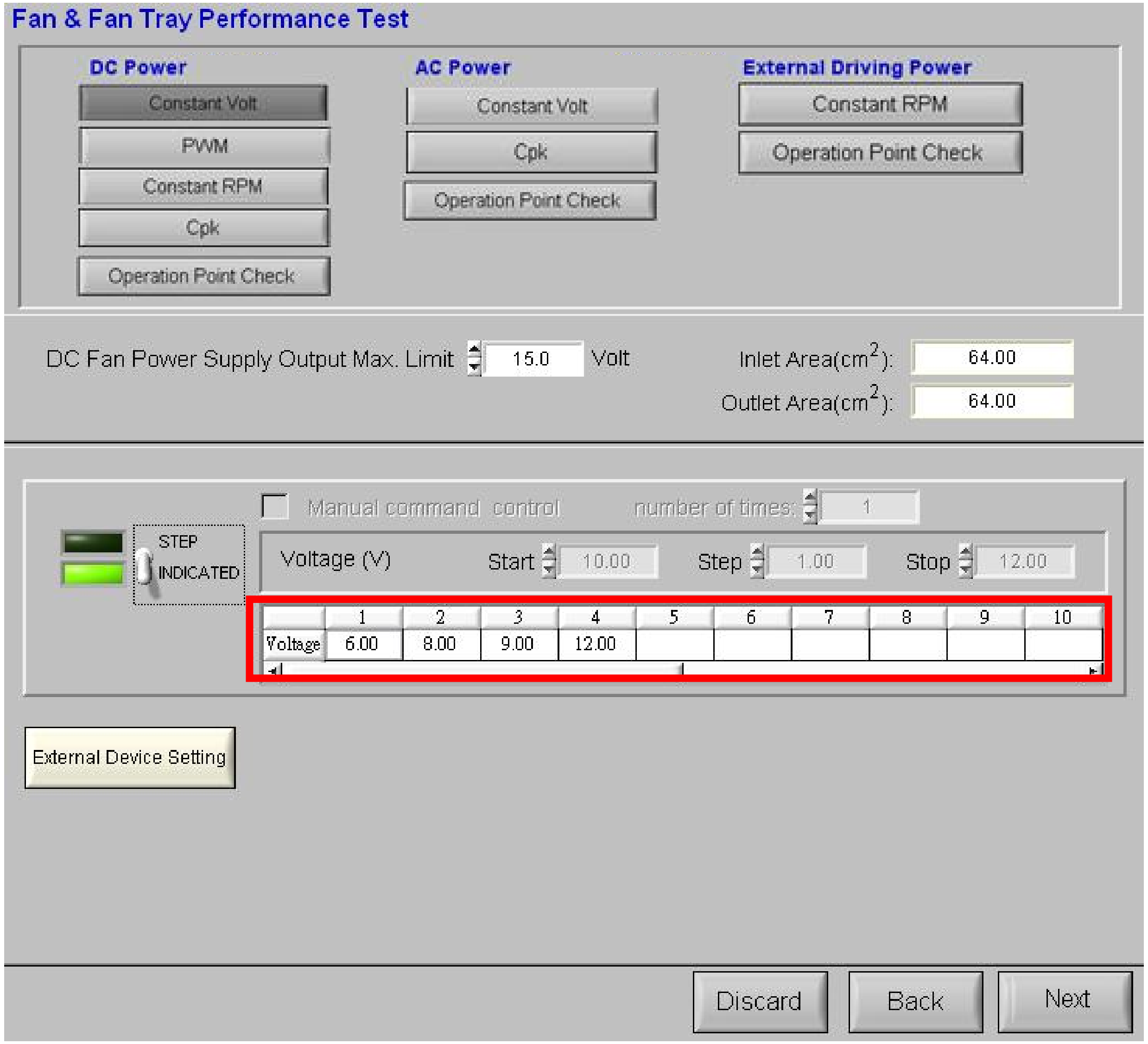
(1) Constant Volt - step mode

Back to Operation



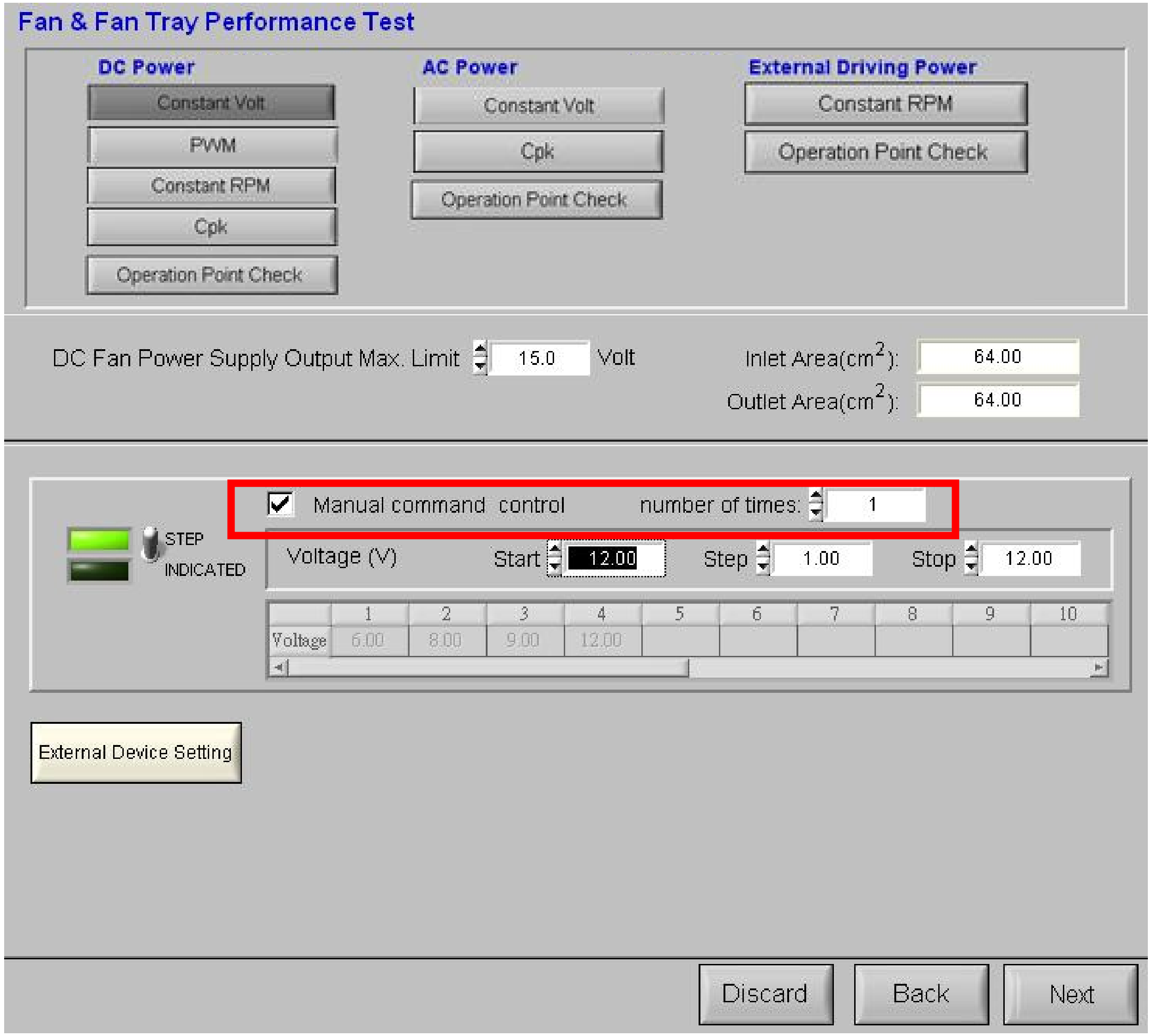
(1) Constant Volt - Indicated mode

Back to Operation



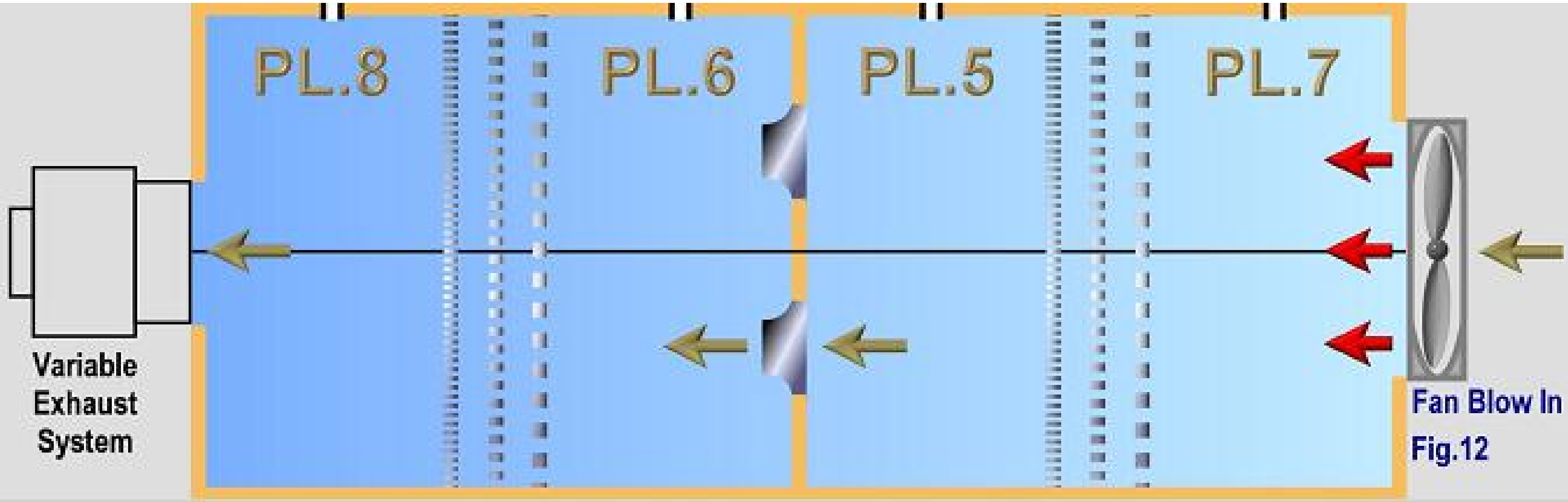
(1) Constant Volt

Back to Operation



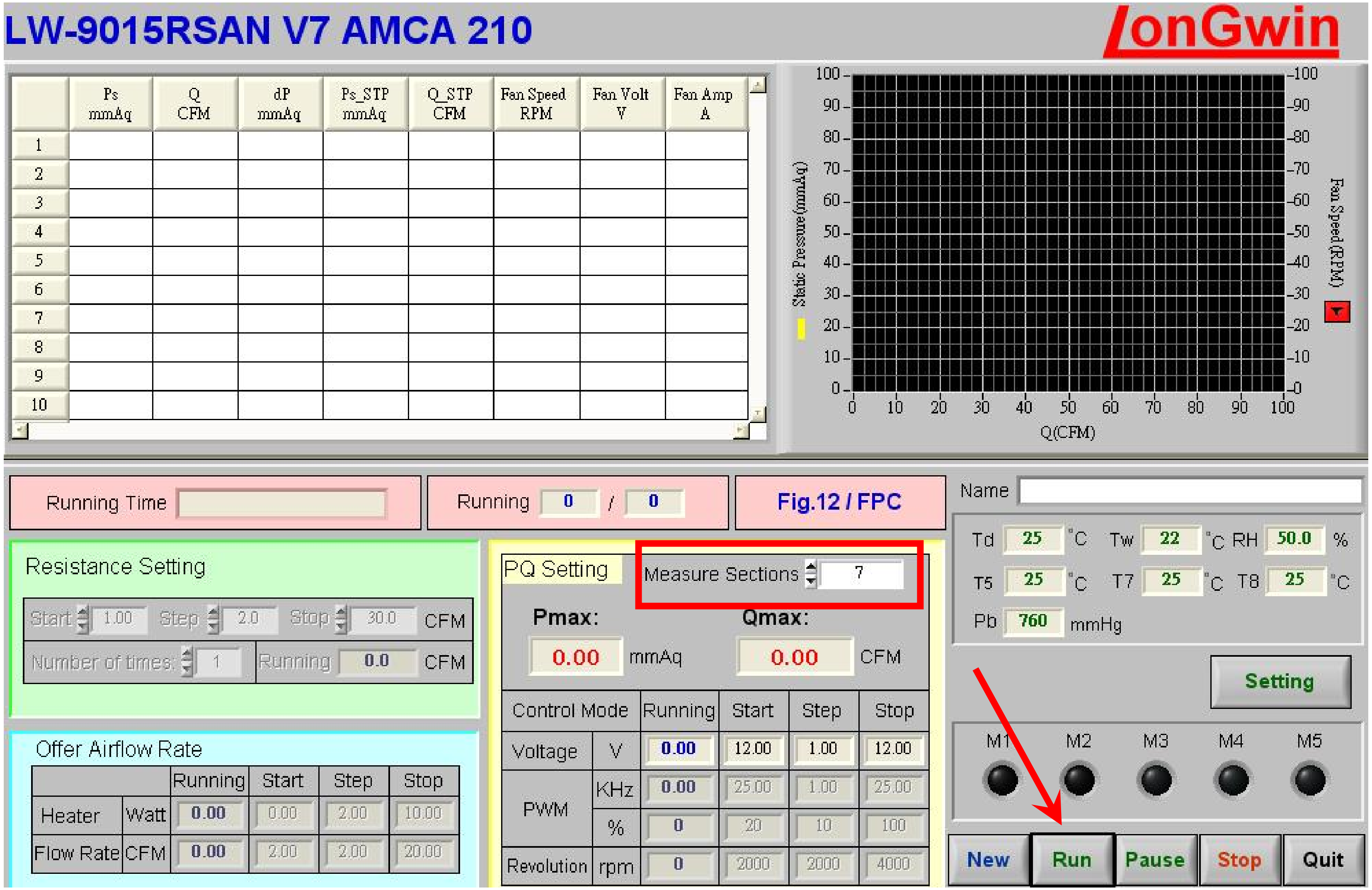
(1) Constant Volt

Back to Operation



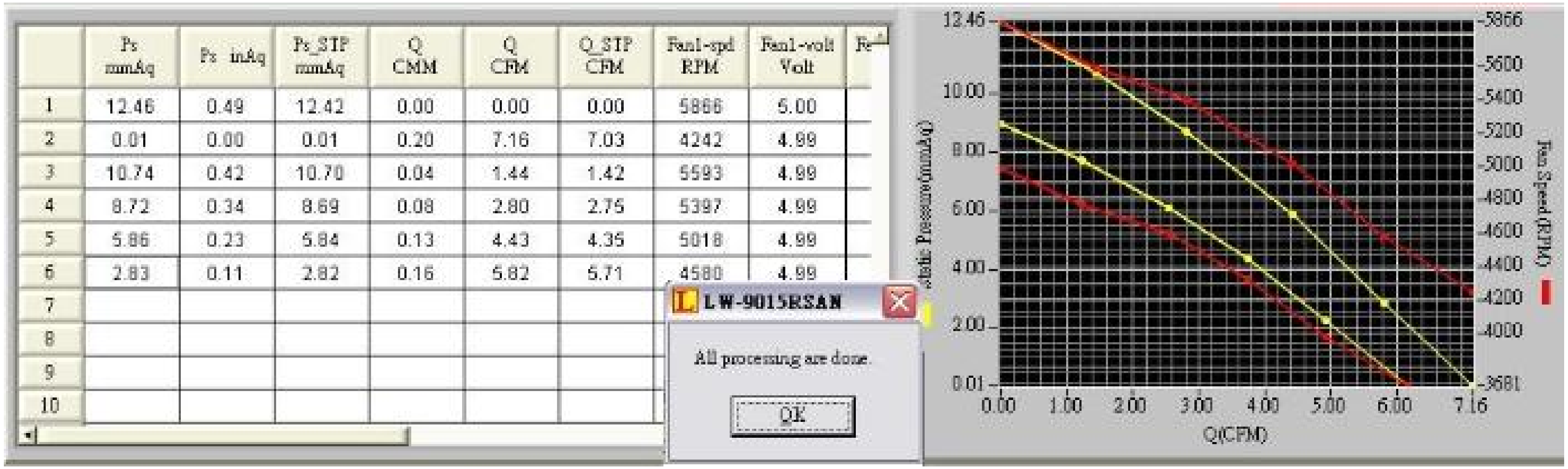
(1) Constant Volt

Back to Operation



(1) Constant Volt

Back to Operation



	Ps mmAq	Ps inAq	Ps_STP mmAq	Q CMM	Q CFM	Q_STP CFM	Fan1-spd RPM	Fan1-volt Volt
1	12.46	0.49	12.42	0.00	0.00	0.00	5866	5.00
2	0.01	0.00	0.01	0.20	7.16	7.03	4242	4.99
3	10.74	0.42	10.70	0.04	1.44	1.42	5593	4.99
4	8.72	0.34	8.69	0.08	2.80	2.75	5397	4.99
5	5.86	0.23	5.84	0.13	4.43	4.35	5018	4.99
6	2.83	0.11	2.82	0.16	5.82	5.71	4580	4.99
7								
8								
9								
10								

(1) Constant Volt

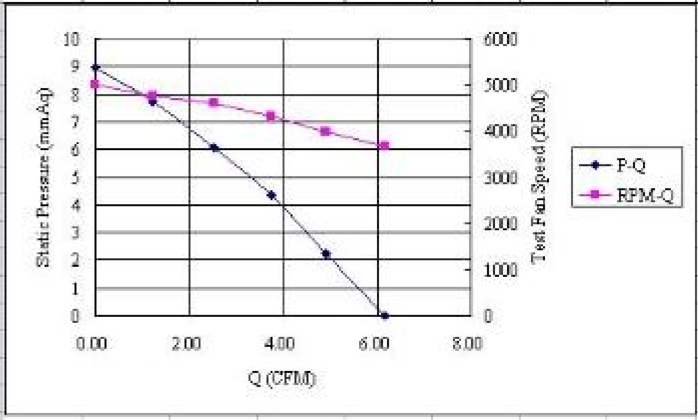
Back to Operation

Microsoft Excel - _VOLT_20070326_093546

[Name]: [Mode]: Constant Voltage

Td	Tw	RH	T5	T7	Pb	Pmax	Qmax	Frequency	Duty cycle
℃	℃	%	℃	℃	mmHg	mmAq	CFM	KHz	%
21	18.9	82.0	21.1	21.1	751.2	8.98	6.17		

Ps		dP	Q		Re	P_{STP}	Q_{STP}	Fan1-Spd	Fan1-Volt	Fan1-Amp
mmAq	inAq	mmAq	CMM	CFM		mmAq	CFM	RPM	Volt	Amp
8.98	0.3535	8.8	0.000	0.00	0	8.95	0.00	4992	3.99	0.140
7.73	0.3043	59.3	0.035	1.23	10288	7.70	1.20	4769	3.99	0.140
6.08	0.2394	120.2	0.072	2.54	17577	6.06	2.49	4593	3.99	0.150
4.34	0.1709	82.4	0.106	3.75	19404	4.33	3.68	4319	3.99	0.160
2.22	0.0874	58.6	0.139	4.92	0	2.21	4.83	3975.5	3.98	0.170
0.02	0.0008	41.5	0.175	6.17	0	0.02	6.05	3681	3.98	0.180



1985 Long Win Fundamental, Forward & First

(1) Constant Volt

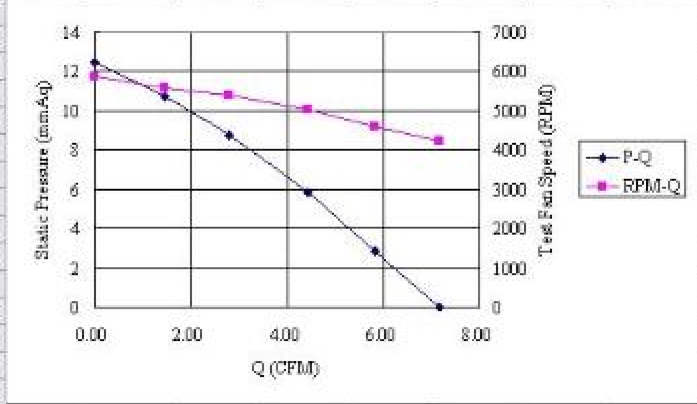
Back to Operation

Microsoft Excel - _VOLT_20070326_093546

[Name]: [Mode]: Constant Voltage

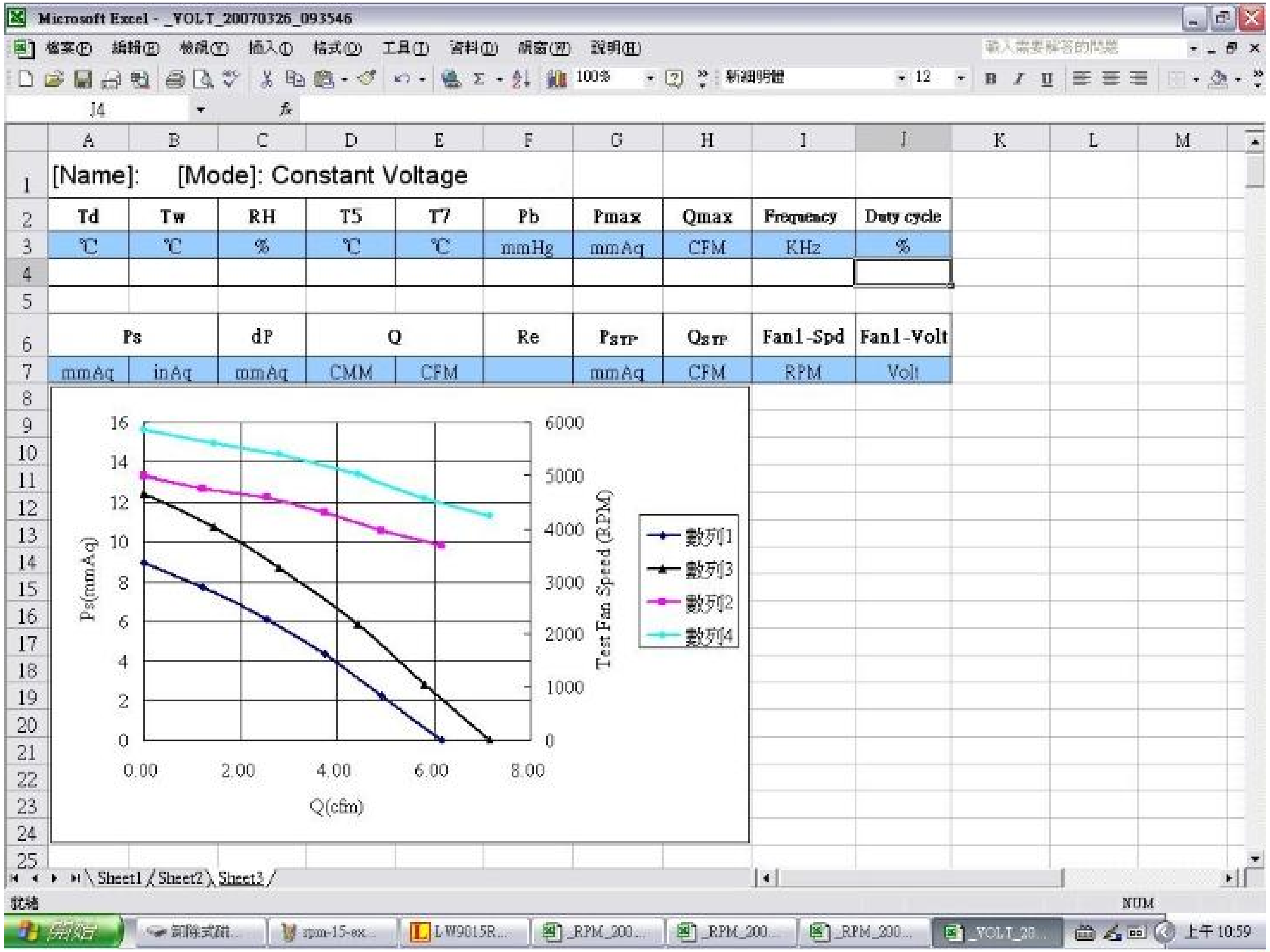
Td	Tw	RH	T5	T7	Pb	Pmax	Qmax	Frequency	Duty cycle
℃	℃	%	℃	℃	mmHg	mmAq	CFM	KHz	%
21	18.9	82.0	21.3	21.2	751.2	12.46	7.16		

Ps		dP	Q		Re	P_{STP}	Q_{STP}	Fan1-Spd	Fan1-Volt	Fan1-Amp
mmAq	inAq	mmAq	CMM	CFM		mmAq	CFM	RPM	Volt	Amp
12.46	0.4906	12.2	0.000	0.00	0	12.42	0.00	5866	5.00	0.180
10.74	0.4228	81.8	0.041	1.44	12083	10.70	1.42	5593	4.99	0.180
8.72	0.3433	46.5	0.079	2.80	14576	8.69	2.75	5397	4.99	0.180
5.86	0.2307	114.7	0.125	4.43	22893	5.84	4.35	5017.5	4.99	0.200
2.83	0.1114	81.7	0.165	5.82	0	2.82	5.71	4580.5	4.99	0.210
0.01	0.0004	55.6	0.203	7.16	0	0.01	7.03	4242	4.99	0.220

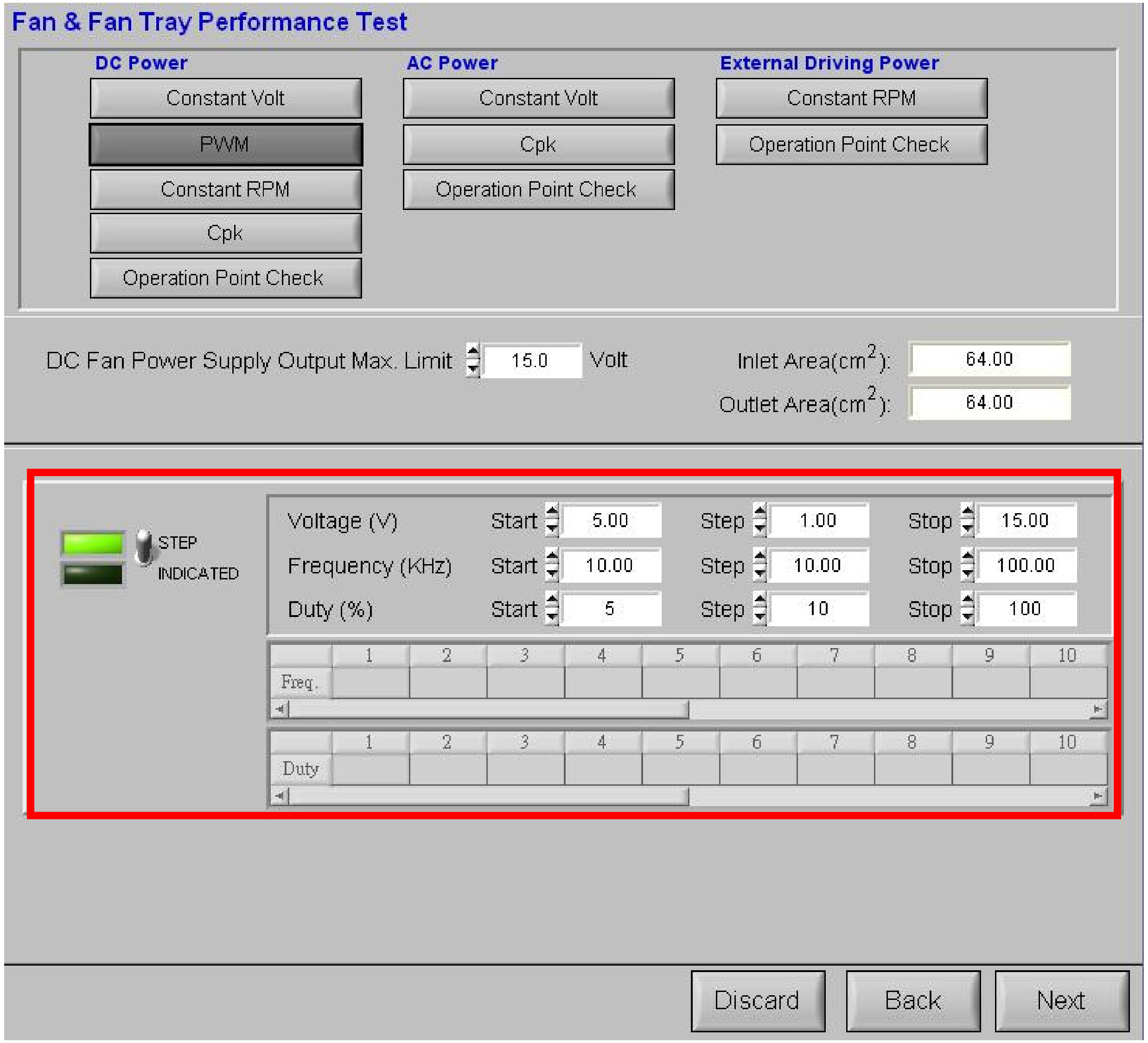


(1) Constant Volt

Back to Operation

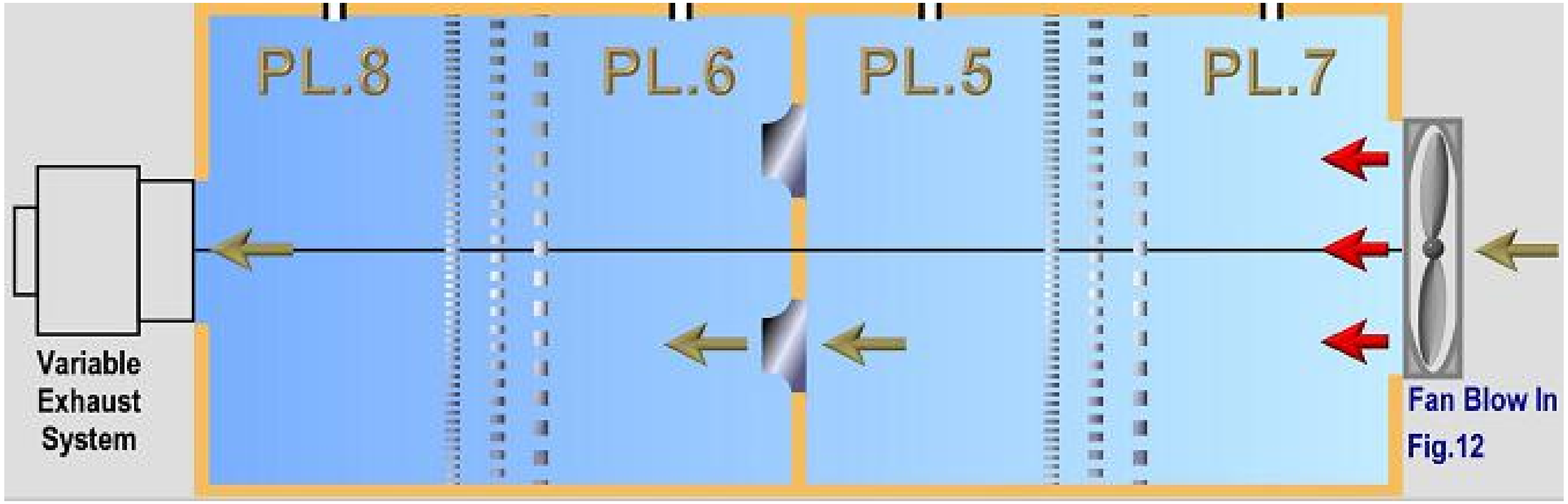


(2) PWM


Fan & Fan Tray Performance Test
DC Power
Constant Volt
PWM
Constant RPM
Cpk
Operation Point Check
AC Power
Constant Volt
Cpk
Operation Point Check
External Driving Power
Constant RPM
Operation Point Check
DC Fan Power Supply Output Max. Limit 15.0 Volt
Inlet Area(cm2): 64.00
Outlet Area(cm2): 64.00
STEP
INDICATED
Voltage (V) Start 5.00 Step 1.00 Stop 15.00
Frequency (KHz) Start 10.00 Step 10.00 Stop 100.00
Duty (%) Start 5 Step 10 Stop 100
Freq. 1 2 3 4 5 6 7 8 9 10
Duty 1 2 3 4 5 6 7 8 9 10
Discard
Back
Next

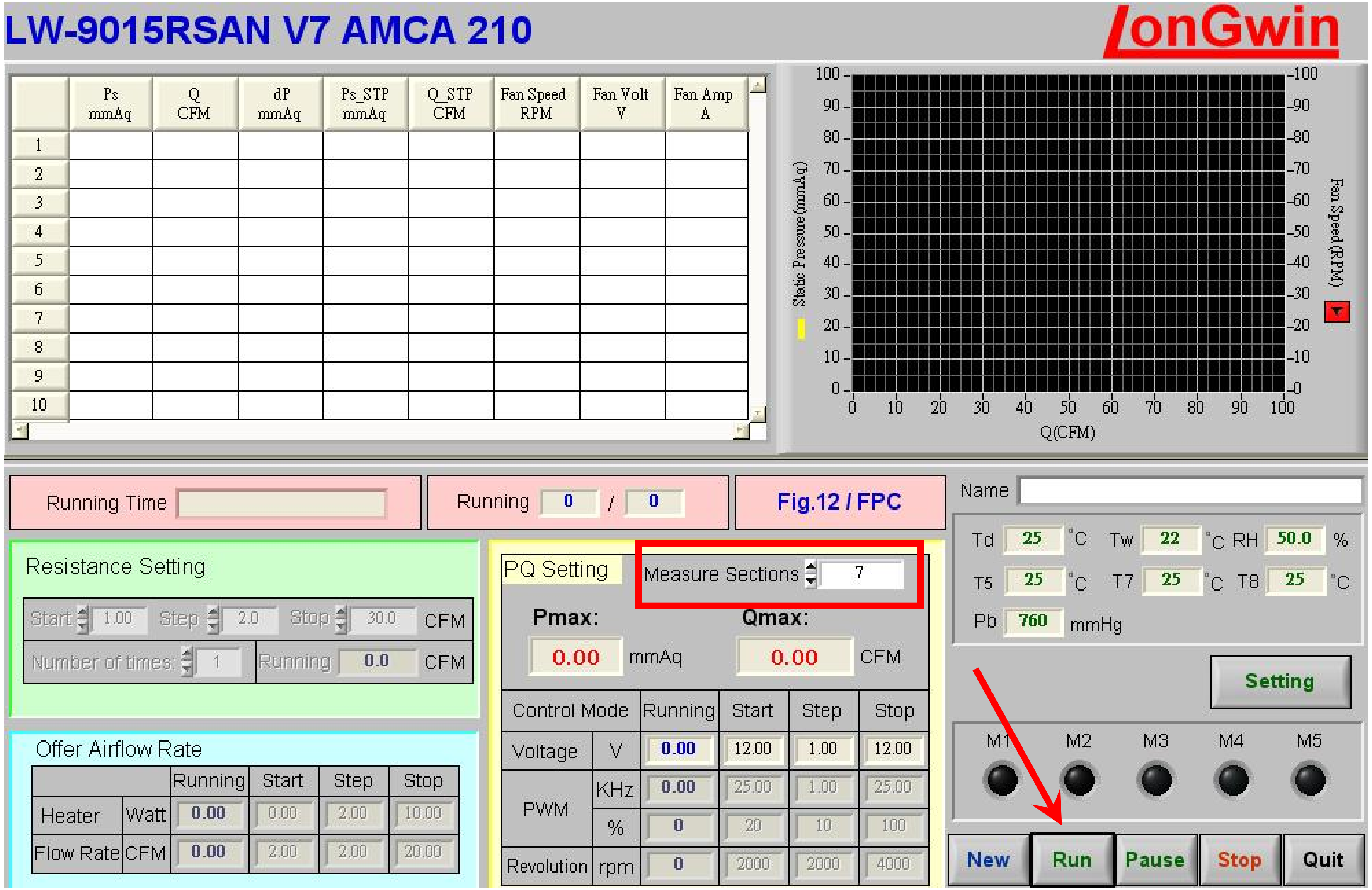
(2) PWM

Back to Operation



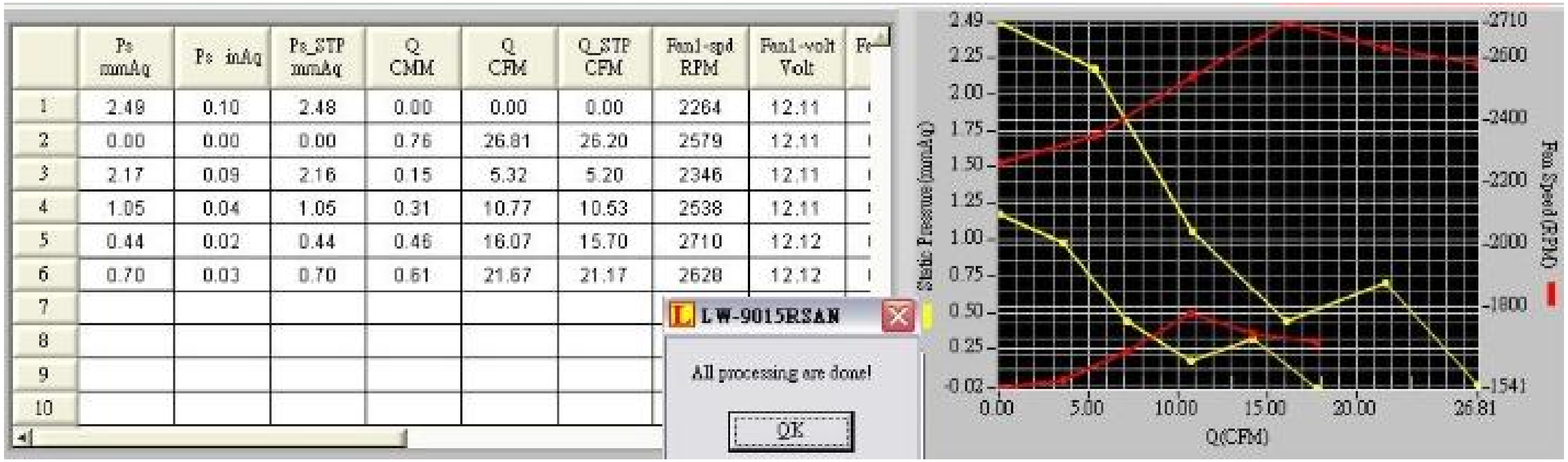
(2) PWM

Back to Operation



(2) PWM

Back to Operation



	Ps mmAq	Ps inAq	Ps_STP mmAq	Q CMM	Q CFM	Q_STP CFM	Fan1-spd RPM	Fan1-volt Volt	Fe
1	2.49	0.10	2.48	0.00	0.00	0.00	2264	12.11	
2	0.00	0.00	0.00	0.76	26.81	26.20	2579	12.11	
3	2.17	0.09	2.16	0.15	5.32	5.20	2346	12.11	
4	1.05	0.04	1.05	0.31	10.77	10.53	2538	12.11	
5	0.44	0.02	0.44	0.46	16.07	15.70	2710	12.12	
6	0.70	0.03	0.70	0.61	21.67	21.17	2628	12.12	
7									
8									
9									
10									

1985 Long Win Fundamental, Forward & First

(2) PWM

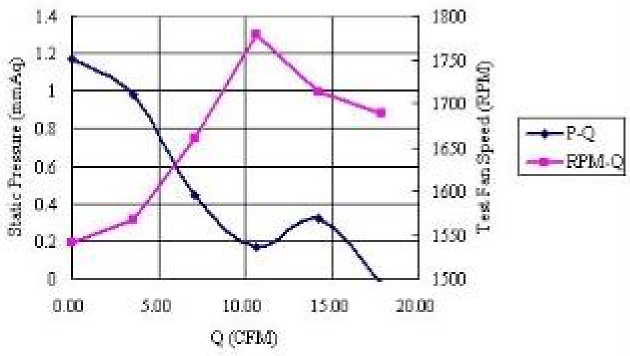
Back to Operation

Microsoft Excel - _PWM_20070326_131739

[Name]: [Mode]: PWM

Td	Tw	RH	T5	T7	Pb	Pmax	Qmax	Frequency	Duty cycle
℃	℃	%	℃	℃	mmHg	mmAq	CFM	KHz	%
19.5	21.4	83.9	20.7	21.1	749.5	1.17	17.81	25	50

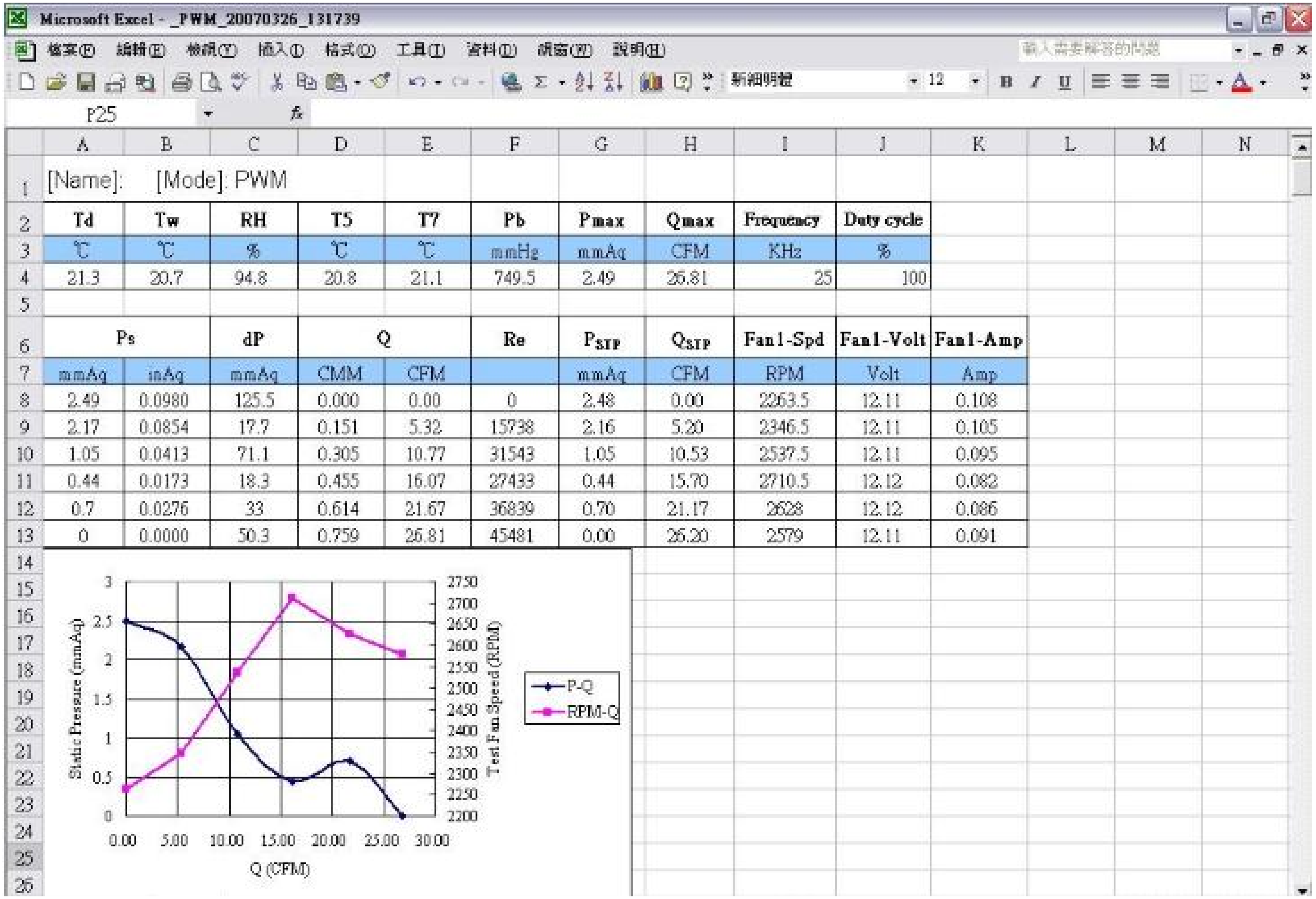
Ps		dP	Q		Re	P_{STP}	Q_{STP}	Fan1-Spd	Fan1-Volt	Fan1-Amp
mmAq	inAq	mmAq	CMM	CFM		mmAq	CFM	RPM	Volt	Amp
1.17	0.0461	0.5	0.000	0.00	0	1.17	0.00	1541	12.12	0.060
0.98	0.0386	73.2	0.100	3.54	18289	0.98	3.47	1567	12.12	0.059
0.44	0.0173	31.4	0.202	7.13	20962	0.44	7.00	1660	12.12	0.054
0.17	0.0067	70.1	0.303	10.70	31320	0.17	10.51	1779.5	12.12	0.051
0.32	0.0126	123.1	0.402	14.20	41504	0.32	13.95	1713.5	12.12	0.053
-0.02	-0.0008	22.4	0.504	17.81	30351	-0.02	17.50	1688.5	12.12	0.054



