

AMCA 210-99 系列 風洞簡介



瑞領科技股份有限公司

Long Win Science & Technology Corp.

+886-3-464-3221

Web Site: www.longwin.com

/onGwin
Fundamental, Forward & First

瑞領科技公司 台灣楊梅幼獅廠

土地面積：4500 m²

廠房面積：6000 m²



瑞領科技公司簡介

- 瑞領公司目前廠房約6600 m²
- 研發能力：擁有2000 m²實驗室
熱傳實驗室，流力實驗室，光學實驗室，
化學實驗室，相變化實驗室。
- 生產能力：自有各種生產工場2500 m²
各種CNC加工設備-車、銑、放電、雷射，
板金工場，焊接結構工場，烤漆表面處理
工場，電氣、裝配工場。
- 相關熱傳研究設備研發100種以上

瑞領科技 – 儀器設備研發中心



瑞領科技 – 儀器設備研發中心



摘要

1. AMCA 210 標準簡介
2. 流量量測原理
3. 校正流程
4. 風洞特點
5. 風扇PQ比較
6. 應用案例

AMCA 是什麼？

Air Movement and Control Association

Lab. Methods of Testing Fans for Aerodynamic Performance Rating

Published by

ANSI/AMCA 210-99
ANSI/ASHRAE 51-1999

American National Standard Institute

American Society of Heating, Refrigerating and Air Conditioning Engineers

風扇性能測試標準

AMCA 210-99

Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

ISO 5801- 1997

Industrial fans -- Performance testing using standardized airways

BS 848

UK

DIN 24163

Germany

GB/T1236-2000.

China

JIS B 8330-1981

Japan

AMCA 210規範腔體配置 Outlet (Fig.12) & Inlet (Fig.15)

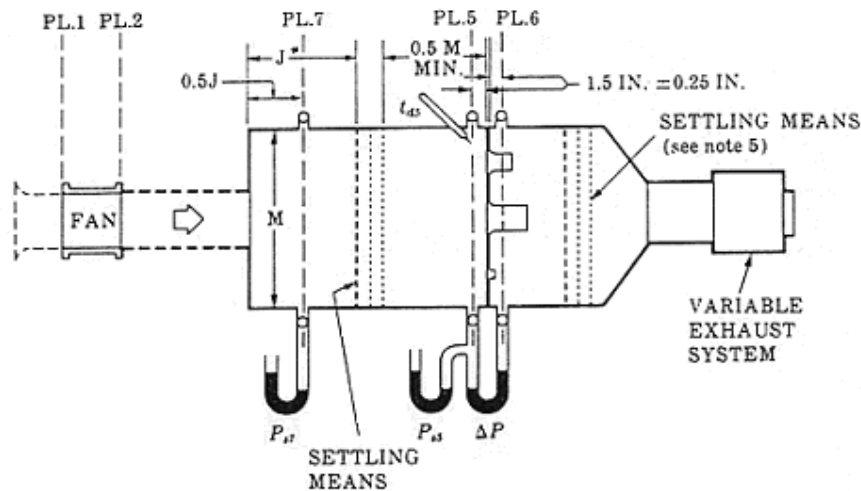


Figure 12 Outlet Chamber
ANSI/AMCA STANDARD 210-85

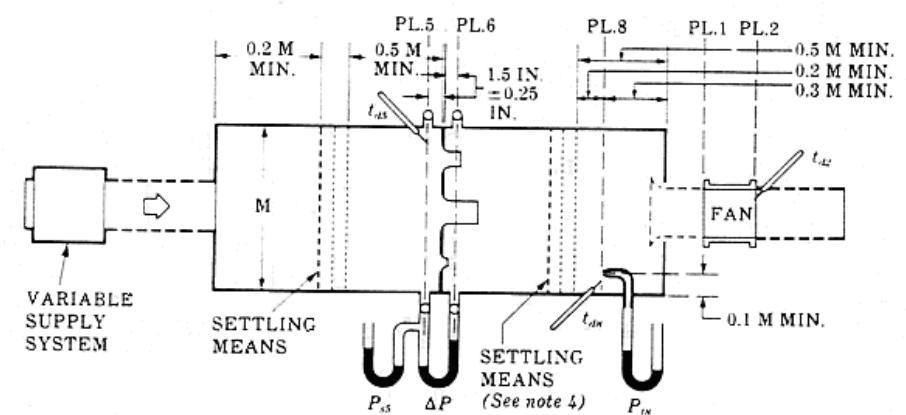
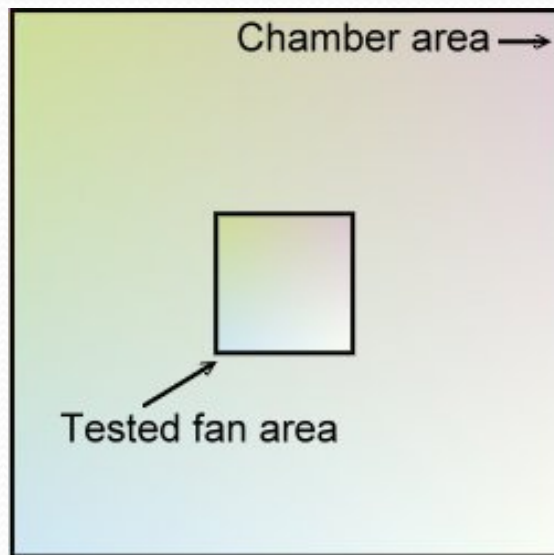


Figure 15 Inlet Chamber
ANSI/AMCA STANDARD 210

AMCA 210 風洞設計標準



Outlet Chambers

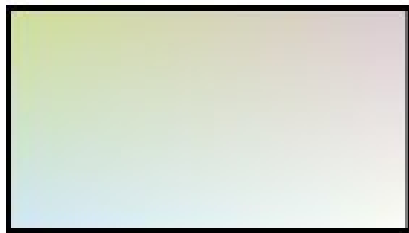
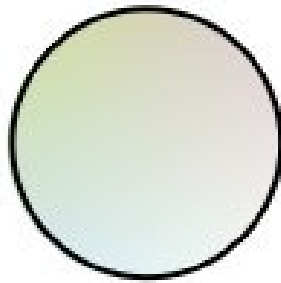
An outlet chamber (figure 12) shall have a cross-sectional area at least **nine times** the area of the fan outlet or outlet duct for fans with axis of rotation perpendicular to the discharge flow and a cross-sectional area at least **sixteen times** the area of the fan outlet or outlet duct for fans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

Inlet Chambers

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

From AMCA 210-99 page10

AMCA 210 風洞設計標準



different chamber shapes

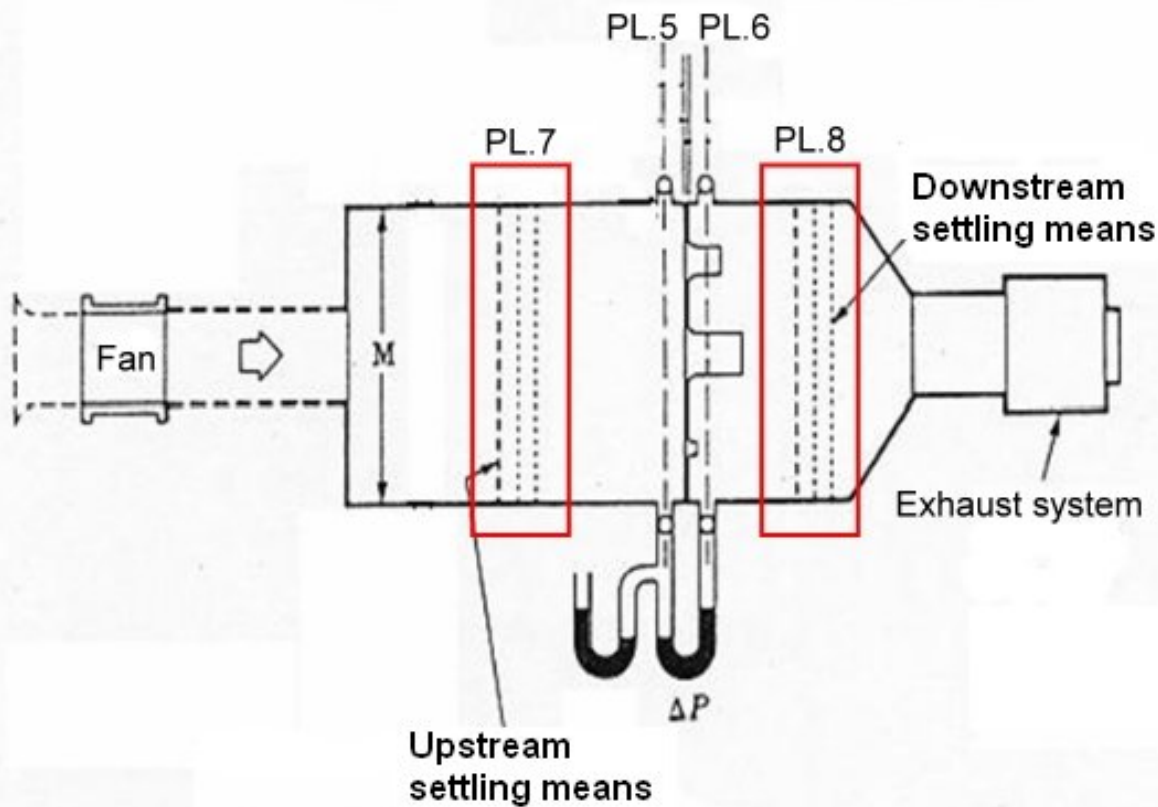
A chamber may have a **circular** or **rectangular** cross-sectional shape.