1985 Long Win
Fundamental, Forward & First

(2) PWM

Back to Operation

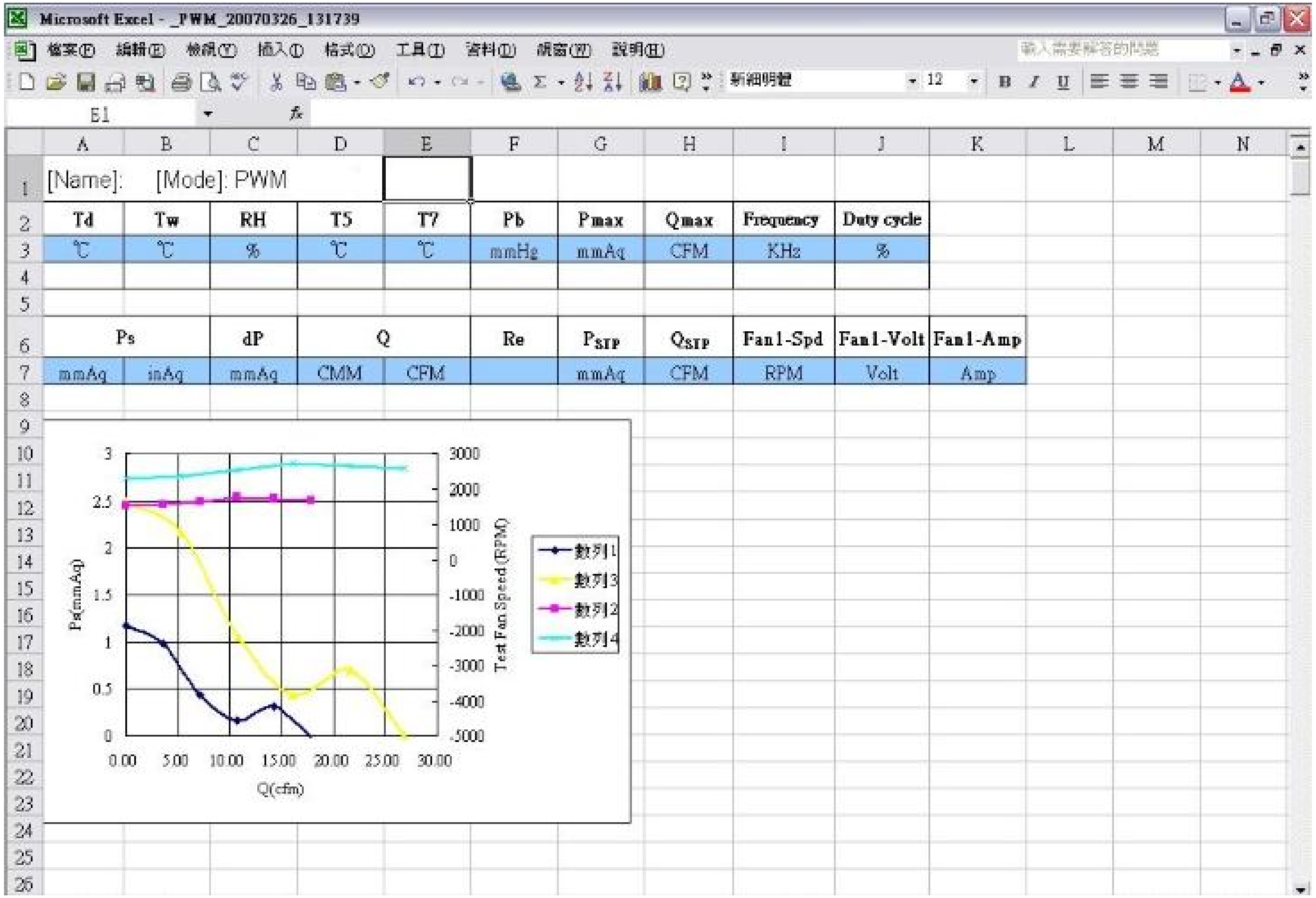


Td	Tw	RH	T5	T7	Pb	Pmax	Qmax	Frequency	Duty cycle
℃	℃	%	℃	℃	mmHg	mmAq	CFM	KHz	%
21.3	20.7	94.8	20.8	21.1	749.5	2.49	26.81	25	100

Ps		dP	Q		Re	P_{STP}	Q_{STP}	Fan1-Spd	Fan1-Volt	Fan1-Amp
mmAq	inAq	mmAq	CMM	CFM		mmAq	CFM	RPM	Volt	Amp
2.49	0.0980	125.5	0.000	0.00	0	2.48	0.00	2263.5	12.11	0.108
2.17	0.0854	17.7	0.151	5.32	15738	2.16	5.20	2346.5	12.11	0.105
1.05	0.0413	71.1	0.305	10.77	31543	1.05	10.53	2537.5	12.11	0.095
0.44	0.0173	18.3	0.455	16.07	27433	0.44	15.70	2710.5	12.12	0.082
0.7	0.0276	33	0.614	21.67	36839	0.70	21.17	2628	12.12	0.086
0	0.0000	50.3	0.759	26.81	45481	0.00	26.20	2579	12.11	0.091

(2) PWM

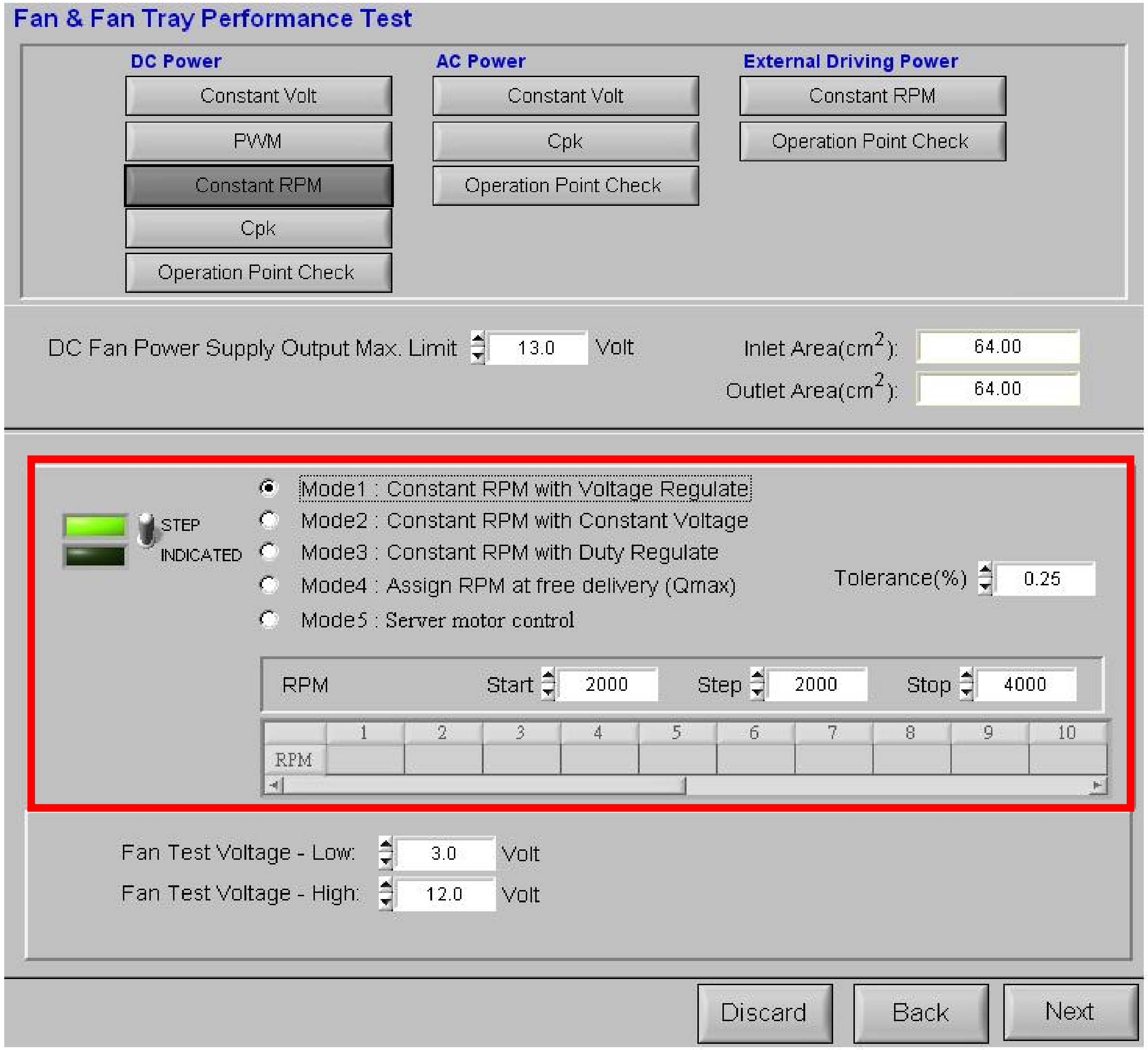
Back to Operation



1985 Long Win
Fundamental, Forward & First

(3) Constant RPM

Back to Operation



(3) Constant RPM

Back to Operation

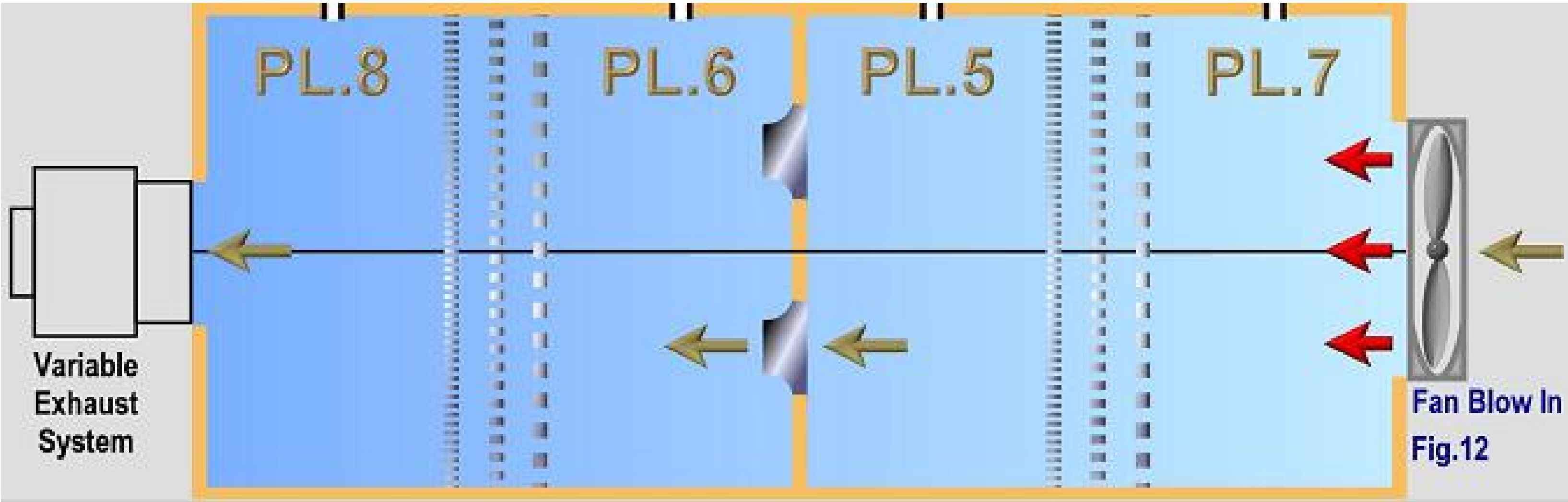
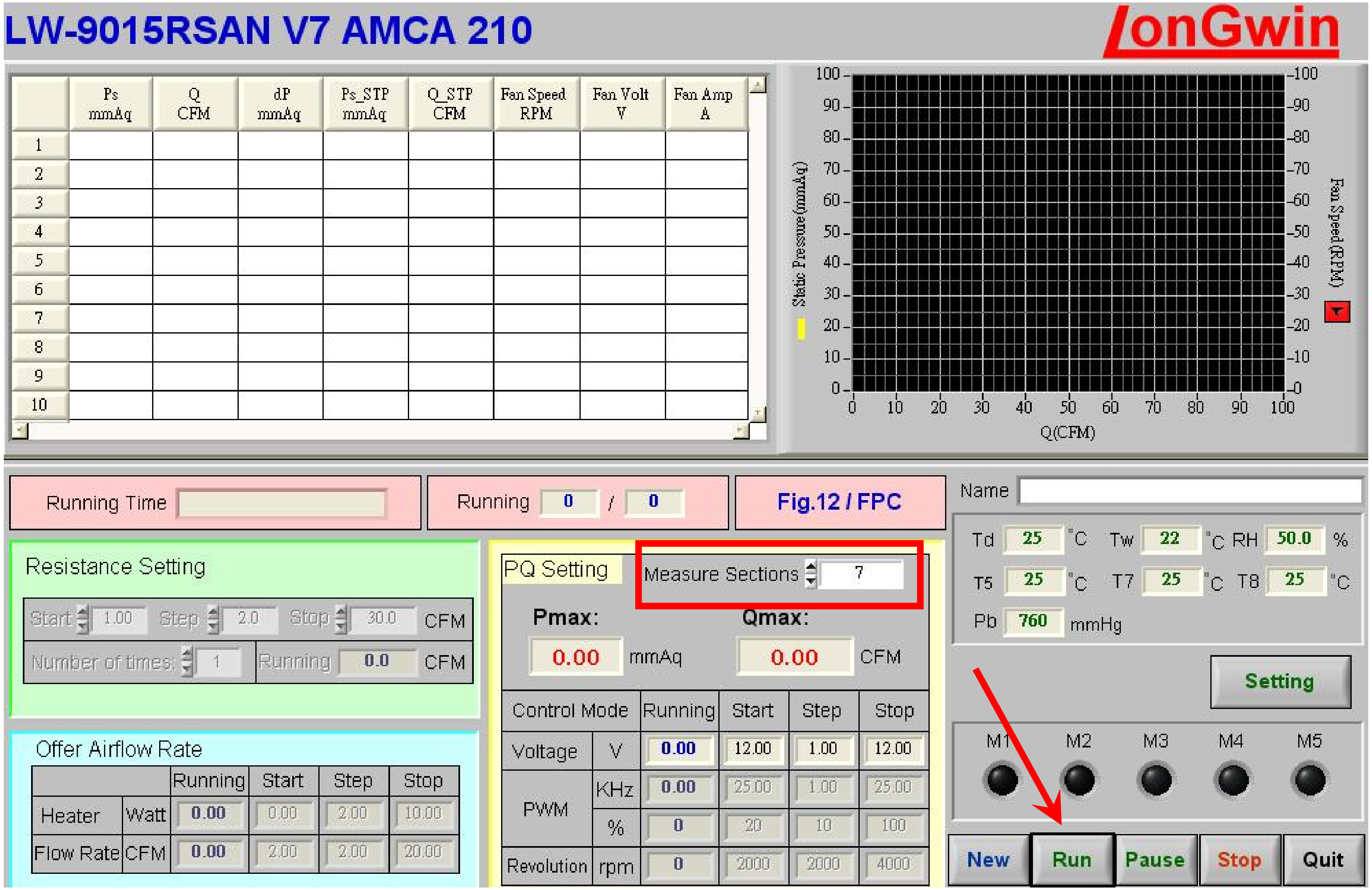


Fig.12

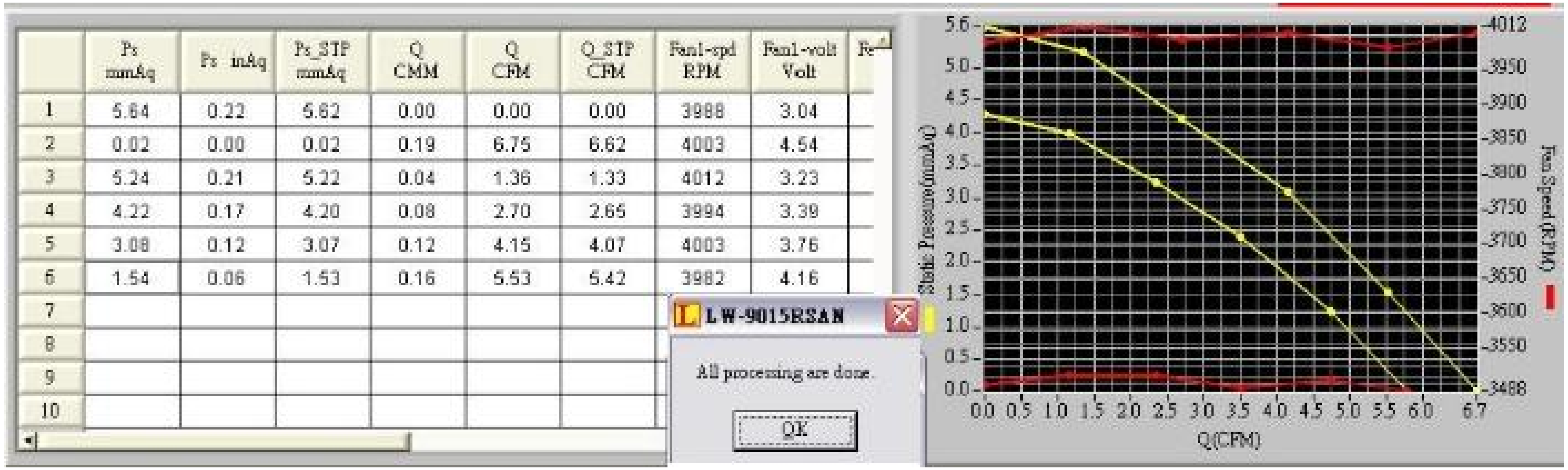
(3) Constant RPM

Back to Operation



(3) Constant RPM

Back to Operation



	Ps mmAq	Ps inAq	Ps_STP mmAq	Q CMM	Q CFM	Q_STP CFM	Fan1-spd RPM	Fan1-volt Volt	Fa
1	5.64	0.22	5.62	0.00	0.00	0.00	3988	3.04	
2	0.02	0.00	0.02	0.19	6.75	6.62	4003	4.54	
3	5.24	0.21	5.22	0.04	1.36	1.33	4012	3.23	
4	4.22	0.17	4.20	0.08	2.70	2.65	3994	3.39	
5	3.08	0.12	3.07	0.12	4.15	4.07	4003	3.76	
6	1.54	0.06	1.53	0.16	5.53	5.42	3982	4.16	
7									
8									
9									
10									

(3) Constant RPM

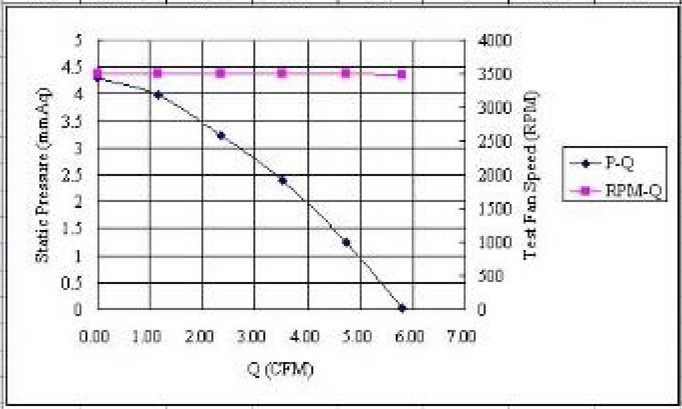
Back to Operation

Microsoft Excel - _RPM_20070326_100519

[Name]: [Mode]: RPM

Td	Tw	RH	T5	T7	Pb	Pmax	Qmax	Frequency	Duty cycle
℃	℃	%	℃	℃	mmHg	mmAq	CFM	KHz	%
21.1	19.1	82.9	21.2	21.2	751.1	4.30	5.78		

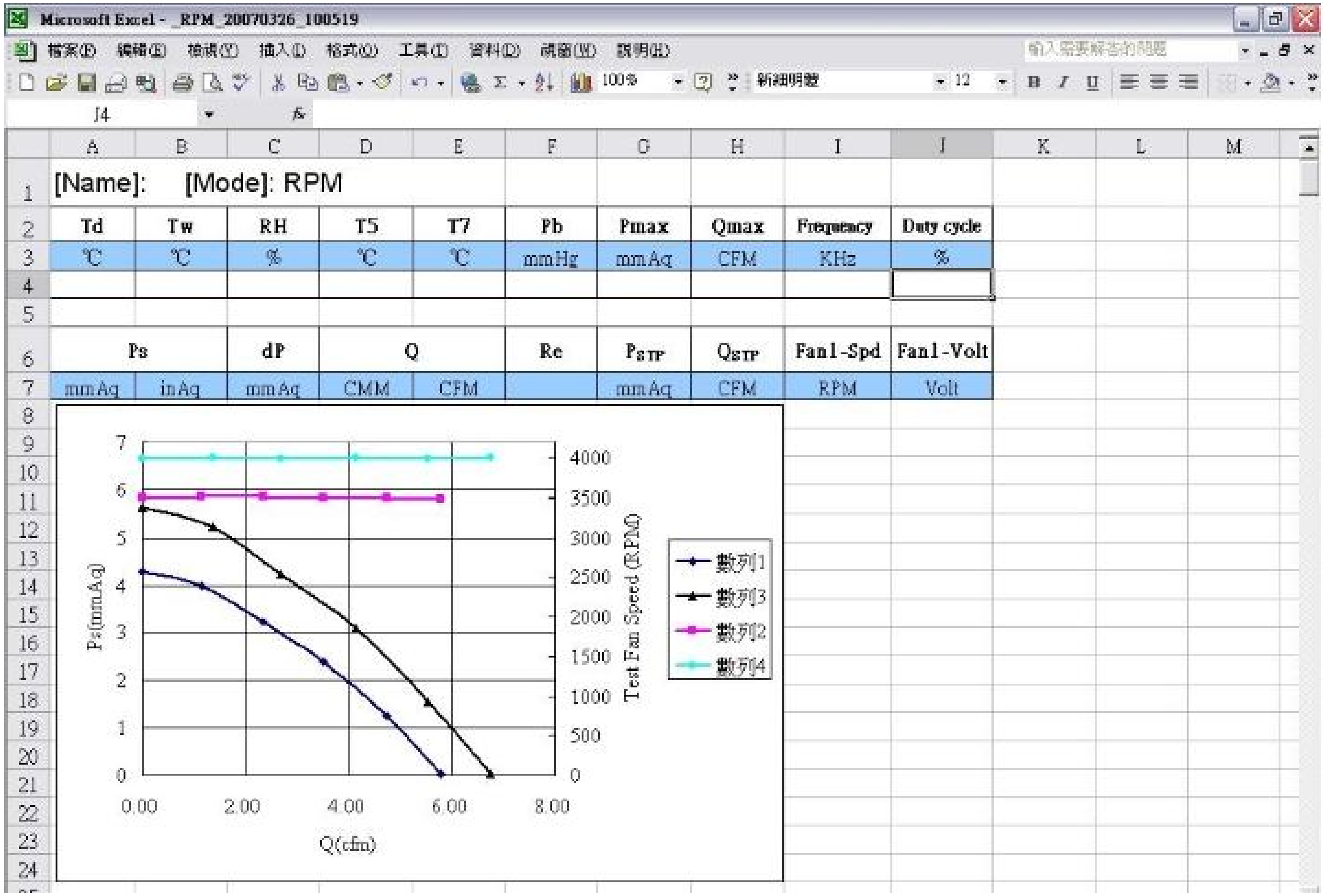
Ps		dP	Q		Re	P_{STP}	Q_{STP}	Fan1-Spd	Fan1-Volt	Fan1-Amp
mmAq	inAq	mmAq	CMM	CFM		mmAq	CFM	RPM	Volt	Amp
4.3	0.1693	4.1	0.000	0.00	0	4.28	0.00	3498	2.60	0.090
3.99	0.1571	52.8	0.033	1.16	9708	3.98	1.14	3510	2.74	0.100
3.23	0.1272	103.4	0.067	2.35	16302	3.22	2.31	3510	2.88	0.110
2.39	0.0941	72.5	0.100	3.51	18201	2.38	3.45	3493	3.12	0.120
1.24	0.0488	131.1	0.134	4.74	24475	1.24	4.65	3505	3.42	0.140
0.02	0.0008	80.7	0.164	5.78	0	0.02	5.68	3488	3.68	0.160



Long Win 1985 Fundamental, Forward & First

(3) Constant RPM

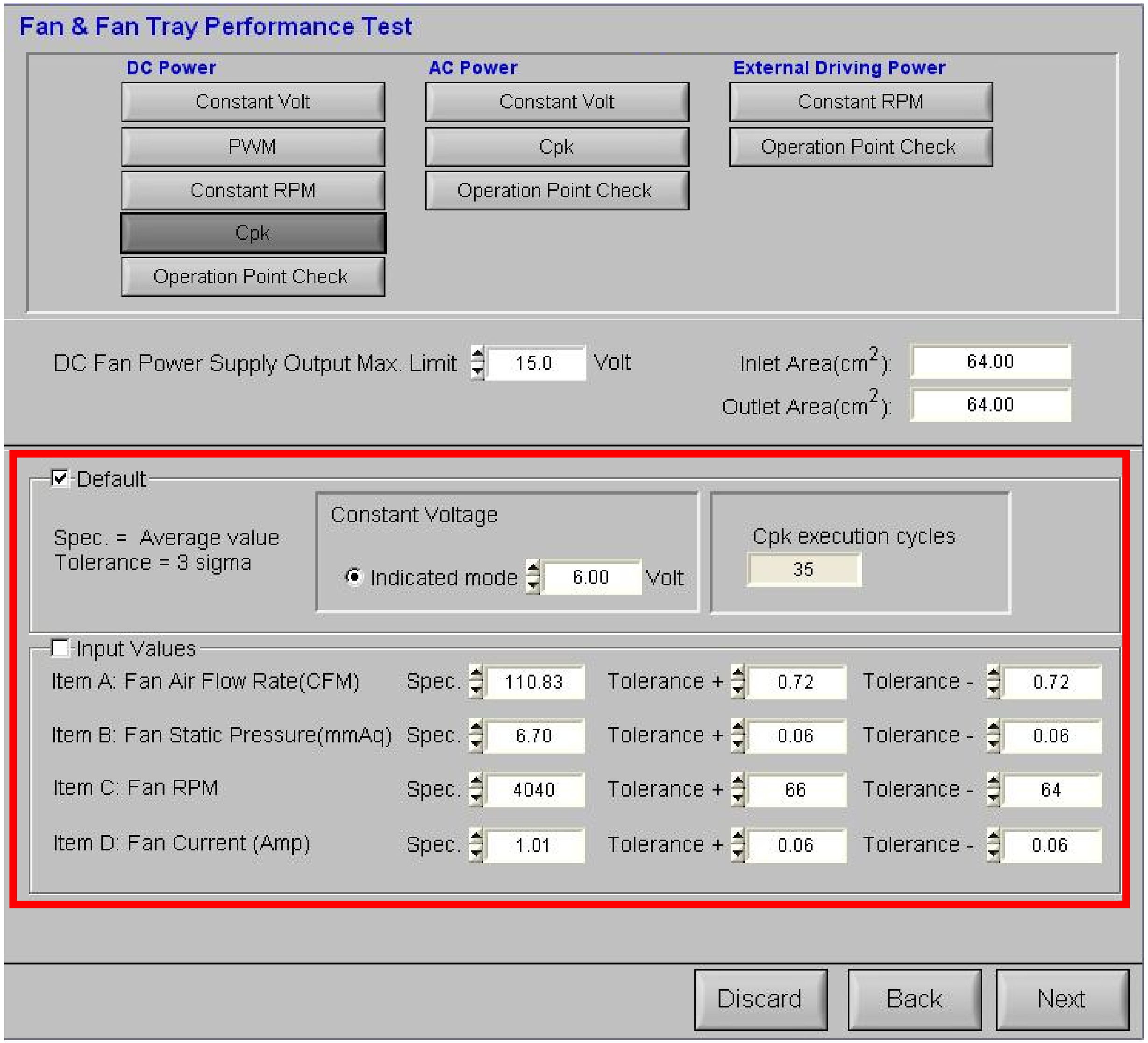
Back to Operation



1985 Long Win
Fundamental, Forward & First

(4) CPK test

Back to Operation

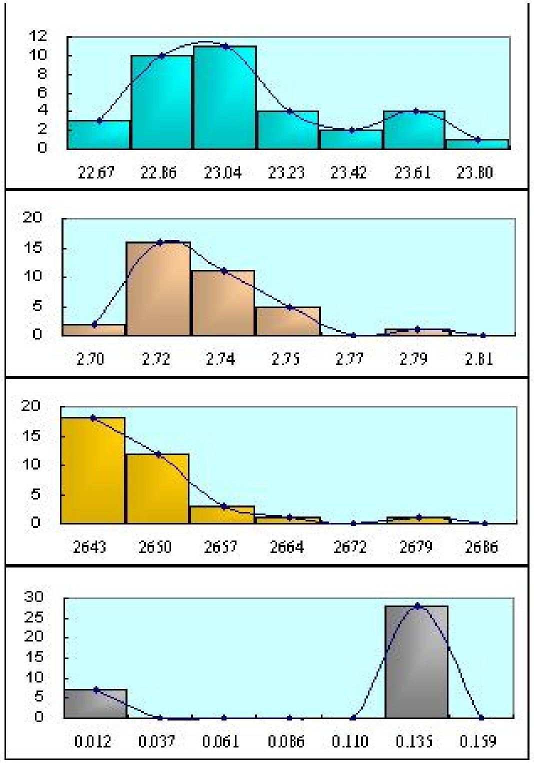


(4) CPK test

Back to Operation

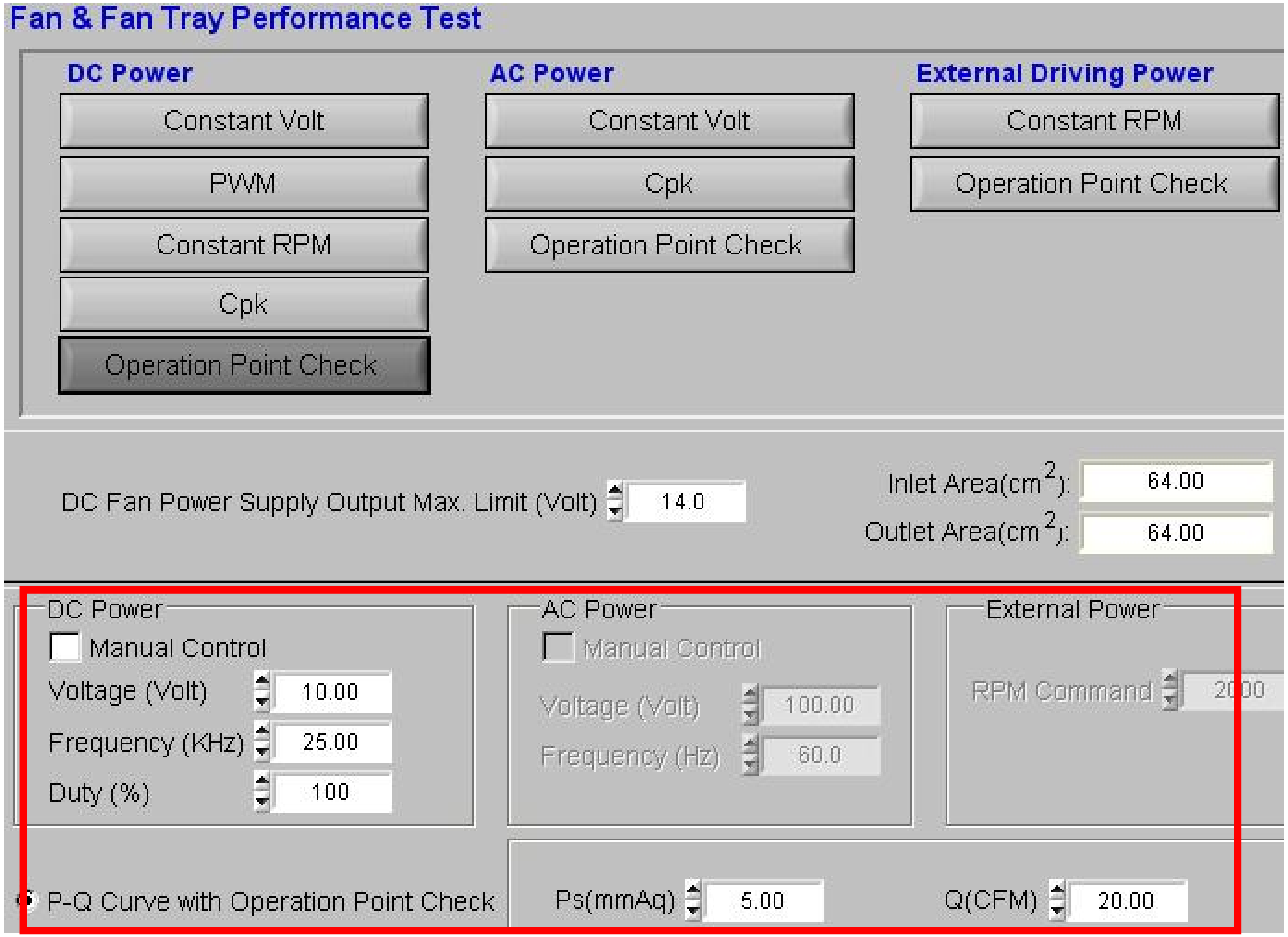
Engineering Specification					
		A	B	C	D
product spe		23.0896	2.72743	2648.09	0.114
+ Tolerence		0.92445	0.06015	23.6424	0.17102
- Tolerence		0.92445	0.06015	23.6424	0.17102
	USL	24.014	2.78758	2671.73	0.28502
	LSL	22.1651	2.66728	2624.44	-0.057
Actual Data					
		A	B	C	D
	X bar	23.0896	2.72743	2647.07	0.114
	Sigma	0.31265	0.02034	7.99585	0.05784
	Median	23.029	2.72	2646	0.142
	Mode	#N/A	2.72	2645	0.142
	Max	23.7085	2.8	2682.5	0.147
	Min	22.5752	2.69	2639	0
UCL 3 Sigma	1 Sigma	23.4022	2.74777	2655.07	0.17184
	2 Sigma	23.7149	2.76811	2663.07	0.22968
	3 Sigma	24.0275	2.78845	2671.06	0.28752
LCL 3 Sigma	1 Sigma	22.7769	2.70709	2639.08	0.05616
	2 Sigma	22.4643	2.68675	2631.08	-0.0017
	3 Sigma	22.1516	2.6664	2623.09	-0.0595
SPC	CP	0.98561	0.98561	0.98561	0.98561
	CPL	0.98561	0.98561	0.94341	0.98561
	CPU	0.98561	0.98561	1.02781	0.98561
	S. CP	0.98561	0.98561	0.94341	0.98561
	Ca	-3.8E-15	0	-0.0428	-2E-16
	Cpk	0.98561	0.98561	0.94341	0.98561

Flow rate
Ps (pressure)
RPM
Current (A)



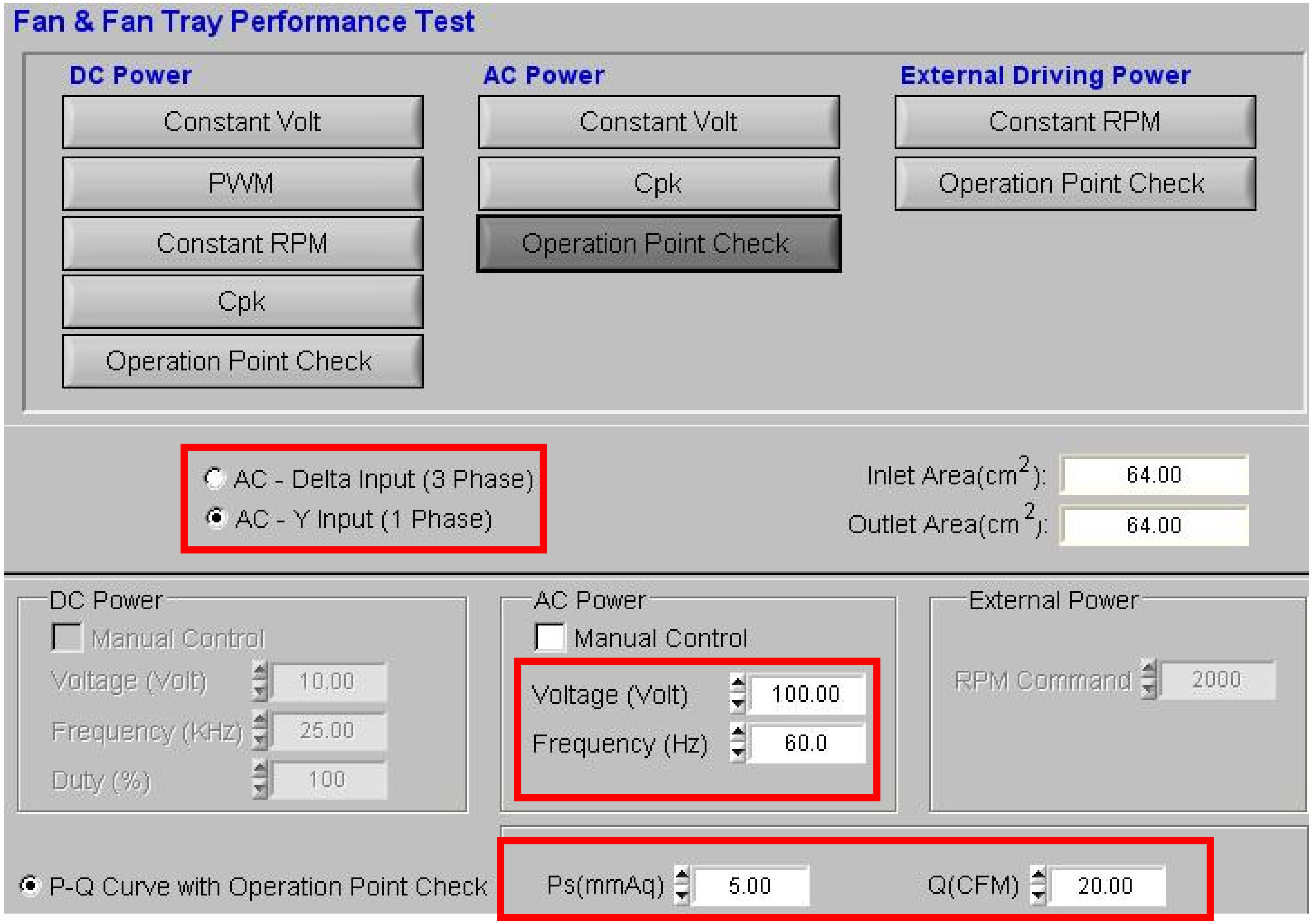
(5) OP (DC Fan)

Back to Operation



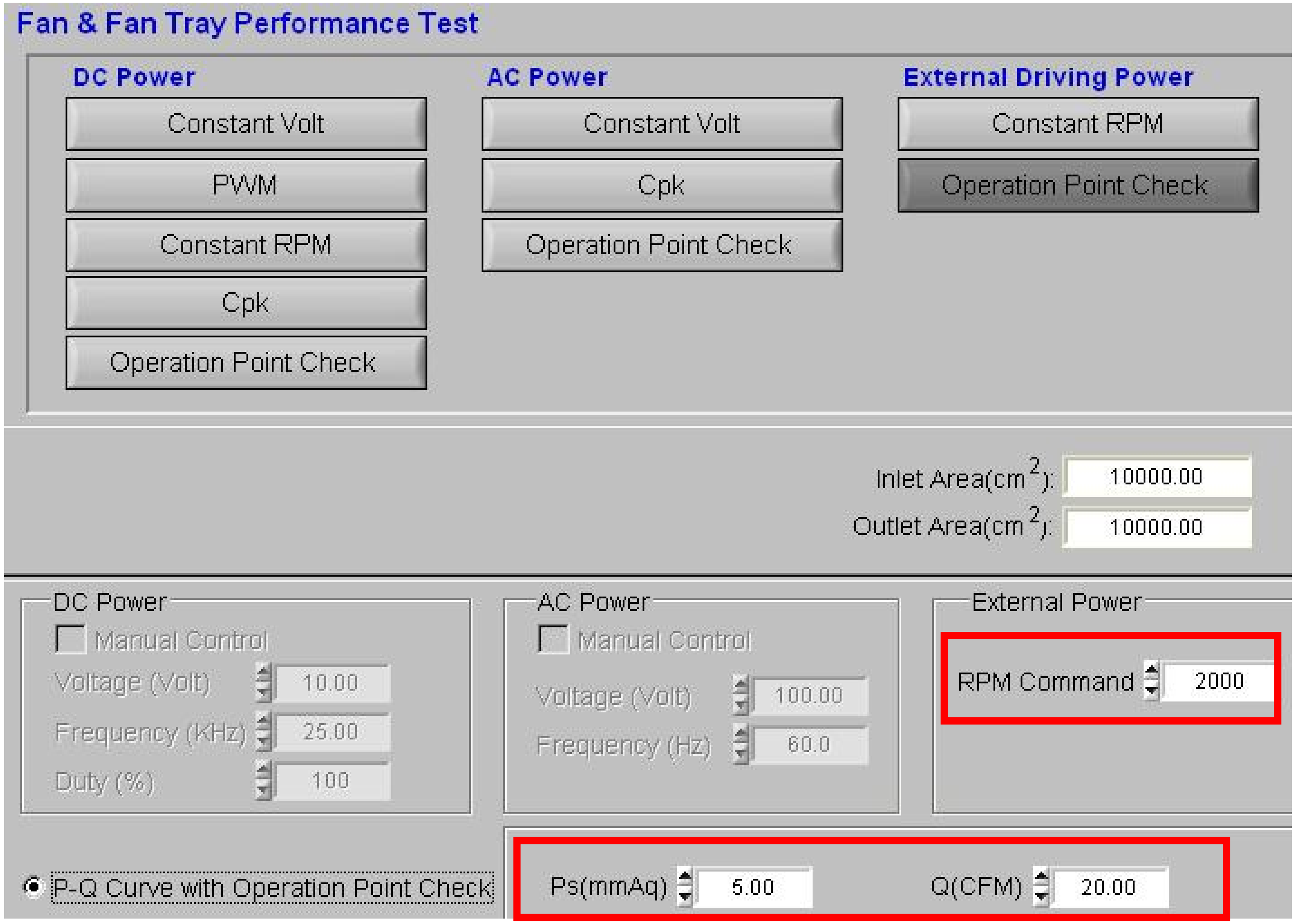
(5) OP (AC Fan)

Back to Operation



(5) OP (Impeller)

Back to Operation



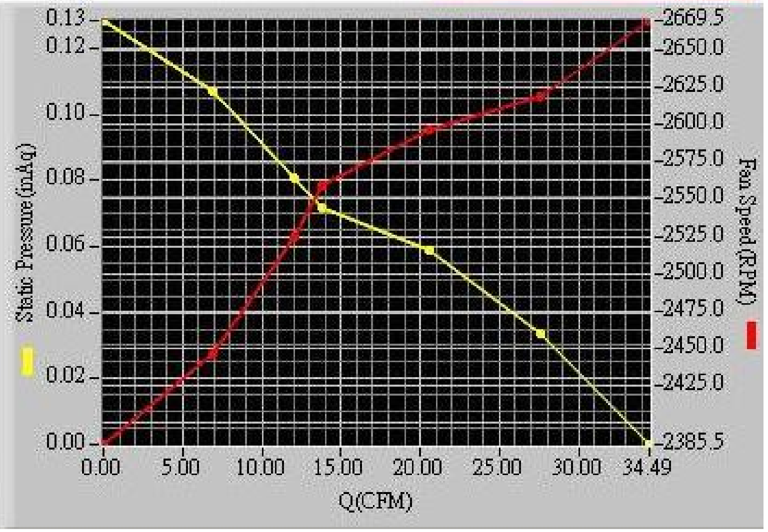
1985 Long Win Fundamental, Forward & First

(5) OP

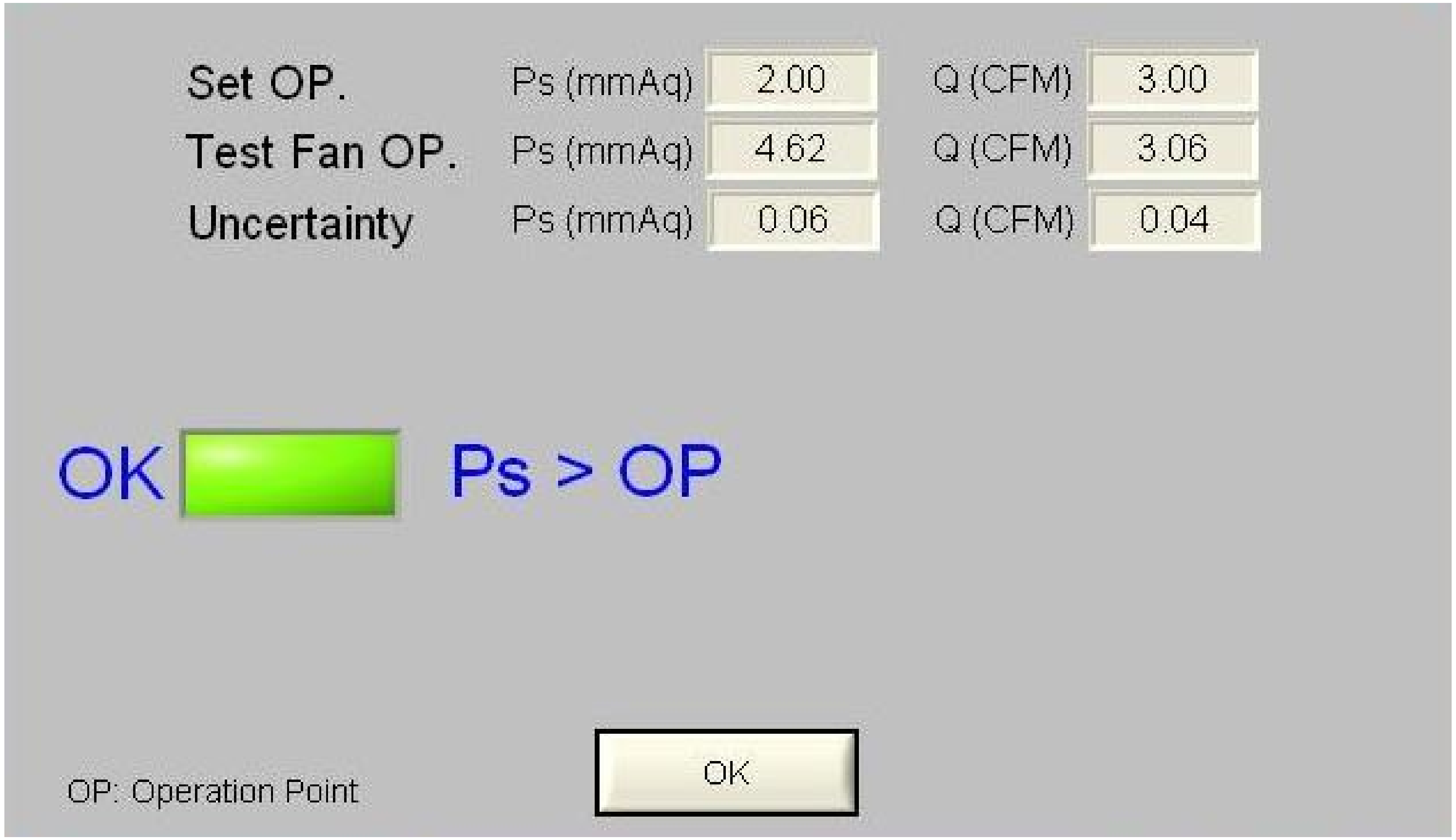
Back to Operation

LW-9015RSAN V4 AMCA 210

	Ps mmAq	Ps inAq	Ps_STP mmAq	Q CMM	Q CFM	Q_STP CFM	Fan Speed RPM	Fan Volt V	Fan Amp A
1	3.26	0.13	3.31	0.00	0.00	0.00	2386	11.99	0.106
2	0.00	0.00	0.00	0.98	34.49	34.02	2670	12.00	0.080
3	2.72	0.11	2.76	0.19	6.84	6.75	2446	11.99	0.100
4	2.05	0.08	2.08	0.34	12.03	11.86	2524	11.99	0.093
5	1.82	0.07	1.85	0.39	13.83	13.64	2560	11.99	0.090
6	1.50	0.06	1.52	0.58	20.61	20.33	2596	12.00	0.087
7	0.85	0.03	0.86	0.78	27.56	27.18	2619	11.99	0.084
8									
9									
10									



(5) OP

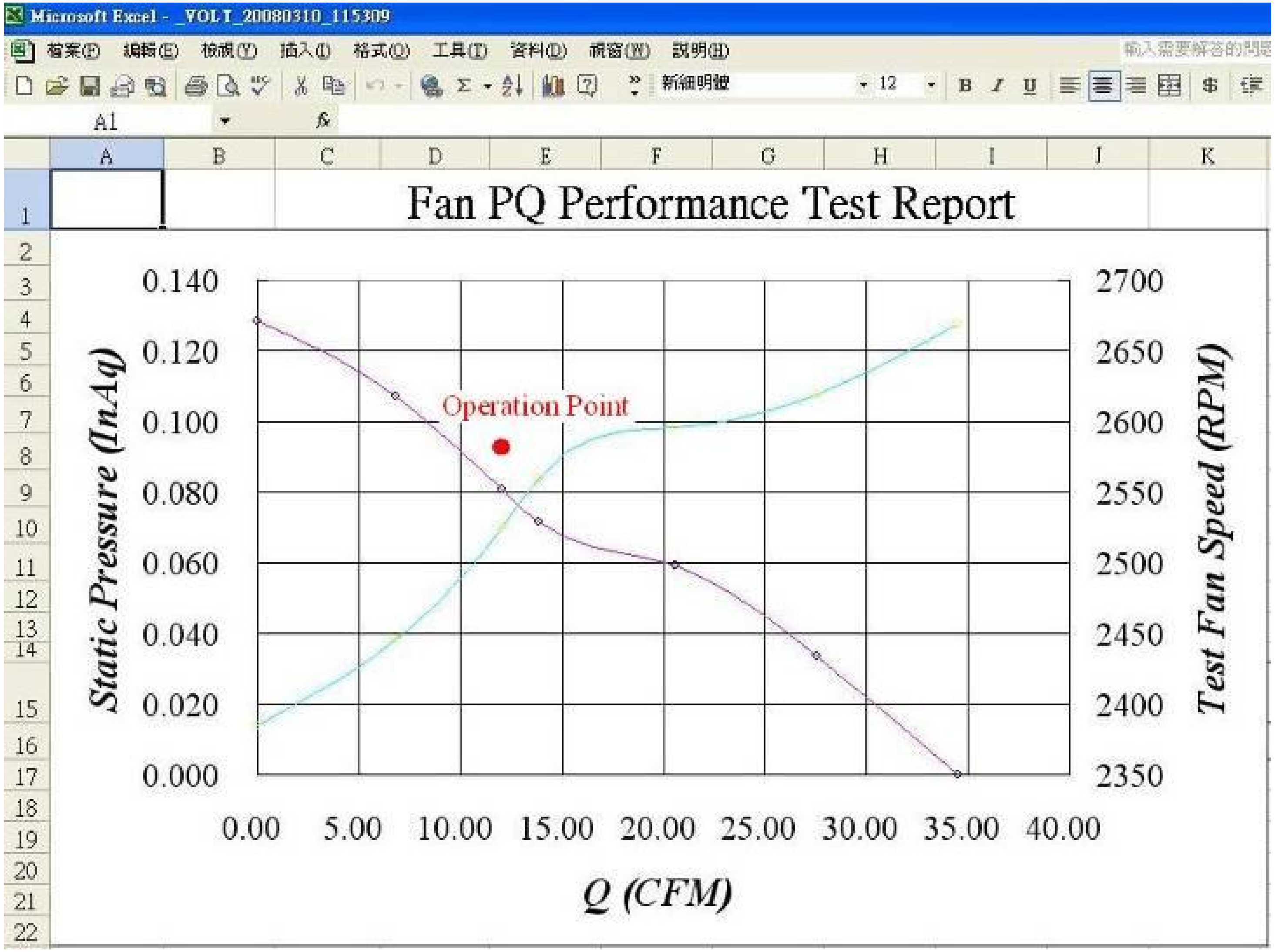

Set OP.
Ps (mmAq) 2.00
Q (CFM) 3.00
Test Fan OP.
Ps (mmAq) 4.62
Q (CFM) 3.06
Uncertainty
Ps (mmAq) 0.06
Q (CFM) 0.04
OK
Ps > OP
OP: Operation Point
OK

(5) OP

Back to Operation

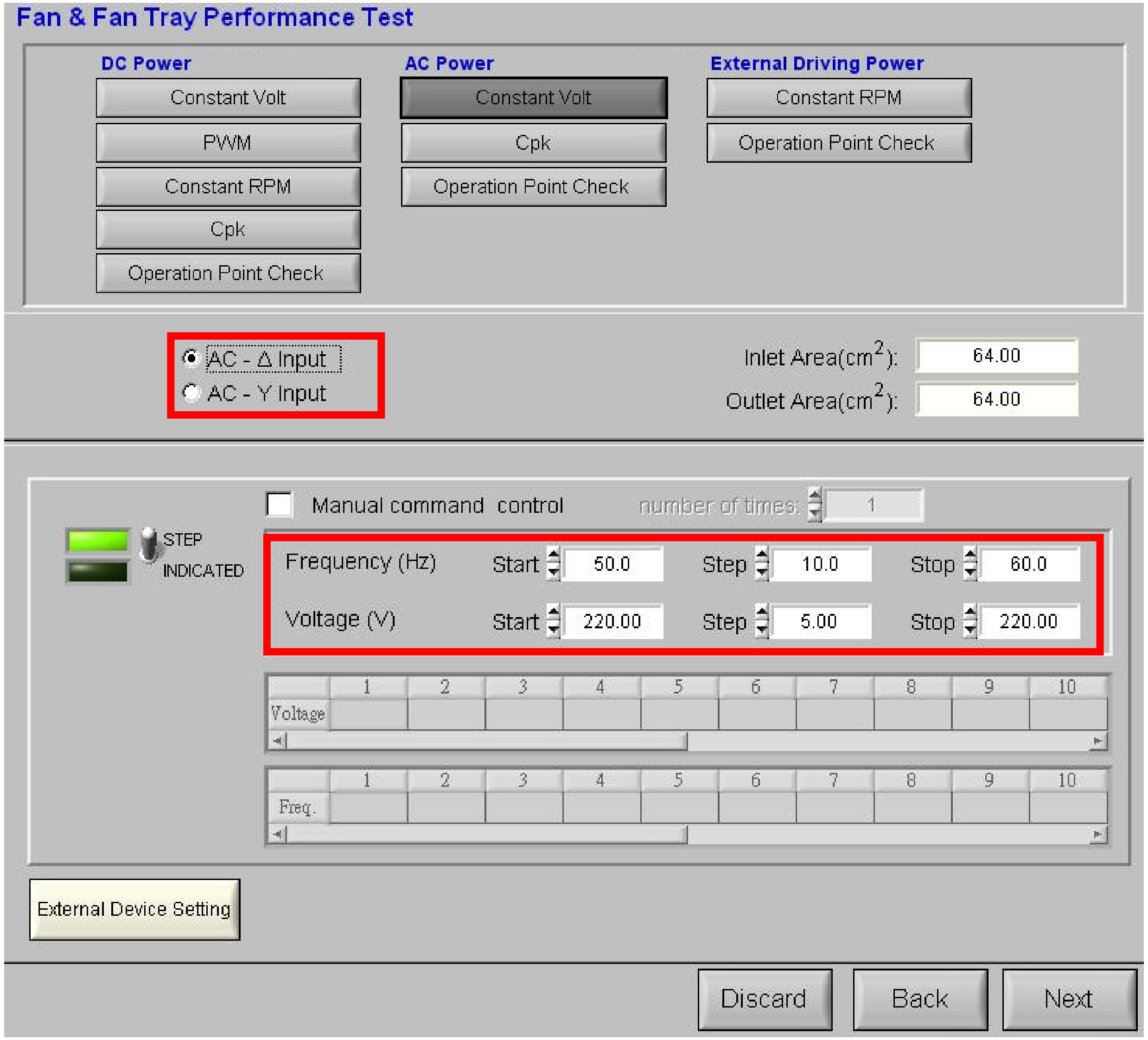
(5) OP

Back to Operation



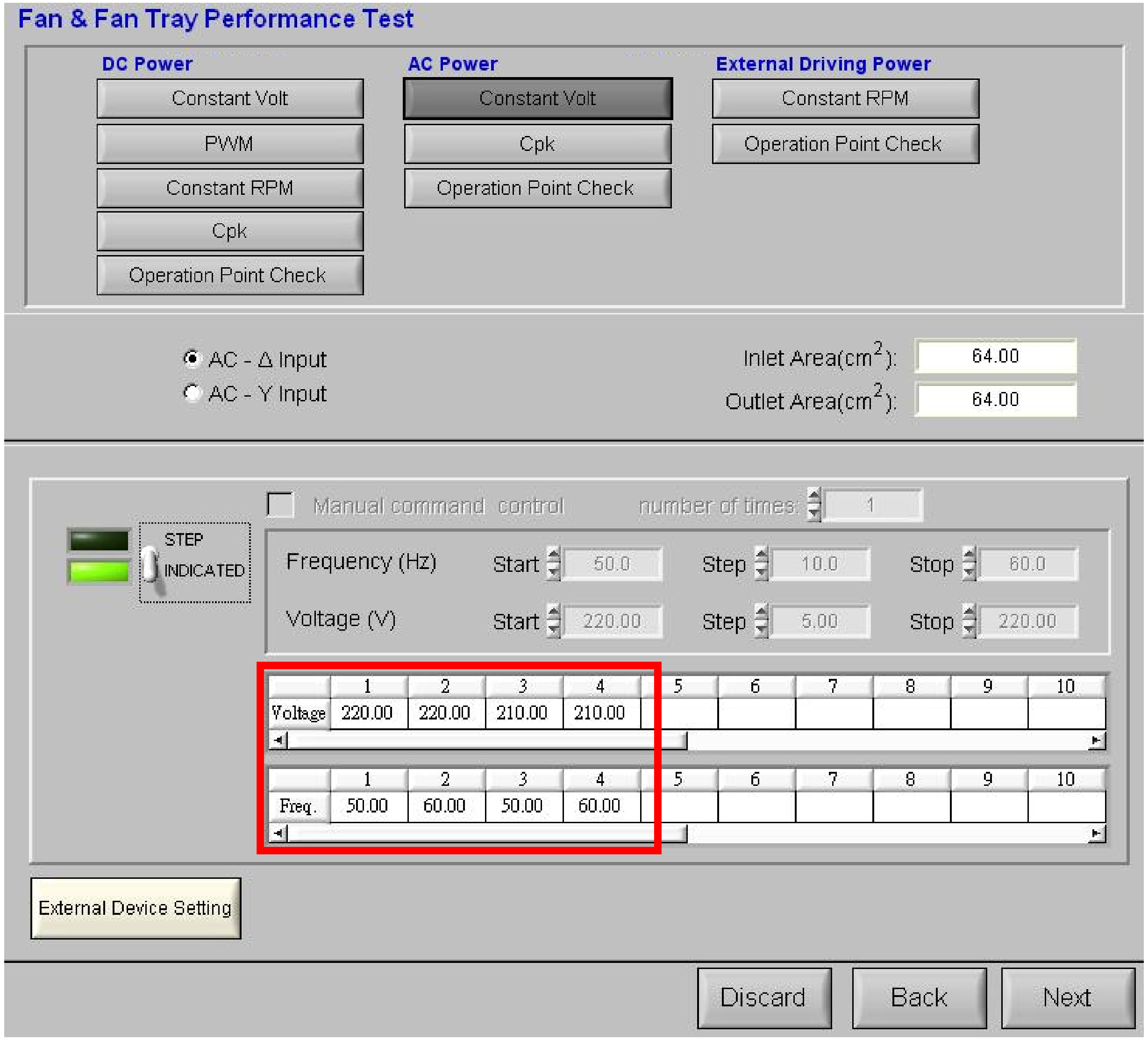
(6) AC Constant Volt

Back to Operation



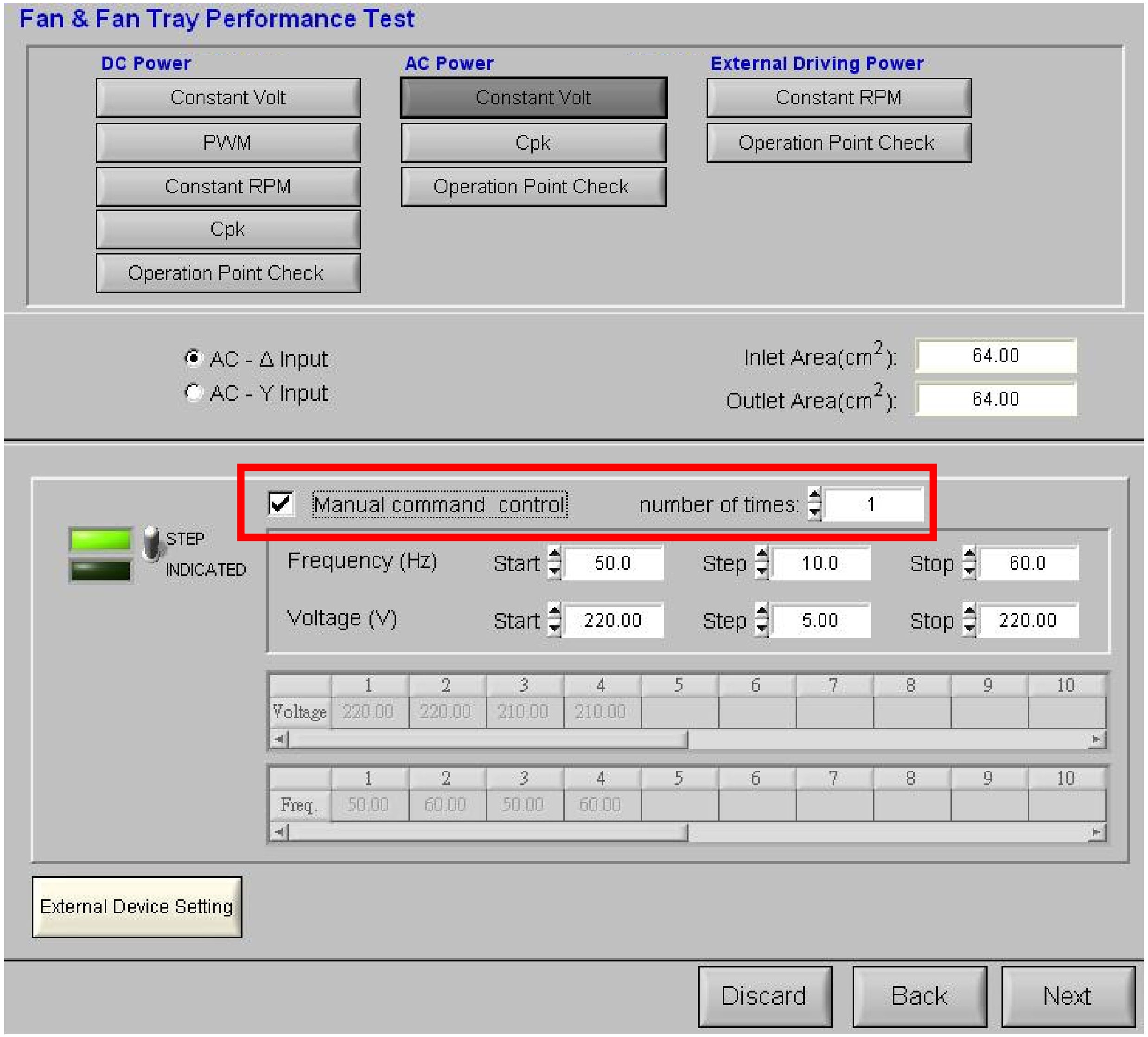
(6) AC Constant Volt

Back to Operation



(6) AC Constant Volt

Back to Operation



(6) AC Constant Volt

Back to Operation

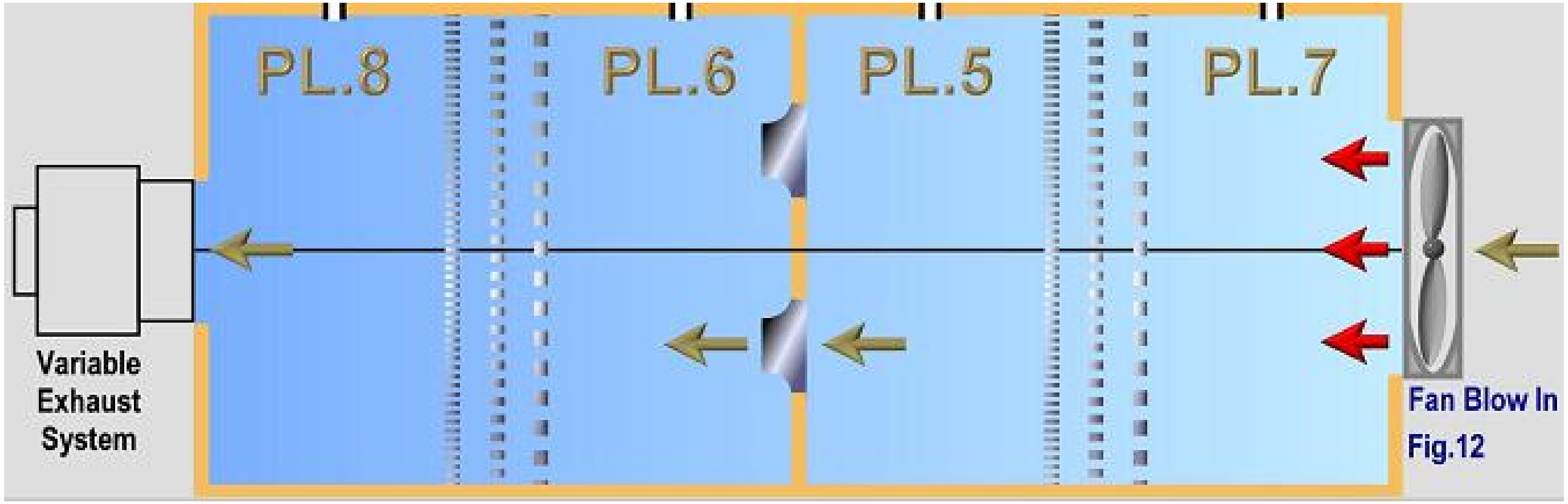
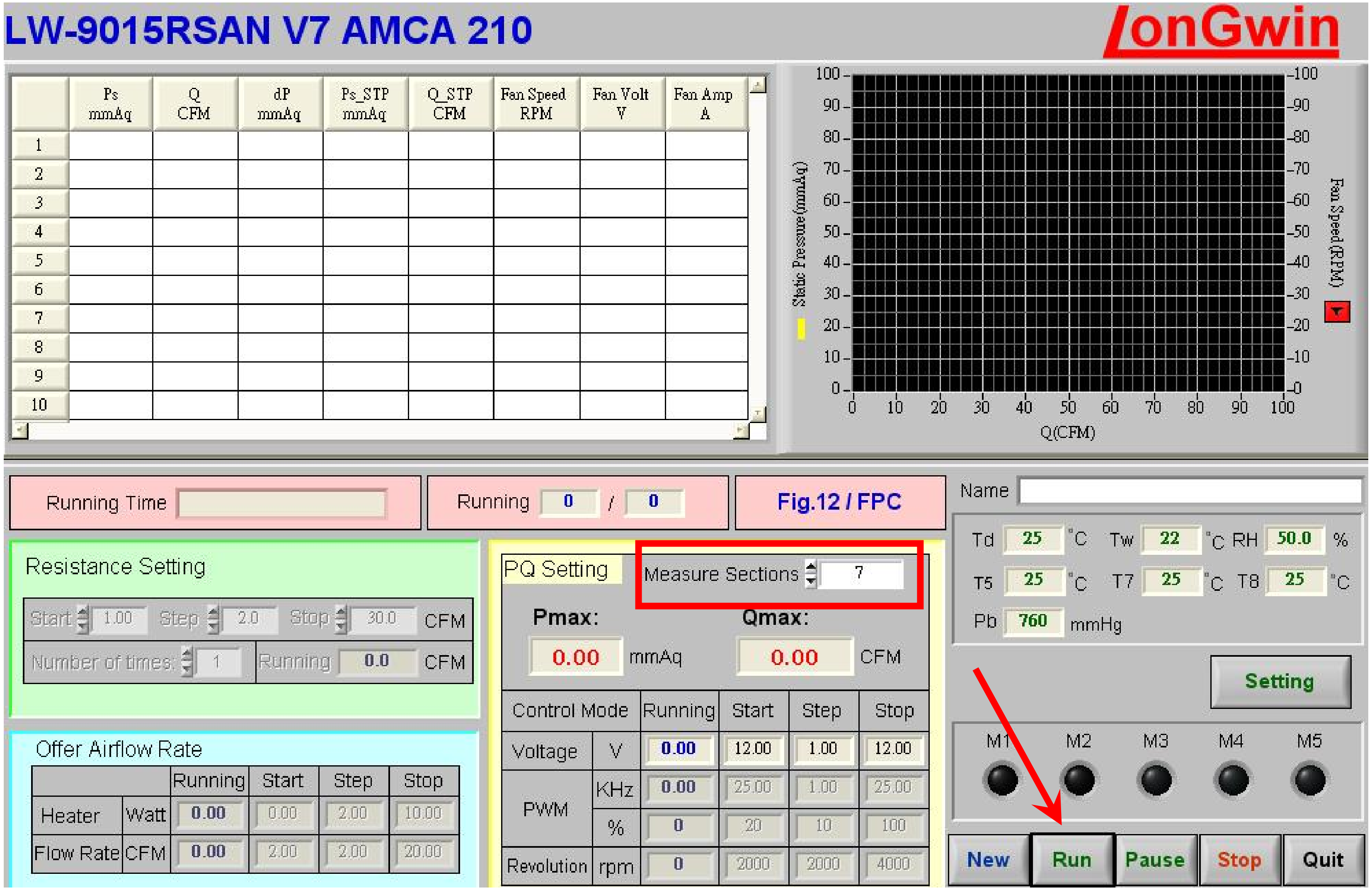


Fig.12

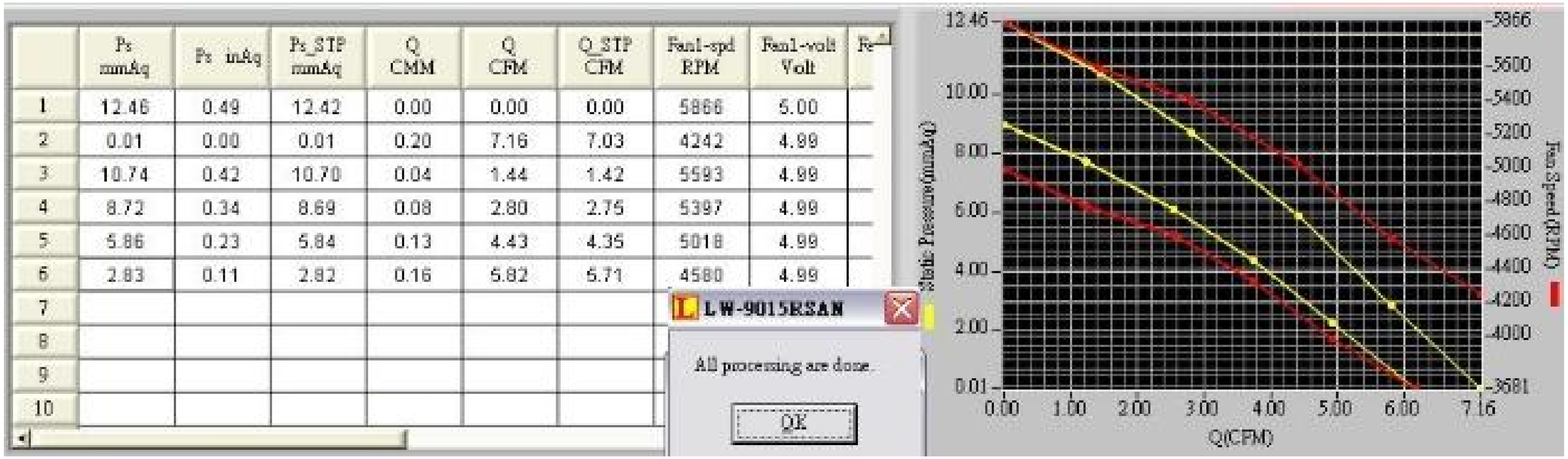
(6) AC Constant Volt

Back to Operation



(6) AC Constant Volt

Back to Operation



	Ps mmAq	Ps inAq	Ps_STP mmAq	Q CMM	Q CFM	Q_STP CFM	Fan1-spd RPM	Fan1-volt Volt	Fe
1	12.46	0.49	12.42	0.00	0.00	0.00	5866	5.00	
2	0.01	0.00	0.01	0.20	7.16	7.03	4242	4.99	
3	10.74	0.42	10.70	0.04	1.44	1.42	5593	4.99	
4	8.72	0.34	8.69	0.08	2.80	2.75	5397	4.99	
5	5.86	0.23	5.84	0.13	4.43	4.35	5018	4.99	
6	2.83	0.11	2.82	0.16	5.82	5.71	4580	4.99	
7									
8									
9									
10									

(6) AC Constant Volt

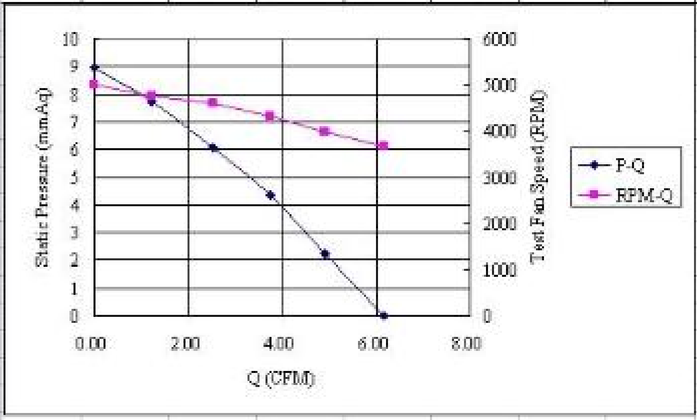
Back to Operation

Microsoft Excel - _VOLT_20070326_093546

[Name]: [Mode]: Constant Voltage

Td	Tw	RH	T5	T7	Pb	Pmax	Qmax	Frequency	Duty cycle
℃	℃	%	℃	℃	mmHg	mmAq	CFM	KHz	%
21	18.9	82.0	21.1	21.1	751.2	8.98	6.17		

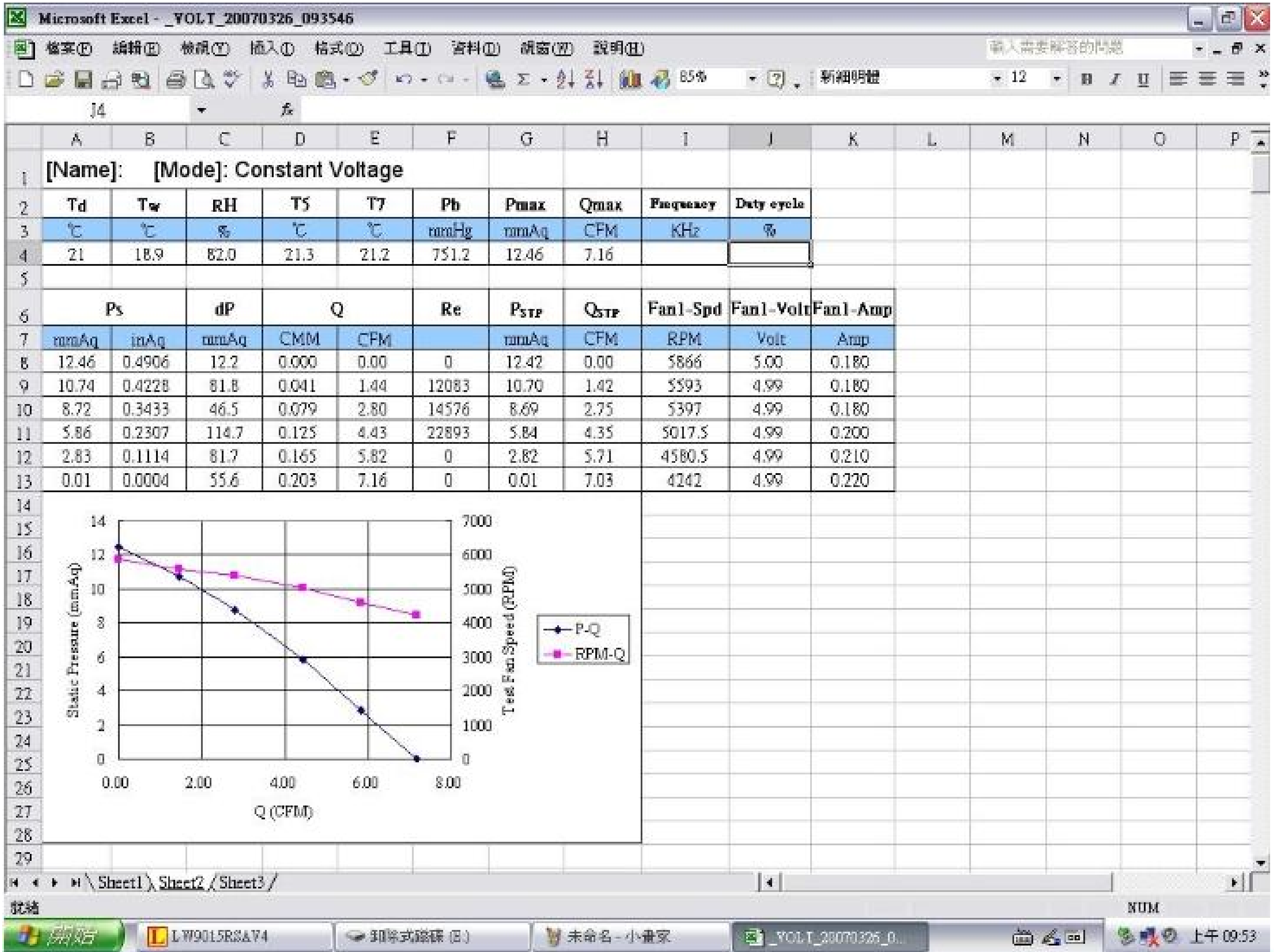
Ps		dP	Q		Re	P_{STP}	Q_{STP}	Fan1-Spd	Fan1-Volt	Fan1-Amp
mmAq	inAq	mmAq	CMM	CFM		mmAq	CFM	RPM	Volt	Amp
8.98	0.3535	8.8	0.000	0.00	0	8.95	0.00	4992	3.99	0.140
7.73	0.3043	59.3	0.035	1.23	10288	7.70	1.20	4769	3.99	0.140
6.08	0.2394	120.2	0.072	2.54	17577	6.06	2.49	4593	3.99	0.150
4.34	0.1709	82.4	0.106	3.75	19404	4.33	3.68	4319	3.99	0.160
2.22	0.0874	58.6	0.139	4.92	0	2.21	4.83	3975.5	3.98	0.170
0.02	0.0008	41.5	0.175	6.17	0	0.02	6.05	3681	3.98	0.180



1985 Long Win Fundamental, Forward & First

(6) AC Constant Volt

Back to Operation


Microsoft Excel - _VOLT_20070326_093546

[Name]: [Mode]: Constant Voltage

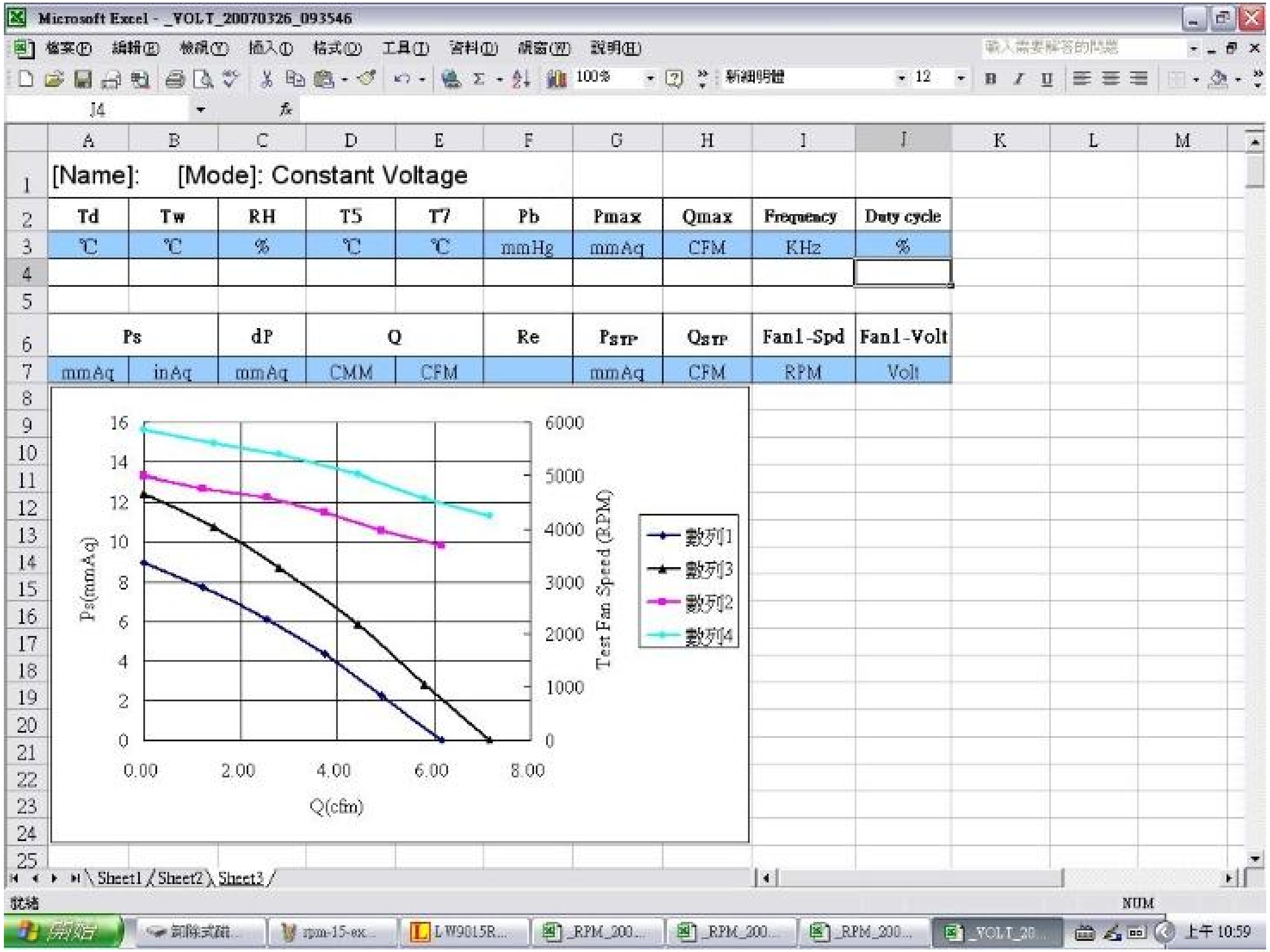
Td	Tw	RH	T5	T7	Pb	Pmax	Qmax	Frequency	Duty cycle
℃	℃	%	℃	℃	mmHg	mmAq	CFM	KHz	%
21	18.9	82.0	21.3	21.2	751.2	12.46	7.16		

Ps		dP	Q		Re	P_{STP}	Q_{STP}	Fan1-Spd	Fan1-Volt	Fan1-Amp
mmAq	inAq	mmAq	CMM	CFM		mmAq	CFM	RPM	Volt	Amp
12.46	0.4906	12.2	0.000	0.00	0	12.42	0.00	5866	5.00	0.180
10.74	0.4228	81.8	0.041	1.44	12083	10.70	1.42	5593	4.99	0.180
8.72	0.3433	46.5	0.079	2.80	14576	8.69	2.75	5397	4.99	0.180
5.86	0.2307	114.7	0.125	4.43	22893	5.84	4.35	5017.5	4.99	0.200
2.83	0.1114	81.7	0.165	5.82	0	2.82	5.71	4580.5	4.99	0.210
0.01	0.0004	55.6	0.203	7.16	0	0.01	7.03	4242	4.99	0.220