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

AMCA 210 風洞設計標準



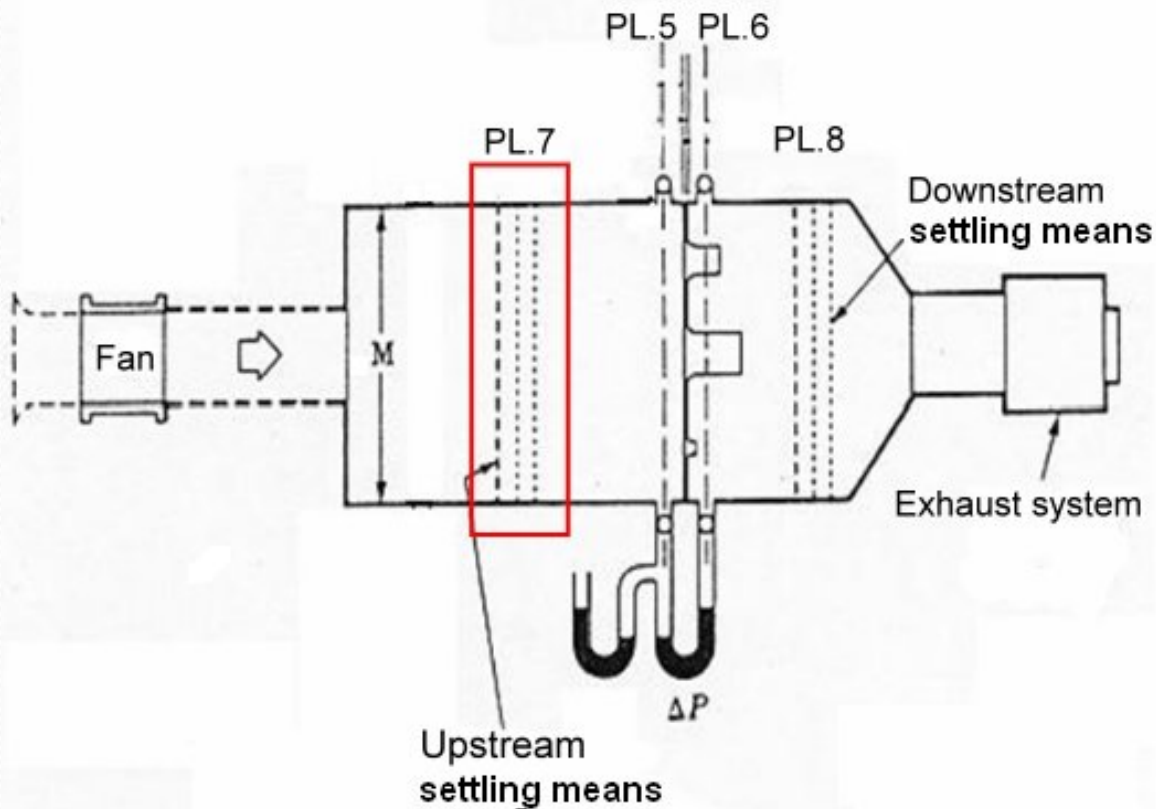
Any combinations of screens or perforated plates that will meet these requirements may be used, but in general a reasonable chamber length for the settling means is necessary to meet both requirements.

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

AMCA 210 風洞設計標準

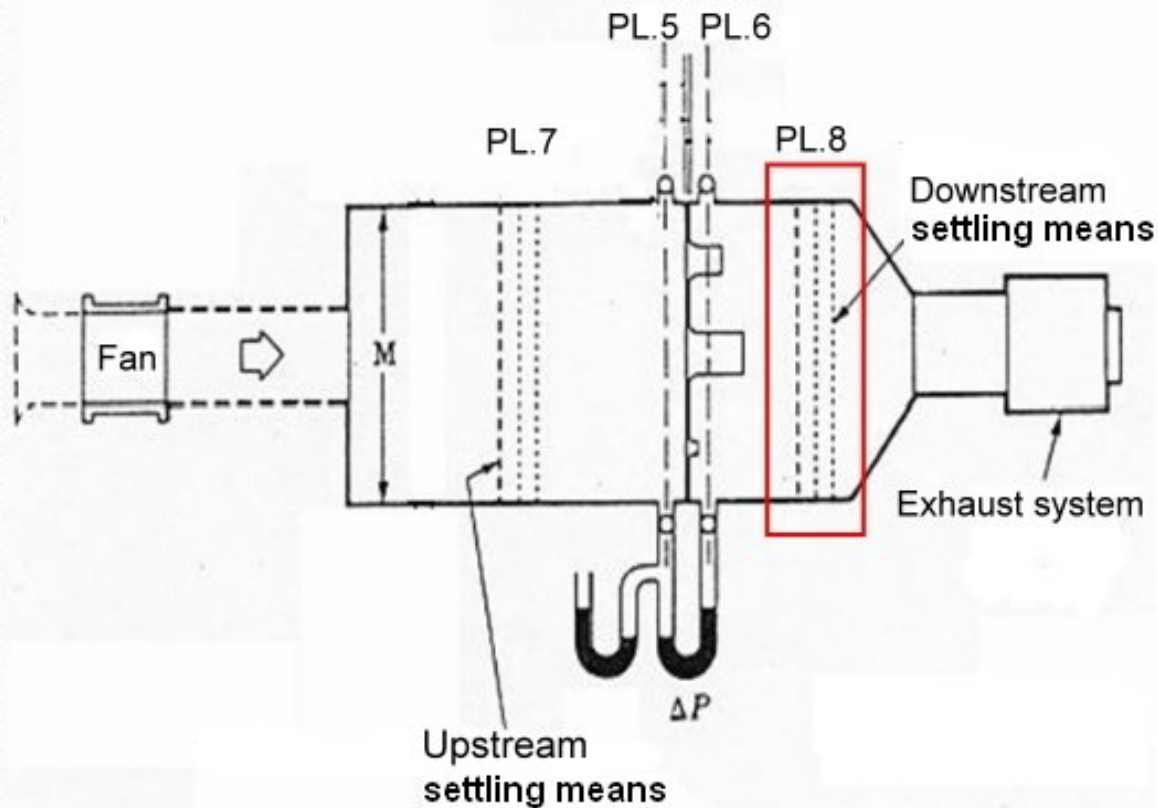


Upstream Settling Means

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.

From AMCA 210-99

AMCA 210 風洞設計標準



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.

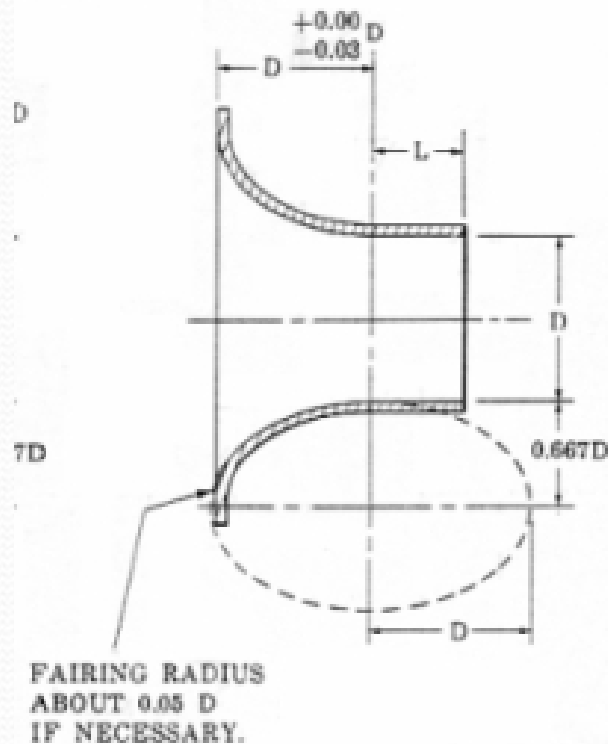
In this case, the maximum local velocity at a distance $0.1 M$ downstream of the screen shall not exceed the average velocity by more than 25% unless the maximum local velocity is less than 2 m/s (400 fpm).

From AMCA 210-99

AMCA 210 風洞設計標準

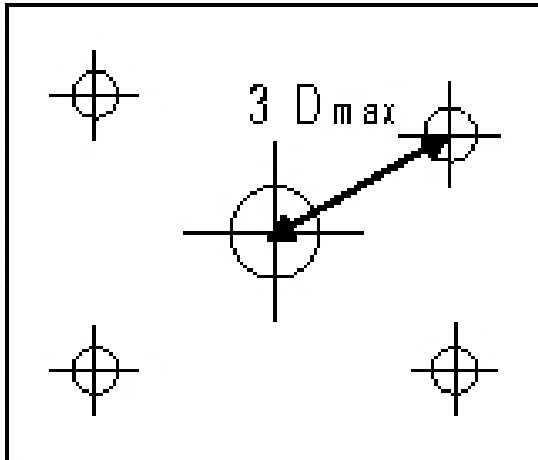
Notes

1. Nozzle throat dimension L shall be either $0.6D \pm 0.005D$ (recommended) or $0.5D \pm 0.005D$.
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 $\pm 0.002 D$ 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.