1985 Long Win Fundamental, Forward & First

(6) AC Constant Volt

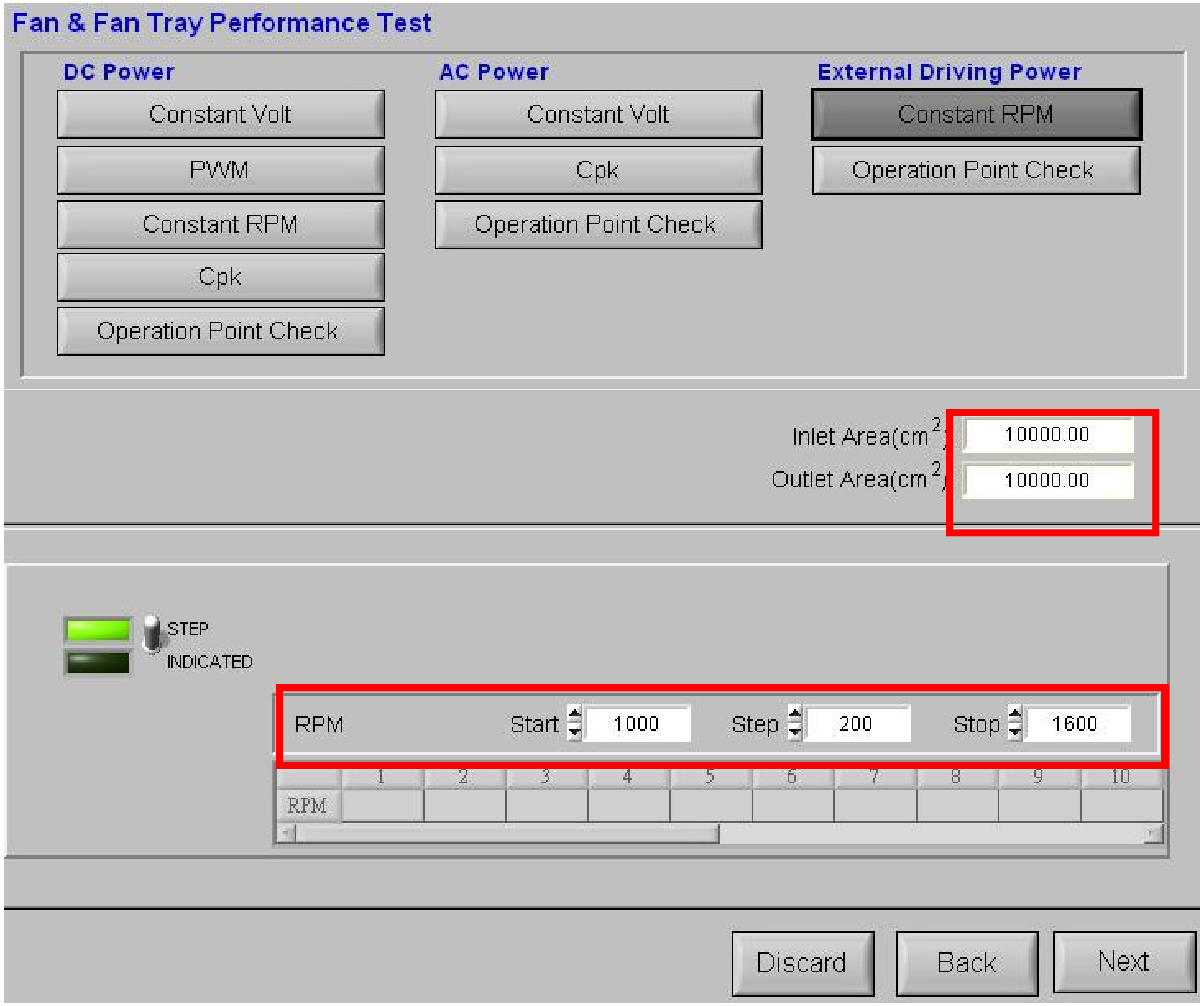
Back to Operation



1985 Long Win
Fandamental, Forward & First

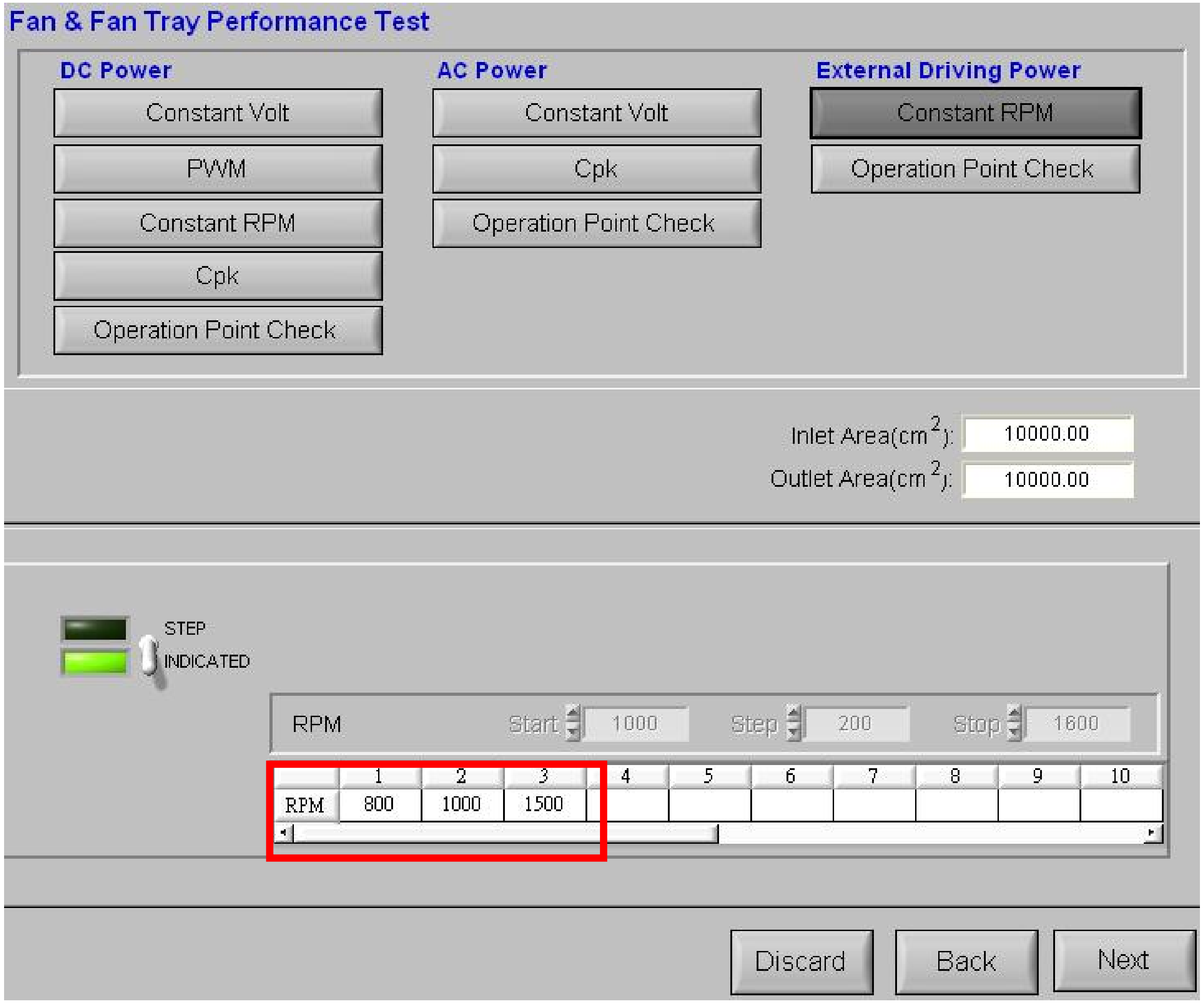
(7) External Constant RPM

Back to Operation



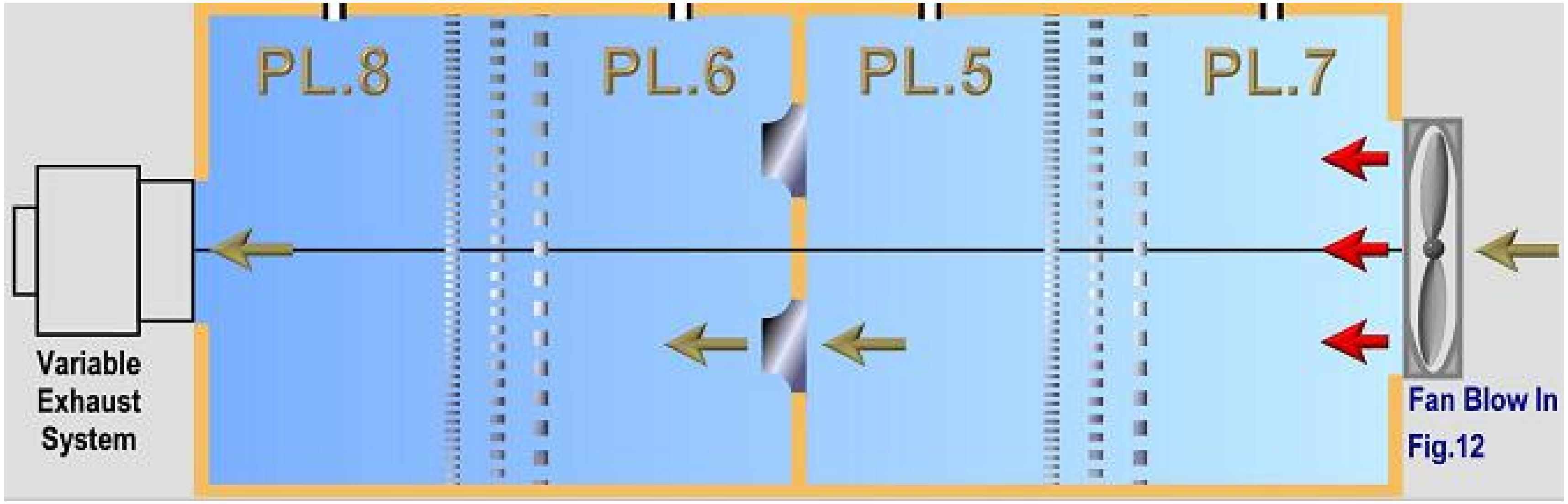
(7) External Constant RPM

Back to Operation



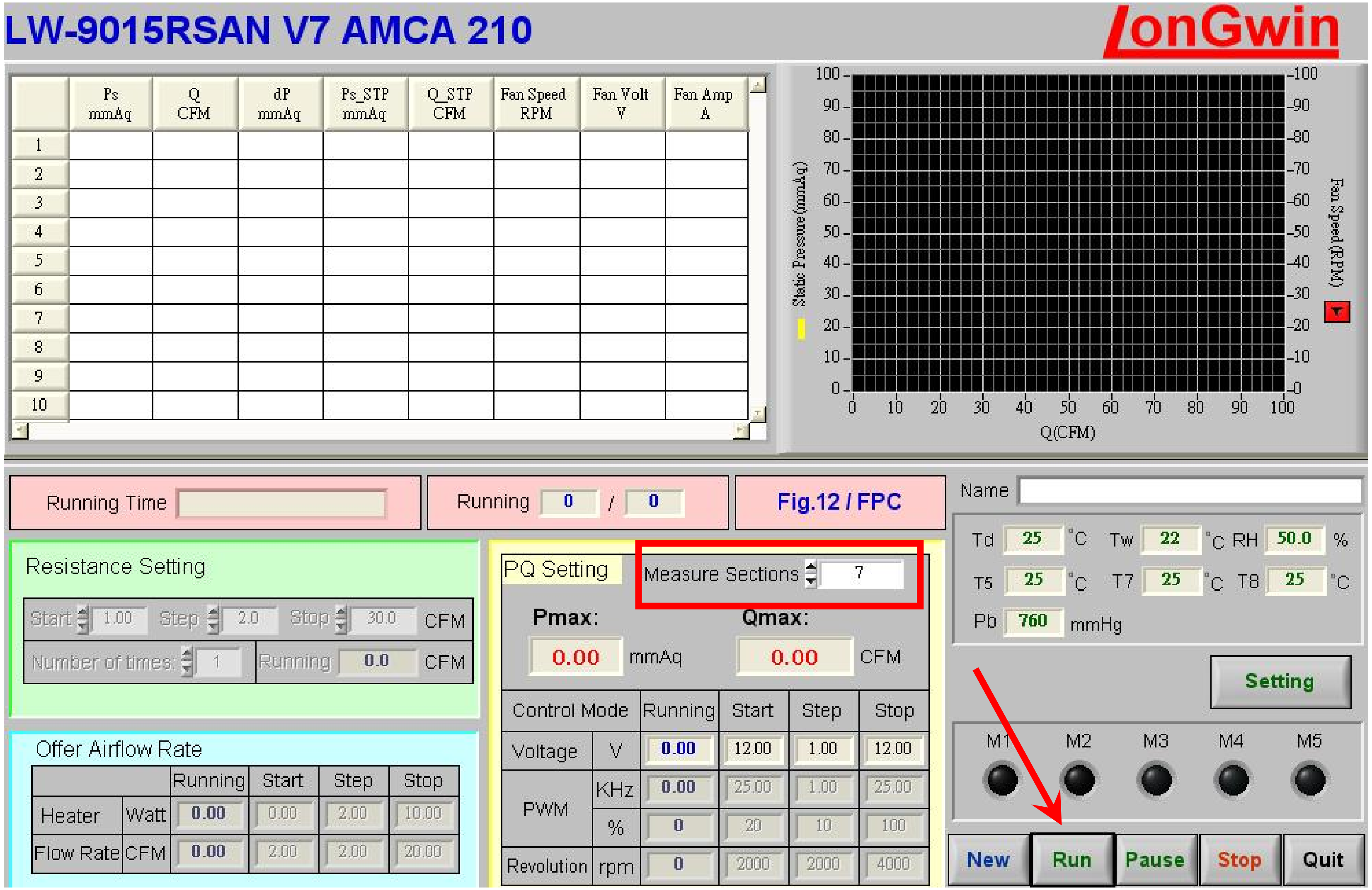
(7) External Constant RPM

Back to Operation



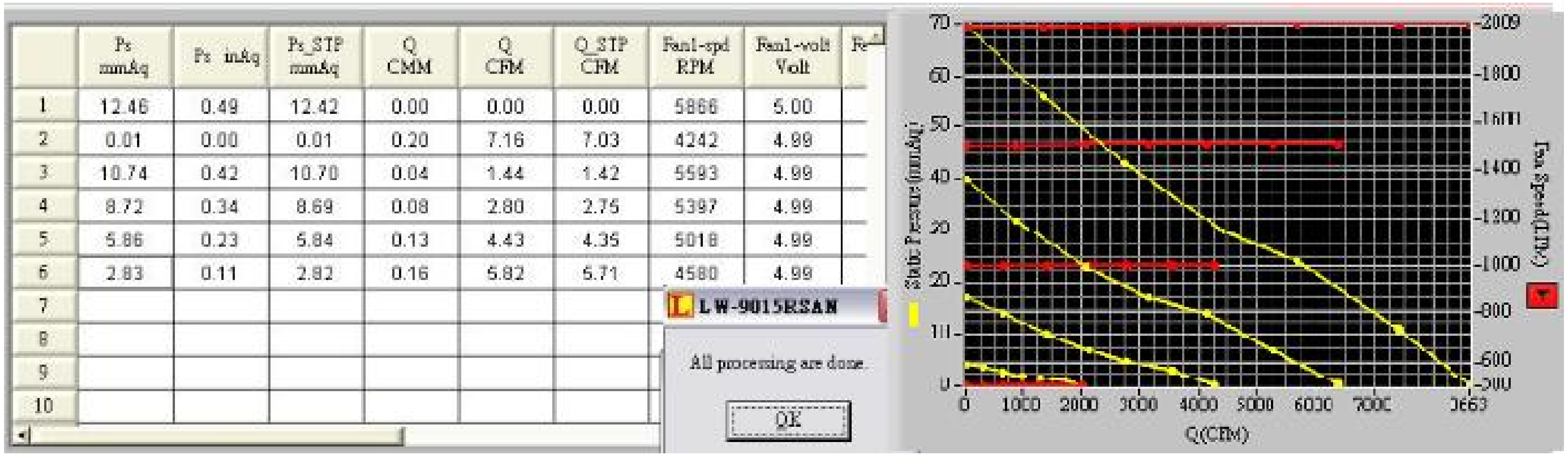
(7) External Constant RPM

Back to Operation



(7) External Constant RPM

Back to Operation



	Ps mmAq	Ps inAq	Ps_STP mmAq	Q CMM	Q CFM	Q_STP CFM	Fan1-spd RPM	Fan1-volt Volt
1	12.46	0.49	12.42	0.00	0.00	0.00	5866	5.00
2	0.01	0.00	0.01	0.20	7.16	7.03	4242	4.99
3	10.74	0.42	10.70	0.04	1.44	1.42	5593	4.99
4	8.72	0.34	8.69	0.08	2.80	2.75	5397	4.99
5	5.86	0.23	5.84	0.13	4.43	4.35	5018	4.99
6	2.83	0.11	2.82	0.16	5.82	5.71	4580	4.99
7								
8								
9								
10								

1985 Long Win
Fundamental, Forward & First

(7) External Constant RPM

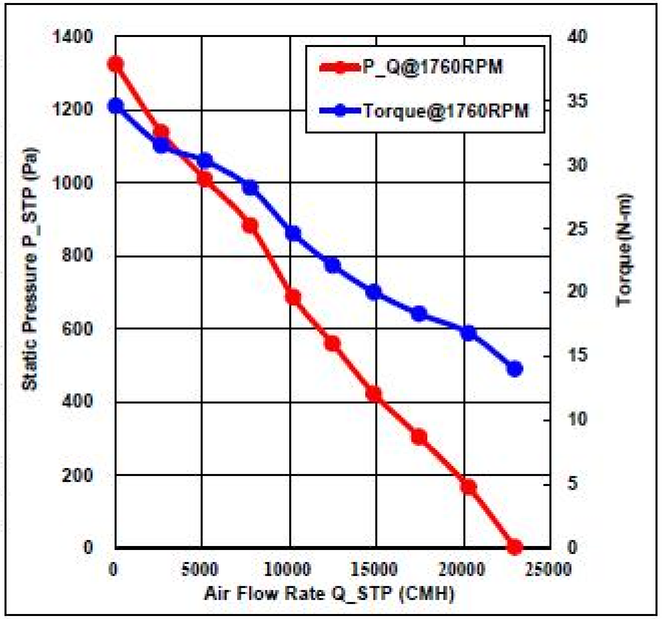
Back to Operation

Td	Tw	RH	T5	T7	T8	Pb
°C	°C	%	°C	°C	°C	mmHg
27.3	24.1	77.8	25.0	30.3	29.7	741.9

Test Setup	AMCA 210-07 Fig. 15, Inlet Chamber
Installation	Type A: free inlet, free outlet, CCW, with duct and bell ring

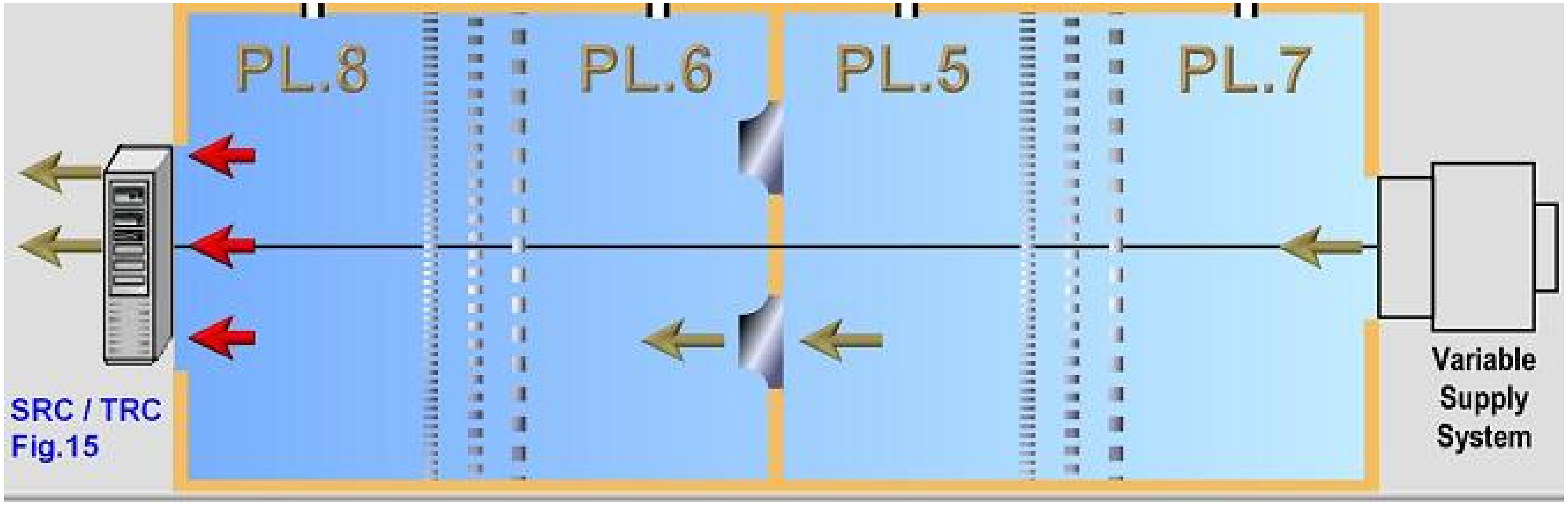
Model	Test Condition @ 1760 RPM								
	Ps	Q	P_{STP}	Q_{STP}	Rotary Speed	Torque	Shaft Power	Ps Efficiency	Pt Efficiency
	Pa	CMH	Pa	CMH	RPM	N-m	Watt	%	%
730/6	1324.8	0	1430.1	0	1763	34.6	6387.9	0.0	0.0
	1138.4	2625	1224.1	2625	1761	31.5	5809.0	14.3	12.9
	1010.8	5129	1081.9	5129	1764	30.3	5597.2	25.7	23.7
	883.2	7711	943.9	7711	1764	28.2	5209.3	36.3	35.1
	686.9	10181	732.7	10181	1762	24.6	4539.1	42.8	42.9
	559.4	12446	595.9	12446	1763	22.1	4080.1	47.4	46.8
	422.0	14824	449.2	14824	1762	20.0	3690.3	47.1	50.6
	304.2	17424	323.8	17424	1761	18.3	3374.7	43.6	54.6
	166.8	20268	177.5	20268	1763	16.8	3101.6	30.3	46.3
	2.4	22925	2.5	22925	1763	14.0	2584.7	0.6	24.5

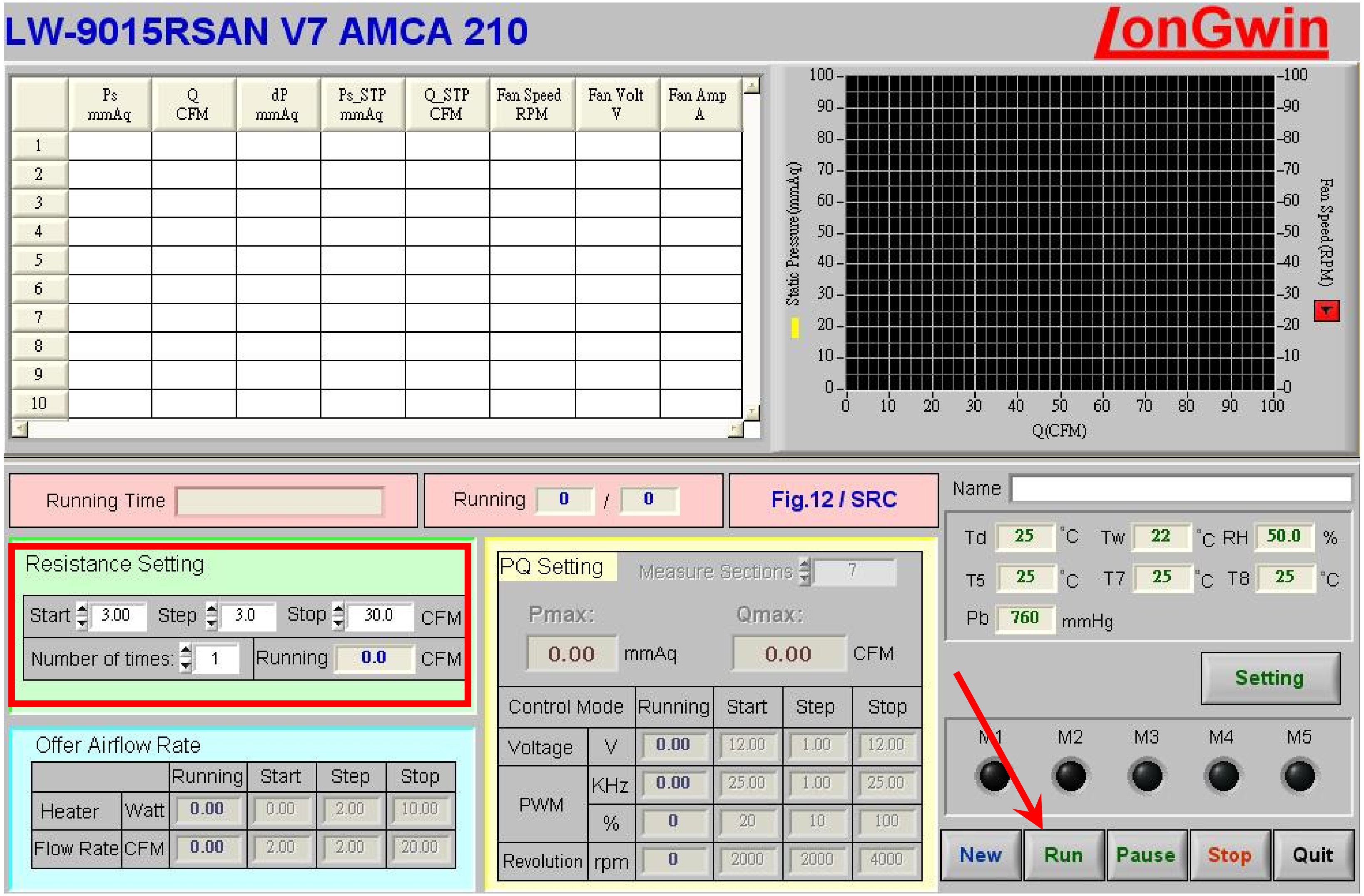
STP: Standard Air Property is Air at (Td) 20 ℃ , (RH) 50 % Relative Humidity, and (Pb) 760 mmHg



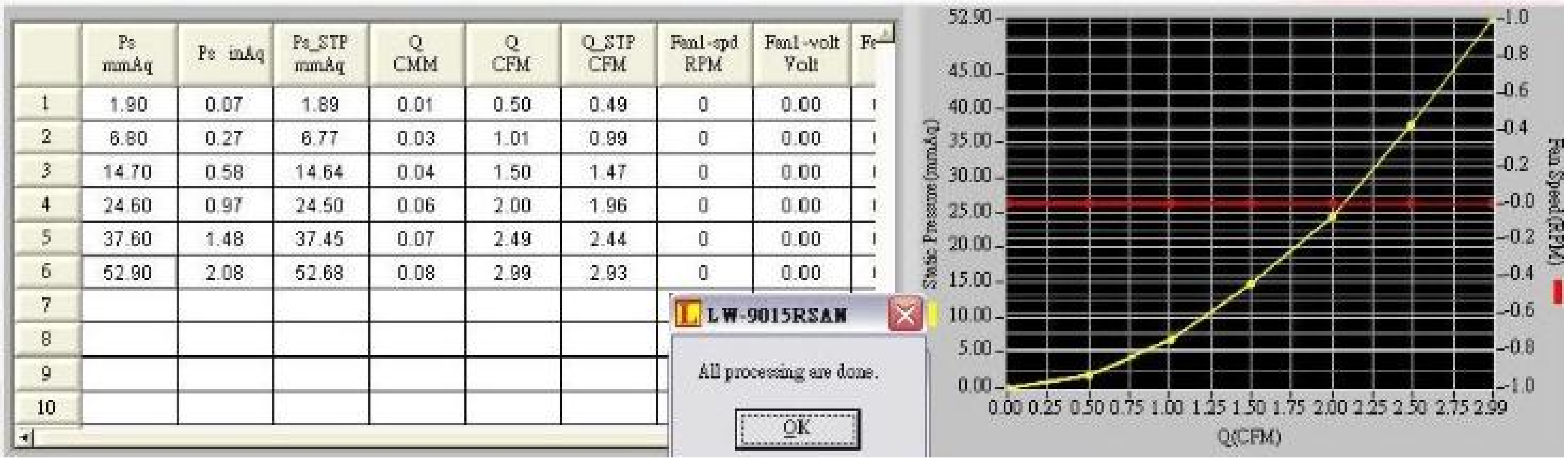
(7) External Constant RPM

Back to Operation


PL.8
PL.6
PL.5
PL.7
Variable
Supply
System
SRC / TRC
Fig.15



1985 Long Win Fundamental, Forward & First

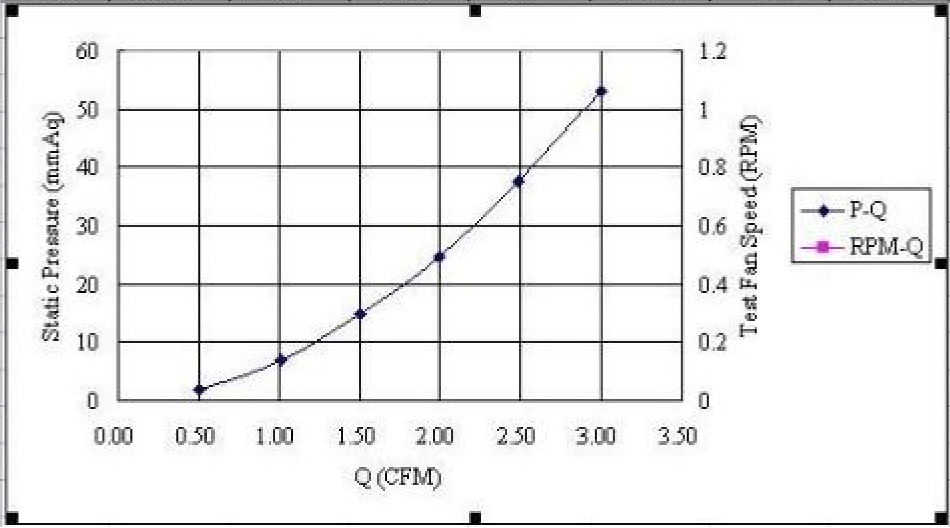


	Ps mmAq	Ps inAq	Ps_STP mmAq	Q CMM	Q CFM	Q_STP CFM	Fan1-spd RPM	Fan1-volt Volt	Fe
1	1.90	0.07	1.89	0.01	0.50	0.49	0	0.00	
2	6.80	0.27	6.77	0.03	1.01	0.99	0	0.00	
3	14.70	0.58	14.64	0.04	1.50	1.47	0	0.00	
4	24.60	0.97	24.50	0.06	2.00	1.96	0	0.00	
5	37.60	1.48	37.45	0.07	2.49	2.44	0	0.00	
6	52.90	2.08	52.68	0.08	2.99	2.93	0	0.00	
7									
8									
9									
10									

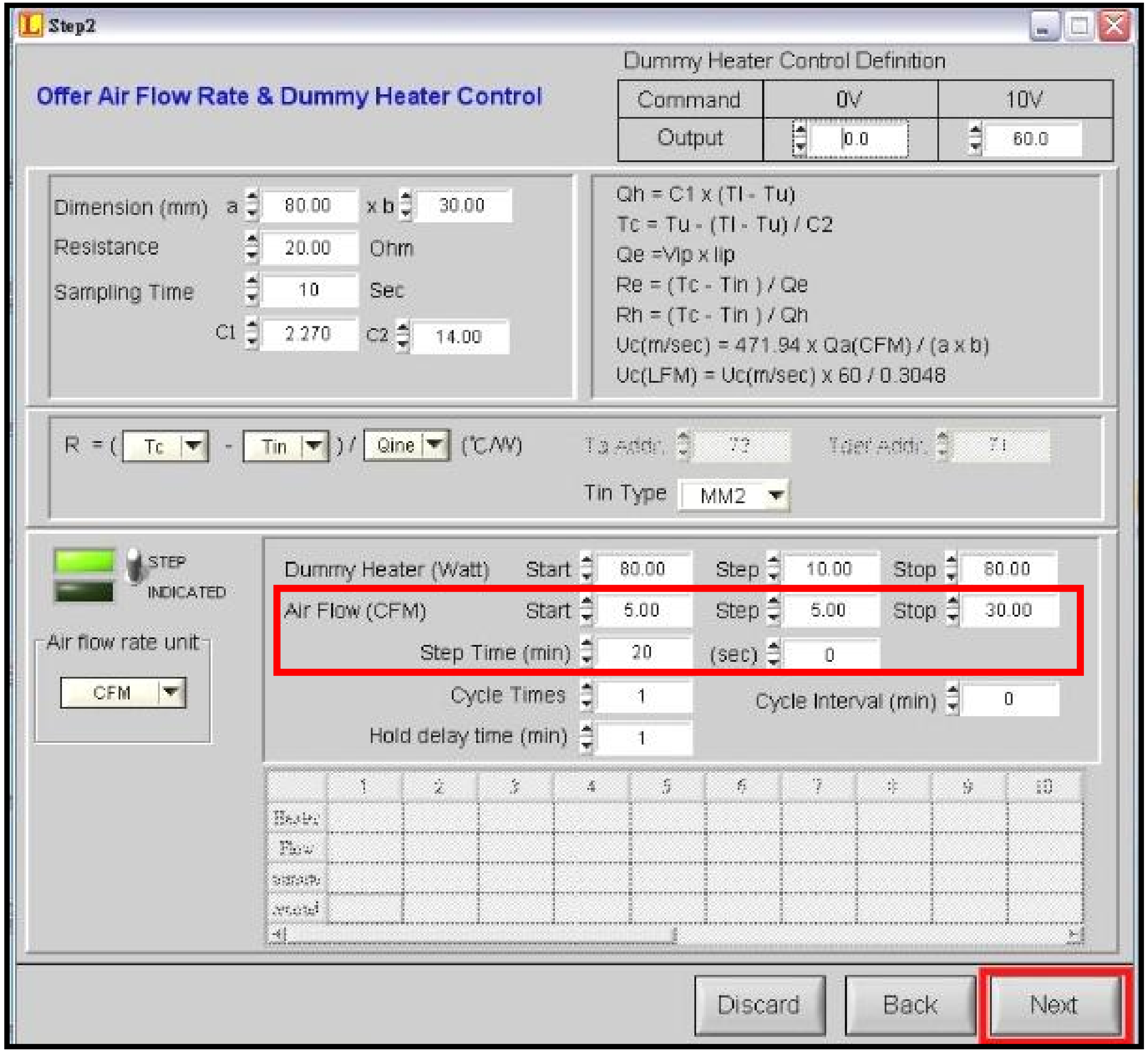
[Name]: [Mode]: Impedance

Td	Tw	RH	T5	T7	Pb	Pmax	Qmax	Frequency	Duty cycle
℃	℃	%	℃	℃	mmHg	mmAq	CFM	KHz	%
21.2	18.8	79.7	20.8	21.1	751.5	52.90	2.99		

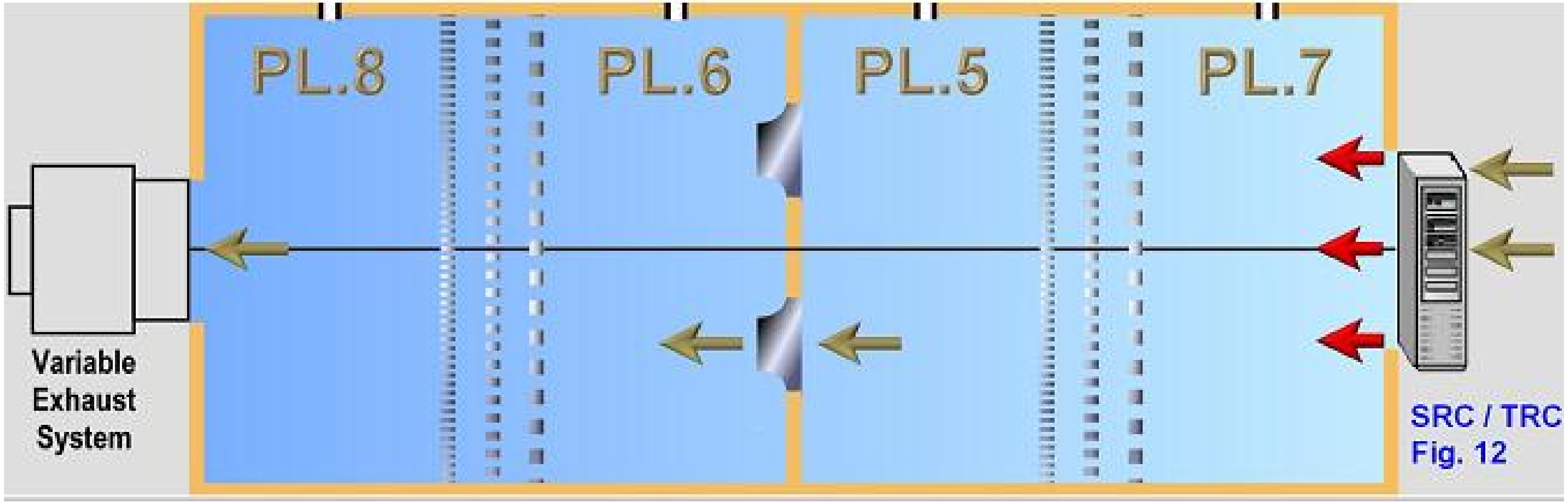
Ps		dP	Q		Re	P_{STP}	Q_{STP}
mmAq	inAq	mmAq	CMM	CFM		mmAq	CFM
1.9	0.0748	10.3	0.014	0.50	4288	1.89	0.49
6.8	0.2677	40.2	0.028	1.01	8471	6.77	0.99
14.7	0.5787	88.1	0.042	1.50	12540	14.64	1.47
24.6	0.9685	75.9	0.057	2.00	13921	24.50	1.96
37.6	1.4803	116.8	0.070	2.49	17269	37.45	2.44
52.9	2.0827	52.8	0.085	2.99	15513	52.68	2.93

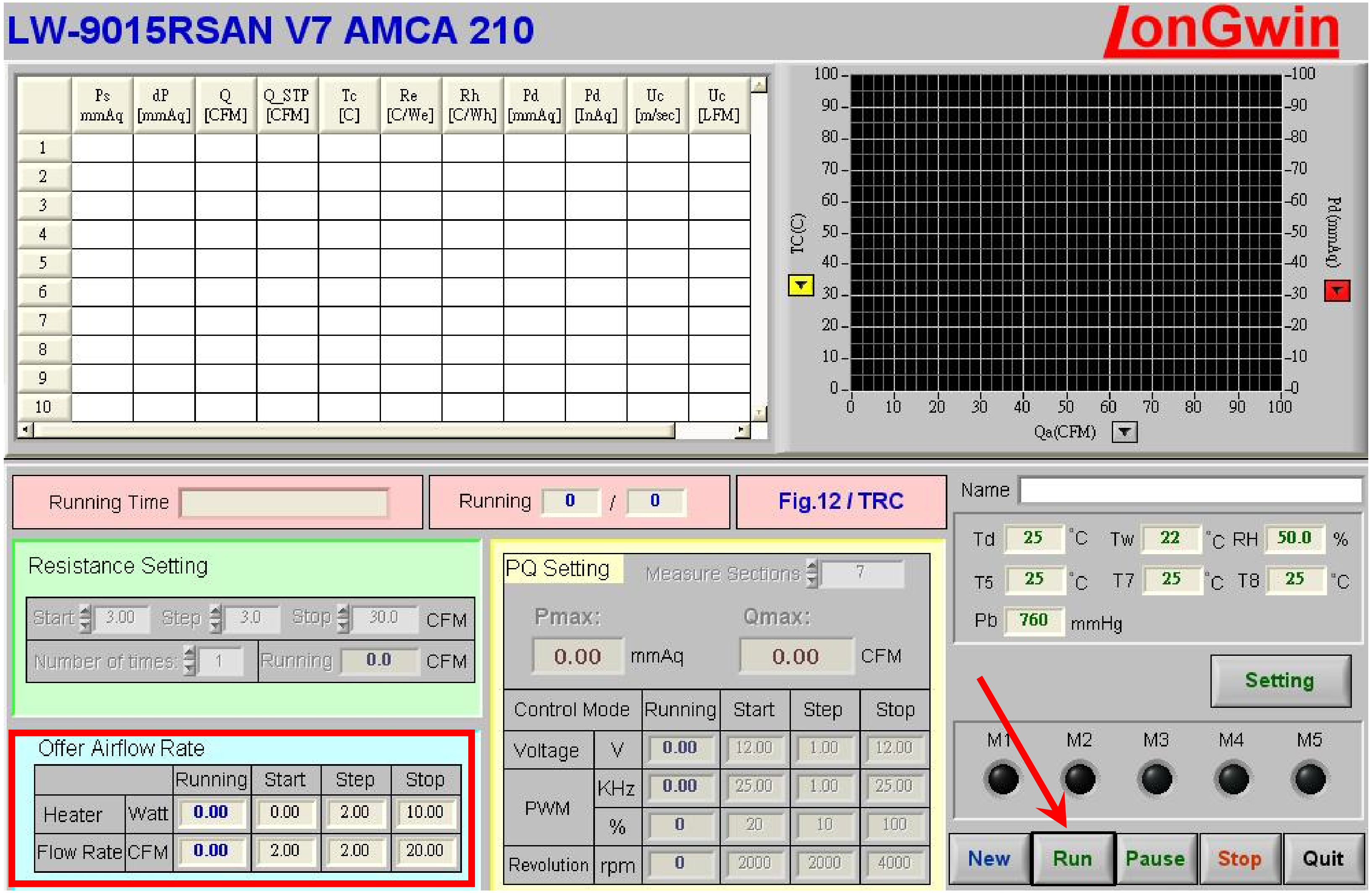


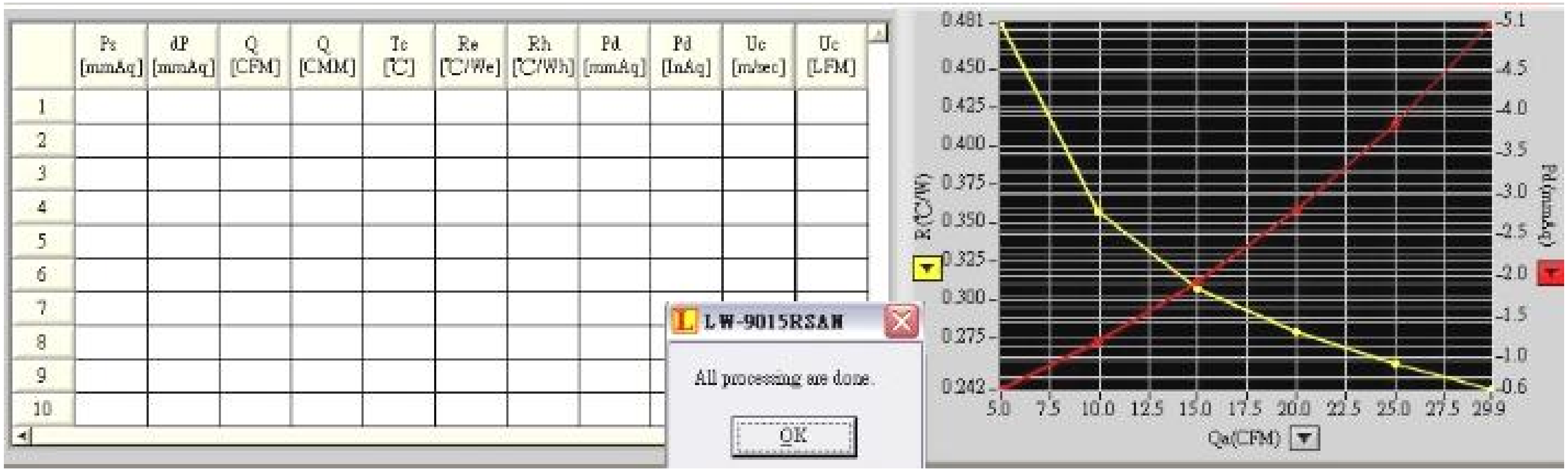
Back to Operation



1985 Long Win Fundamental, Forward & First


PL.8
PL.6
PL.5
PL.7
Variable Exhaust System
SRC / TRC Fig. 12


LW-9015RSAN V7 AMCA 210
LonGwin
Ps mmAq
dP [mmAq]
Q [CFM]
Q_STP [CFM]
Tc [C]
Re [C/We]
Rh [C/Wh]
Pd [mmAq]
Pd [InAq]
Uc [m/sec]
Uc [LFM]
TC(C)
Pd (mmAq)
Qa(CFM)
Running Time
Running 0 / 0
Fig.12 / TRC
Name
Td 25 °C Tw 22 °C RH 50.0 %
T5 25 °C T7 25 °C T8 25 °C
Pb 760 mmHg
Resistance Setting
Start 3.00 Step 3.0 Stop 30.0 CFM
Number of times: 1 Running 0.0 CFM
PQ Setting
Measure Sections 7
Pmax: 0.00 mmAq
Qmax: 0.00 CFM
Control Mode Running Start Step Stop
Voltage V 0.00 12.00 1.00 12.00
PWM KHz 0.00 25.00 1.00 25.00
% 0 20 10 100
Revolution rpm 0 2000 2000 4000
Offer Airflow Rate
Running Start Step Stop
Heater Watt 0.00 0.00 2.00 10.00
Flow Rate CFM 0.00 2.00 2.00 20.00
Setting
M1 M2 M3 M4 M5
New Run Pause Stop Quit

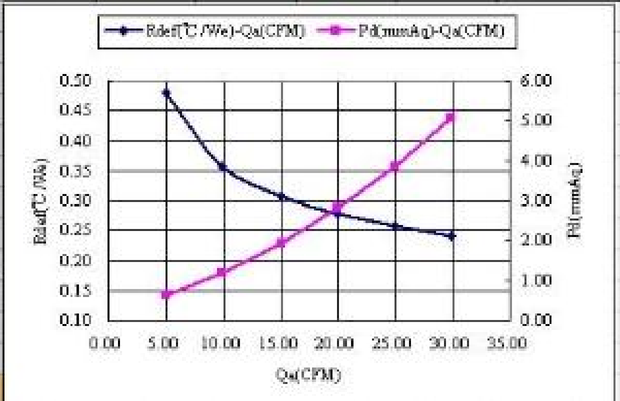

Ps [mmAq]
dP [mmAq]
Q [CFM]
Q [CMM]
Tc [℃]
Rc [℃/We]
Rh [℃/Wh]
Pd [mmAq]
Pd [InAq]
Uc [m/sec]
Uc [LFM]
1
2
3
4
5
6
7
8
9
10
LW-9015RSAN
All processing are done.
OK
R(℃/W)
0.481
0.450
0.425
0.400
0.375
0.350
0.325
0.300
0.275
0.242
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
27.5
29.9
Qa(CFM)
5.1
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.6
Pd(mmAq)

Microsoft Excel - _OAFR_20070326_105536.xls

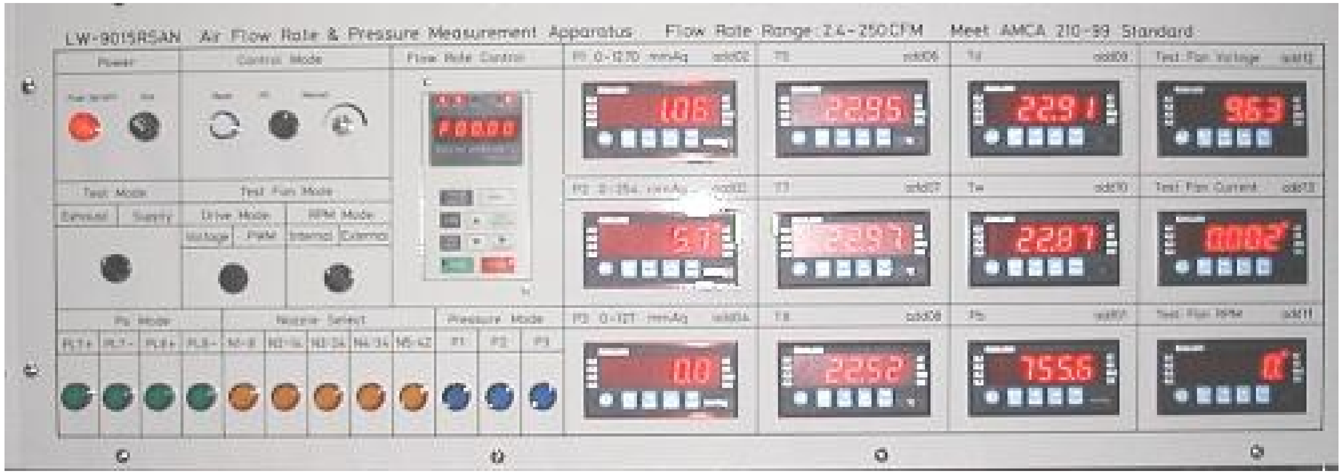
Offer Air Flow Rate

Td	Tw	RH	T5	T7	Pb
℃	℃	%	℃	℃	mmHg
21.94	19.22	77.63	21.22	21.15	750.5

Ps	dP	Q		Tc	Re	Rh	Pd		Uc		Tin	Tu	Tm
mmAq	mmAq	CFM	CMM	℃	℃/We	℃/Wh	mmAq	InAq	m/sec	LFM	℃	℃	℃
15	15.7	5.00	0.1416	60.45	0.481	0.573	0.62	0.0244	0.49	97	21.93	61.94	0
62	61.4	9.97	0.2823	50.59	0.358	0.408	1.20	0.0472	0.98	193	21.92	52.14	0
17.2	16	14.99	0.4245	46.64	0.308	0.350	1.92	0.0756	1.47	290	21.99	48.2	0
31	28.2	19.97	0.5654	44.44	0.279	0.316	2.80	0.1102	1.96	386	22.12	46	0
48.7	44.1	25.01	0.7083	42.93	0.258	0.292	3.85	0.1516	2.46	484	22.26	44.49	0
69.9	62.9	29.88	0.8462	41.77	0.242	0.273	5.08	0.2000	2.94	578	22.44	43.34	0

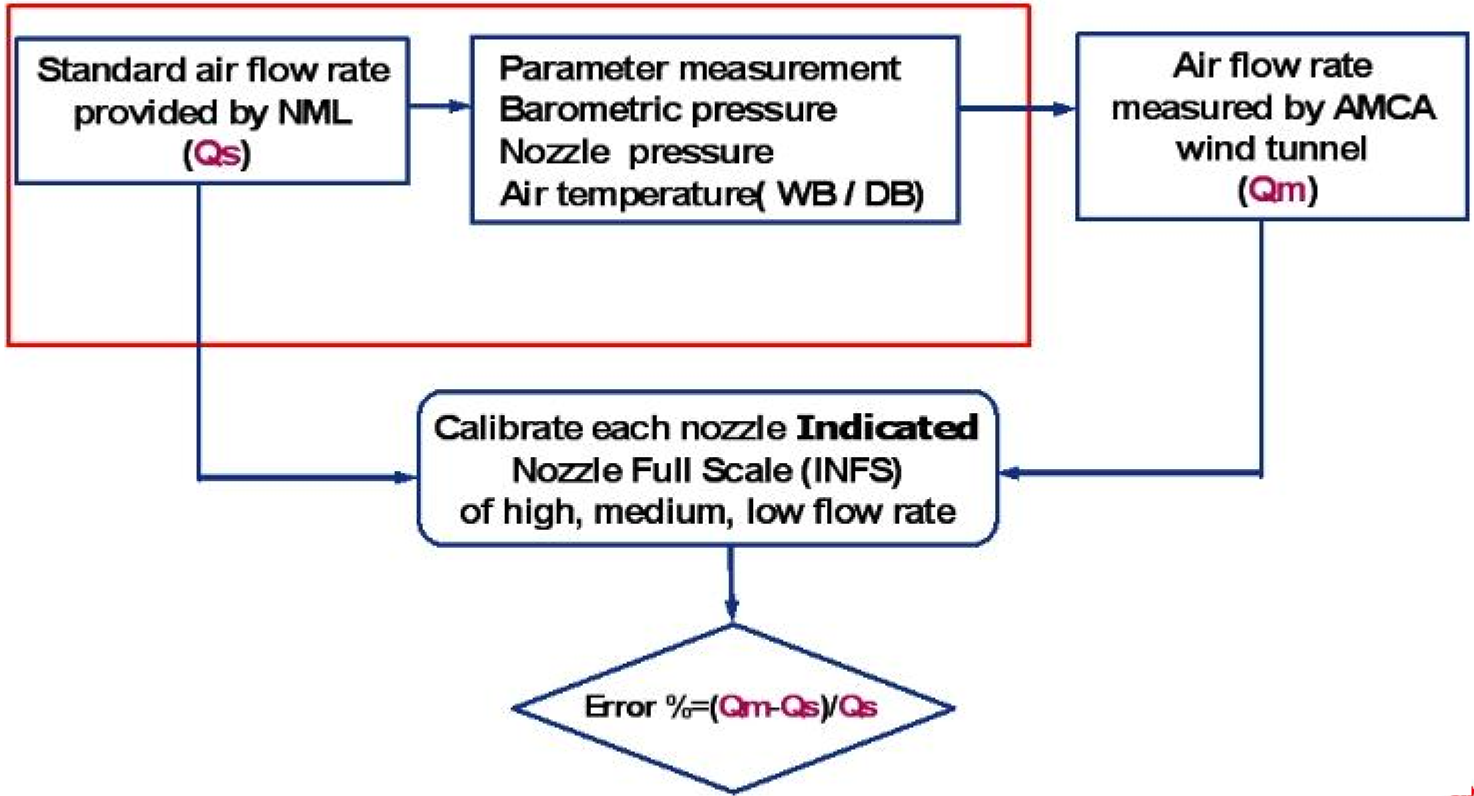


1985 Long Win
Fundamental, Forward & First

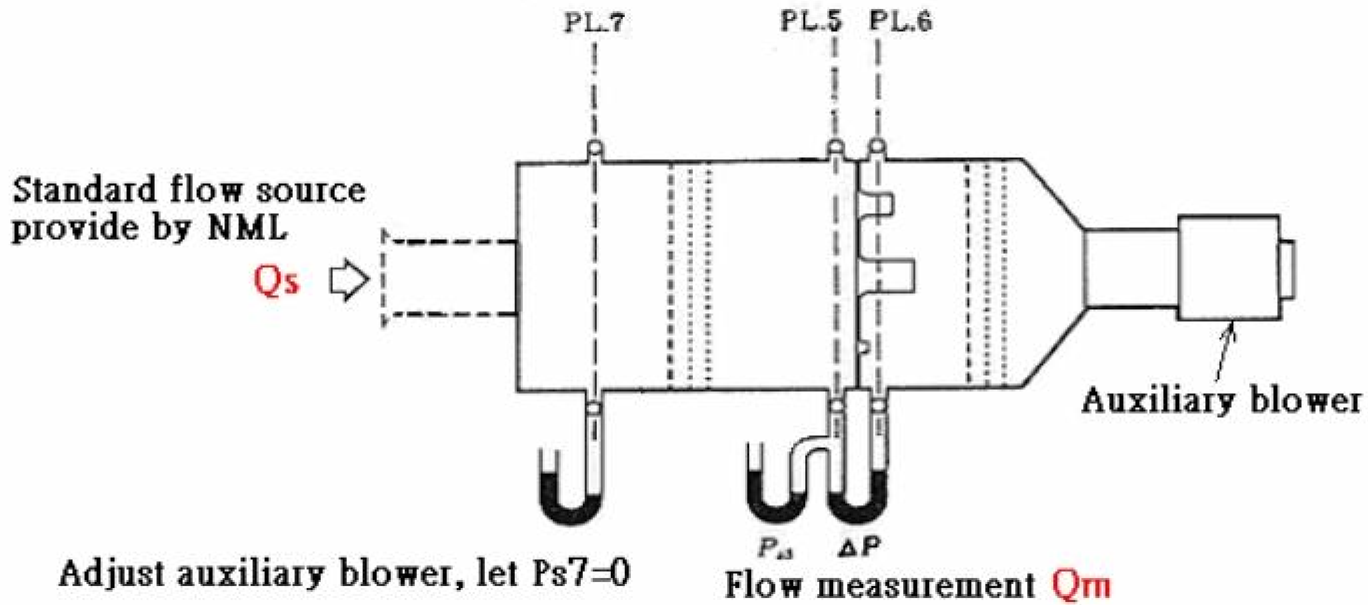


The quality of our thermometer, pressure, electrical meter (voltage, current, fan speed) will be approved by a third party (SGS) under supervision of Chinese National Laboratory Accreditation (CNLA).