AMCA 210 風洞設計標準

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

AMCA 210 風洞設計標準

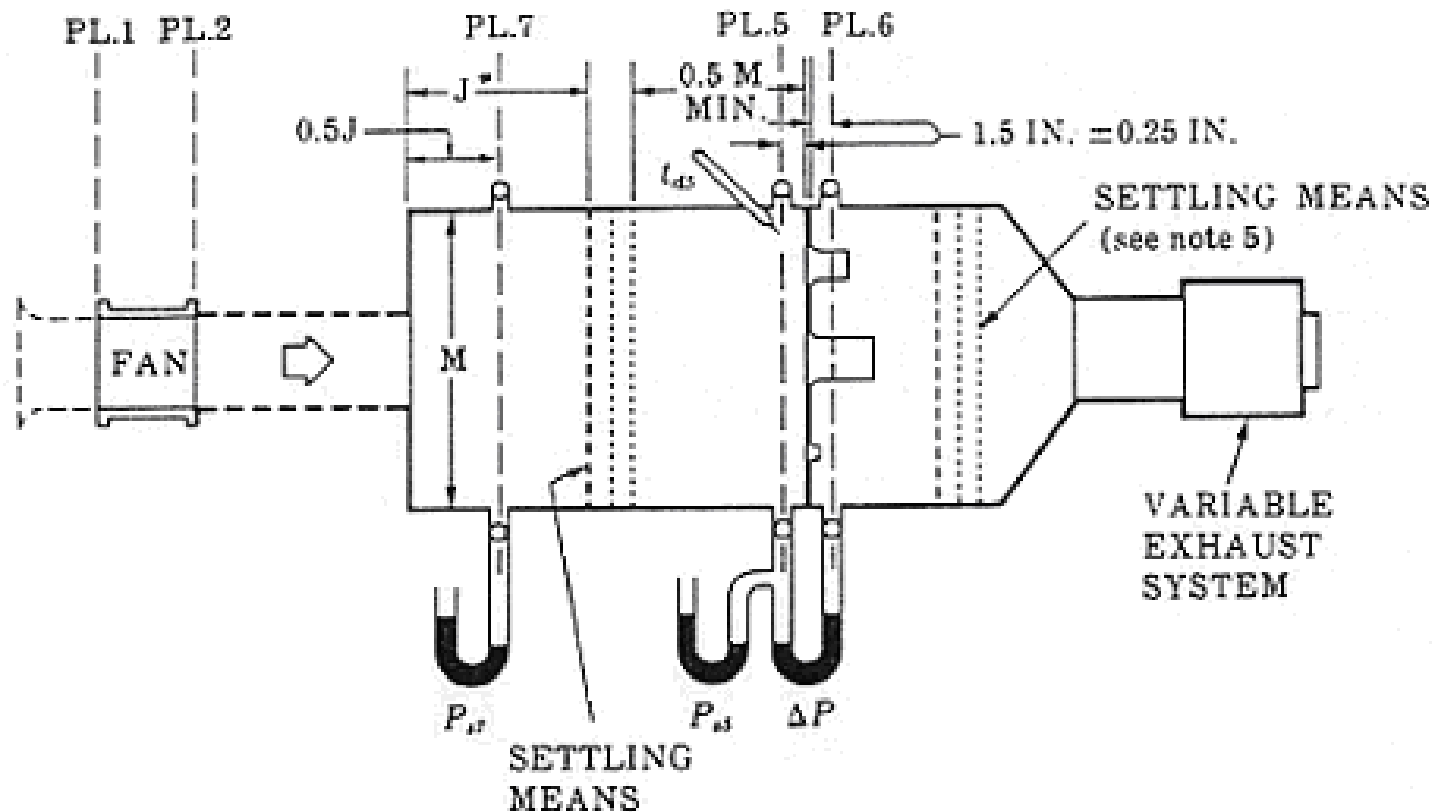


Figure 12 Outlet Chamber
ANSI/AMCA STANDARD 210-85

摘要

1. AMCA 210 標準簡介
2. 流量量測原理
3. 校正流程
4. 風洞特點
5. 風扇PQ比較
6. 應用案例

流量量測原理

Bernoulli's equation

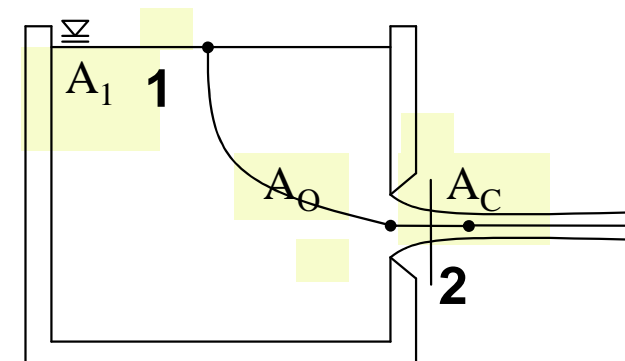
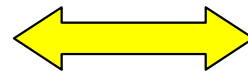
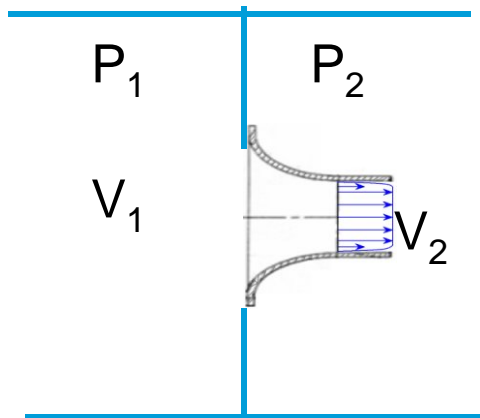
$$P_1 + \frac{1}{2} \cdot \rho \cdot V_1^2 = P_2 + \frac{1}{2} \cdot \rho \cdot V_2^2$$

$$V_2 \gg V_1 \quad V_2 = \sqrt{\frac{2 \times (P_1 - P_2)}{\rho}}$$

$$Q_{\text{real}} = C_d \times V_2 \times A$$

Cd:discharge coefficient

A: nozzle throttle area



流量量測原理

How to get the C_d ?