AMCA 210-99 Wind Tunnel Flow Calibration Process in National Measurement Lab (NML)



AMCA 210-99 Wind Tunnel
Flow Calibration Process in NML

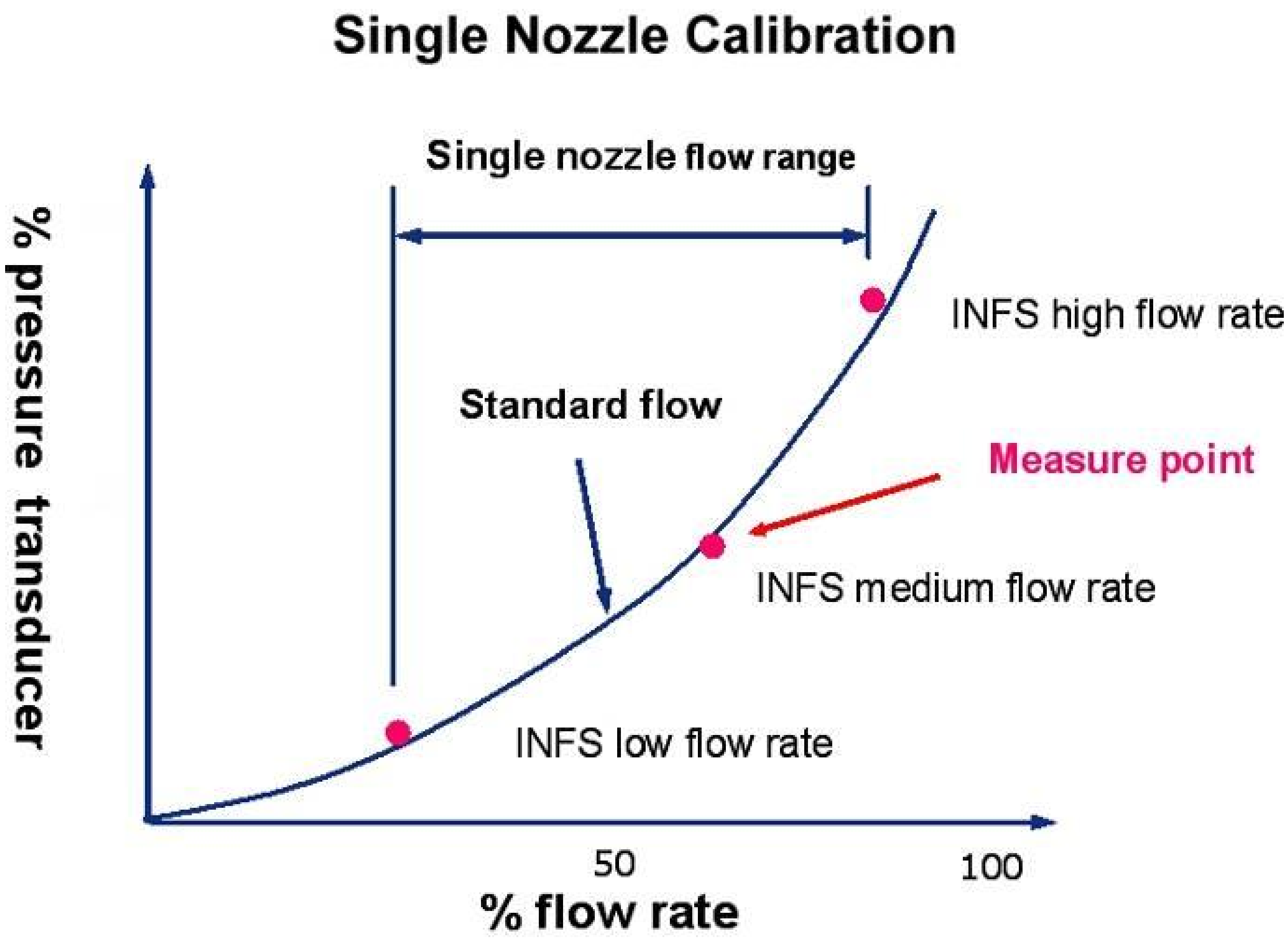


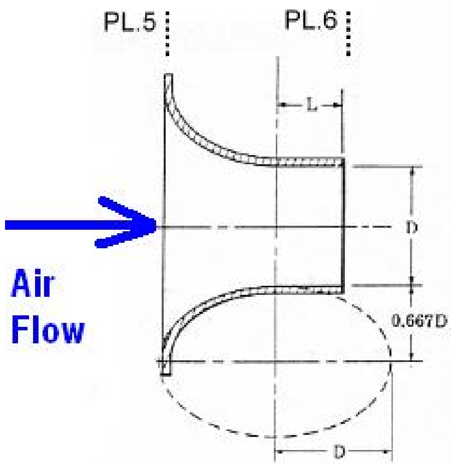
$$\text{Relative error} = \frac{Qs - Qm}{Qm}$$

Wind tunnel calibration Scheme

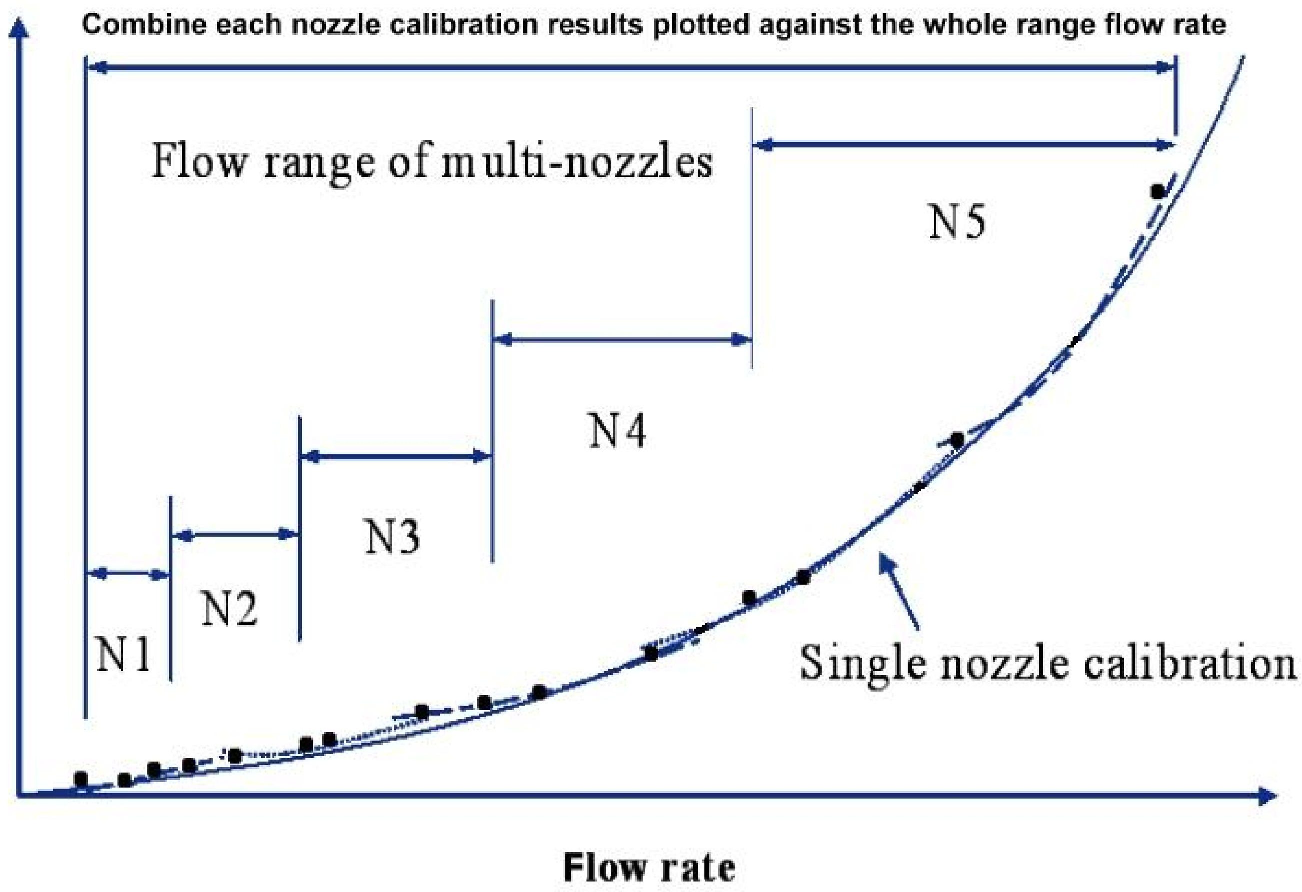
Comparison of measurement by NML with other laboratories

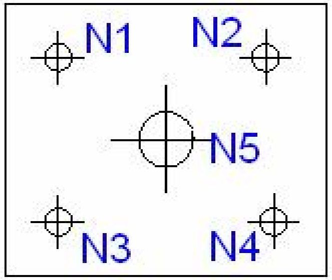
Max Flow Rate (m^3/h)	Gas	Accuracy (%)	laboratory	Country
1.8×10^4	air	±0.28	NML	Taiwan
36	air	±0.03	NMI	Netherland
5000	air	±0.11	NIST	USA
7600	air	±0.08	CEES	USA
130	air	±0.03	CEES	USA
1.0×10^4	Natural gas	±0.25	Gaz de France	France
2500	air	±0.1	PTB	Germany
2.0×10^4	air	±0.2	QMI	Japan
36	air	±0.2	KRISS	Korea
5.75×10^5	Natural gas	±0.25	KMTL	Norway
1.2×10^4	air	±0.2	NEL	United Kingdom
1.5×10^6	Natural gas	±0.5	BGC	United Kingdom


Single Nozzle Calibration
Single nozzle flow range
Standard flow
Measure point
INFS high flow rate
INFS medium flow rate
INFS low flow rate
% pressure transducer
50
100
% flow rate


PL.5
PL.6
L
D
0.667D
D
Air Flow

Multi-Nozzles Calibration





Calibration Report-1

Calibration test result in NML. It provides the correction between standard flow and measurement data. These data can be traced for future calibration.

Model: LW-9185 800CFM AMCA Wind Tunnel calibration data date: 06/16/2005

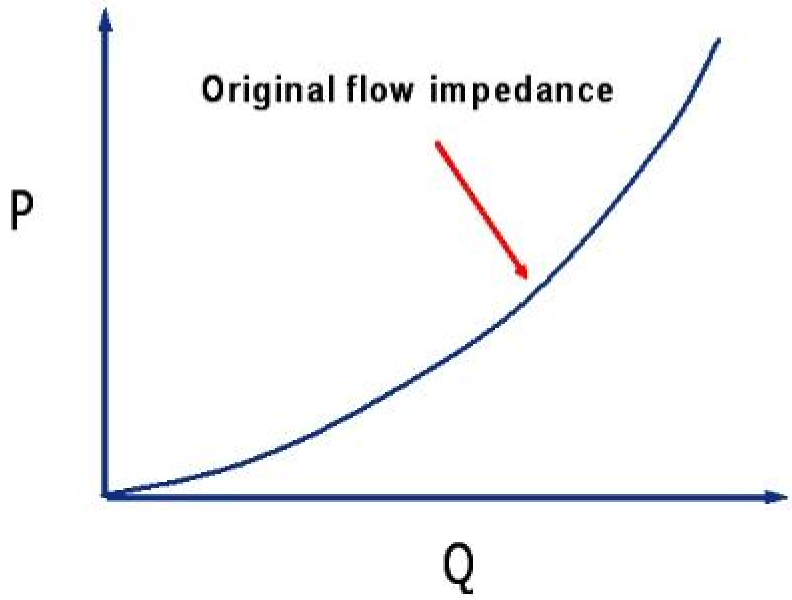
Measurement data						Standard flow and wind tunnel flow measurement comparison					
No of test	Nozzle	Pressure drop	Barometric Pressure	Win tunnel Air temp.	Standard flow in CNLA	flow measurement in each nozzle			Sum of each nozzle Qt=Qm1+Qm2+Qm3		Error e=(Qt-Qs)*100/Qs
	diameter	dP	Pb	T5	Qs	Qm1	Qm2	Qm3	Qt		e
	mm	mmAq	mmHg	℃	m^3/h	m^3/h			m^3/h	CFM	%
1	17	31.20	747.3	26.7	17.891	18.0			18.0	10.59	0.6
2		31.20	747.3	26.7	17.891						
3		31.30	747.3	26.7	17.887						
4		72.80	747.2	26.7	27.449	27.6			27.6	16.24	0.5
5		72.70	747.2	26.7	27.442						
6		72.60	747.2	26.7	27.433						
7		121.20	747.2	26.6	35.844	35.6			35.6	20.95	-0.7
8		121.30	747.2	26.6	35.910						
9		121.30	747.2	26.6	35.940						

Calibration Report-2

10		30.80	747.2	26.7	23.867	6.1	17.8		23.9	14.07	0.1
11		30.90	747.2	26.7	23.914						
12		30.90	747.2	26.7	23.931						
13		70.80	747.2	26.6	36.531	9.3	27.2		36.5	21.48	-0.1
14	10 + 17	70.80	747.2	26.6	36.535						
15		70.85	747.2	26.6	36.536						
16		117.70	747.1	26.6	47.295	12.0	35.1		47.1	27.72	-0.4
17		117.95	747.1	26.6	47.495						
18		118.15	747.1	26.6	47.593						
19		30.00	747	26.6	55.366	55.3			55.3	32.55	-0.1
20		30.10	747	26.6	55.512						
21		30.20	747	26.6	55.605						
22		70.00	746.9	26.6	84.462	84.8			84.8	49.91	0.4
23	30	70.40	746.9	26.6	84.897						
24		70.40	746.9	26.8	85.079						
25		121.50	746.9	26.9	110.865	111.8			111.8	65.80	0.8
26		121.50	746.9	26.9	111.999						
27		121.55	746.9	26.9	112.291						

Calibration Report-3

28		19.90	746.8	26.8	142.059	141.4			141.4	83.23	-0.5
29		20.00	746.8	26.8	142.631						
30		20.00	746.8	26.8	142.855						
31		61.95	746.8	26.9	250.718	250.6			250.6	147.50	0.0
32	53	62.00	746.8	26.9	251.451						
33		61.90	746.8	26.9	251.485						
34		125.00	746.8	26.8	356.501	355.9			355.9	209.48	-0.2
35		124.85	746.8	26.8	356.232						
36		124.70	746.8	26.8	356.023						
37		20.65	746.8	26.8	365.748	363.9			363.9	214.18	-0.5
38		20.60	746.8	26.8	365.300						
39		20.60	746.8	26.8	364.864						
40		65.10	746.9	26.7	645.402	647.9			647.9	381.34	0.4
41	84	65.00	746.9	26.7	644.682						
42		64.90	746.9	26.7	644.278						
43		122.00	746.9	26.0	878.538	886.3			886.3	521.66	0.9
44		122.00	746.9	26.0	878.364						
45		122.00	746.9	26.0	878.234						



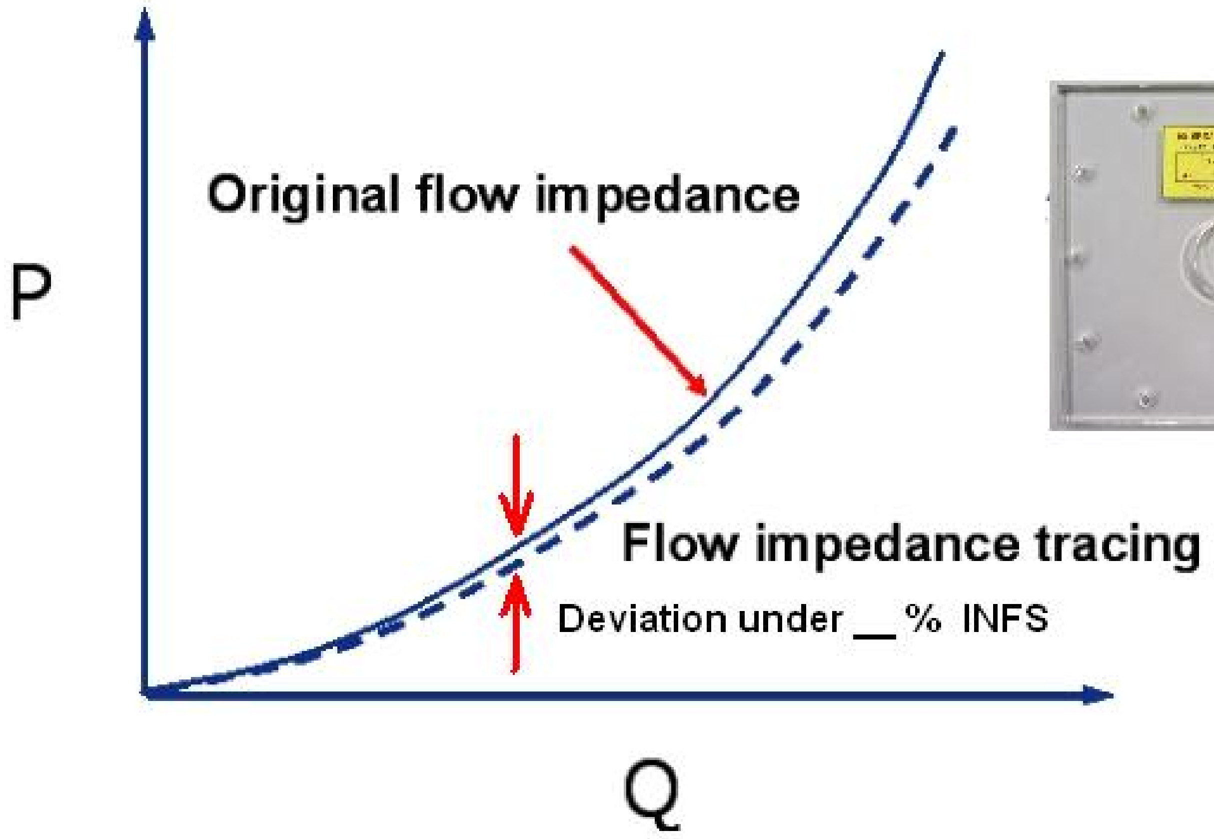
Long Win provides the orifice plate to create original flow impedance curve.

Traceability

1. Schedule the calibration for thermometers, pressure meters and electrical meters
2. Schedule the wind tunnel flow calibration and validation in third party lab
3. Tracing the wind tunnel flow impedance data with the original database

Traceability

Long Win provides the orifice plate to measure flow impedance curve for tracing.



Repeatability

Result of a fan (12025) performance test for 35 times

Flow test data:

110.77	110.77	110.90	111.46	110.71	110.52	110.71	110.64
110.77	110.90	110.83	110.96	110.96	110.77	111.15	110.96
110.96	110.27	111.08	110.96	110.83	111.33	110.96	111.15
111.02	110.90	110.58	110.52	110.83	110.71	110.71	110.45
110.64	110.71	110.64					

Q max variance = (111.46 - 110.83) / 110.83 = **0.57 %**

Pressure test data:

6.73	6.70	6.70	6.70	6.72	6.73	6.71	6.72
6.72	6.73	6.68	6.72	6.72	6.70	6.72	6.76
6.73	6.71	6.74	6.71	6.72	6.73	6.72	6.76
6.73	6.75	6.73	6.70	6.75	6.72	6.73	6.77
6.74	6.74	6.71					

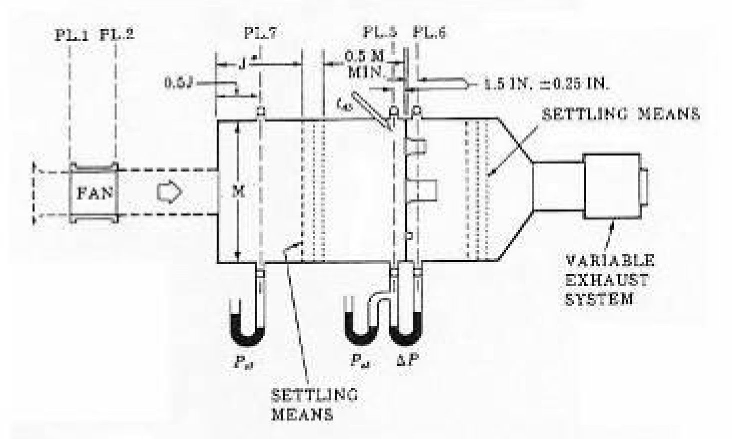
P max variance = (6.77 - 6.72) / 6.72 = **0.74 %**

Max variance: Max[X-X_bar] / X_bar

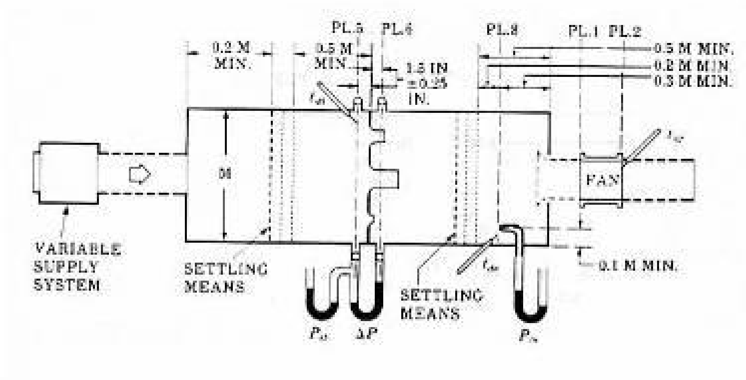
Features

- ☆ **2 in 1** Combine AMCA 210-99 Fig.12 & Fig.15
- ☆ System **Control Automatically**
- ☆ Equipment **Accuracy Certificate**
- ☆ **5 Mode** Fan Performance Curve Test
- ☆ **STP** Conversion
- ☆ **Multi Fan** Performance Curve Test
- ☆ **High Ps** Fan Performance Curve Test
- ☆ System Impedance Curve (**SRC**) Test
- ☆ Thermal Module Performance **R-Q Test** Automatically
- ☆ **QC** – **Cpk** Test
- ☆ **QC** – **Operation Point Check**

2 in 1
Combine AMCA 210-99
Fig.12 & Fig.15 Two Structures



AMCA 210 Fig.12 Outlet Chamber Setup Multiple Nozzles in Chamber



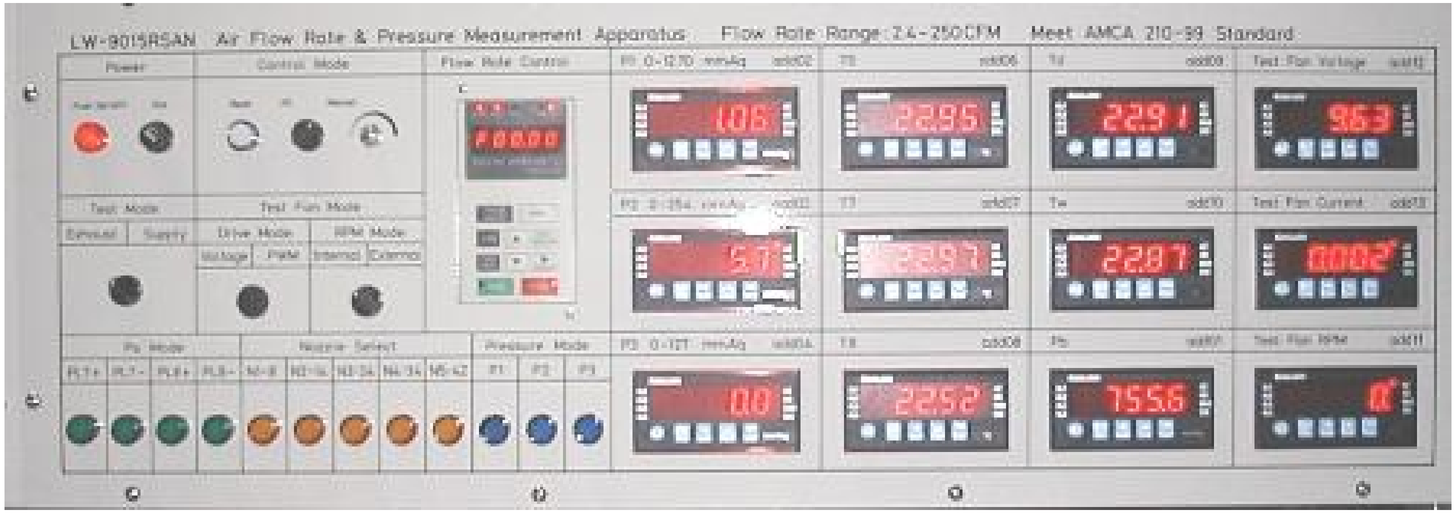
AMCA 210 Figure 15 Inlet Chamber Setup Multiple Nozzle in Chamber

☆ System Control Automatically

- ∗ Auto Change Nozzles
- ∗ Auto Switching Ps
- ∗ Dynamic Scanning and
  Optimize Testing Parameters
- ∗ Good Gauge R&R
  (Repeatability and Reproducibility)

☆ Auto Switching Nozzle Open & Closed

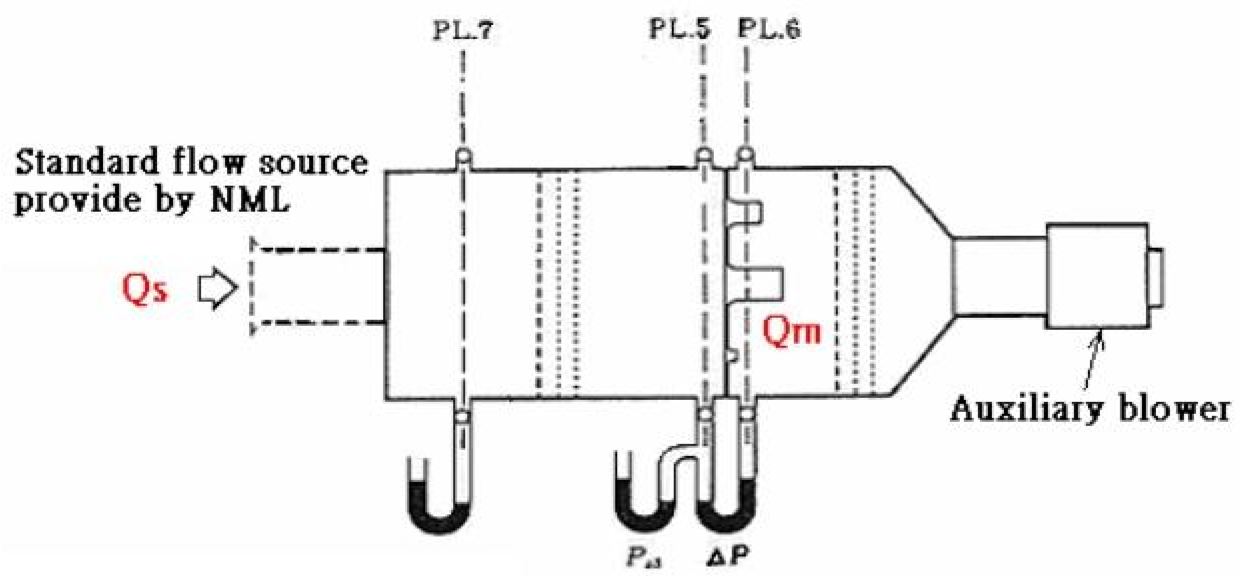
☆ Equipment Accuracy Certificate



All meter will be approved by a third party (SGS).

☆ Equipment Accuracy Certificate

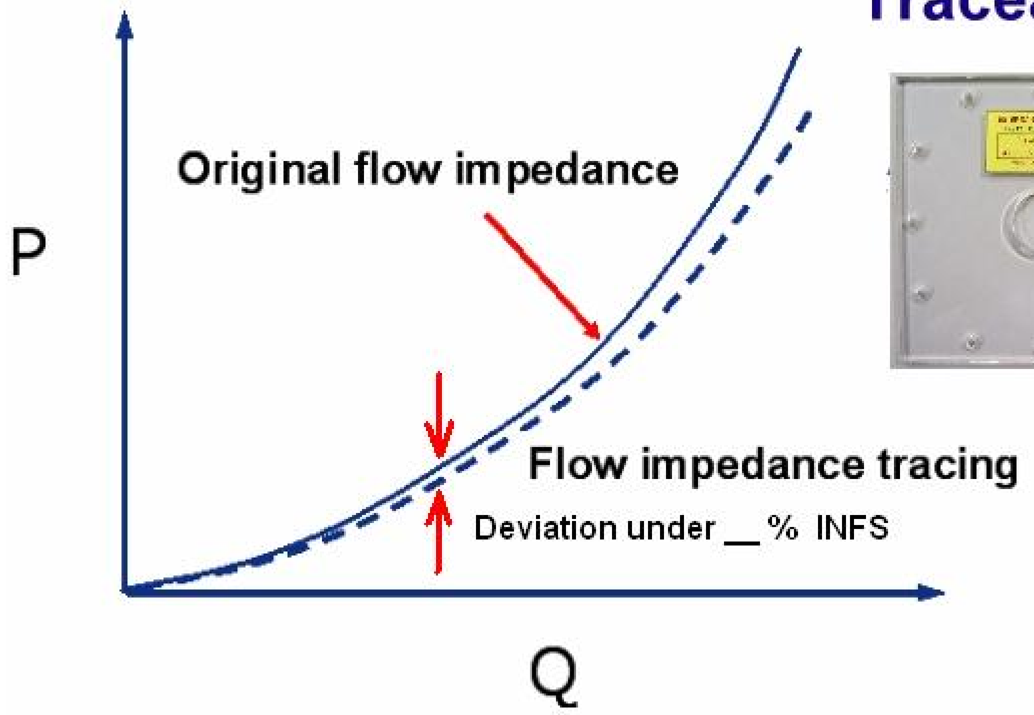
Flow Calibration Process in NML



$$\text{Relative error} = \frac{Qs - Qm}{Qm}$$

NML: National Measurement Lab

☆ Equipment Accuracy Certificate

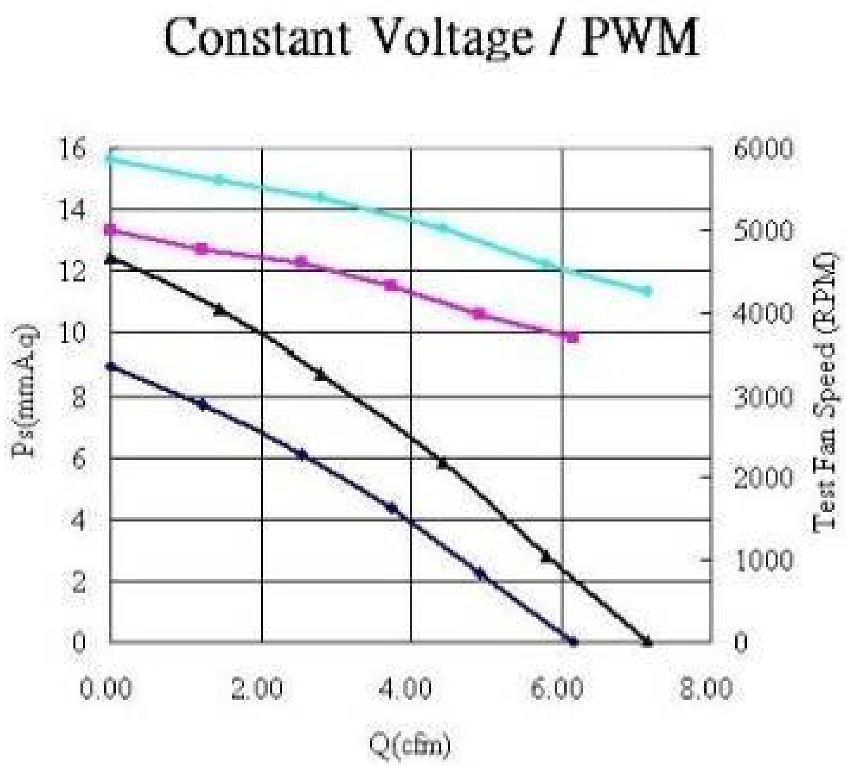


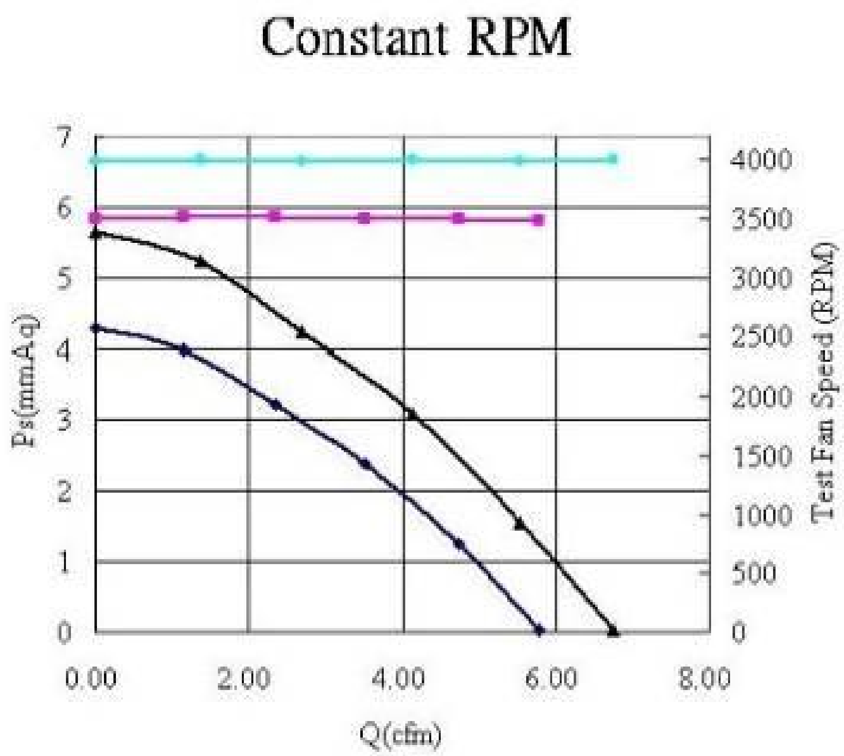
Traceability

☆ 5 Mode Fan Performance Curve Test

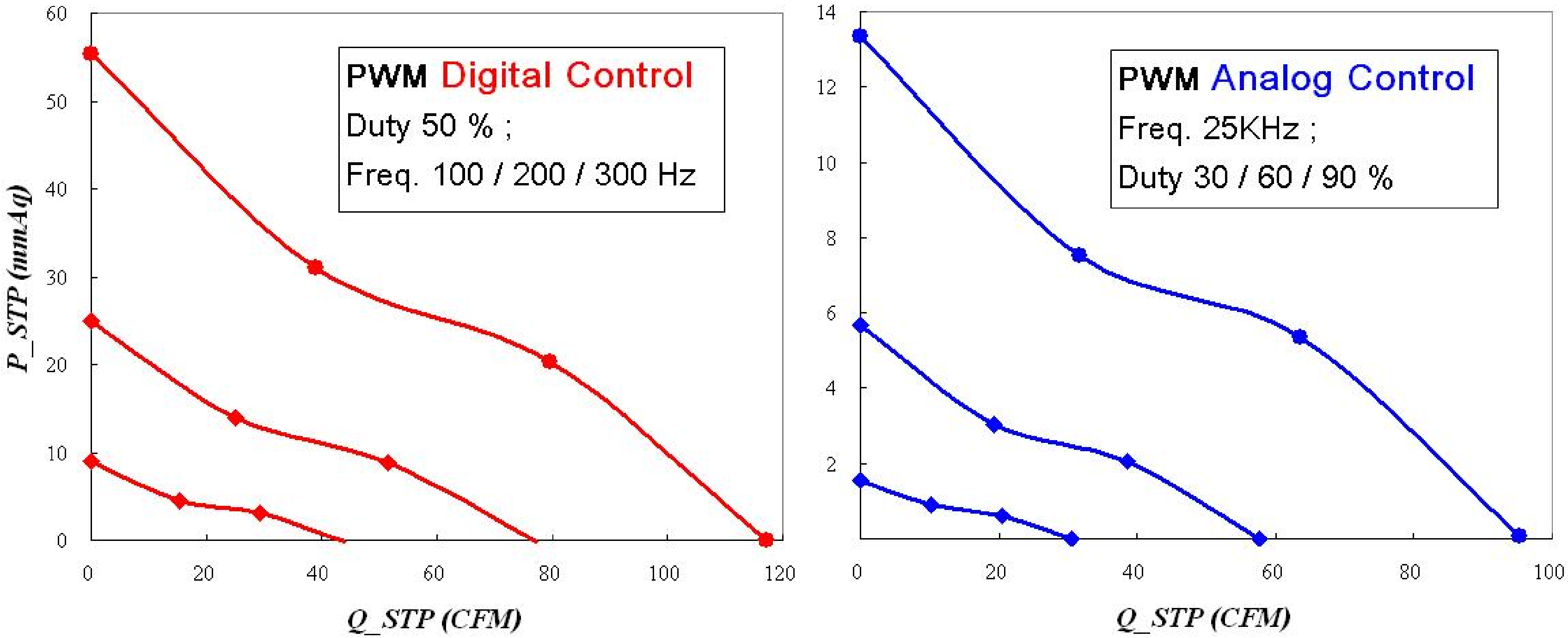
- Constant Volt
- PWM
- Constant RPM
- Cpk
- Operation Point Check

☆ 5 Mode Fan Performance Curve Test

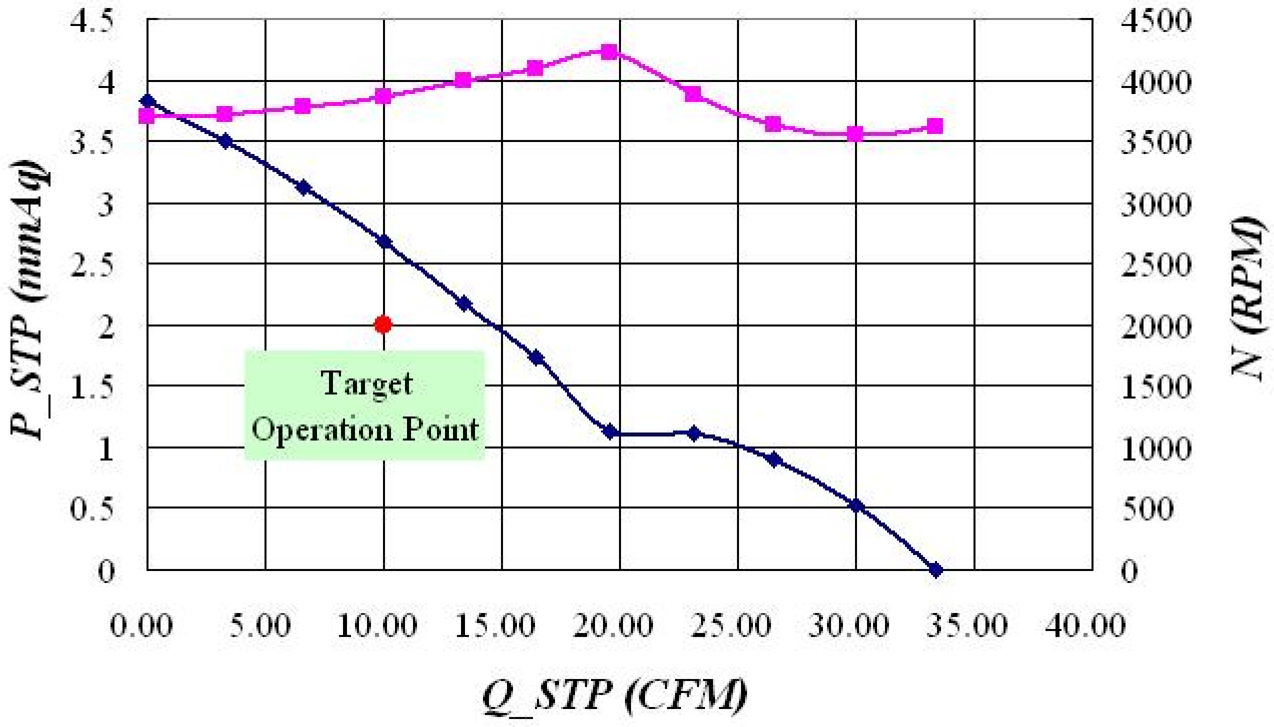




☆ 5 Mode Fan Performance Curve Test



☆ 5 Mode Fan Performance Curve Test



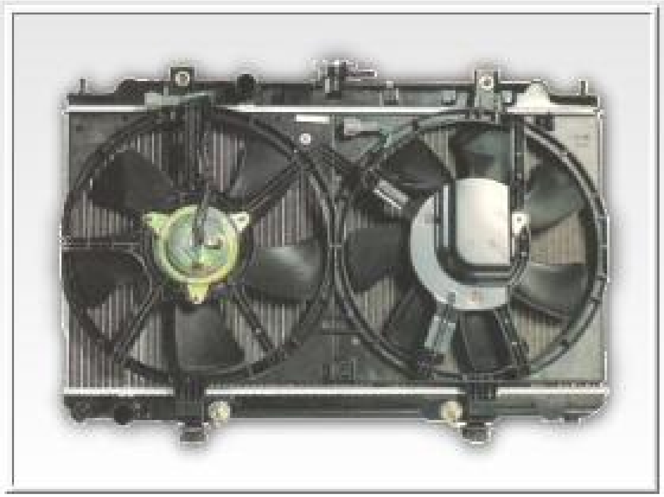
Test Fan Op.

Ps	2.69	mmAq
Q	9.97	CFM
Torque	20.62	gr*cm
Input P	2.39	Watt
Fan Input	0.80	Watt
Motor Eff.	33.28	%
Fan Ps Eff.	15.58	%
Overall Eff.	5.18	%

☆ 5 Mode Fan Performance Curve Test

Different Kind of Fan Test.