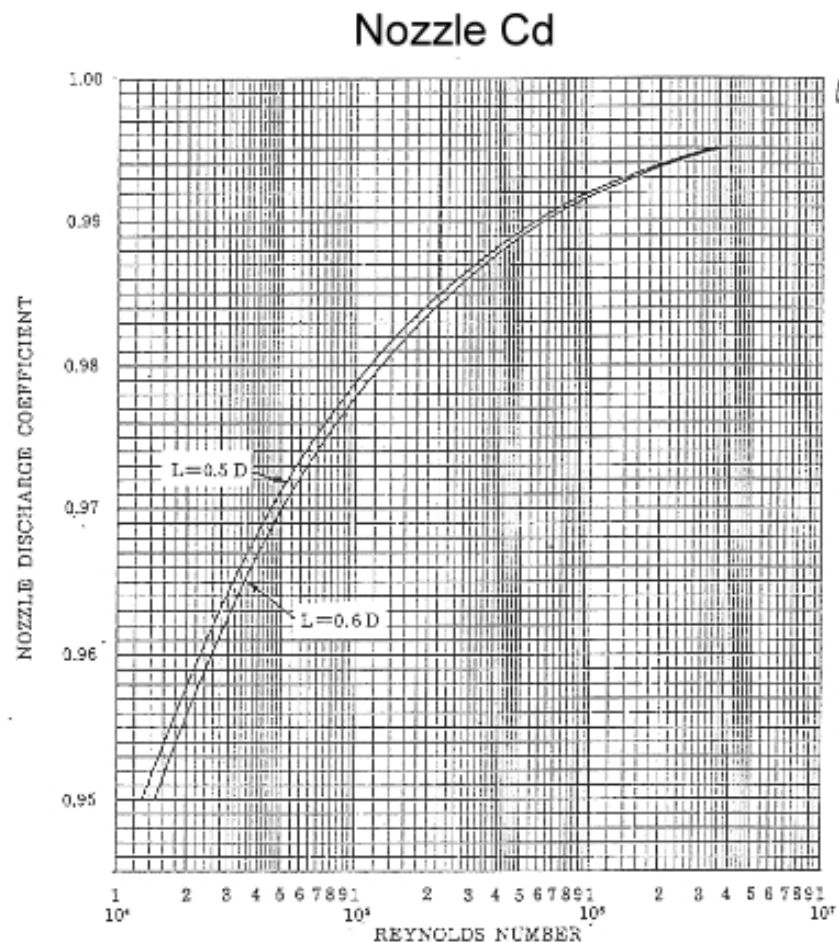


Figure 18 Coefficients of Discharge For Flow Nozzles

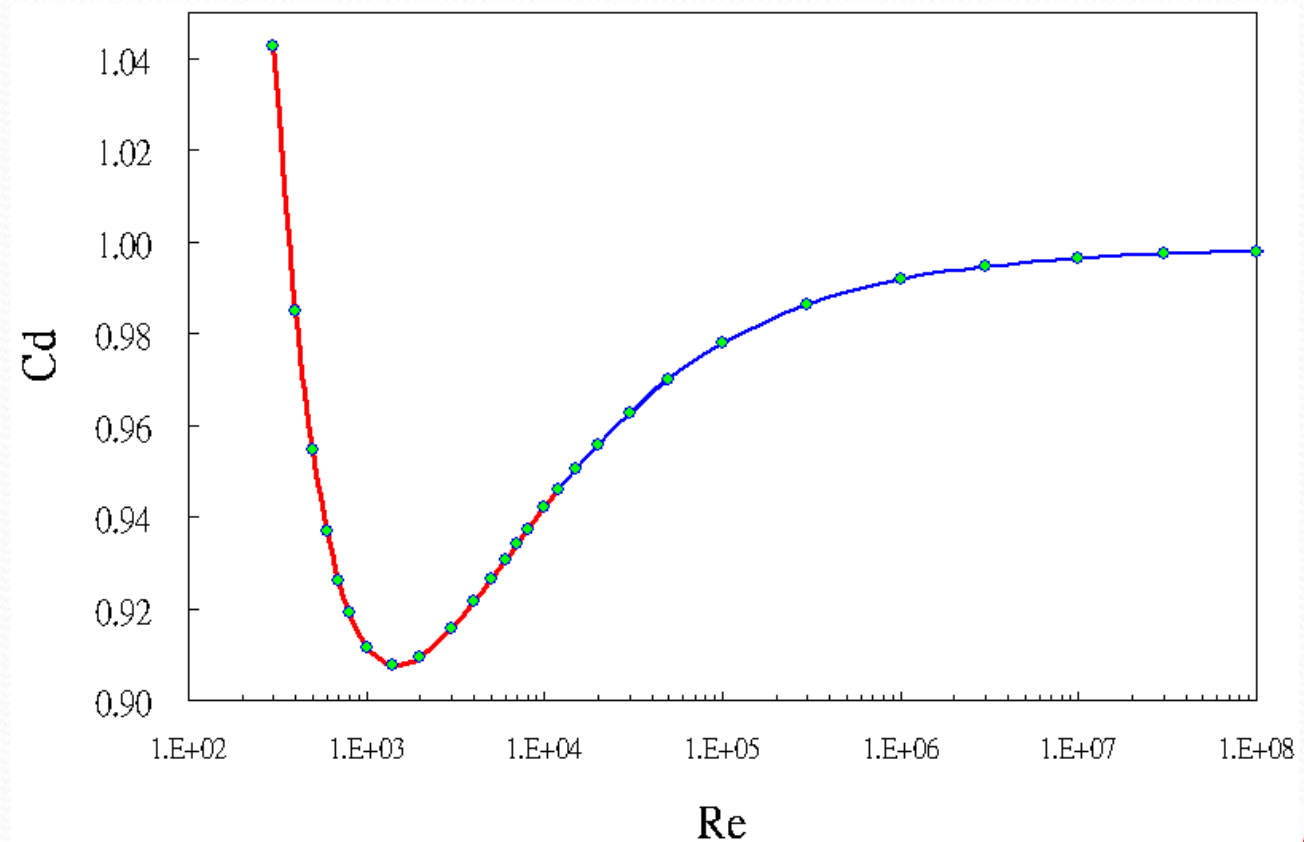
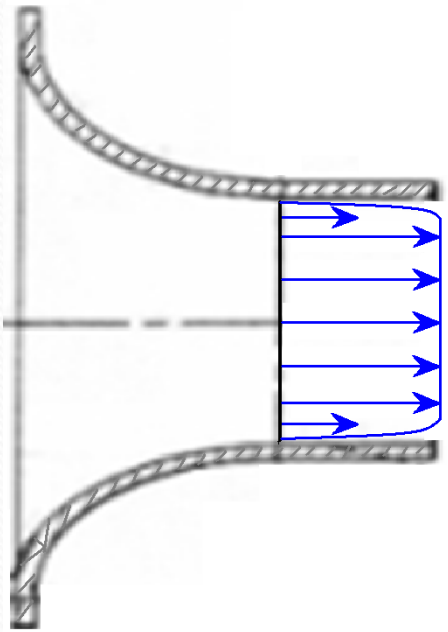
From AMCA 210-85 Page 38

$$C_d = 0.9986 - \frac{7.006}{\sqrt{Re}} + \frac{134.6}{Re}$$
$$Re = \frac{D_n \cdot U_n}{\nu}$$

流量量測原理

From AMCA 210 Standard

$$C_d \text{ for } Re > 12000 = 0.9986 - \frac{7.006}{\sqrt{Re}} + \frac{134.6}{Re} \quad \text{for } \frac{L}{D} = 0.6$$



流量量測原理

Cd calculation formula

$$\mathbf{Cd}_{\text{Re}>12000} = 0.9986 - \frac{7.006}{\sqrt{\text{Re}}} + \frac{134.6}{\text{Re}} \quad \text{for } \frac{L}{D} = 0.6$$

Cd modify equation :

$$\mathbf{Cd}_{\text{Re}<12000} = 0.999976 - \frac{5.922888}{\sqrt{\text{Re}}} \quad \text{for } \frac{L}{D} = 0.6$$

Ref.

Journal: Flow Measurement and Instrument

多噴嘴 流量量測

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

$Q_T = Q_N$ multi-nozzle

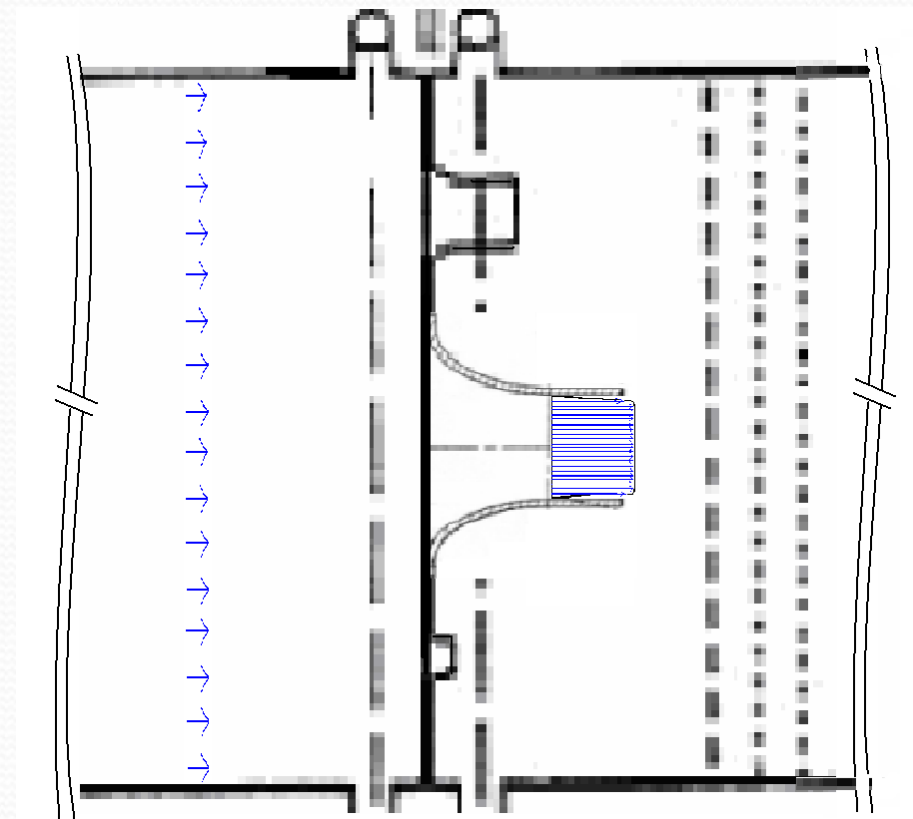
C_d : Discharge Coefficient.

U_n : Velocity at Nozzle Throttle.

A_n : Nozzle Throttle Cross-section.

Q_N : Single Nozzle Air Flow Rate

Q_T : Multi Nozzle Air Flow Rate.