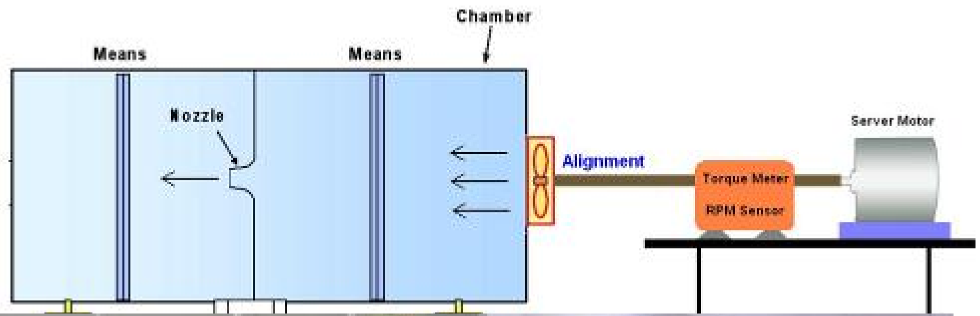
☆ Fan with Heat Exchanger Performance Test

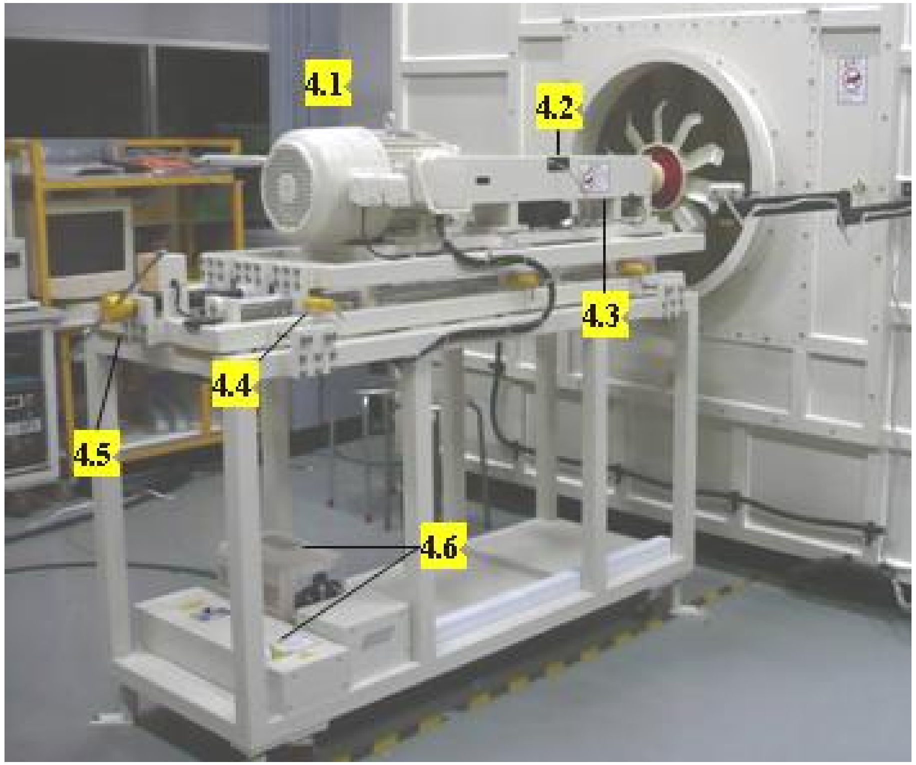


☆ 5 Mode Fan Performance Curve Test

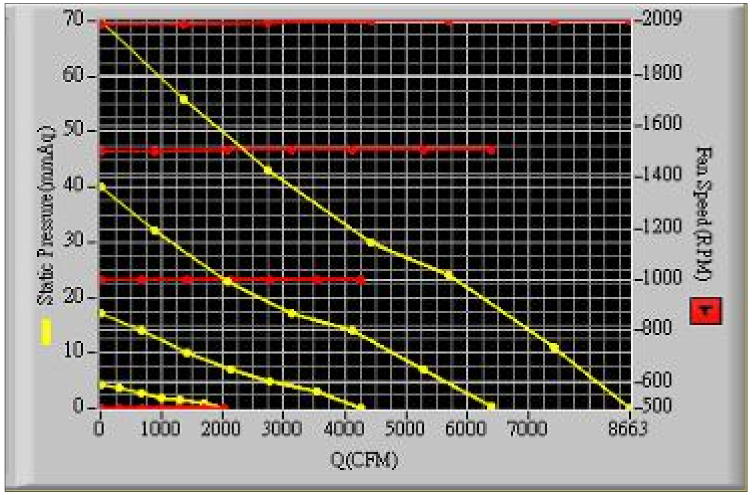
☆ 5 Mode Fan Performance Curve Test

AMCA 210-99 Fig.12





2000 RPM			
P_{STP}	Q_{STP}	Torque	N
mmAq	CFM	N-m	RPM
72.25	0.00	10.220	1995
57.72	1369.73	9.300	1999
44.26	2728.86	8.520	2003
30.84	4420.32	7.860	2006
24.66	5700.39	7.970	2006
0.06	8662.61	7.260	2009



Fan Aerodynamics Performance Test

☆ STP Conversion

Parameter 1 : Test Condition

Test Condition									
Td	Tw	RH	T5	T7	T8	Pb	Pmax	Qmax	Note
℃	℃	%	℃	℃	℃	mmHg	mmAq	CFM	
Dry-Bulb Temperature	Wet-Bulb Temperature	Relative Humidity	Plane 5 Temperature	Plane 7 Temperatur	Plane 8 Temperature	Barometric Pressure			
							21.5	90.00	?
20.3	18.3	82.5	20.1	20.2	20.1	745.5	20.7	94.11	Test Condition
20.0	14.0	50.0	20.0	20.0	20.0	760.0	21.2	91.99	STP
1. Temperature (Td) variation from 5 to 30 ℃								Deviation	9.2%
2. Barometric (Pb) variation from 0.95 to 1.05 atm								Deviation	10.0%
3. Both Temperature & Barometric variation								Deviation	20.1%

Axial FAN 8038 AMCA 210 Fig.12 Setup,
Installation Type B, Constant Voltage DC 12V

(Standard Temperature and Pressure)

☆ STP Conversion

Ps		dP_{56}	Q		P_{STP}	Q_{STP}
mmAq	inAq	mmAq	CMM	CFM	mmAq	CFM
2.94	0.116	2.9	0.000	0.00	3.14	0.00
1.40	0.055	64.9	0.298	10.52	1.50	10.52
0.00	0.000	38.0	0.674	23.79	0.00	23.79

From Test Condition convert to Nominal Values (STP).

STP: Standard Air Property is Air at
(Td) 20 ℃ Temperature,
(RH) 50 % Relative Humidity,
(Pb) 760 mmHg Barometric Pressure.

☆ STP Conversion

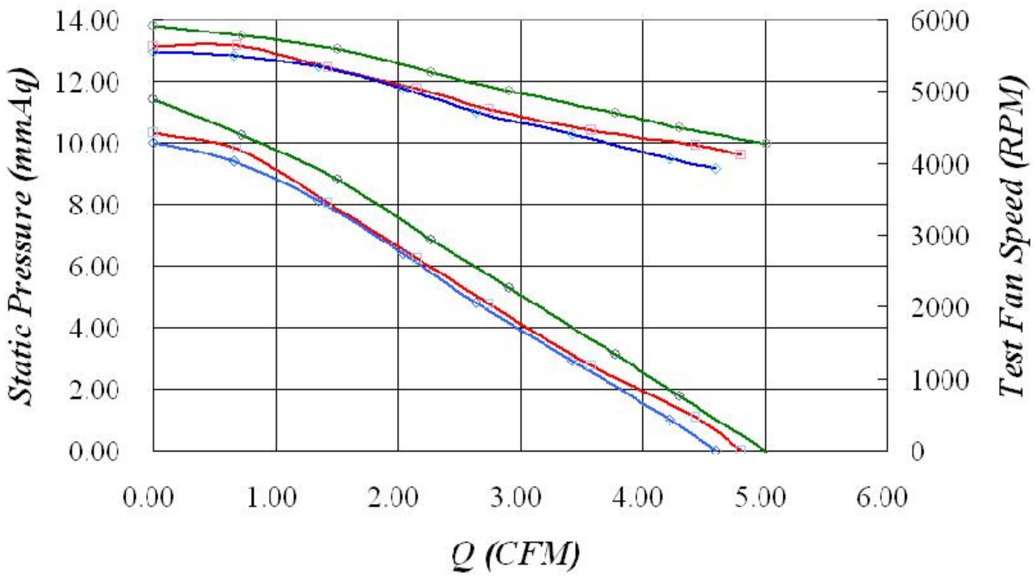
Parameter 1 : Test Condition

Blower 6010			
Test No.	**Pmax**	**Qmax**	**Input Volt**
	mmAq	CFM	Volt
1	11.40	5.02	5.00
3	10.00	4.59	5.00
6	10.34	4.80	5.00

Same Fan, Same Wind Tunnel,

Constant Voltage Input.

Not Sure Get Same Result



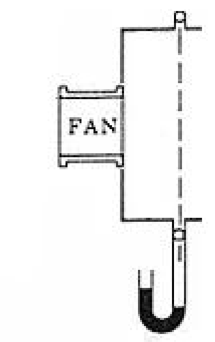
☆ STP Conversion

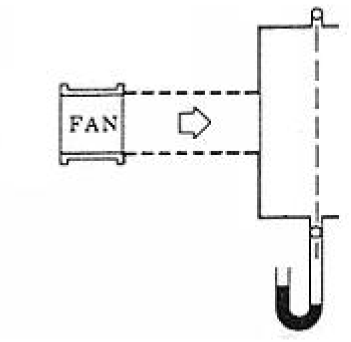
Parameter 2 : Installation Type

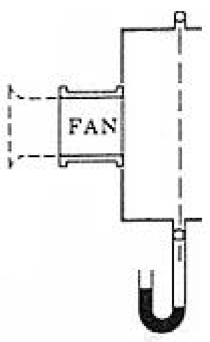
Report Info.

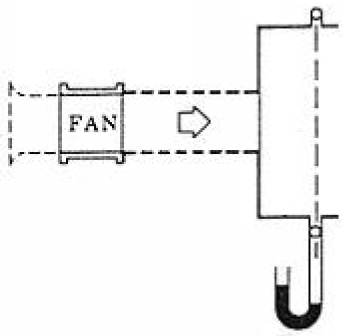
Production Name:	OOO Axial fan		Date:	2008/1/28	
Model Name:	12HDB		Laboratory:	Long Win	
Production size:	8038	(mm)	Test Number:	97001	
Impeller Tip Diameter:	78	(mm)	Curve by:	Eric Feng	
Inlet Area:	64	(cm^2)	Test Setup:	AMCA 210 Fig.12	
Outlet Area:	64	(cm^2)	Installation Type:	Type A	
Accessary:			Chamber Corss-section:	1024	(cm^2)

☆ STP Conversion









Type A

**Free Inlet,
Free Outlet**

Type B

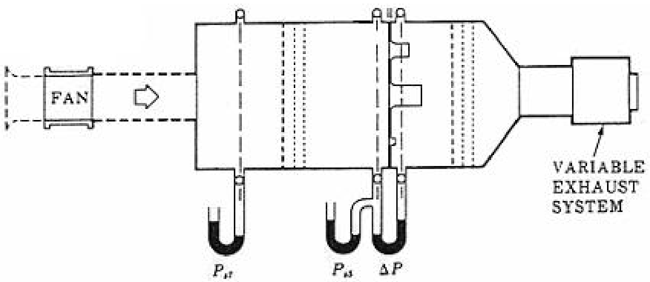
Free Inlet,
Ducted Outlet

Type C

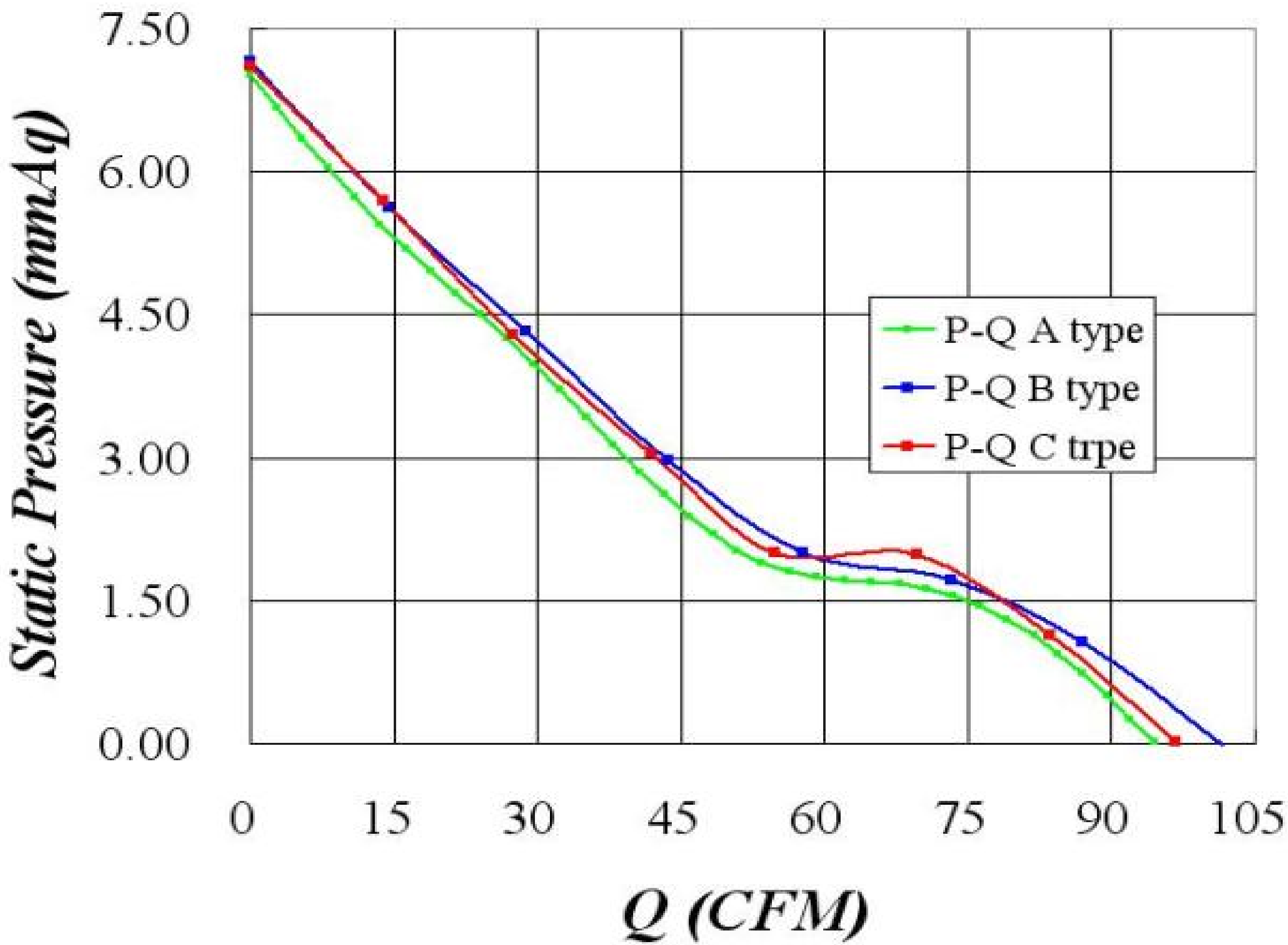
Ducted Inlet,
Free Outlet

Type D

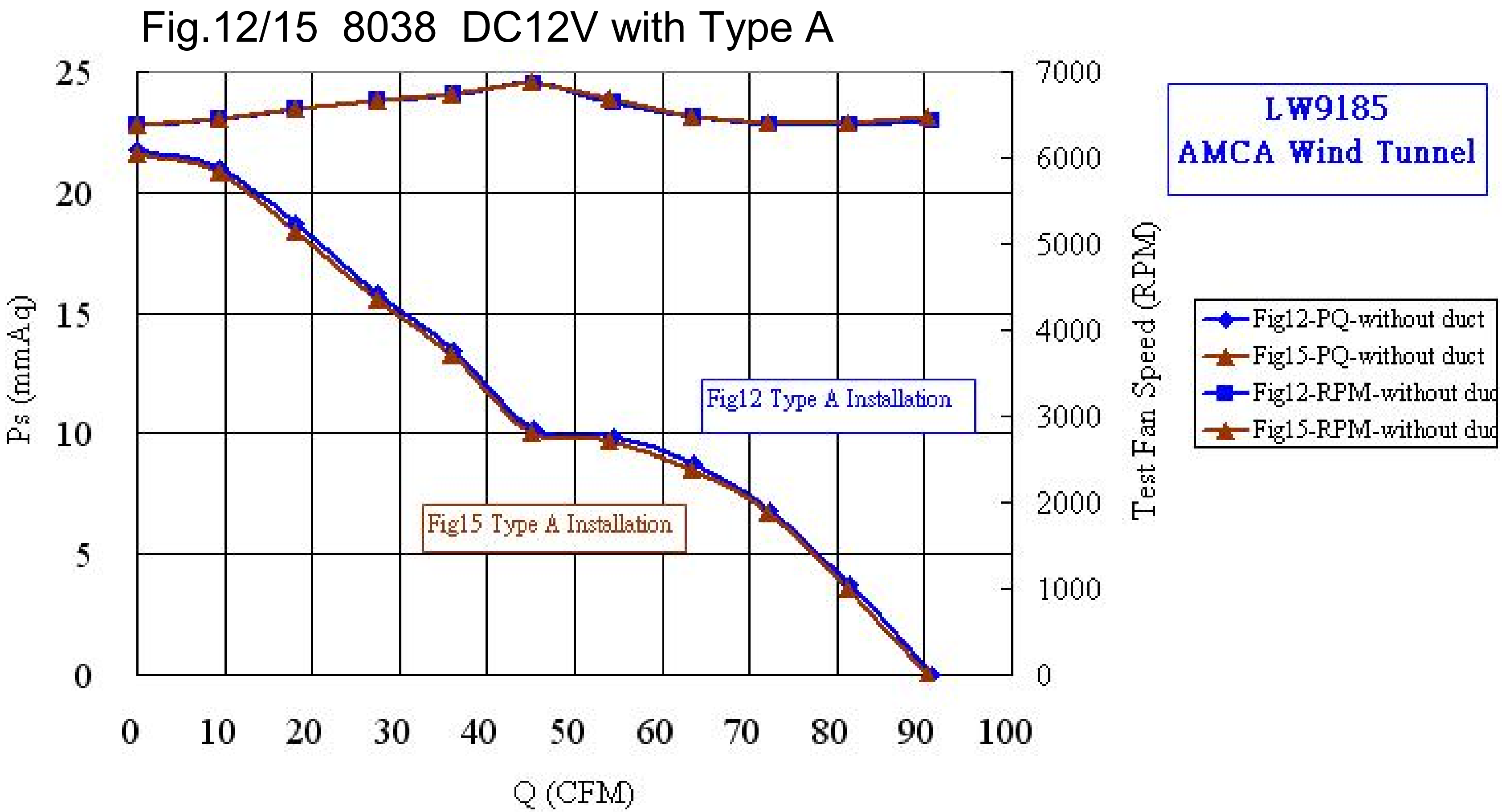
Ducted Inlet,
Ducted Outlet



☆ STP Conversion



☆ STP Conversion



☆ STP Conversion

Comparison Methodology

1. Check Same **Installation Type.**

2. Convert PQ Curve from
   Test Condition to **STP Condition**.

3. Convert PQ Curve to **Assigned RPM** by Fan Law.

☆ STP Conversion

Test Condition to STP Condition.

Assume Fan constant RPM, $Nc = N$ at Different Condition

$$Q_c = Q\left(\frac{N_c}{N}\right)\left(\frac{K_p}{K_{pc}}\right)$$

Q_c / P_{sc} : Nominal Values

$$P_{sc} = P_{tc} - P_{vc}$$

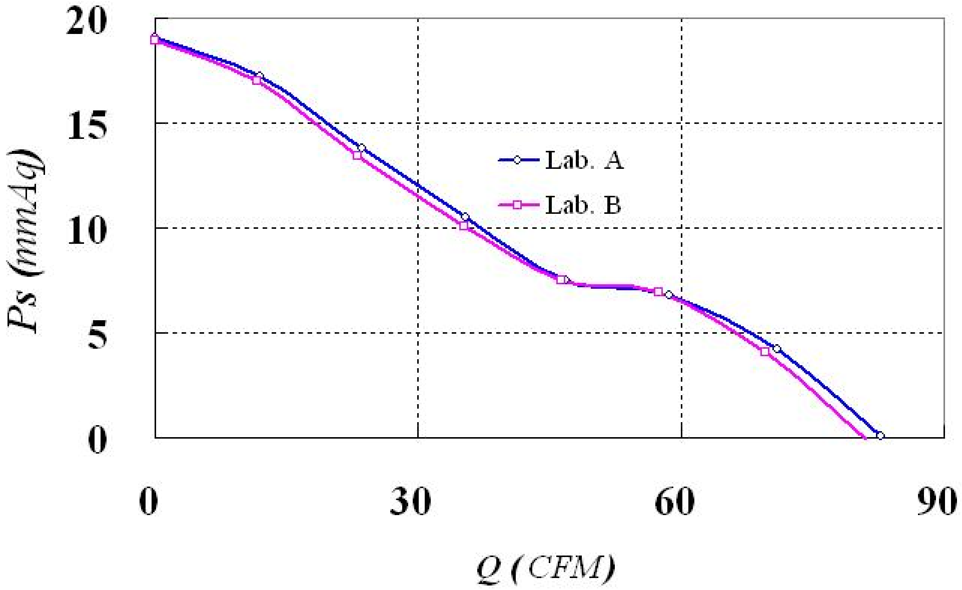
$$= P_t\left(\frac{N_c}{N}\right)^2\left(\frac{\rho_c}{\rho}\right)\left(\frac{k_p}{k_{pc}}\right) - P_v\left(\frac{N_c}{N}\right)^2\left(\frac{\rho_c}{\rho}\right)$$

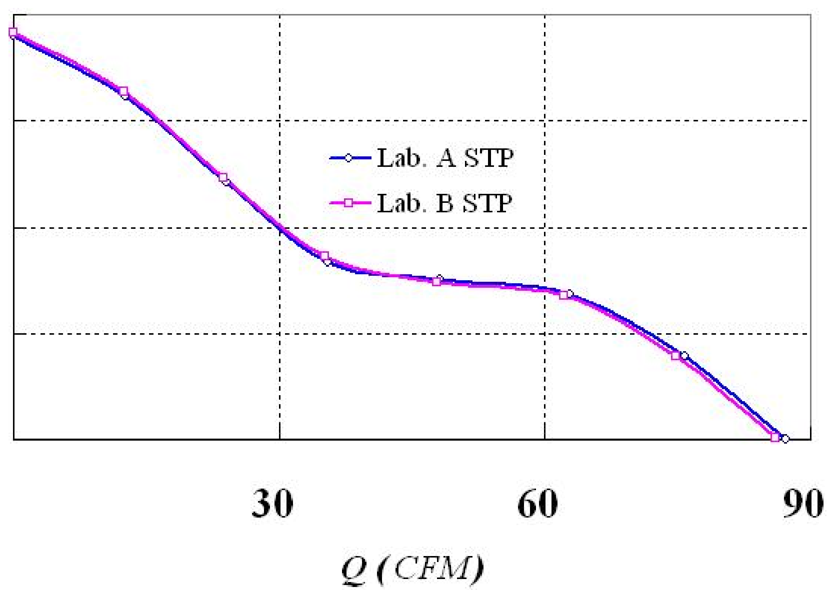
From AMCA 210-99 Eq. 8.59~8.62

☆ STP Conversion

Td	Tw	RH	T5	T7	T8	Pb	
℃	℃	%	℃	℃	℃	mmHg	
23.8	20.4	73.7	23.9	24.2	23.8	760.5	F
19.7	16.5	72.1	19.3	19.2	19.5	742.6	LongWin

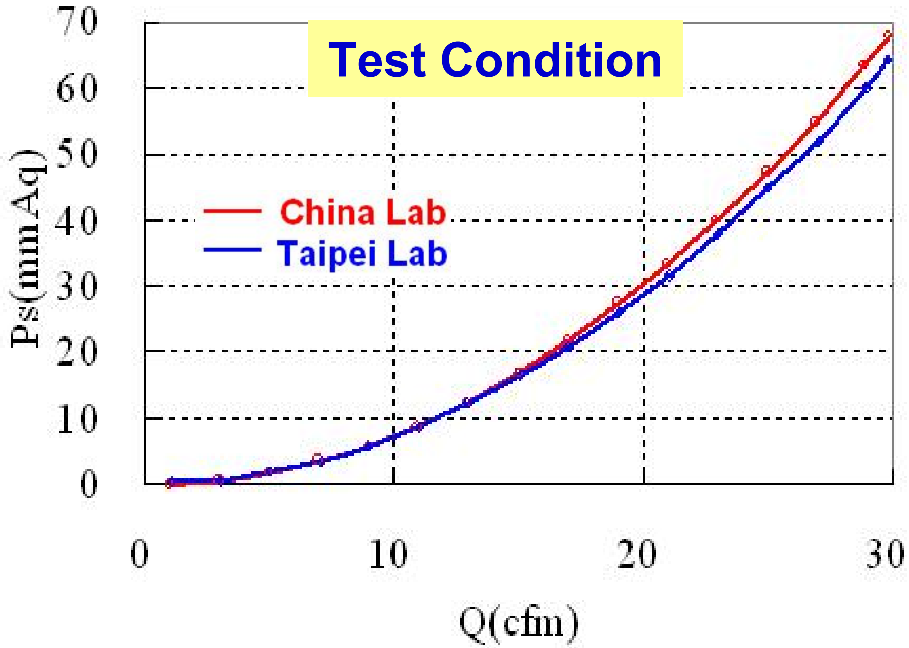
Date:	2008/3/13
Laboratory:	F. VS LongWin
Test Number:	SN9273
Curve by:	Ericfeng
Test Setup:	AMCA 210 Fig.12
Installation Type:	Type A

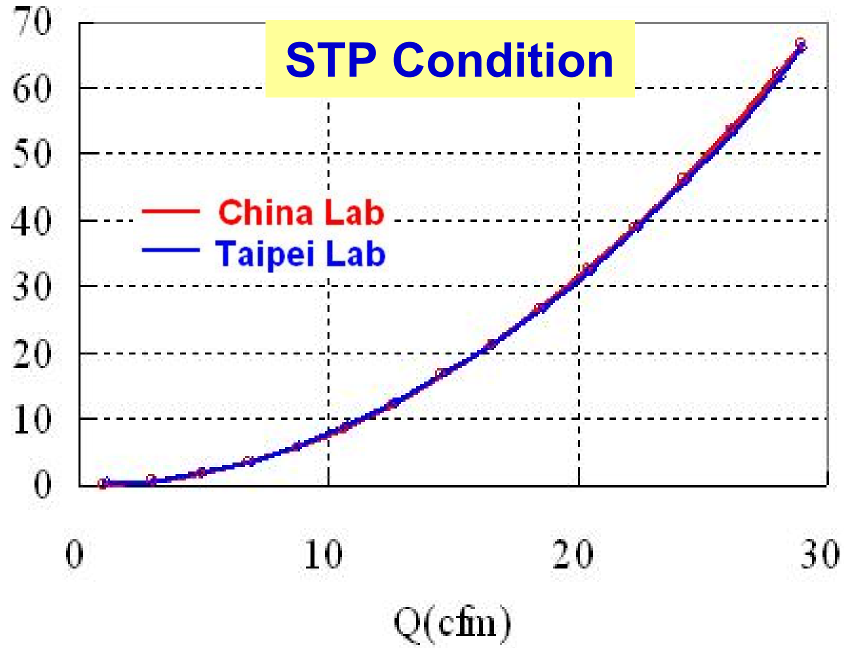




☆ STP Conversion

Orifice Plate SRC Test





☆ STP Conversion

Test Report (1 – 4)

Test Condition

Production Name:			Date:	2008/7/9	
Model Name:			Laboratory:	Long Win	
Production size:		(mm)	Test Number:	3846	
mpeller Tip Diameter:		(mm)	Curve by:	Eric	
Inlet Area:	144	(cm^2)	Test Setup:	AMCA 210 Fig.12	
Outlet Area:	144	(cm^2)	Installation Type:	Type A	
Accessary:			Chamber Corss-sectional Area:	9216	(cm^2)

STP: Standard Air Property is Air at (Td) 20 ℃ Temperature, (RH) 50 % Relative Humidity, and (Pb) 760 mmHg Barometric Pressu

Td	Tw	RH	T5	T7	T8	Pb	Pmax	Qmax
℃	℃	%	℃	℃	℃	mmHg	mmAq	CFM
28.1	24.2	73.8	29.2	28.7	23.8	740.9	6.88	94.08

☆ STP Conversion

Test Report (2 – 4)

Row Data

Ps		dp	Q		P_{STP}		Q_{STP}		Rotary Speed
mmAq	inAq	mmAq	CMM	CFM	mmAq	inAq	CMM	CFM	RPM
6.88	0.271	6.54	0.000	0.00	7.31	0.29	0.00	0.00	2380
6.58	0.259	13.10	0.271	9.57	6.99	0.28	0.27	9.57	2582
6.10	0.240	47.43	0.521	18.38	6.48	0.26	0.52	18.38	2694
5.01	0.197	112.26	0.803	28.36	5.32	0.21	0.80	28.36	2814
4.01	0.158	38.61	1.062	37.51	4.26	0.17	1.06	37.51	2892
2.94	0.116	60.35	1.331	46.99	3.12	0.12	1.33	46.99	2975
2.94	0.116	85.65	1.586	56.02	3.12	0.12	1.59	56.02	2864
2.64	0.104	119.86	1.877	66.27	2.81	0.11	1.88	66.27	2722
2.11	0.083	48.14	2.119	74.82	2.24	0.09	2.12	74.82	2714
1.13	0.044	60.89	2.384	84.21	1.20	0.05	2.38	84.21	2770
0.01	0.000	75.94	2.664	94.08	0.01	0.00	2.66	94.08	2845

☆ STP Conversion

Test Report (3 – 4)

Row Data

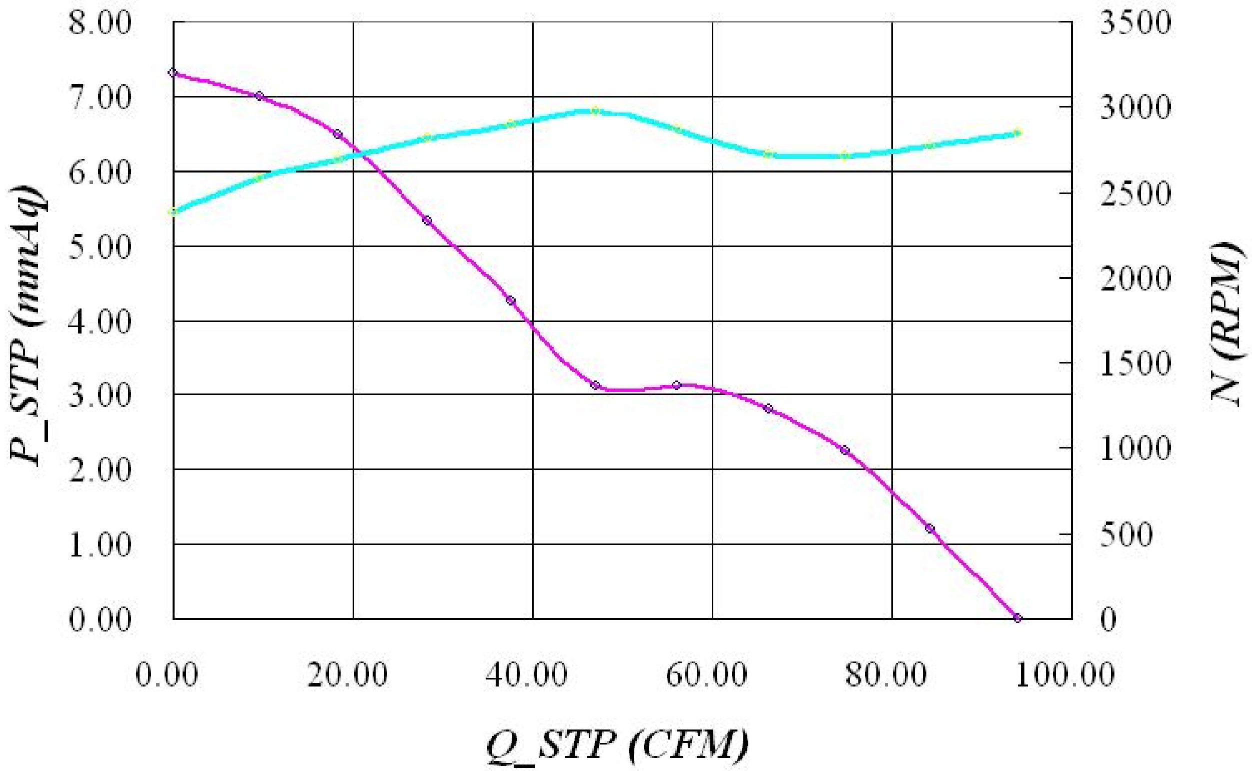
Coverage Factor k=2.00 , Probability 95%

Freq.	R Volt	S Volt	T Volt	Σ Volt	Current	Power	Σ Volt x Current	Power Factor	Air Density	Pv	Pt	Comp. Factor	Pt Eff.	Ps Uncertainty		Q Uncertainty	
Hz	Volt	Volt	Volt	Volt	Amp.	Watt.	VA	PF	kg/m^3	mmAq	mmAq	Kp	%	± %	± mmAq	± %	± CFM
60	220.0	220.0	219.8	380.9	0.113	18.2	24.86	0.732	1.128	0.00	6.88	0.9998	1.2	1.16	0.079	1.42	0.000
60	220.0	220.0	219.8	380.9	0.109	17.7	23.98	0.731	1.128	0.01	6.59	0.9998	1.6	1.16	0.076	12.17	1.164
60	220.0	220.0	219.8	380.9	0.107	17.2	23.54	0.730	1.128	0.02	6.12	0.9998	3.0	1.17	0.071	3.57	0.656
60	220.0	220.0	220.0	380.9	0.105	16.8	23.10	0.727	1.128	0.05	5.06	0.9998	3.9	1.19	0.060	1.97	0.560
60	220.0	220.0	219.8	380.9	0.104	16.3	22.88	0.712	1.127	0.09	4.10	0.9999	4.4	1.22	0.049	1.62	0.608
60	220.0	220.0	220.0	380.9	0.102	16.0	22.44	0.713	1.127	0.14	3.08	0.9999	4.2	1.31	0.039	1.50	0.706
60	220.0	220.0	219.8	380.9	0.104	16.6	22.88	0.724	1.127	0.19	3.13	0.9999	4.9	1.33	0.039	1.46	0.818
60	220.0	220.0	220.0	380.9	0.107	17.3	23.54	0.734	1.127	0.27	2.91	0.9999	5.1	1.42	0.038	1.44	0.954
60	220.0	220.0	219.8	380.9	0.108	17.3	23.76	0.728	1.127	0.35	2.46	0.9999	4.9	1.64	0.035	1.43	1.070
60	220.0	220.0	219.8	380.9	0.106	17.1	23.32	0.733	1.127	0.44	1.57	0.9999	3.6	2.76	0.031	1.43	1.200
60	220.0	220.0	220.0	380.9	0.105	16.8	23.10	0.727	1.127	0.55	0.56	1.0000	1.4		0.022	1.42	1.338

☆ STP Conversion

Test Report (4 – 4)

Chart

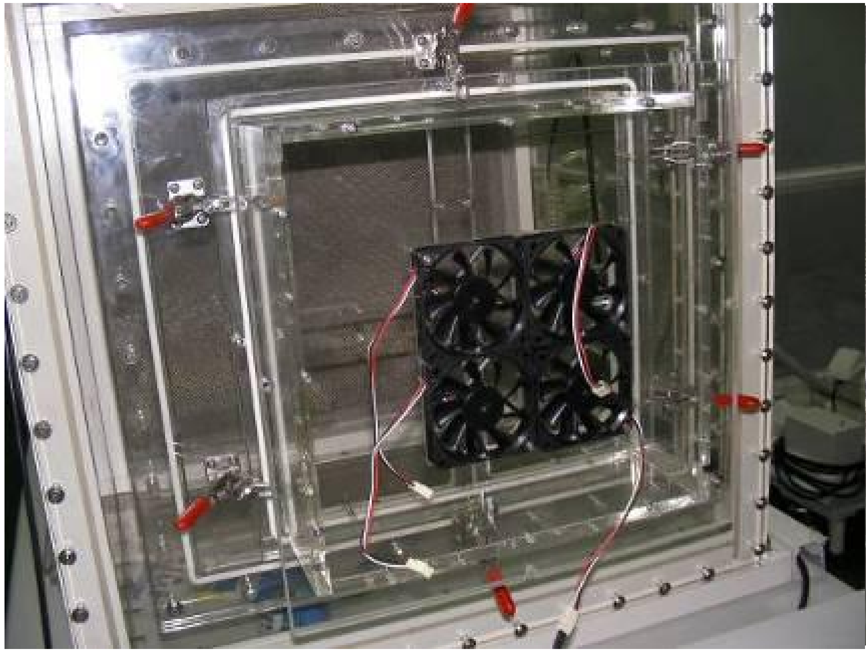


☆ Multi Fan Performance Curve Test

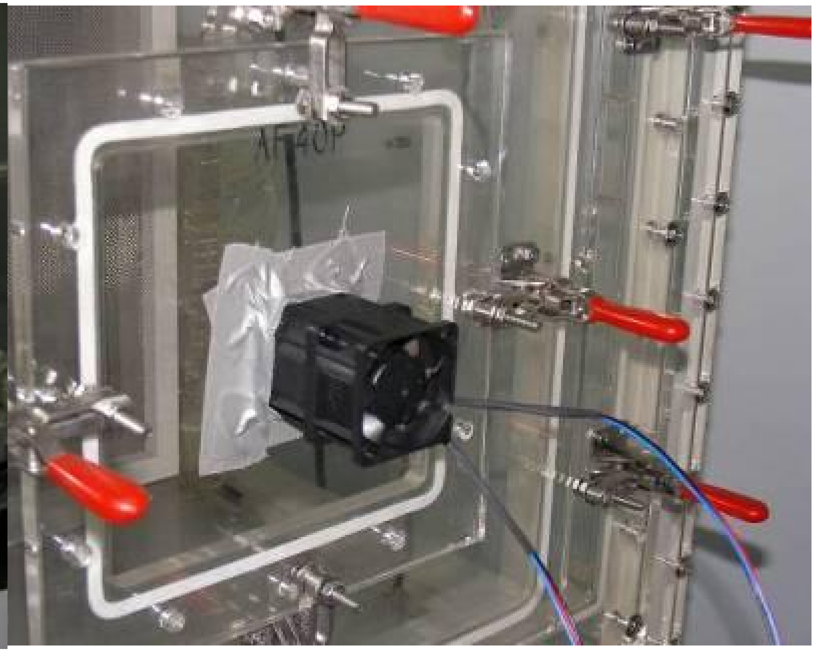
Up to 7 Fan.

(Amp. / Volt. / RPM)

☆ **Multi Fan** Performance Curve Test



Parallel



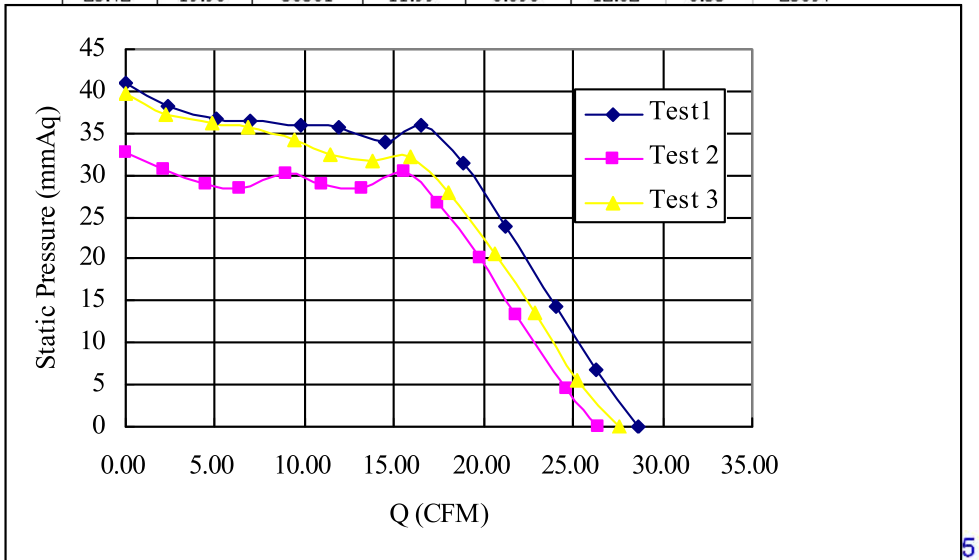
Series

Back to Features

☆ **Multi Fan** Performance Curve Test

	Fan1	Fan2
test1	12V	12V
test2	10V	12V
test3	12V	10V

PSTP	QSTP	Fan-Speed	Fan-Volt	Fan-Amp	Volt2	AMP2	RPM2
mmAq	CFM	RPM	Volt	Amp			
40.11	0.00	31867	11.99	0.671	12.06	0.44	29891
37.28	2.20	32576	12.00	0.639	12.06	0.43	29921
35.92	4.73	31325	12.00	0.615	12.06	0.45	28784
35.53	6.58	30526	12.00	0.599	12.05	0.47	27532
35.04	9.18	32658	11.99	0.647	12.04	0.49	26762
34.94	11.21	32643	11.99	0.656	12.04	0.50	26028
33.09	13.64	32261	11.99	0.663	12.03	0.51	25123
35.04	15.51	31269	11.99	0.671	12.02	0.52	24498
30.55	17.71	30666	11.99	0.695	12.02	0.53	24220
23.42	19.90	30501	11.99	0.690	12.02	0.53	23897

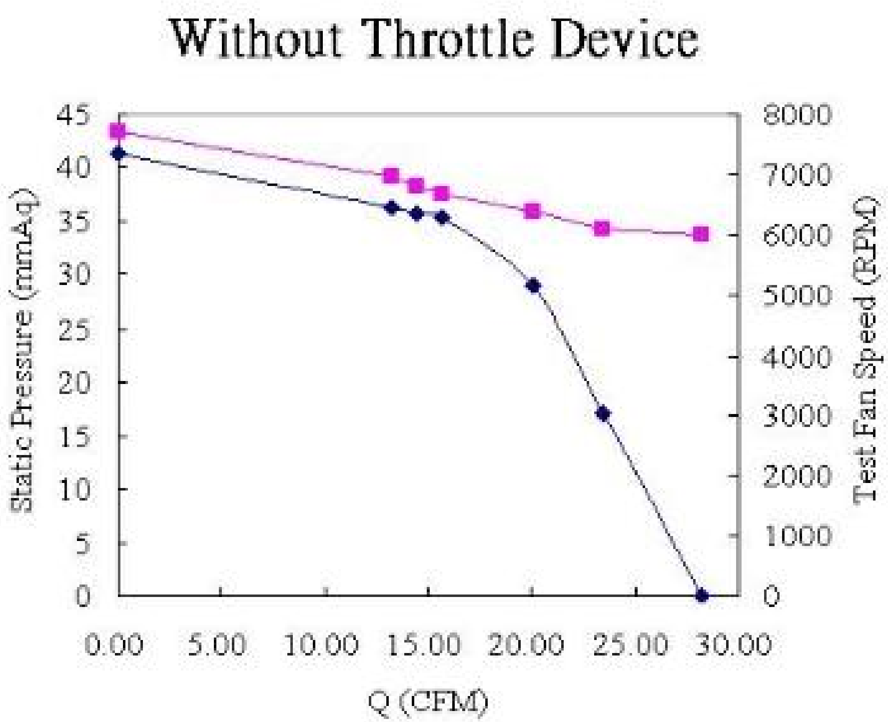


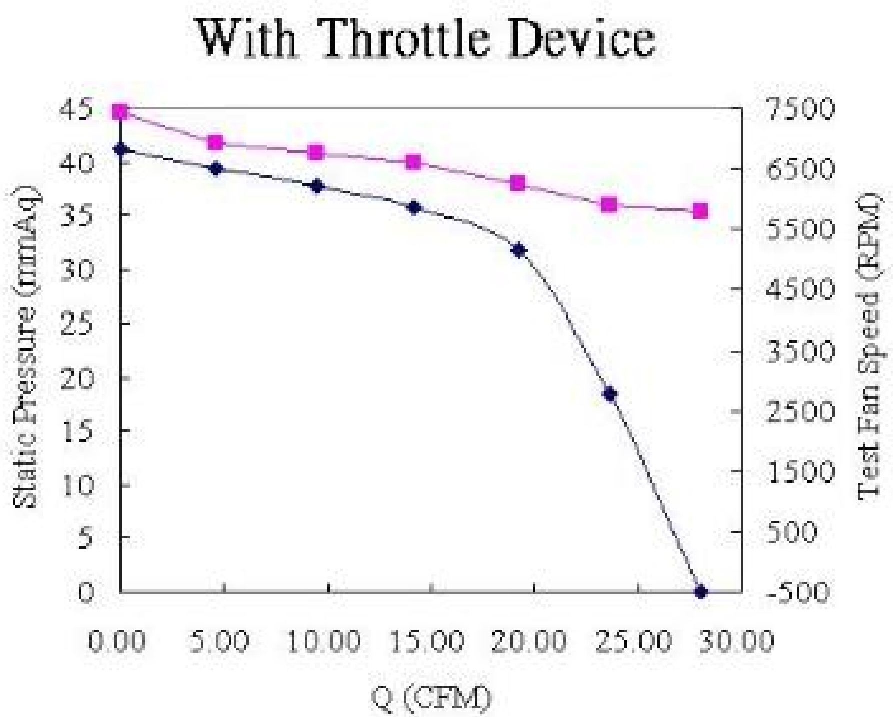
☆ Multi Fan Performance Curve Test

☆ High Ps Fan Performance Curve Test

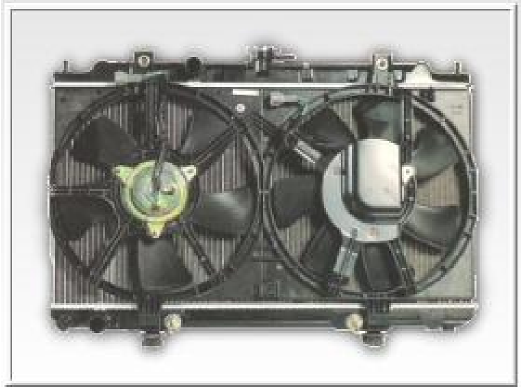
Ps up to 200 mmAq

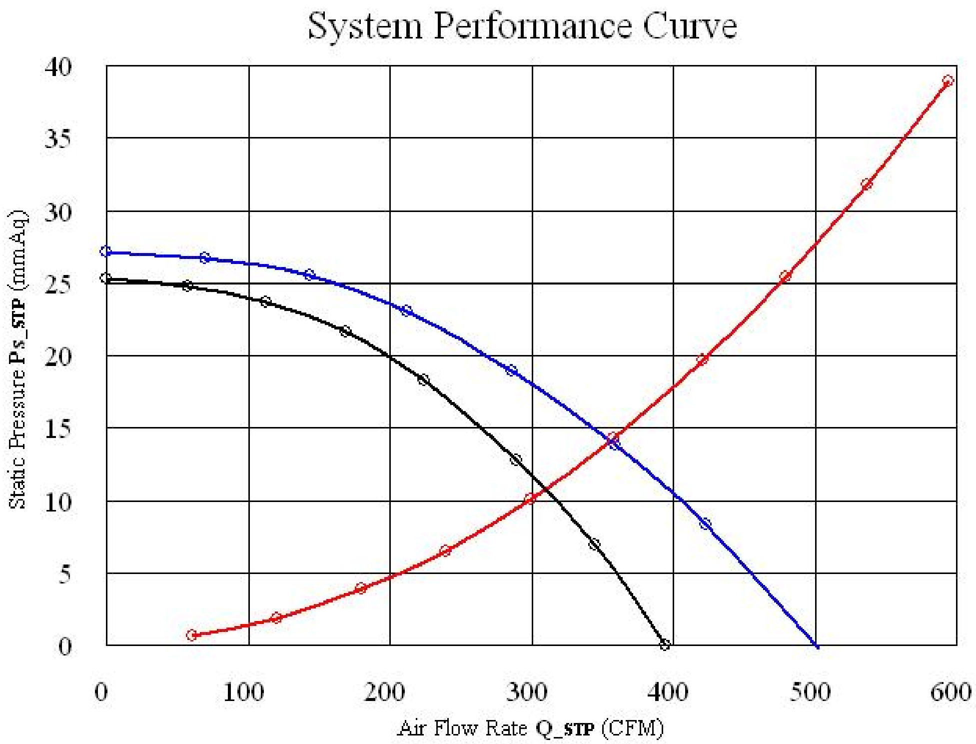
☆ High Ps Fan Performance Curve Test





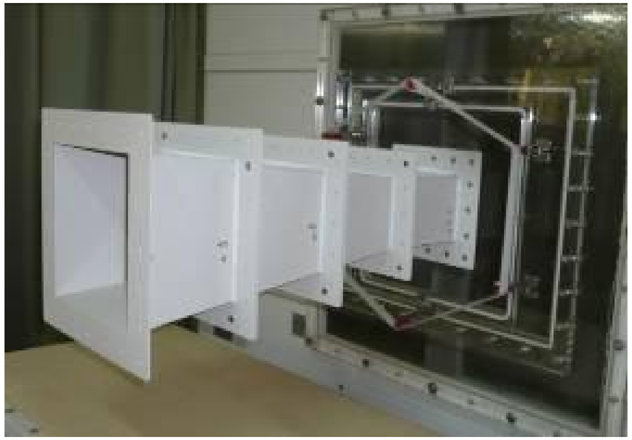
☆ System Impedance Curve (SRC) Test



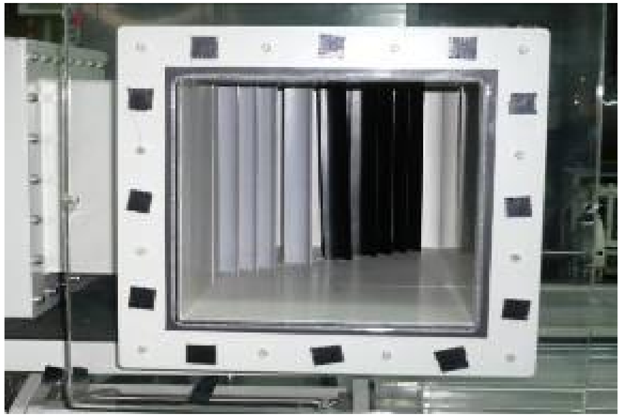


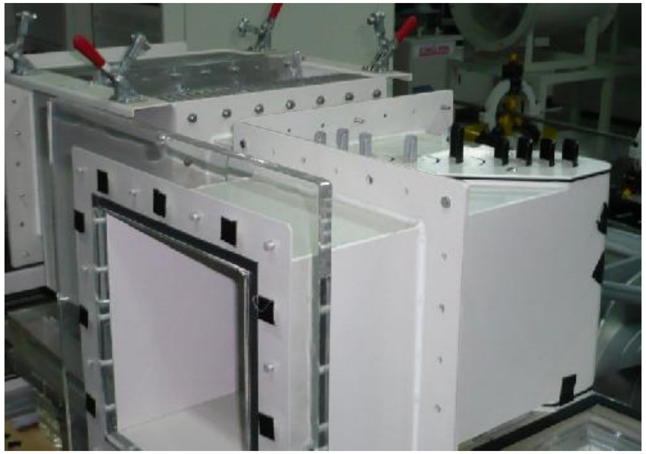
☆ System Resistance Curve (SRC) Test

☆ SRC : Duct Pressure Drop Test



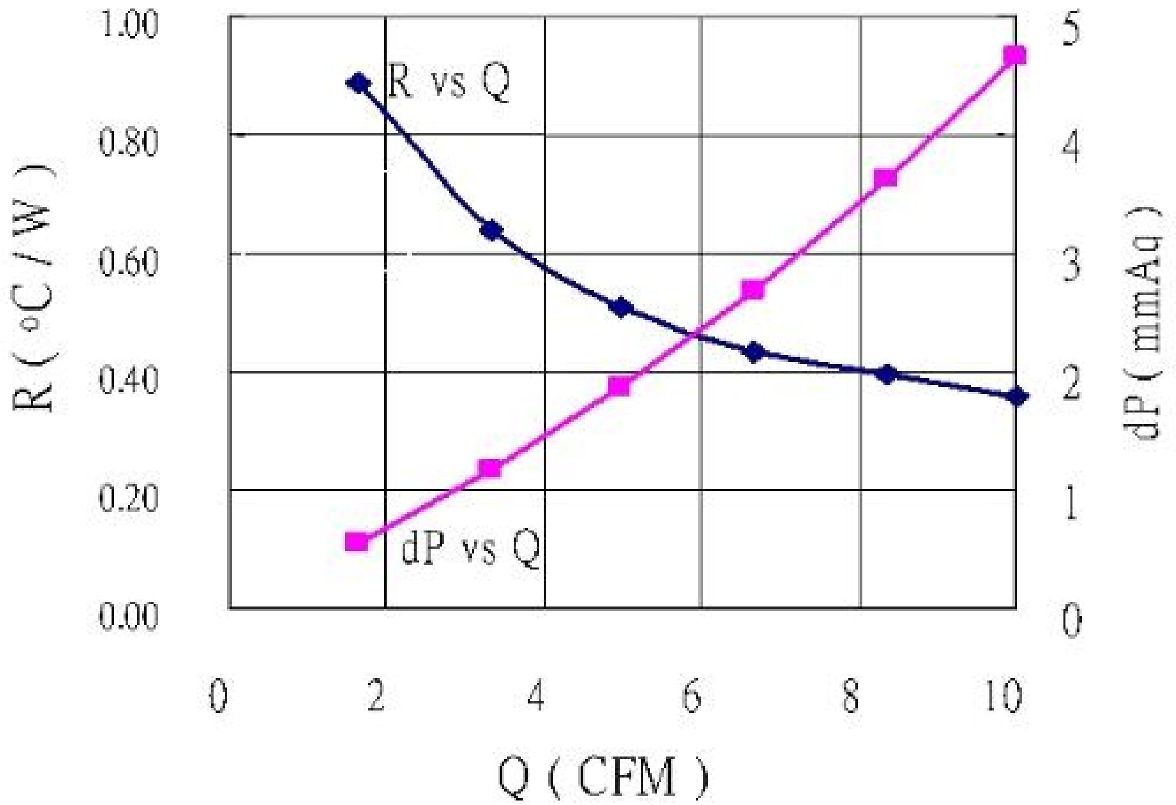
1. Straight
2. Bend
3. Converge
4. Diverge

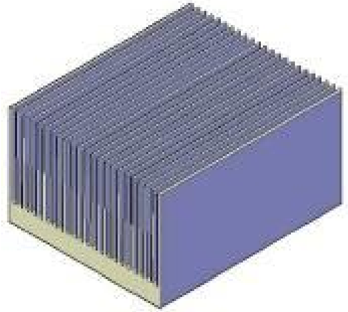




☆ **Offer Air Flow** Rate Automatically

☆ Thermal Module **R-Q Test** Automatically (Option)





☆ QC – Cpk Test

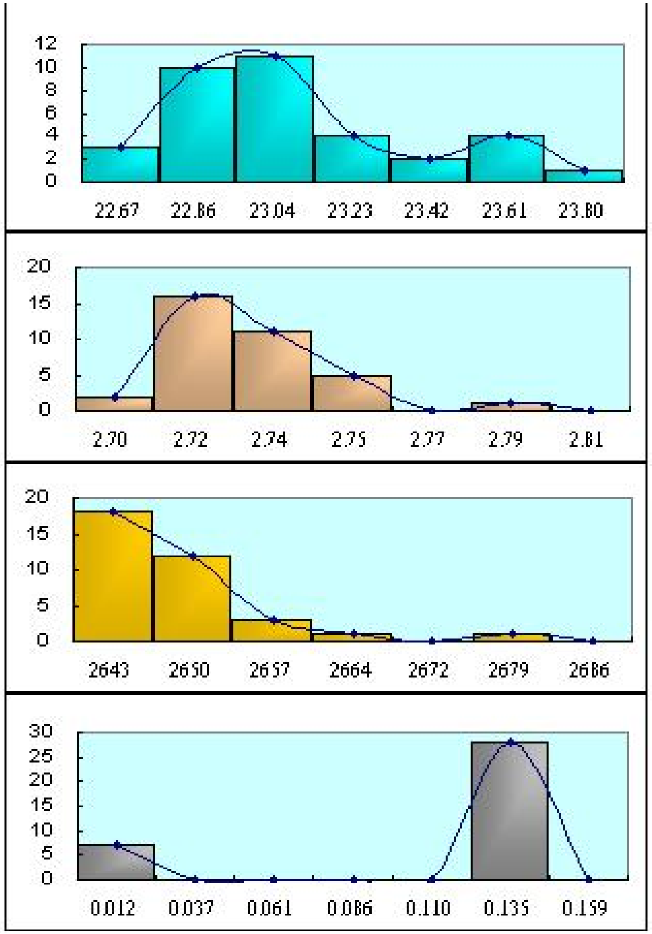
		A	B	C	D
Engineering Specification					
		A	B	C	D
product spe		23.0896	2.72743	2648.09	0.114
+ Tolerenc		0.92445	0.06015	23.6424	0.17102
- Tolerenc		0.92445	0.06015	23.6424	0.17102
	USL	24.014	2.78758	2671.73	0.28502
	LSL	22.1651	2.66728	2624.44	-0.057
Actual Data					
		A	B	C	D
	X bar	23.0896	2.72743	2647.07	0.114
	Sigma	0.31265	0.02034	7.99585	0.05784
	Median	23.029	2.72	2646	0.142
	Mode	#N/A	2.72	2645	0.142
	Max	23.7085	2.8	2682.5	0.147
	Min	22.5752	2.69	2639	0
UCL 3 Sigma	**1 Sigma**	23.4022	2.74777	2655.07	0.17184
	2 Sigma	23.7149	2.76811	2663.07	0.22968
	3 Sigma	24.0275	2.78845	2671.06	0.28752
LCL 3 Sigma	**1 Sigma**	22.7769	2.70709	2639.08	0.05616
	2 Sigma	22.4643	2.68675	2631.08	-0.0017
	3 Sigma	22.1516	2.6664	2623.09	-0.0595
SPC	**CP**	0.98561	0.98561	0.98561	0.98561
	CPL	0.98561	0.98561	0.94341	0.98561
	CPU	0.98561	0.98561	1.02781	0.98561
	S. CP	0.98561	0.98561	0.94341	0.98561
	Ca	-3.8E-15	0	-0.0428	-2E-16
	Cpk	0.98561	0.98561	0.94341	0.98561

Flow rate

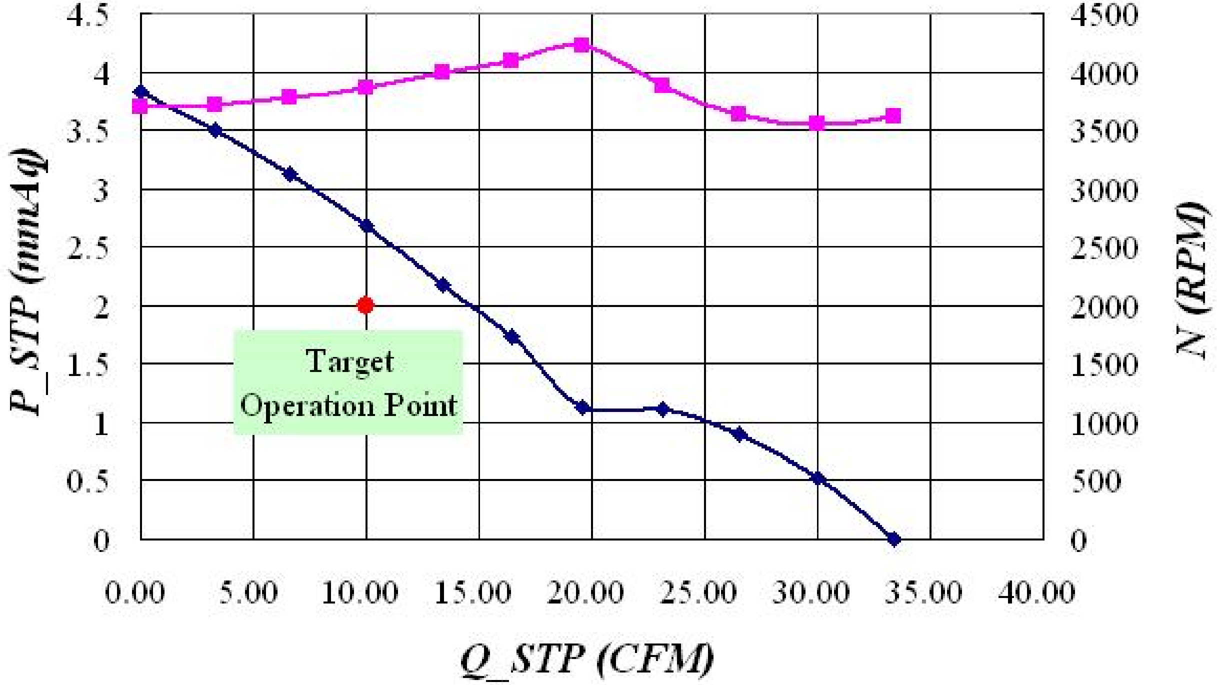
Ps (pressure)

RPM

Current (A)



☆ QC – Operation Point Check



Test Fan Op.

Ps	2.69	mmAq
Q	9.97	CFM
Torque	20.62	gr*cm
Input P	2.39	Watt
Fan Input	0.80	Watt
Motor Eff.	33.28	%
Fan Ps Eff.	15.58	%
Overall Eff.	5.18	%

Operation Point Setting	2.30	mmAq ,	12.00	CFM
Test Fan Performance	1.98	mmAq ,	12.05	CFM

OK Ps > Op.

NG (Op.-Uncertainty) > Ps

1985 Long Win Fundamental, Forward & First

1. Basic Specifications:

Model	Air Flow Rate (CFM)	Overall Dimension W x L x H (M)
9014	0.2 ~ 18	0.6 x 3 x 1.6
9081	1.6 ~ 60	0.6 x 3 x 1.6
9015	2.4 ~ 250	0.85 x 3.6 x 1.8
9185	5 ~ 1500	1.2 x 4.6 x 1.9
9120	100 ~ 5000	2.6 x 7 x 2.3
9293	230 ~ 30000 850 CMM	3.0 x 10 x 2.6

Specifications:

1.Air Flow Rate Range: 0.2 ~ 10 CFM.

2.Nozzle Definition:

NO.	Dimension	Air flow rate		Accuracy
	mm	min.	max.	% INFS
1	3	0.20	0.64	3.5
2	4	0.32	1.15	3
3	5	0.87	1.80	2.5
4	6	1.26	2.60	2
5	8	2.25	4.66	1.5

INFS is the full scale of designated nozzle

3. Power source: AC 220 V，single phase，3A.
4. Overall dimension: 0.6 (W) x 3 (L) x 1.6 (H) M.

Specifications:

1.Air Flow Rate Range: 1.6 ~ 60 CFM.

2.Nozzle Definition:

NO.	Dimension	Air flow rate		Accuracy
	mm	min.	max.	% INFS
1	5	1.5	1.8	3.5
2	6	1.7	2.6	3
3	8	2.5	4.6	2.5
4	14	4.5	14.4	2
5	24	14.5	42.6	1.5

INFS is the full scale of designated nozzle

3. Power source: AC 220 V，single phase，3A.

4. Overall dimension:
   0.6 (W) x 3 (L) x 1.6 (H) M.

Specifications:

1.Air Flow Rate Range: 2.4 ~ 250 CFM.

2.Nozzle Definition:

NO.	Dimension	Air flow rate		Accuracy
	mm	min.	max.	% INFS
1	8	2.4	4.6	3.5
2	14	4.5	14.1	3
3	24	13	41	2.5
4	34	26	83	2
5	42	40	127	1.5

INFS is the full scale of designated nozzle

3. Power source: AC 220 V，single phase，5A.
4. Overall dimension:

   0.85 (W) x 3.6 (L) x 1.8 (H) M.

Specifications:

1.Air Flow Rate Range: 2.9 ~ 800 CFM.

2.Nozzle Definition:

NO.	Dimension	Air flow rate		Accuracy
	mm	min.	max.	% INFS
1	10	2.9	7.2	3.5
2	17	6.6	20.9	3
3	32	23	73	2.5
4	53	63	202	2
5	84	160	509	1.5

INFS is the full scale of designated nozzle

3. Power source: AC 220 V，3 phase，20A.
4. Overall dimension:
   1.2 (W) x 4.6 (L) x 1.9 (H) M.

Specifications:

1.Air Flow Rate Range: 40 ~ 5000 CFM.

2.Nozzle Definition:

NO.	Dimension	Air flow rate		Accuracy
	mm	min.	max.	% INFS
1	24	20	42	3.5
2	42	41	131	3
3	53	66	209	2.5
4	62	90	287	2
5	72	121	388	1.5

INFS is the full scale of designated nozzle

3. Power source: AC 220 V，3 phase，20A.
4. Overall dimension:
   2.6 (W) x 5.2 (L) x 2.3 (H) M.

Specifications:

1.Air Flow Rate Range: 50 ~ 8000 CFM.

2.Nozzle Definition:

NO.	Dimension	Air flow rate		Accuracy
	mm	min.	max.	% INFS
1	40	50	119	3.5
2	70	115	367	3
3	90	188	600	2.5
4	110	282	898	2.5
5	130	395	1256	2.5

INFS is the full scale of designated nozzle

3. Power source: AC 220 V，3 phase，30A.
4. Overall dimension:
   2.6 (W) x 7 (L) x 2.6 (H) M.

Specifications:

1.Air Flow Rate Range: 230 ~ 30000 CFM.

2.Nozzle Definition: ϕ145 mm X 20 pcs

3. Power source: AC 380 V，3 phase，100A.

4. Overall dimension:
   3.0 (W) x 10 (L) x 2.6 (H) M.

Back to Top

Application

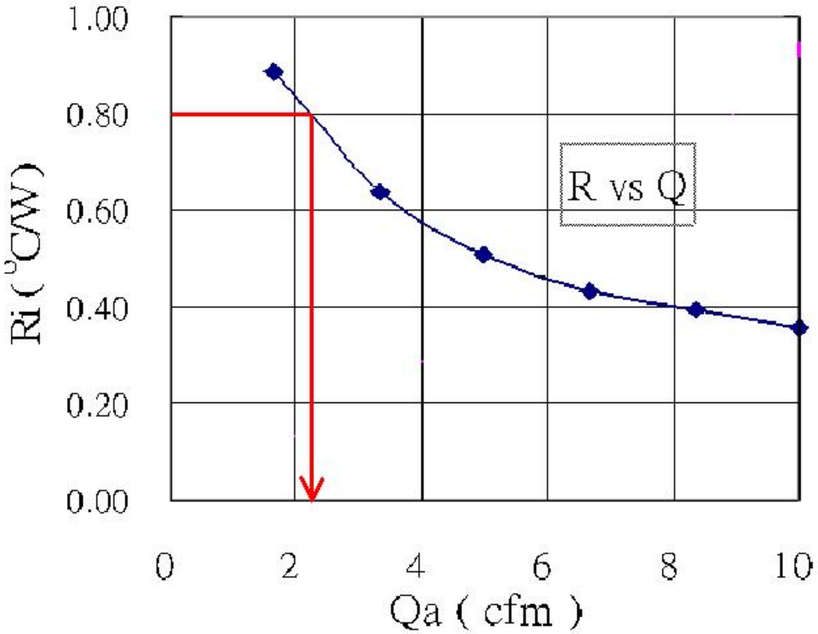
- ☆ **NB** Thermal Design
- ☆ **Server** Thermal Design
- ☆ **Power Supply** Thermal Design
- ☆ **Car Radiator** Thermal Design
- ☆ **Range Hood** Airflow Design
- ☆ **Application** Summary

Back to Top
Back Application

Application

☆ NB Thermal Design

Step1 :

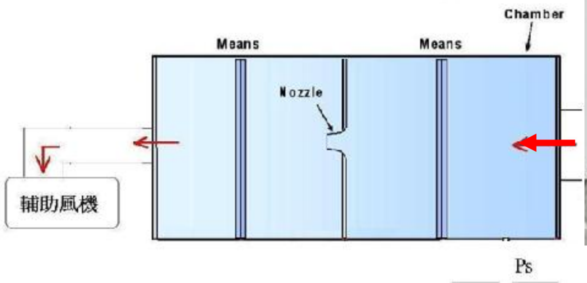


Worst case

Define mini air flow rate

NB
Power ON

AMCA 210-85 Fig.12



Offer Air Flow $\mathbf{Q}_{\mathbf{air}}$

Temperature
Data Log

AMCA 210-07 Wind Tunnel

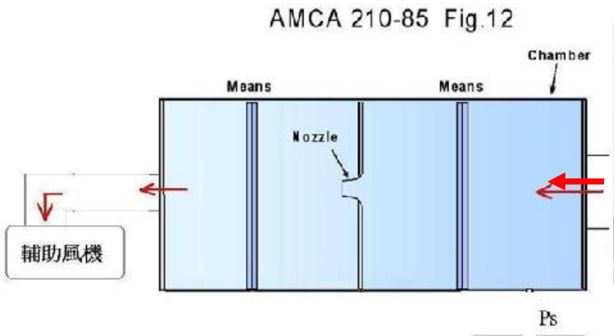
1985 Long Win
Fundamental, Forward & First

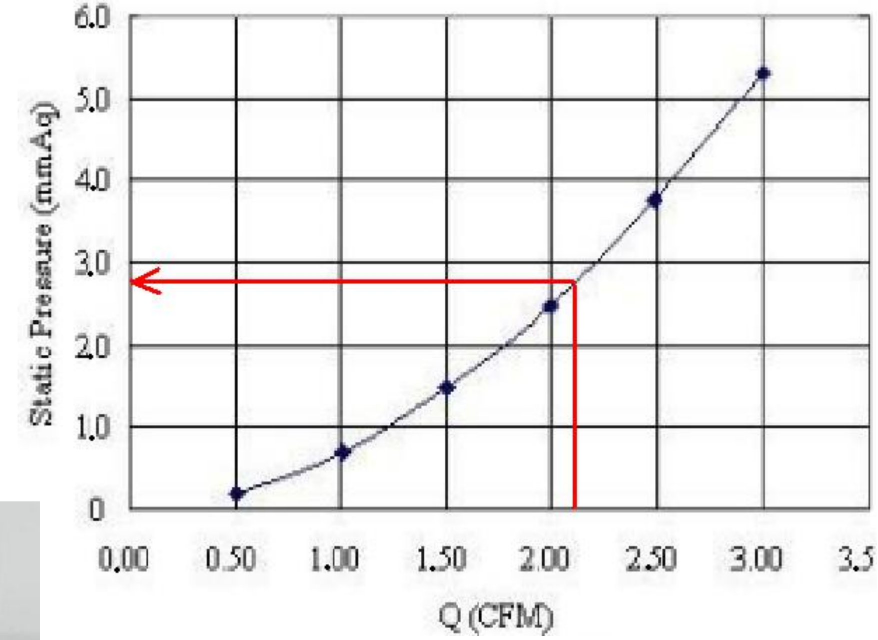
Application

☆ NB Thermal Design

Step2 :

NB
Flow Impedance





Back to Top
Back Application

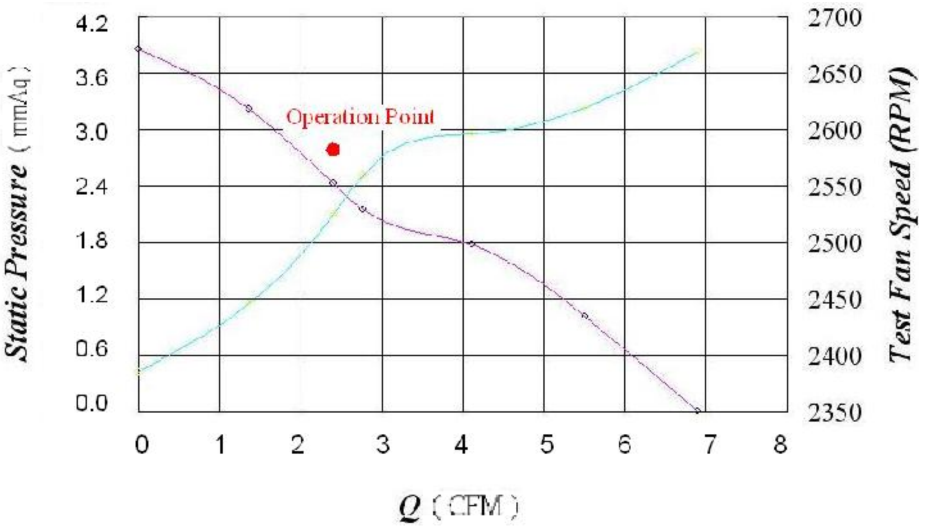
Application

☆ NB Thermal Design

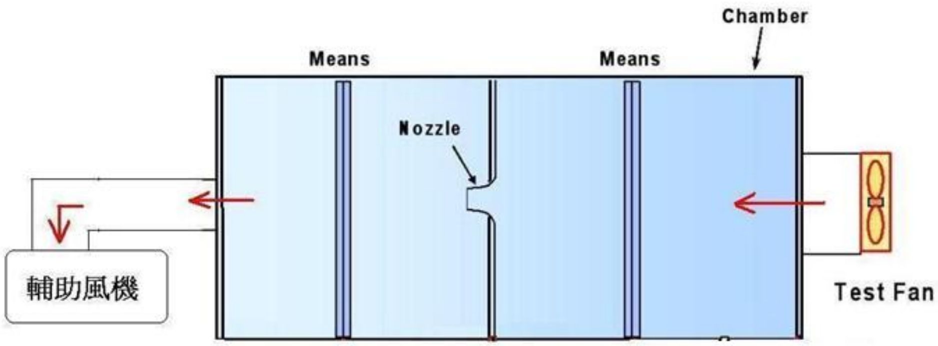
Step3 :

Step 3

NB
Blower



AMCA 210-85 Fig.12



AMCA 210-07 Wind Tunnel

Back to Top

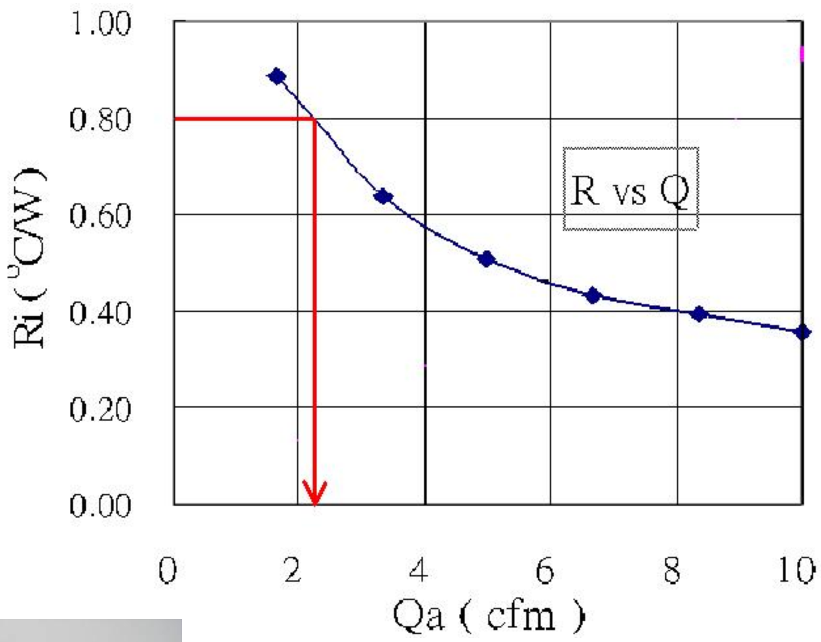
Back Application

☆ Server Thermal Design

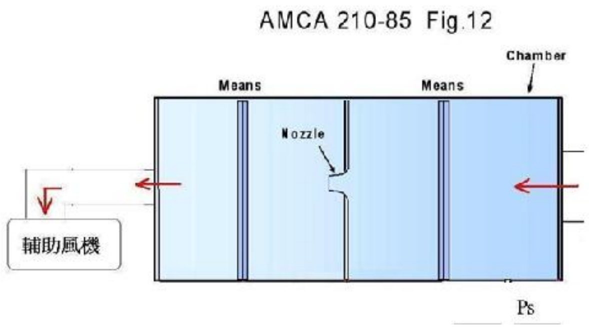
Step1 :

Worst case

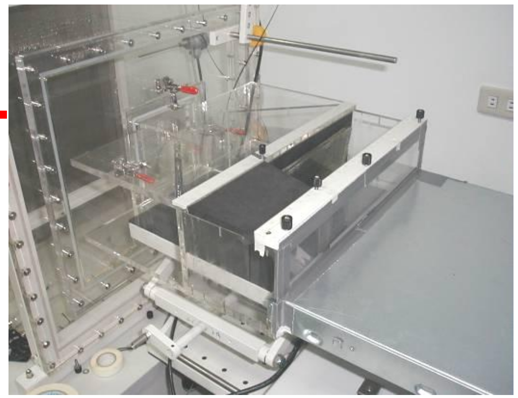
Define mini air flow rate



Server



Offer Air Flow $\mathbf{Q}_{air}$



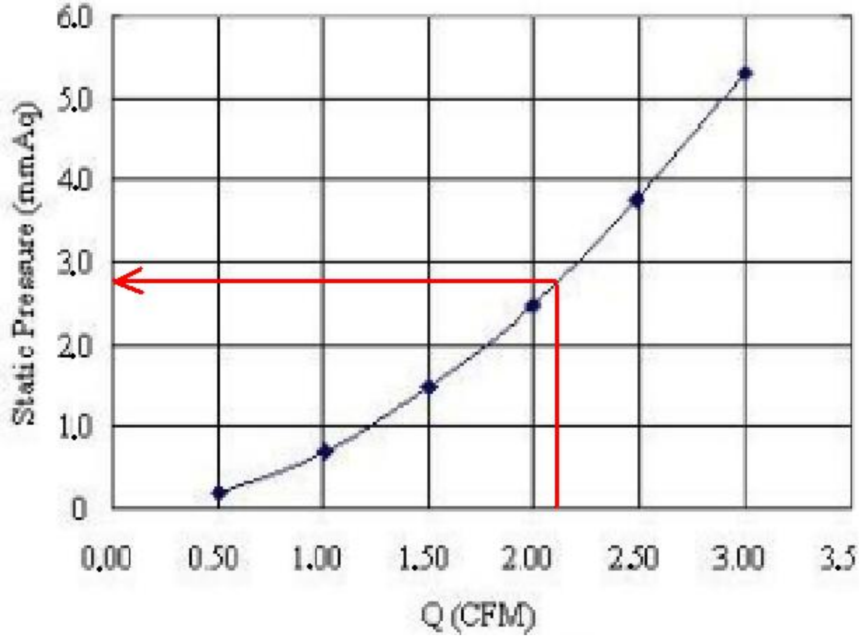
AMCA 210-07 Wind Tunnel

1985 Long Win Fundamental, Forward & First

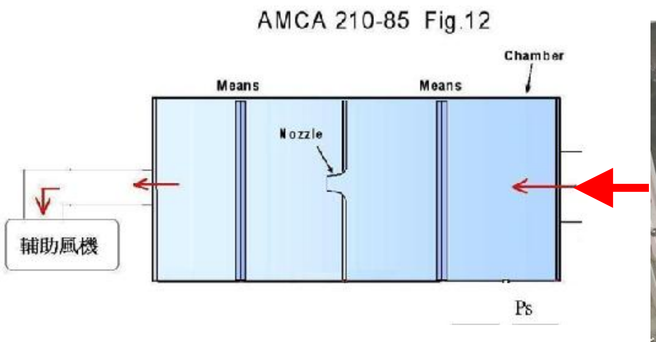
☆ Server Thermal Design

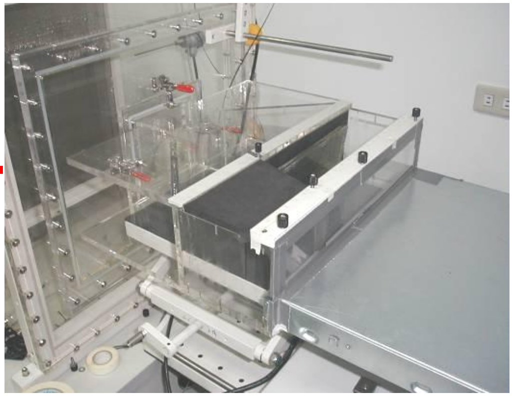
Step2 :

Server Flow Impedance



Server





AMCA 210-07 Wind Tunnel

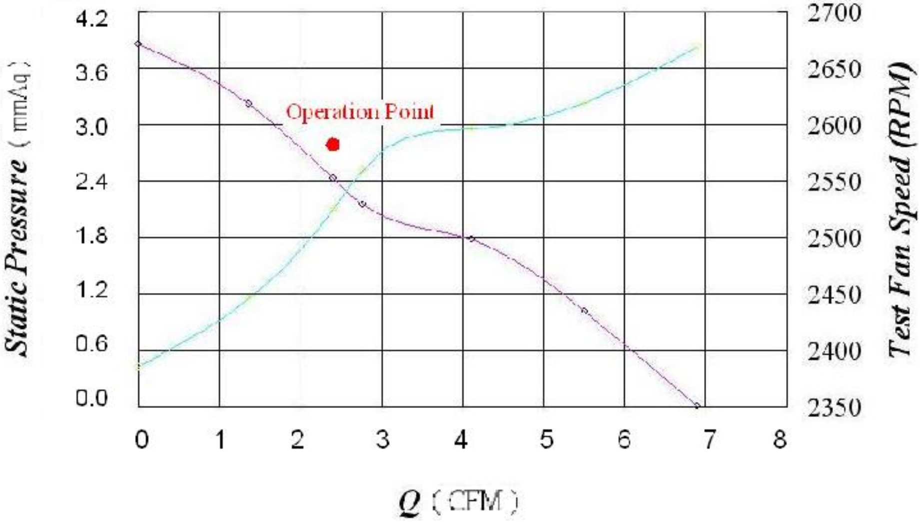
Back to Top

Back Application

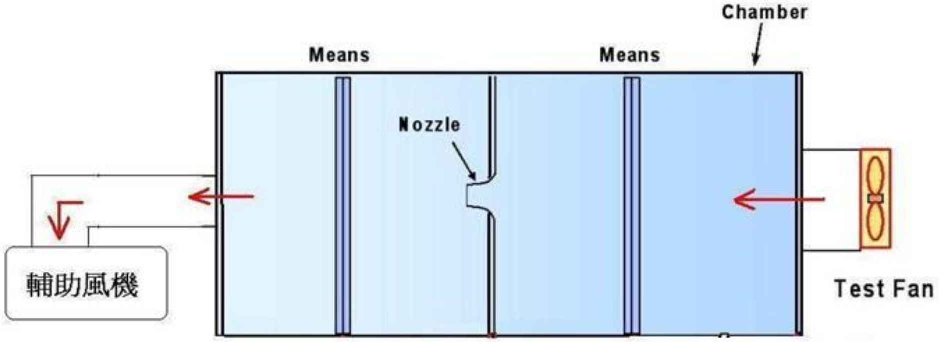
☆ Server Thermal Design

Step3 :

Check Operation Point



AMCA 210-85 Fig.12

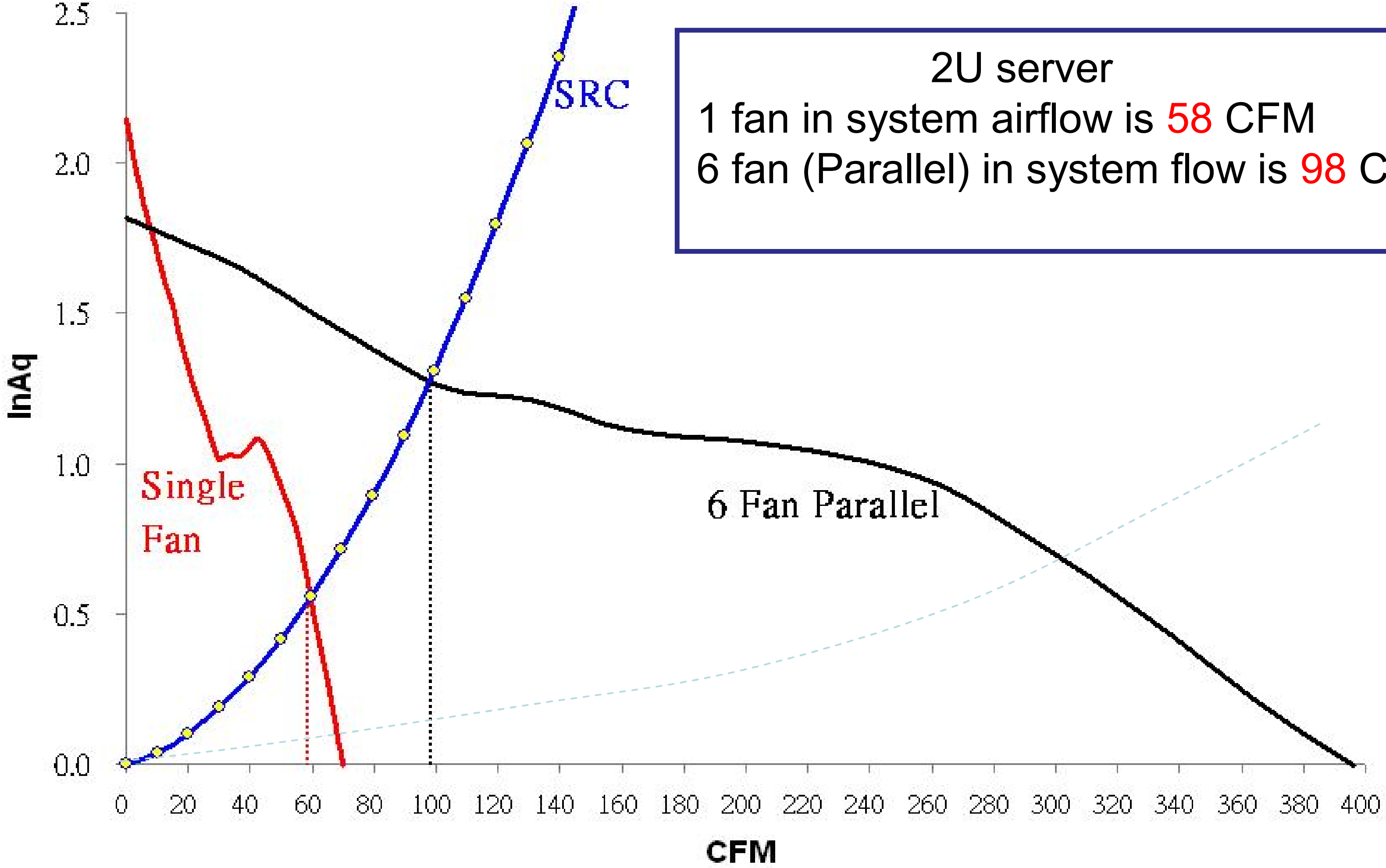


Back to Top

Back Application

Server

Server fan tray case study

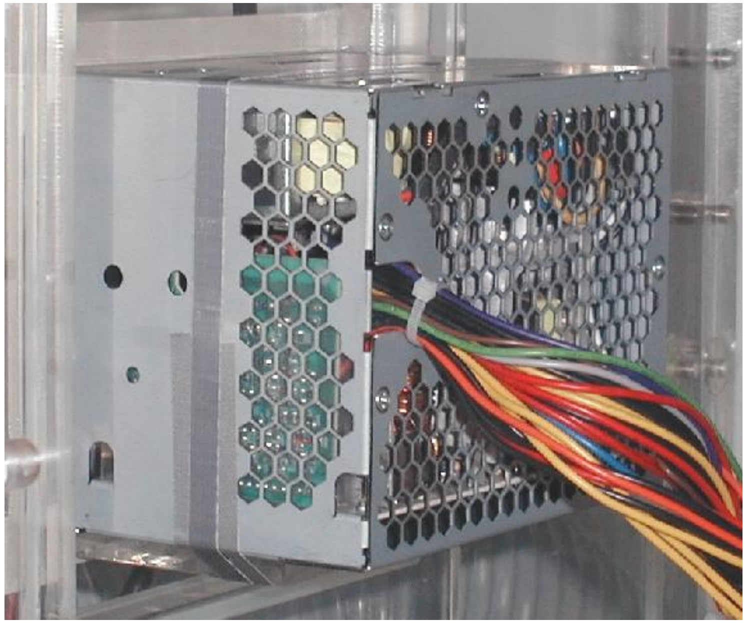


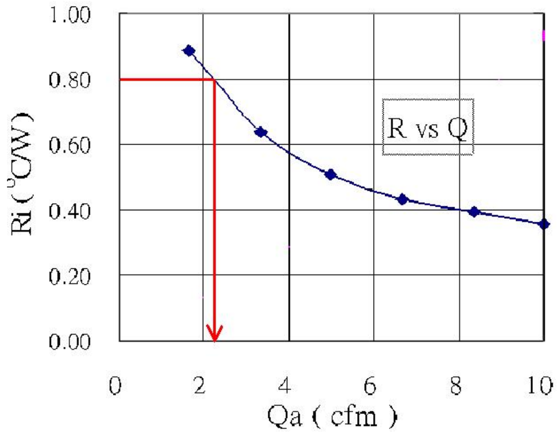
2U server
1 fan in system airflow is 58 CFM
6 fan (Parallel) in system flow is 98 CFM

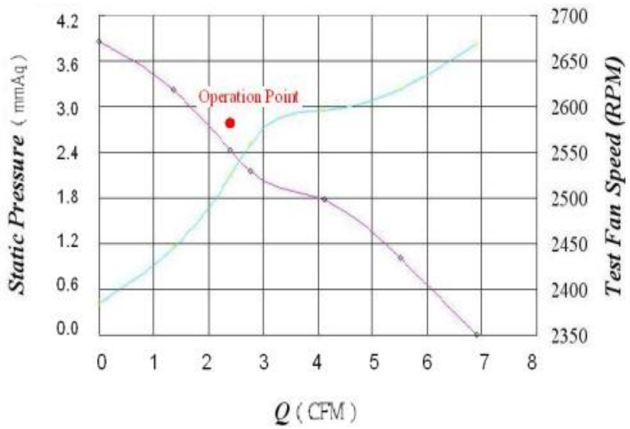
Back to Top

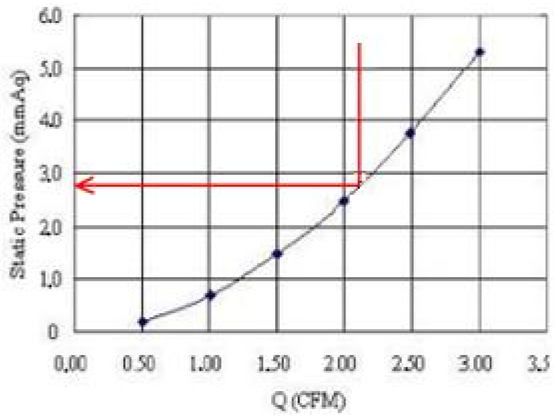
Back Application

☆ PSU Thermal Design









Check Operation Point

AMCA 210-07 Wind Tunnel

Long Win 1985 Fundamental, Forward & First

☆ **PSU** Thermal Design

Thermal Evaluation

1. Layout scenario analysis
2. Worse case study
3. Cooling method choice
4. HS choice
5. Required cooling airflow rate
6. Airflow impedance (SRC)
7. Fan selection