P Across the Nozzle

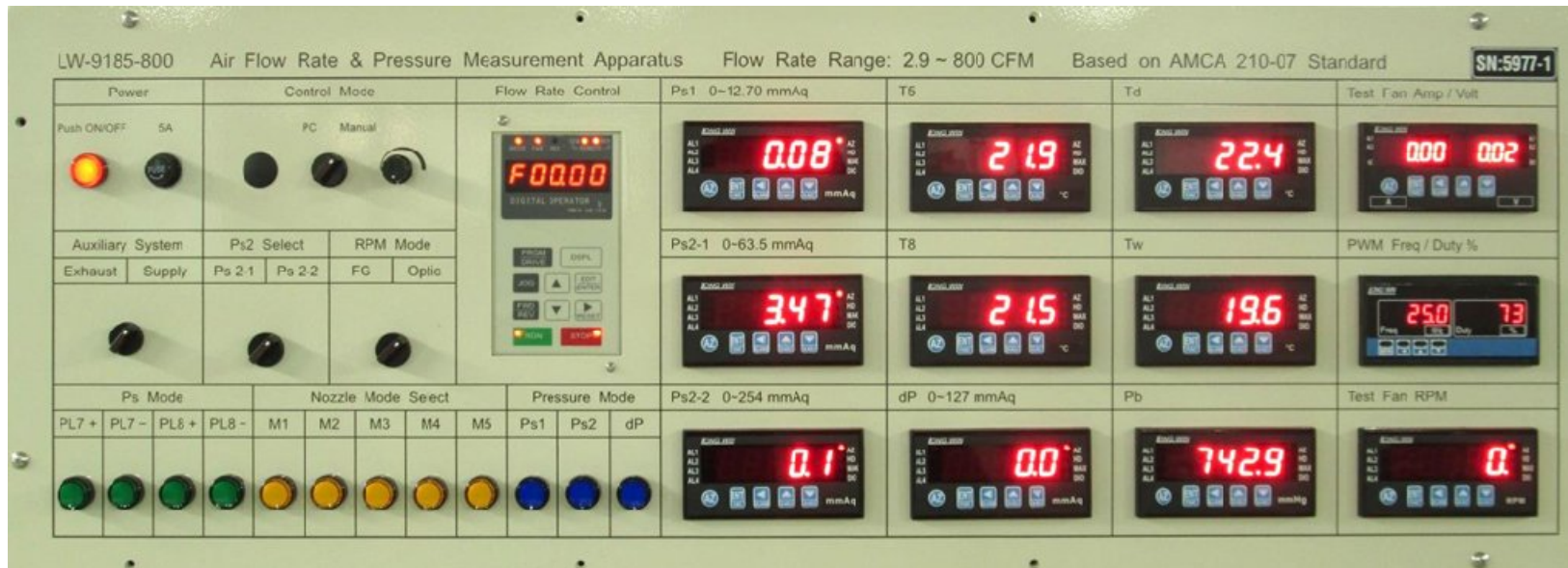
AMCA 標準噴嘴



摘要

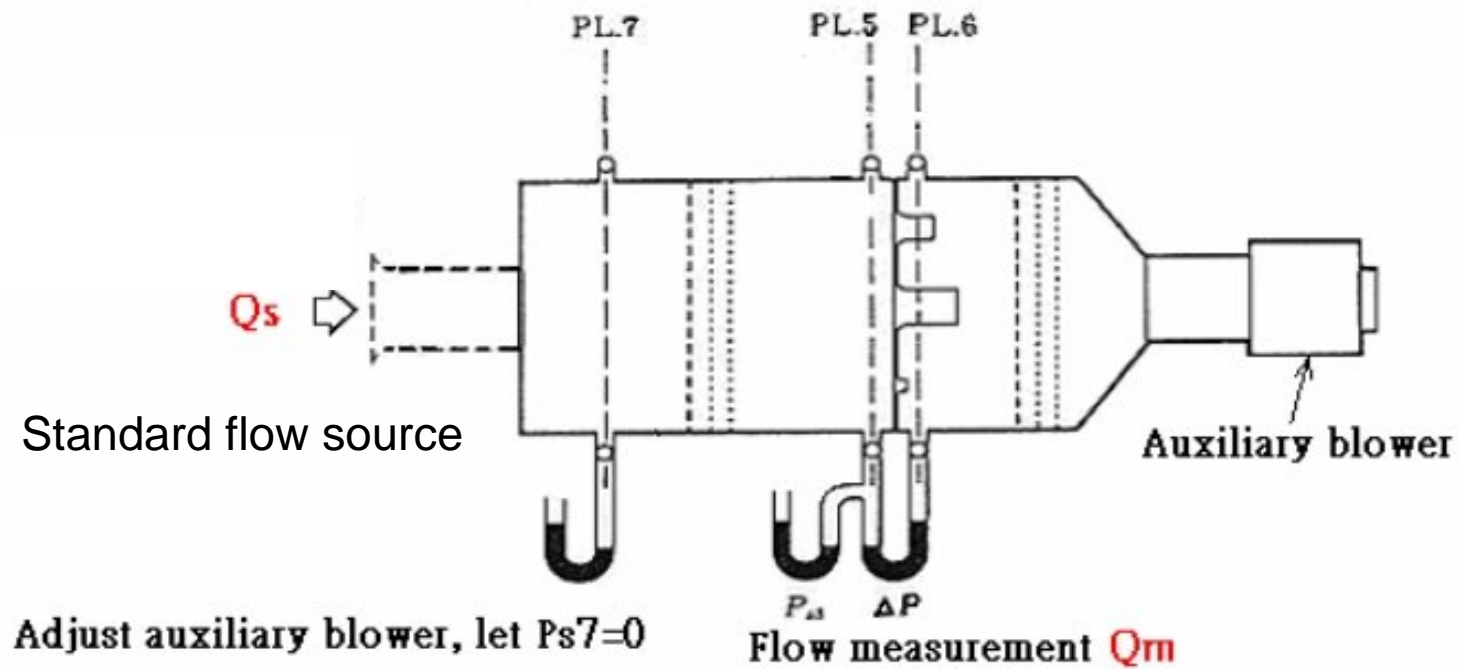
1. AMCA 210 標準簡介
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儀表校正



The quality of our thermometer, pressure, electrical meter (voltage, current, fan speed) will be approved by a third party (SGS).

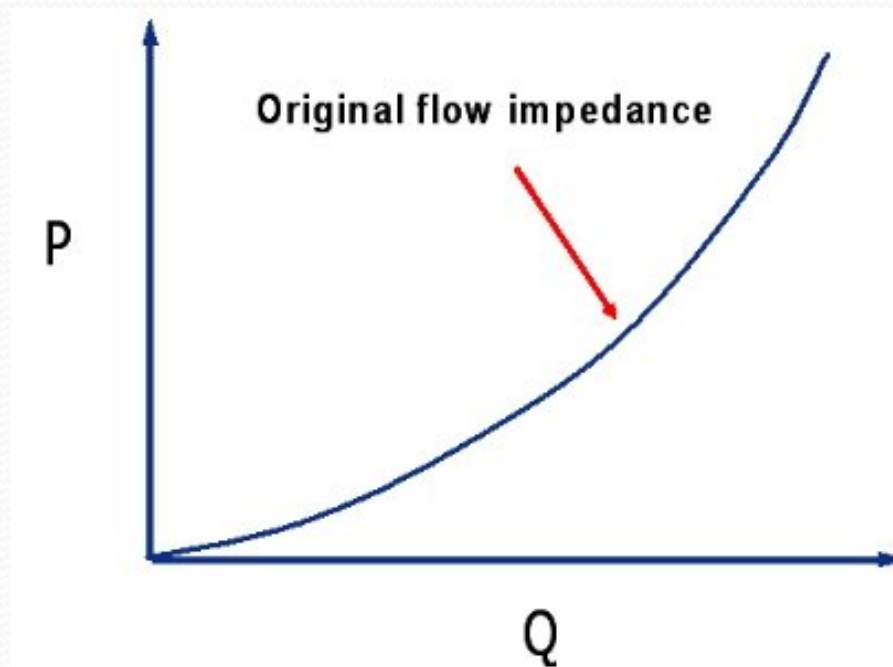
風洞校正流程



$$\text{Relative error} = \frac{Q_s - Q_m}{Q_m}$$

Wind tunnel calibration Scheme

風洞校正流程

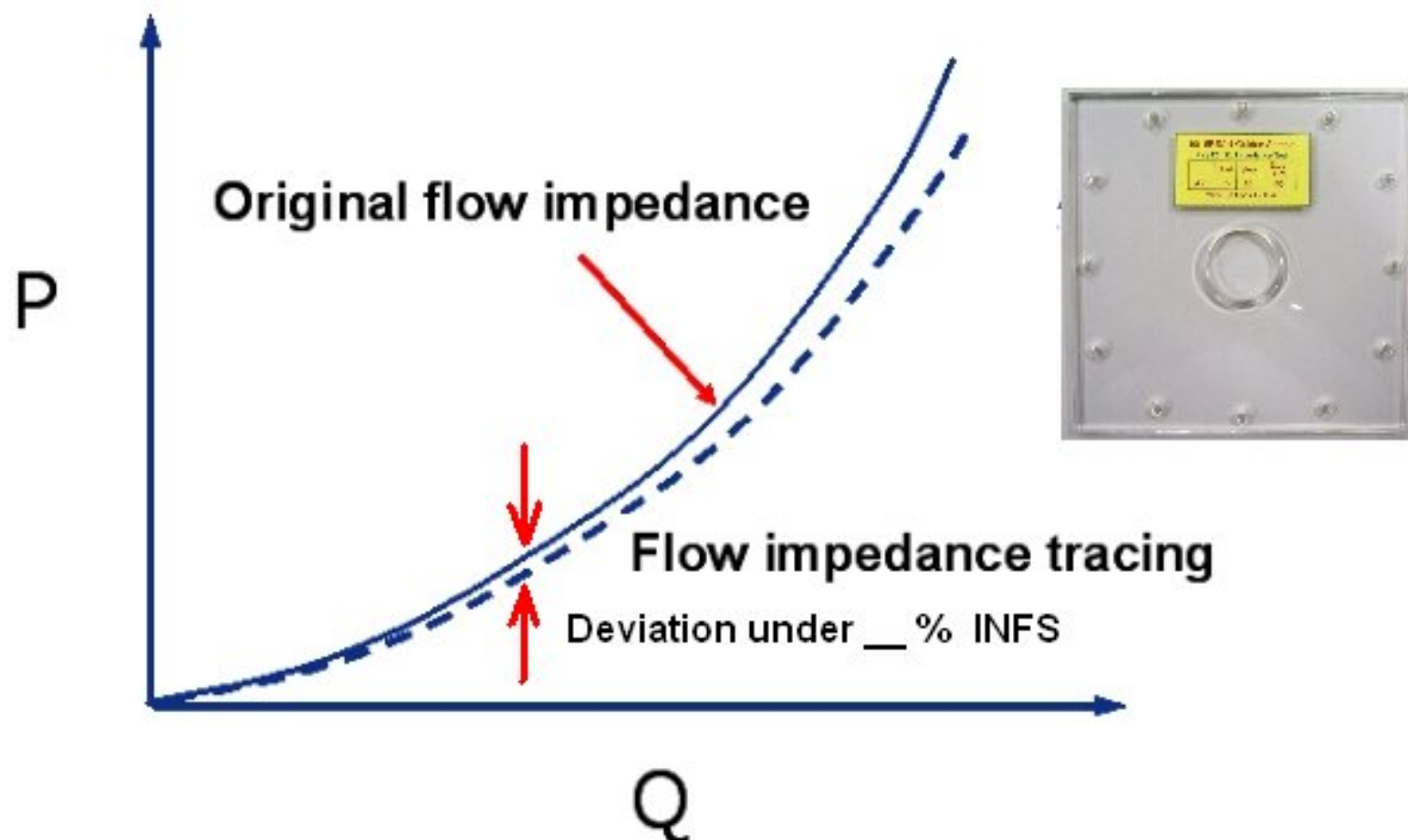


Long Win provides the orifice plate to create original flow impedance curve.