Back to Top
Back Application

☆ **PSU** Thermal Design

Thermal Simulation

1. CFD
2. Input / Output
3. Tools

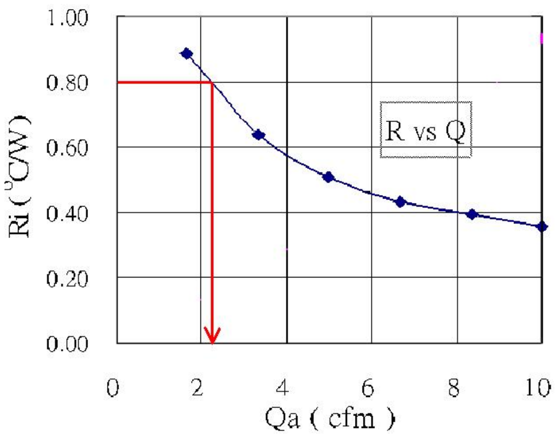
Back to Top

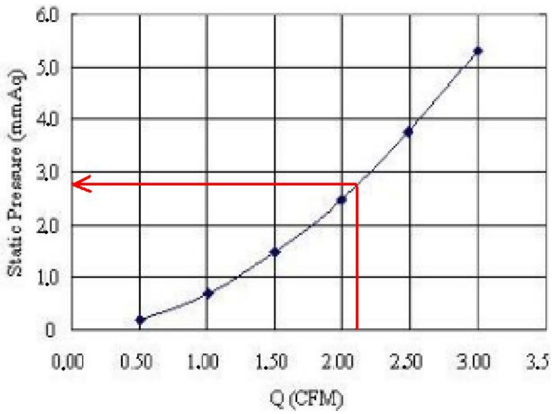
Back Application

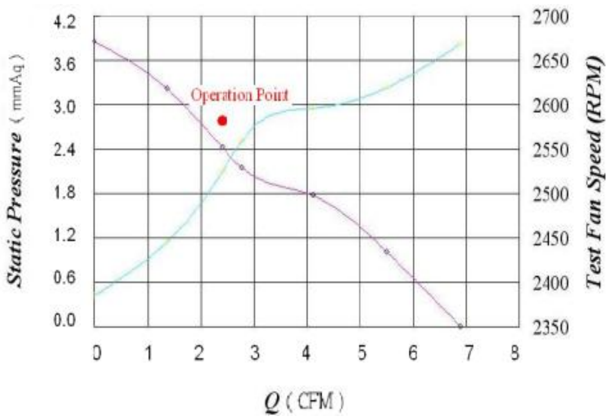
☆ **PSU Thermal Design**

Thermal Verification

1. IR scanning
2. Temperature testing
3. Airflow testing







AMCA 210-07 Wind Tunnel

1985 Long Win
Fundamental, Forward & First

☆ **PSU** Thermal Design

Thermal Verification

Testing Facilities

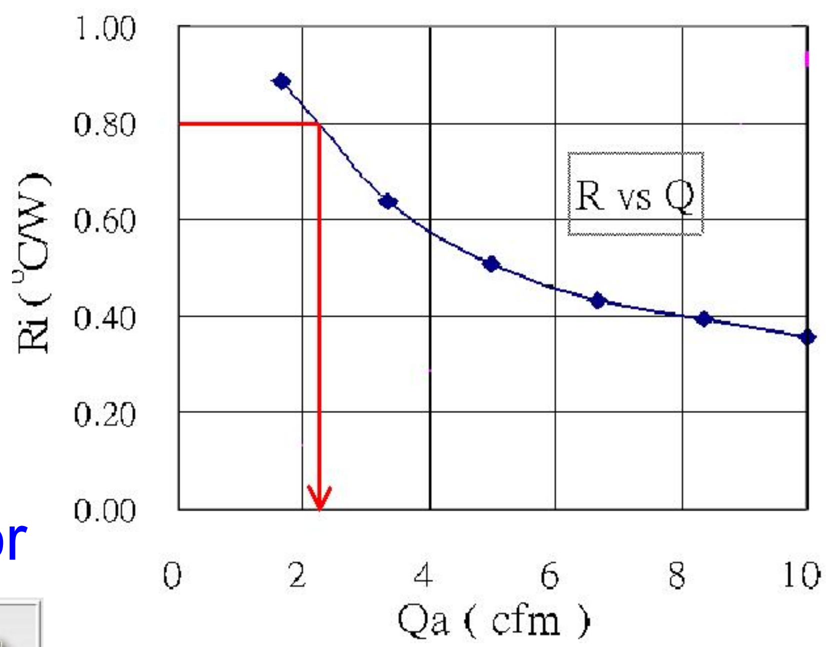
1. IR Camera
2. Thermocouples / Data Log
3. Worst ambient chamber
4. AMCA 210 wind tunnel

☆ Car Radiator Thermal Design

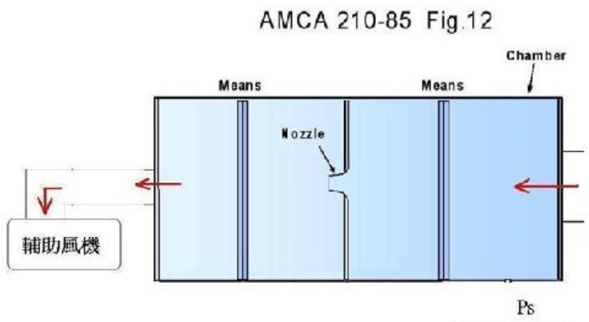
Step1 :

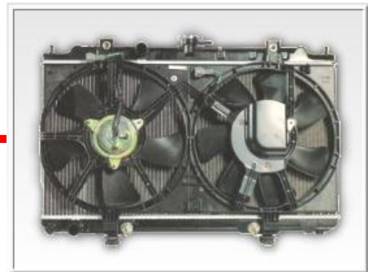
Worst case

Define mini air flow rate



Car Radiator





Offer Air Flow $\mathbf{Q}_{air}$

Temperature Data Log

AMCA 210-07 Wind Tunnel

1985 Long Win
Fundamental, Forward & First

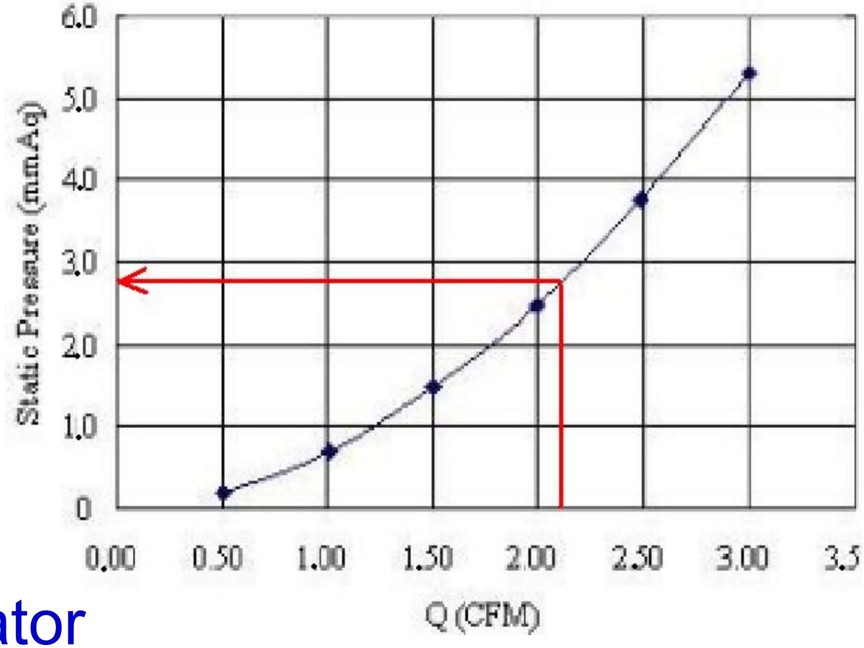
[Back to Top](#)

[Back Application](#)

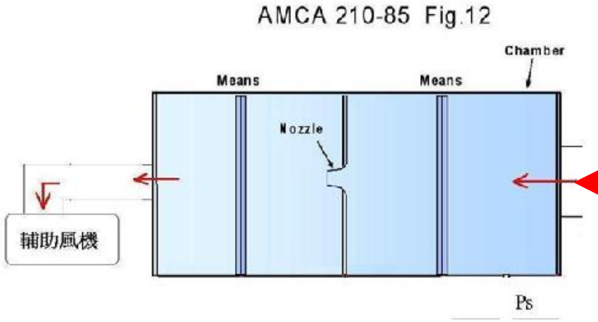
☆ Car Radiator Thermal Design

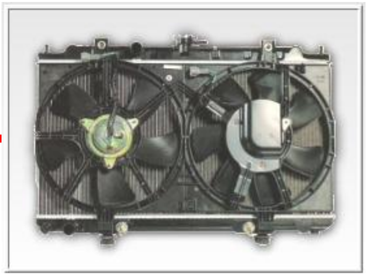
Step2 :

Car Radiator
Flow Impedance



Car Radiator

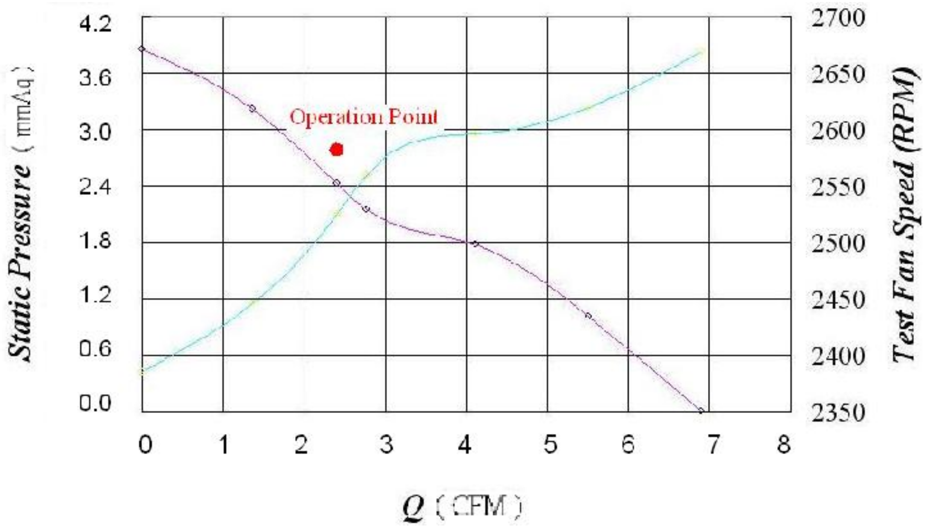


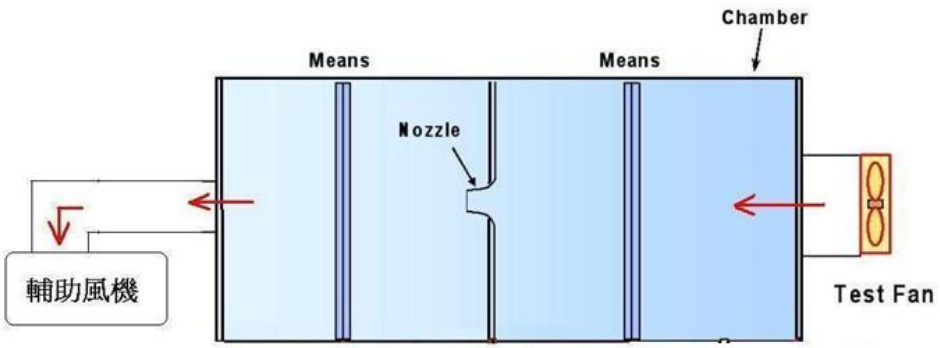


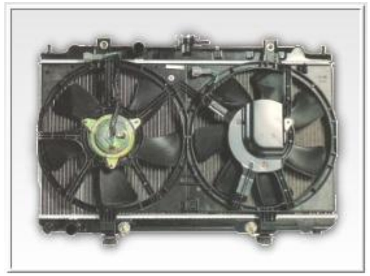
☆ Car Radiator Thermal Design

Step3 :

Check Operation Point



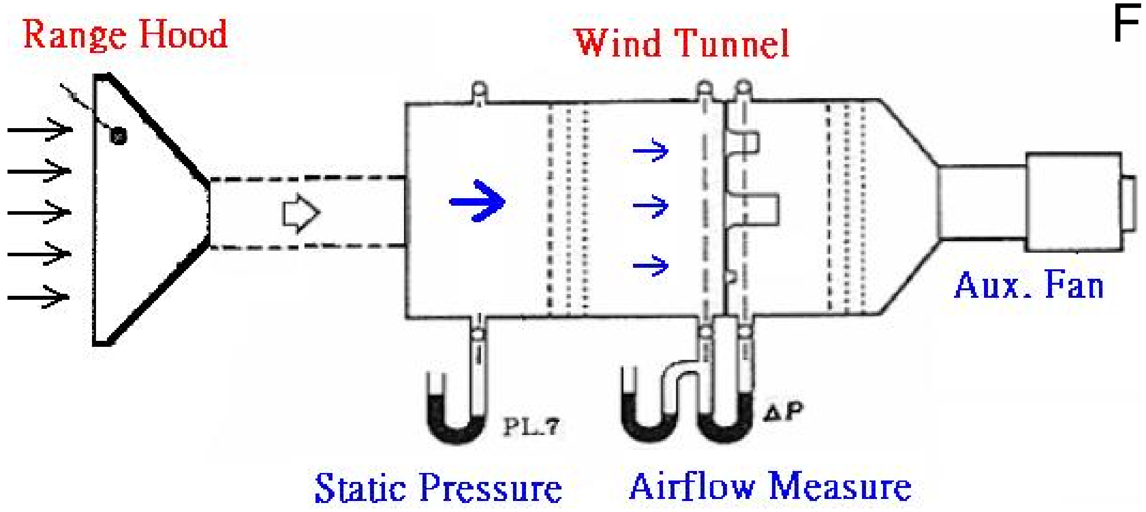


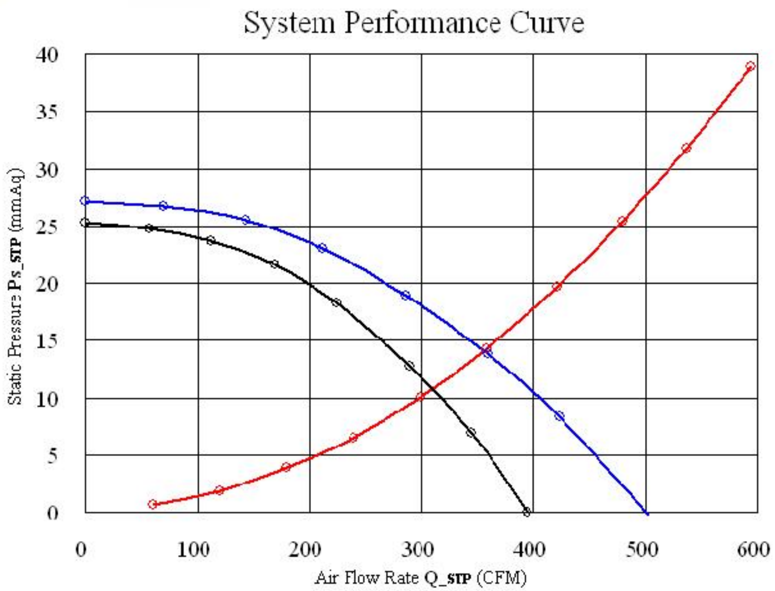


Back to Top
Back Application

☆ Range Hood Airflow Design

Fig.12 - Outlet Chamber



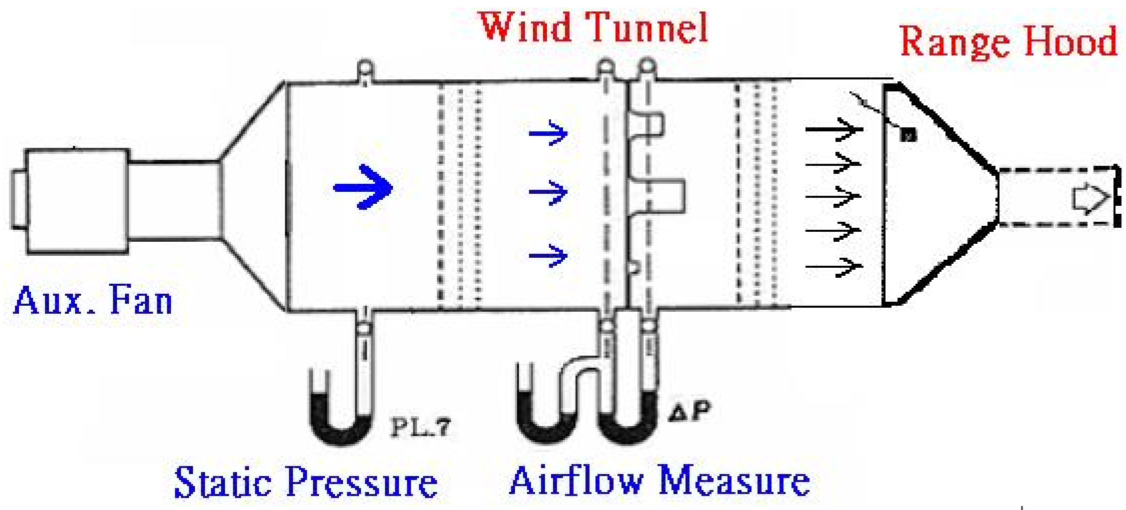


Back to Top

Back Application

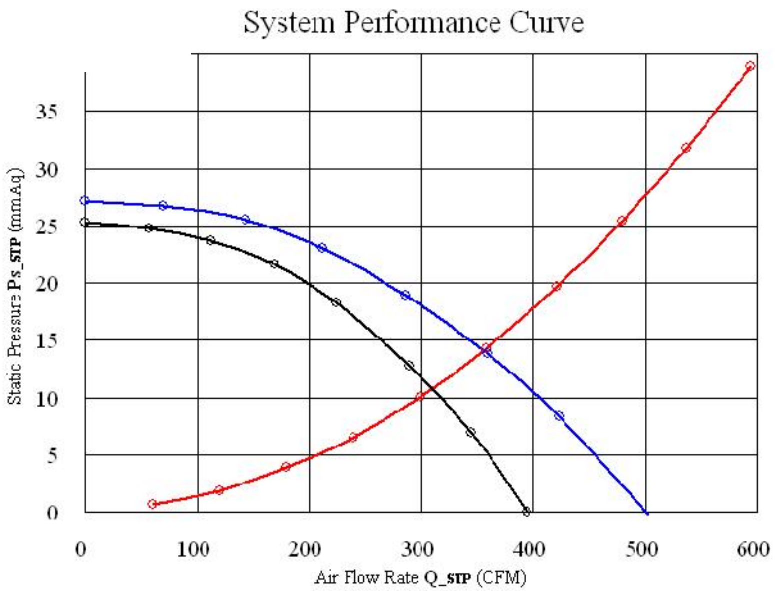
☆ Range Hood Airflow Design

Fig.15 - Inlet Chamber



O.P.

15 CMM at **250** Pa



☆ Range Hood Airflow Design

Flow Visualization

AMCA 210-07 Wind Tunnel

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Back to Top
Back Application

Application

Fan Performance Test

AMCA 210 Fig.12
Blow In Test

AMCA 210 Fig.15
Exhaust Test

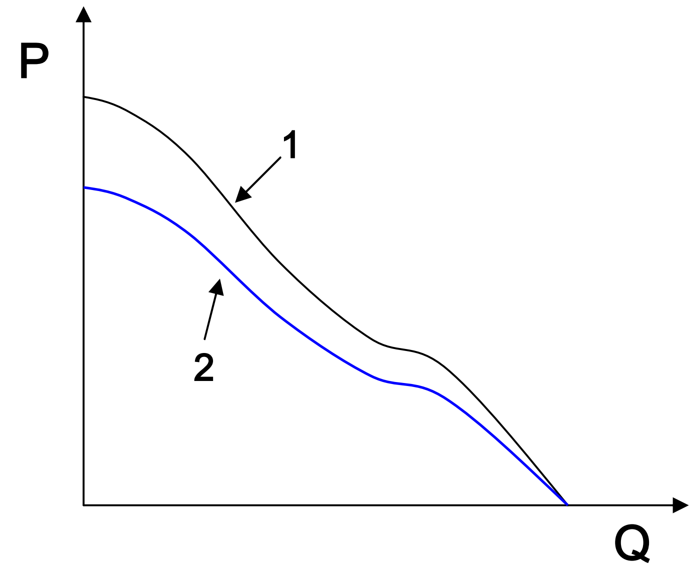
Back to Top

Back Application

☆ Fan Performance at High Land

$$Q_2 = Q_1 \times \left(\frac{RPM_1}{RPM_2}\right) \qquad P_2 = P_1 \times \left(\frac{RPM_2}{RPM_1}\right)^2 \times \left(\frac{\rho_2}{\rho_1}\right)$$

(A) Constant Fan RPM



$$P_2 = P_1 \times \left(\frac{\rho_2}{\rho_1}\right)$$

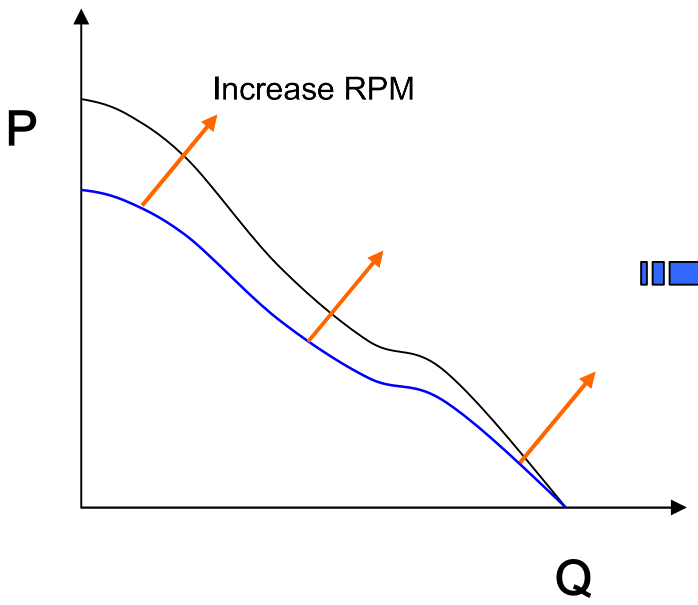
1 Sea Level, 2: High Land

Back to Top

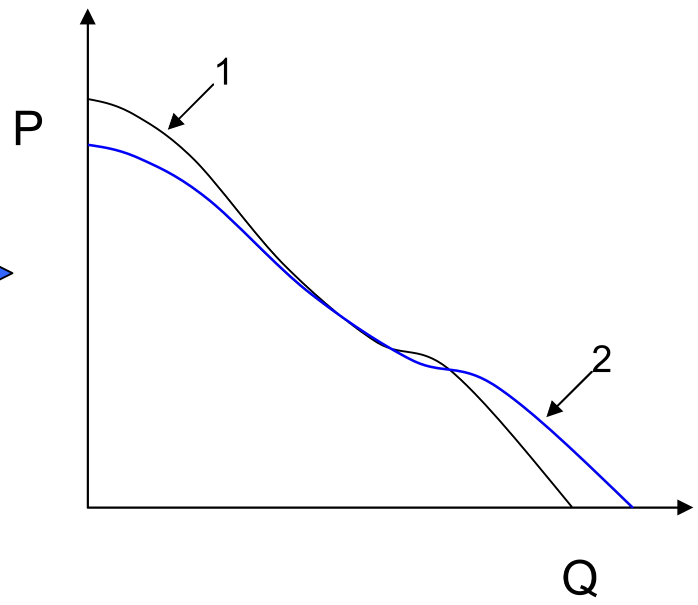
Back Application

☆ Fan Performance at High Land

(B) Constant Fan Voltage



Constant RPM

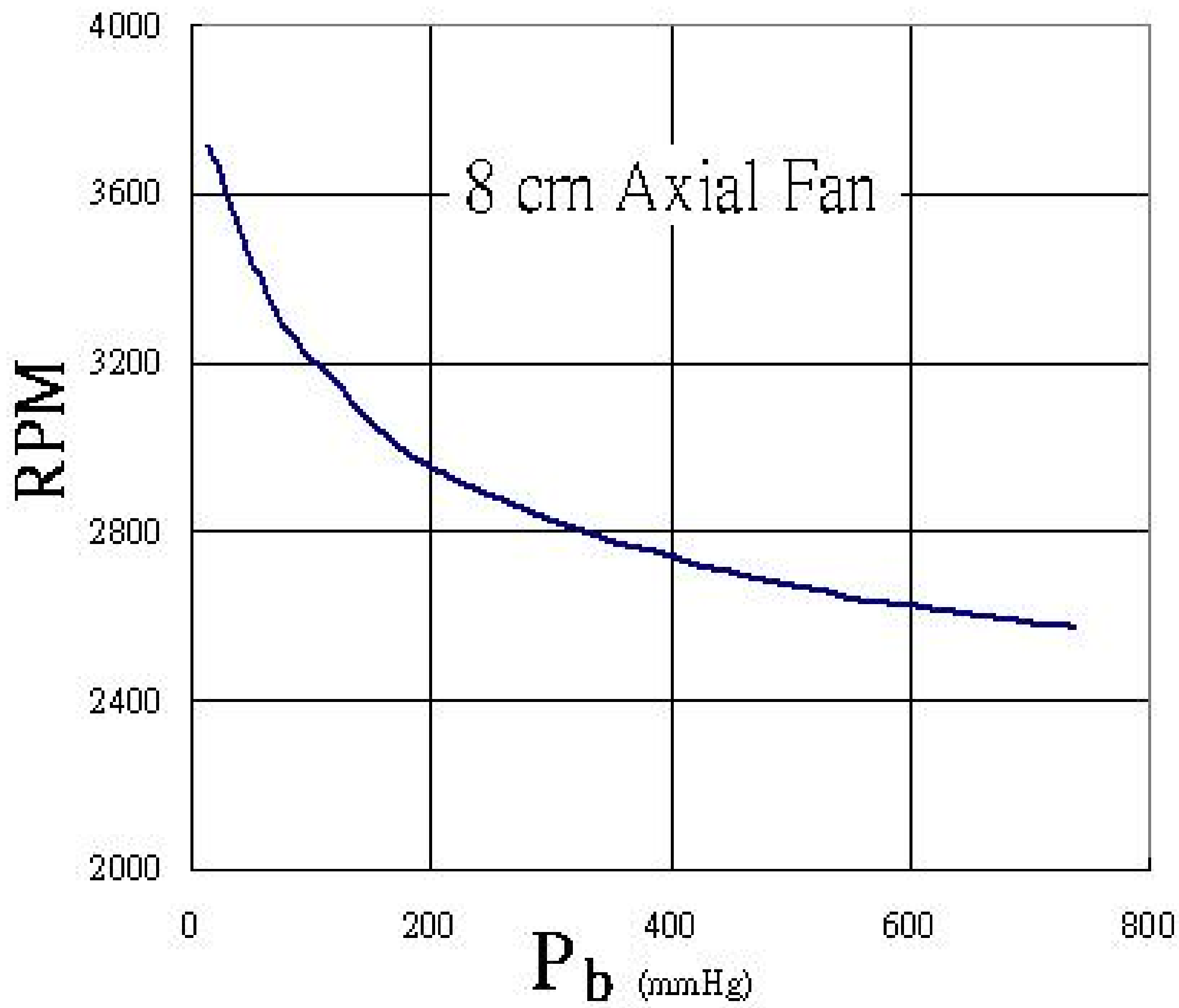


Constant Voltage

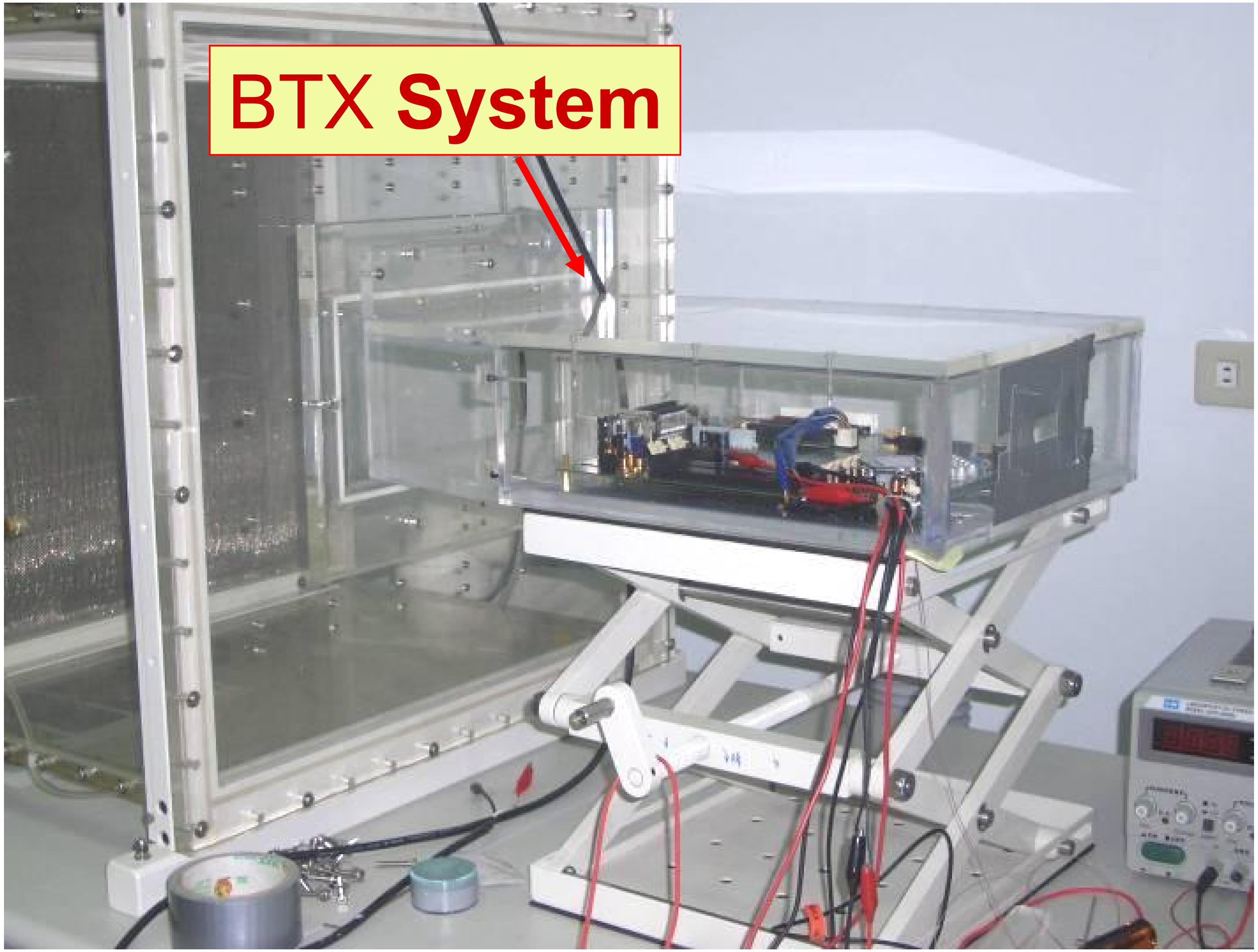
Back to Top

Back Application

☆ Fan Performance at High Land



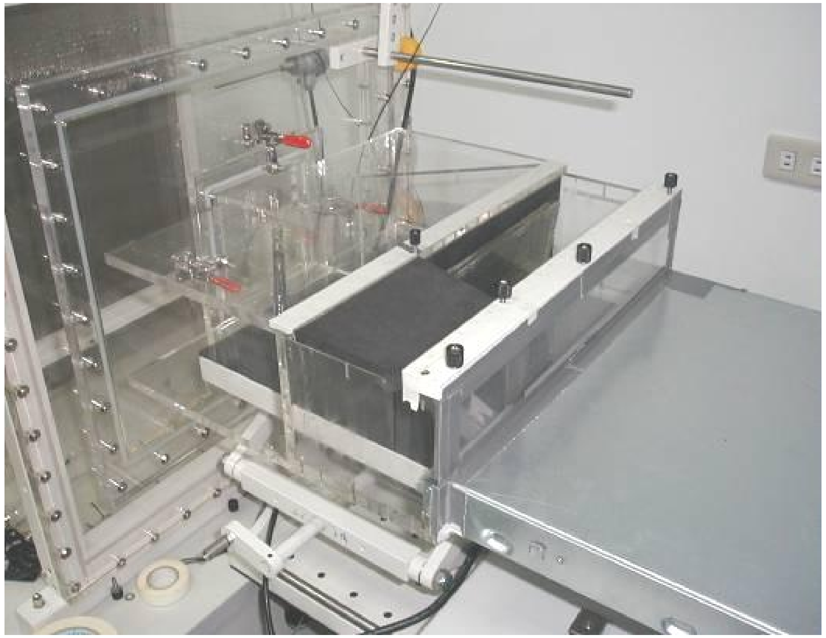
System
Resistance Test

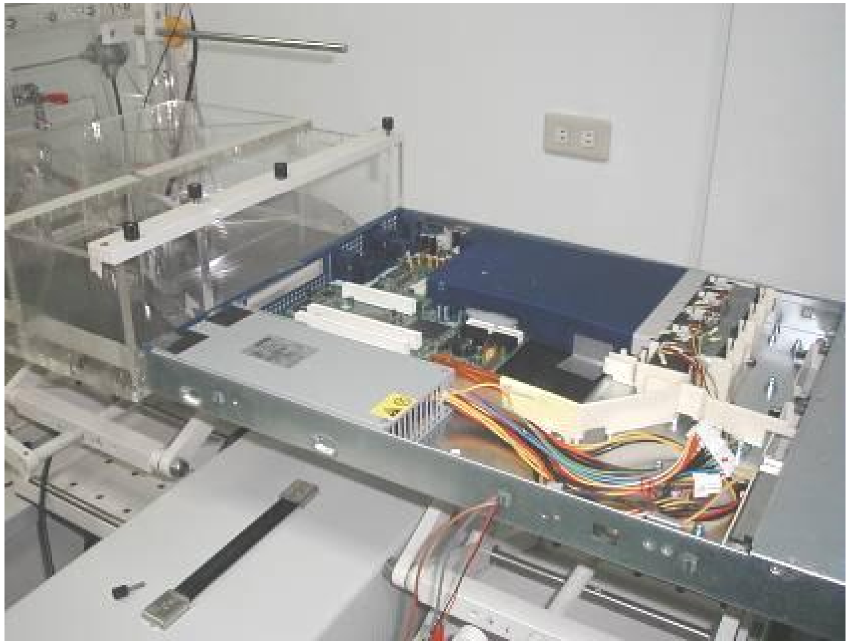


Back to Top

Back Application

Server Thermal Test
Impedance Test
Airflow Test





Back to Top
Back Application

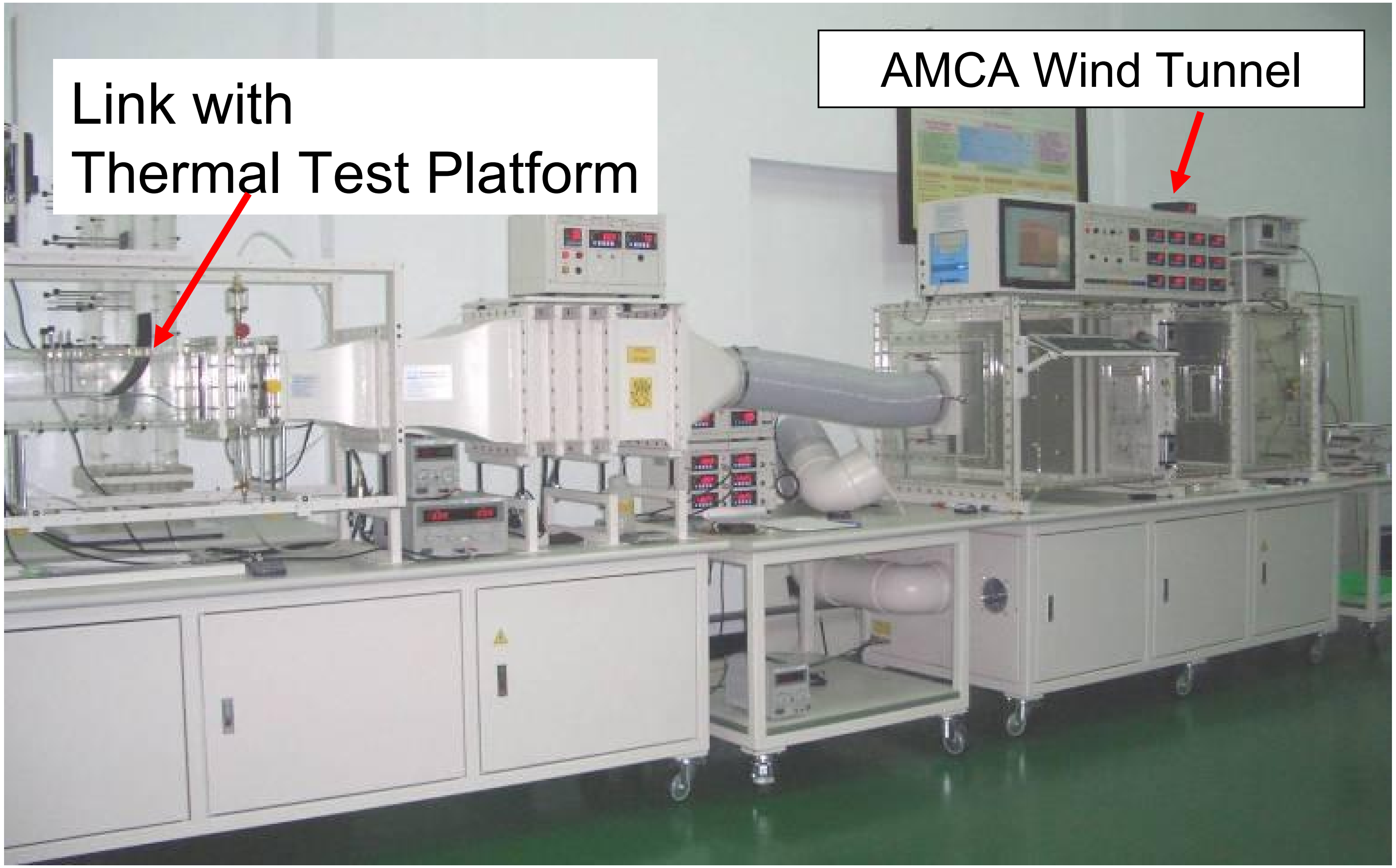
PSU
System Resistance Test

Back to Top
Back Application

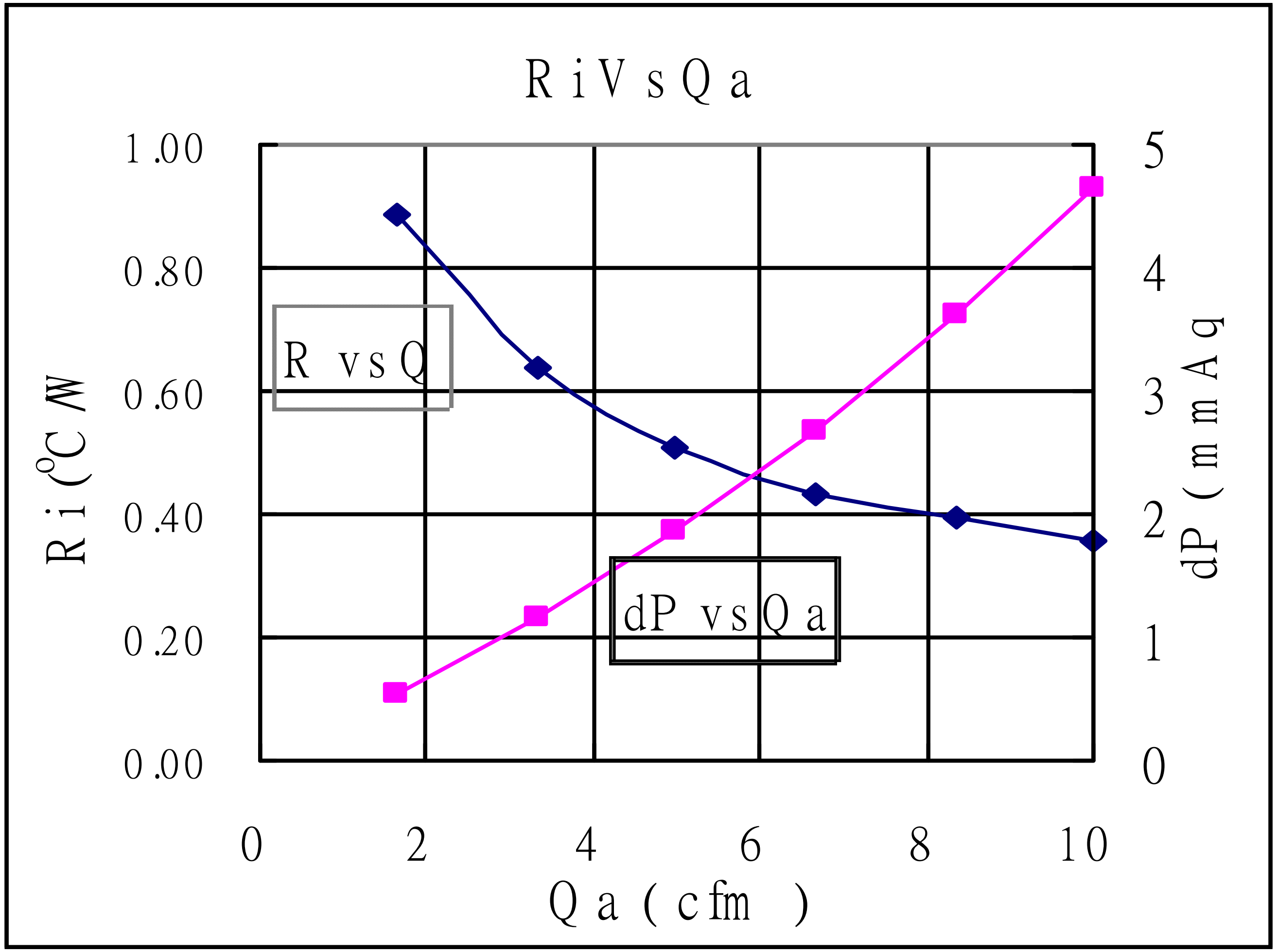
Thermal Wind Tunnel

Thermal Test Platform with
AMCA 210 Wind Tunnel

AMCA 210 Link with TTP



Thermal Module - Thermal Resistance RQ Curve Test



Heat Exchanger Performance Test

Heat Exchanger Performance Test

Chiller for Liquid Cooling

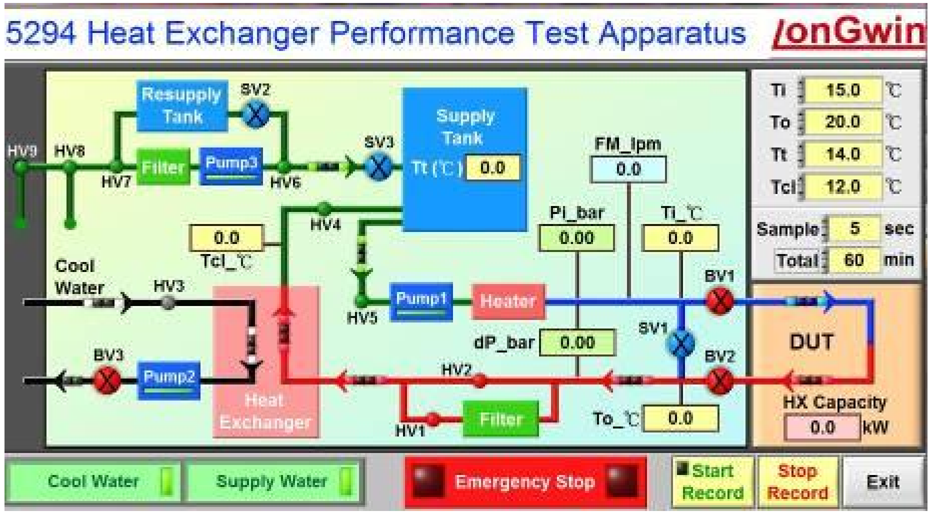
Cooling Capacity：35KW

Temperature Controlled Airflow

Heating Capacity：30kW-Hr

Heat Exchanger Performance Test

△P、 △T、Cooling Capacity



Cooling Capacity：40KW

Liquid Flow : 120 LPM

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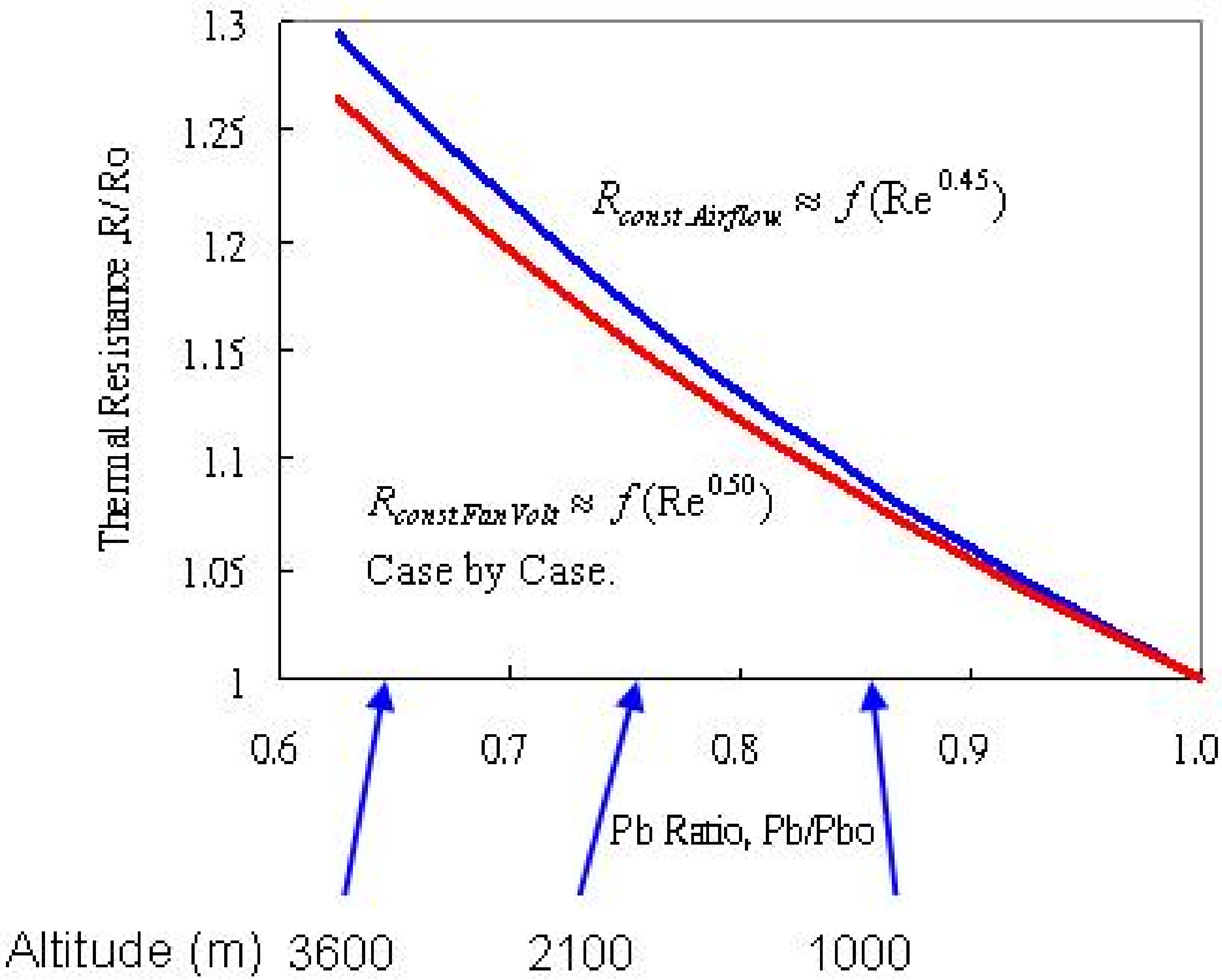
☆ Thermal Module – Performance at High Land



Thank you !

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