風洞校正流程

Traceability

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



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風洞特點

AMCA 210規範 Fig.12 & Fig.15二合一結構

全系統自動化控制

設備流量精度

風扇PQ五種測試模式

標準狀態STP轉換

高靜壓風扇測試

系統流阻曲線(SRC)測試

散熱模組自動熱阻-流量(R-Q)測試

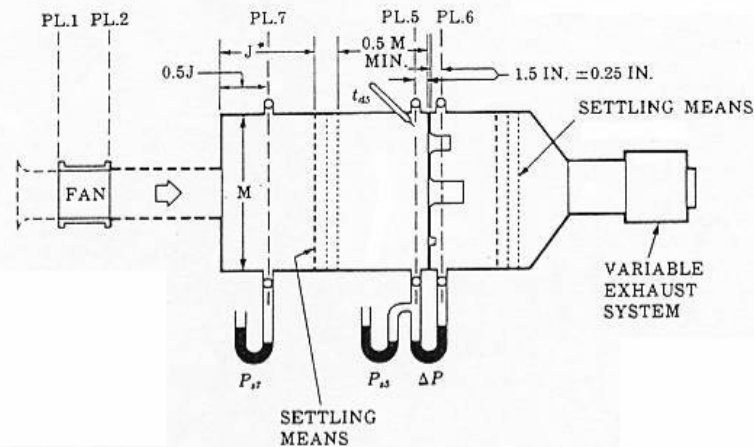
品管 - Cpk測試

品管 - 控制點(Operation Point)檢查

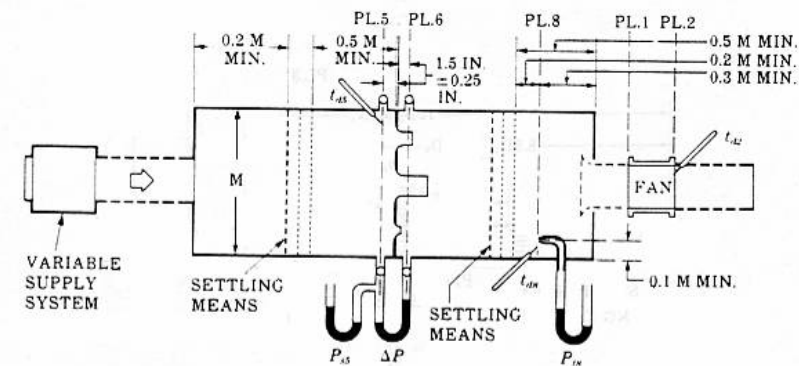
AMCA 210規範 Fig.12 & Fig.15二合一結構

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

全系統自動化控制

- * Auto Change Nozzles
- * Auto Switching Ps
(Ps1,Ps2,Ps3 auto switching)
- * Smart fan PQ measurment

LW-Series Air Flow Rate & Pressure Measurement Apparatus

Meeting AMCA 210-99 Standard

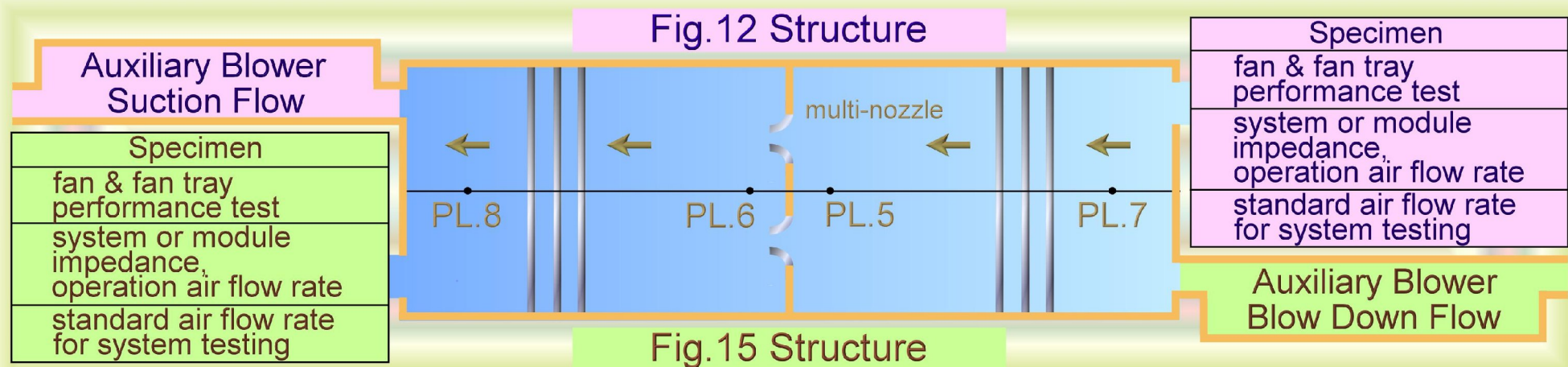
Including Fig.12 & Fig.15 Structure

design & manufacturer : Long Win Science & Technology Corporation

Web site : <http://www.longwin.com>

Tel : 886-3-464-3221

Fax : 886-3-496-1307



Features

- fan performance, PQ curve, blade design, electric function
- system & module impedance
- offer operation air flow rate set up T-Q / R-Q chart

Measurement Item

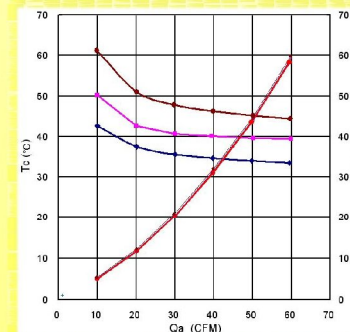
- air flow rate : series 2.4 ~ 3000 CFM
- accuracy : 1 ~ 3.5% INFS full scale of indicated nozzle
- I , V , rpm of Fan

Air Flow Rate Calculation

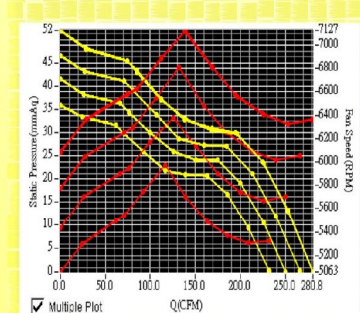
$$Q = C_d \cdot \Sigma A \cdot U$$

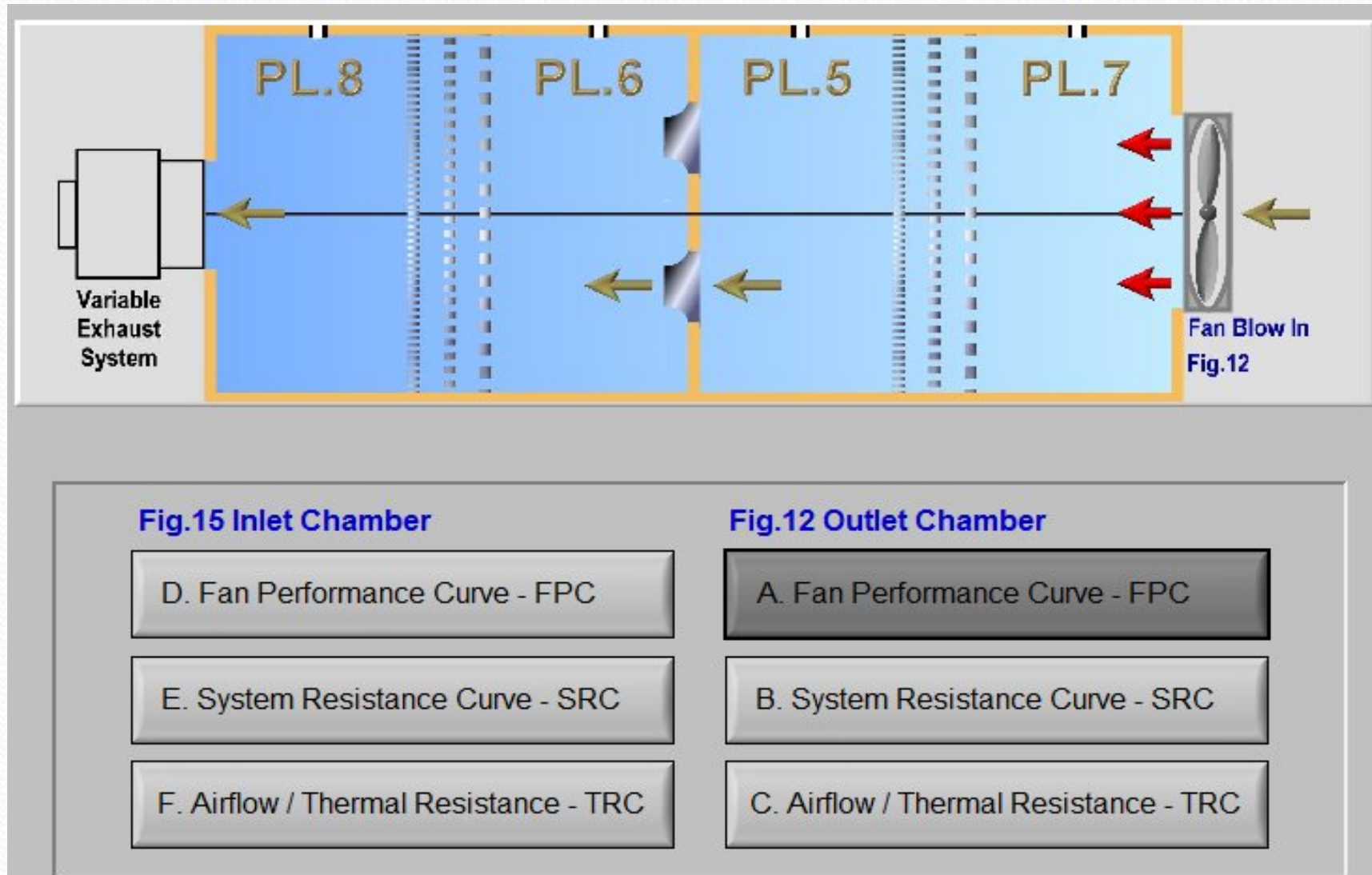
Q : air flow rate
 ΣA : nozzle area
 C_d : discharge coefficient
 $1/2 \rho U^2 = \Delta P = P_{56}$
 $\rho_{air} = f(T_d, T_w, T_c, P_{PL.5})$
 $C_d = f(Re)$
 $Re = f(D, U, \mu, \rho)$

RQ Chart



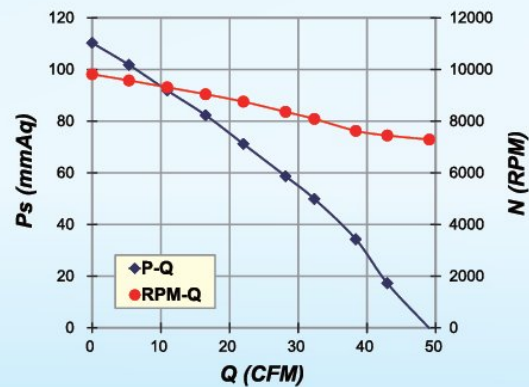
PQ Chart





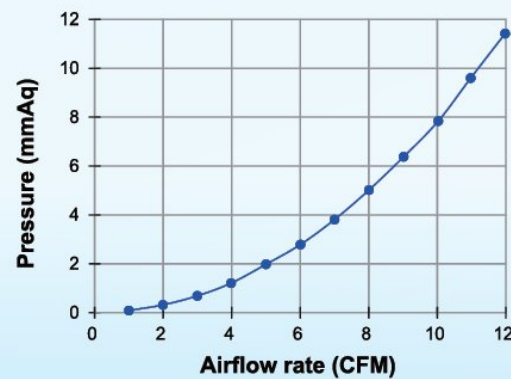
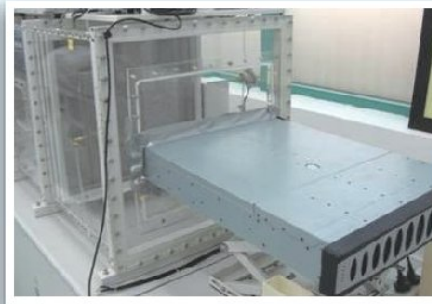
PQ curve

- The fan performance curve with pressure (P) and airflow rate (Q).



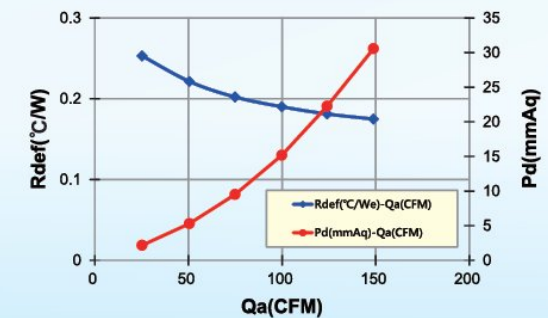
SRC curve

- Applicable to system resistance measurement for PC, Notebook, and server.



RQ curve

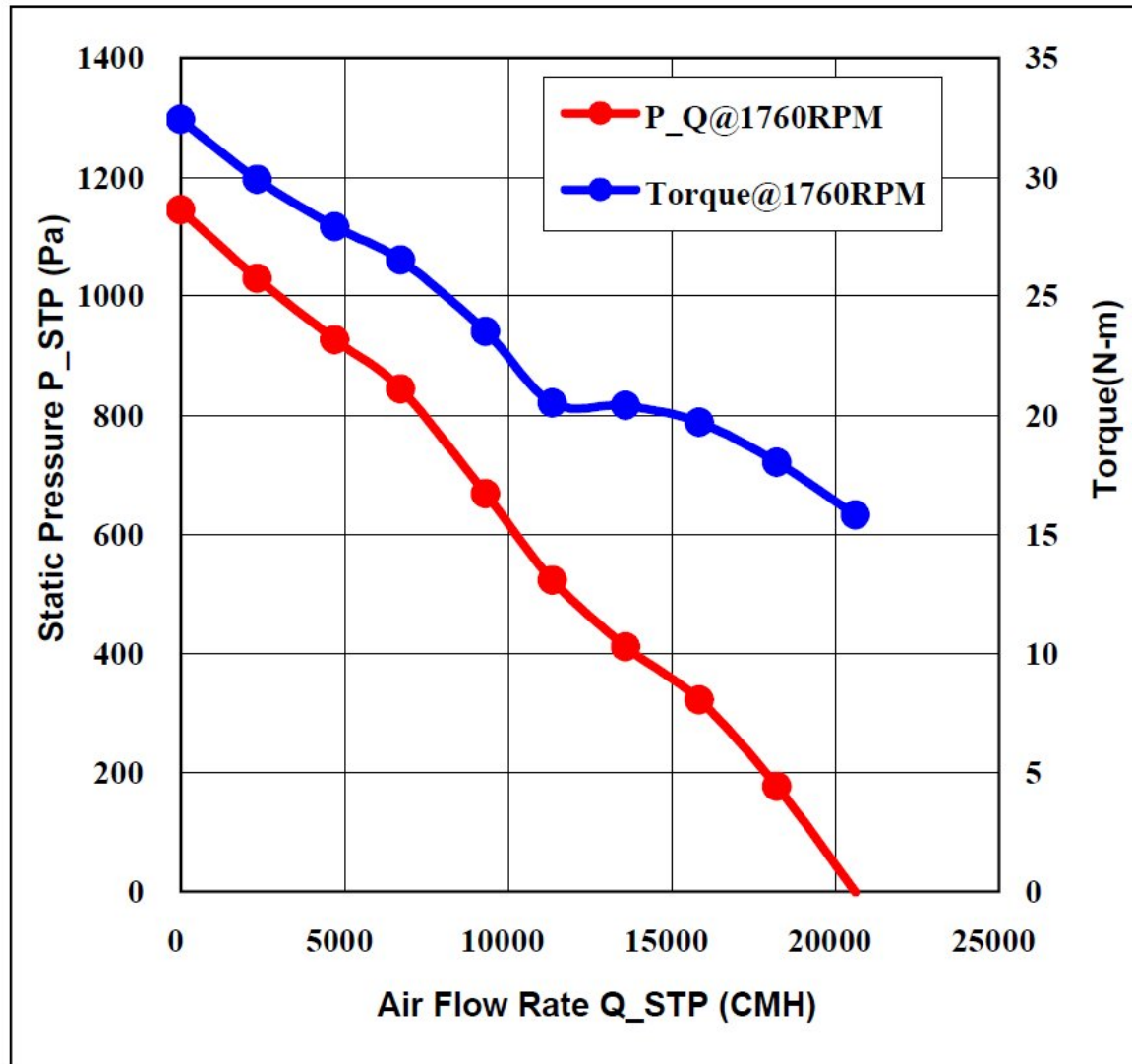
- To analyze thermal resistance (R) and the correlation of P and Q. A thermal wind tunnel or standard TTP can be cooperated.



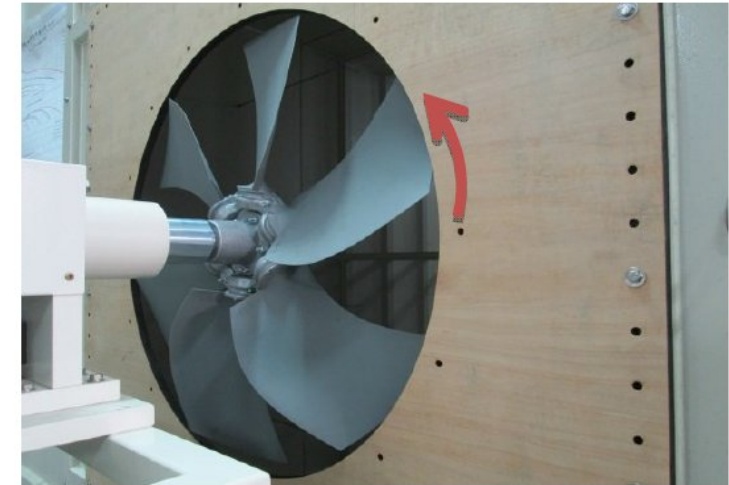
測試數據範例

| 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 | % | % |
| 1144.3 | 0 | 1238.8 | 0 | 1762 | 32.4 | 5978.3 | 0.0 | 0.0 |
| 1029.4 | 2344 | 1112.5 | 2344 | 1763 | 29.9 | 5520.2 | 12.1 | 12.2 |
| 926.4 | 4715 | 995.5 | 4715 | 1760 | 27.9 | 5142.2 | 23.6 | 23.7 |
| 844.0 | 6718 | 904.8 | 6718 | 1760 | 26.5 | 4884.1 | 32.2 | 32.6 |
| 667.3 | 9322 | 713.1 | 9322 | 1762 | 23.5 | 4336.1 | 39.9 | 41.1 |
| 522.1 | 11357 | 556.8 | 11357 | 1761 | 20.5 | 3780.4 | 43.6 | 46.1 |
| 410.2 | 13591 | 437.0 | 13591 | 1760 | 20.4 | 3759.9 | 41.2 | 45.6 |
| 320.9 | 15847 | 341.8 | 15847 | 1761 | 19.7 | 3632.9 | 38.9 | 46.1 |
| 175.7 | 18215 | 186.8 | 18215 | 1762 | 18.0 | 3321.3 | 26.8 | 38.9 |
| -2.0 | 20609 | -2.1 | 20609 | 1760 | 15.8 | 2912.0 | -0.4 | 19.5 |

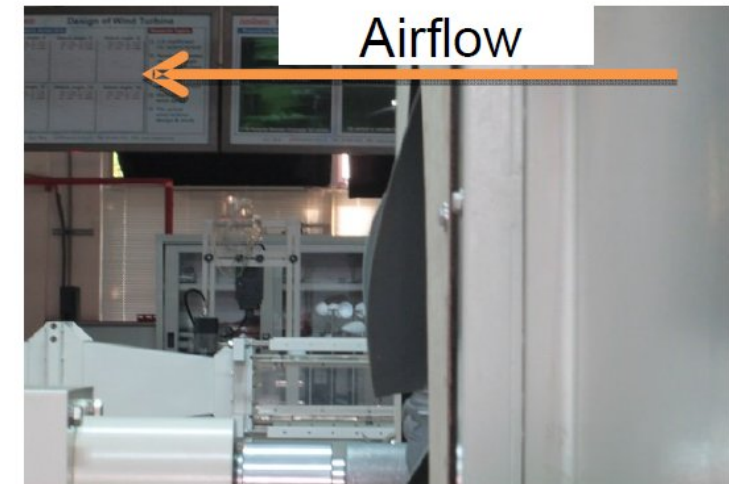
測試數據範例 – PQ & TQ



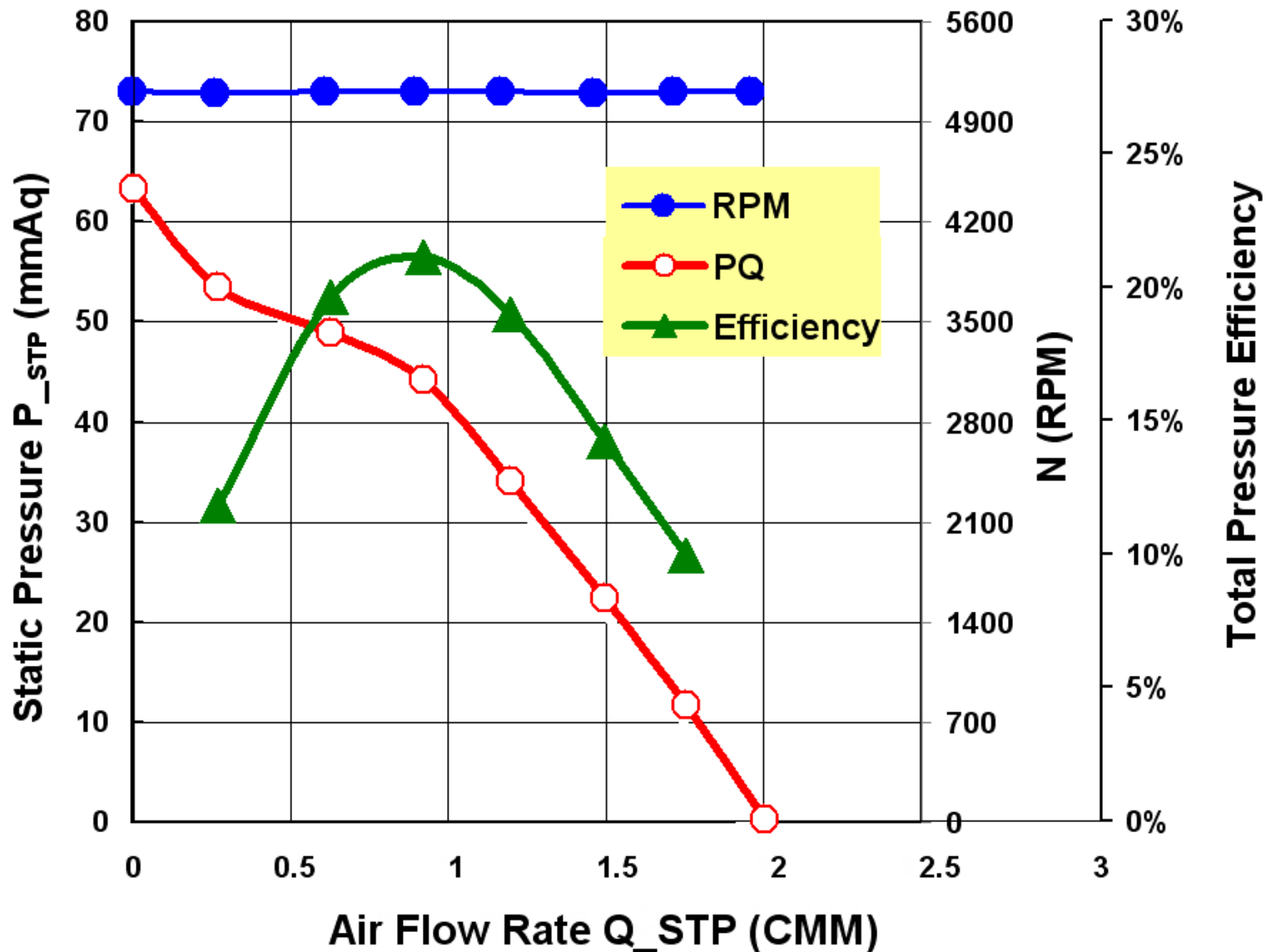
Installation



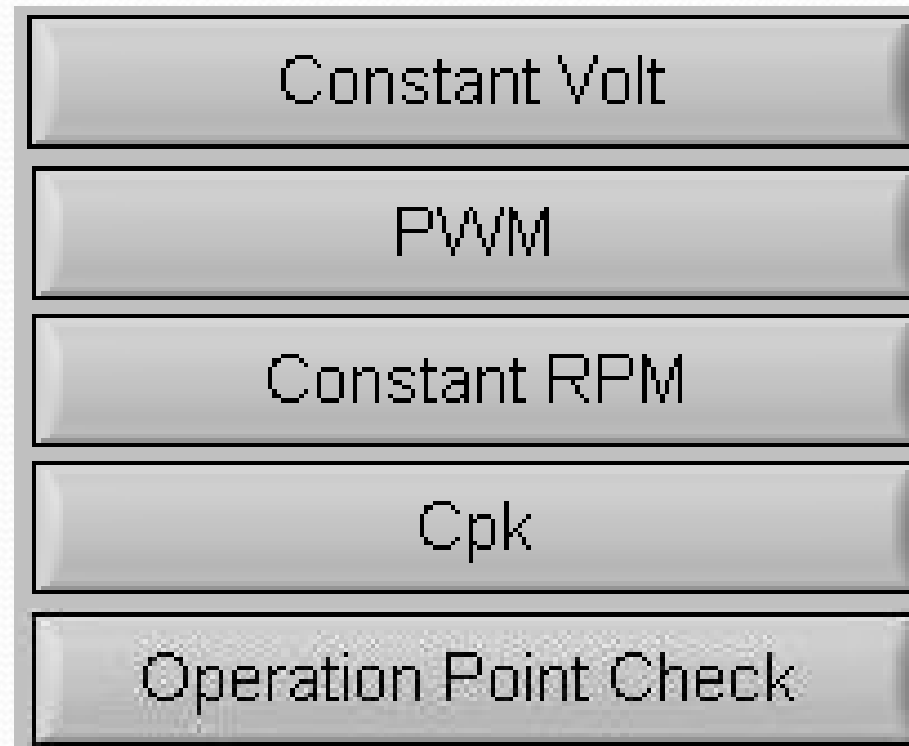
Airflow



測試數據範例 – PQ & Q

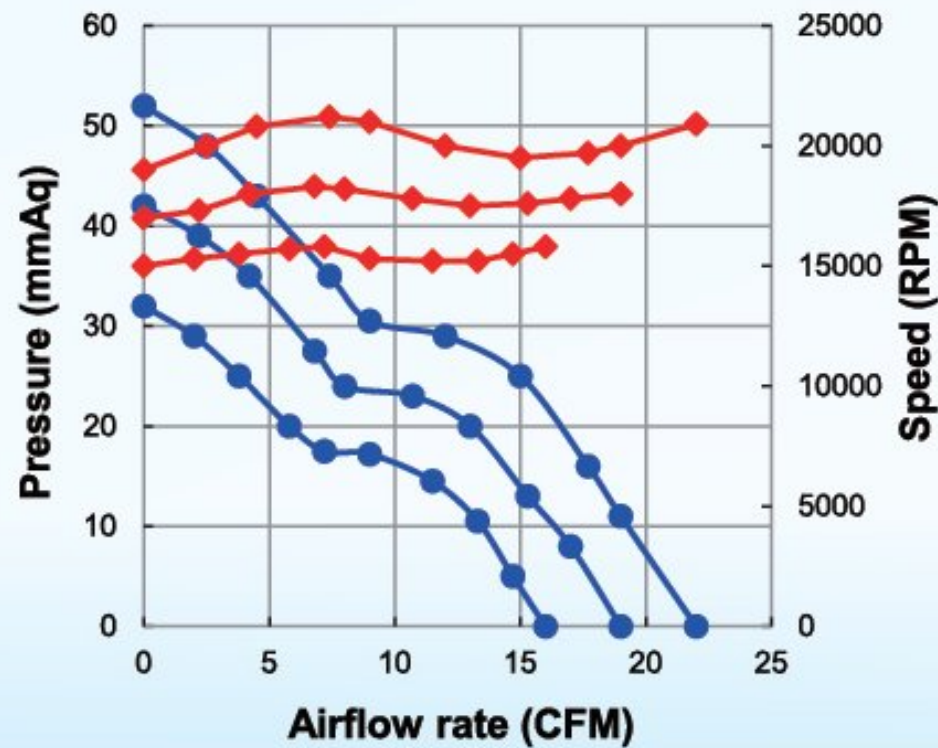


風扇PQ五種測試模式



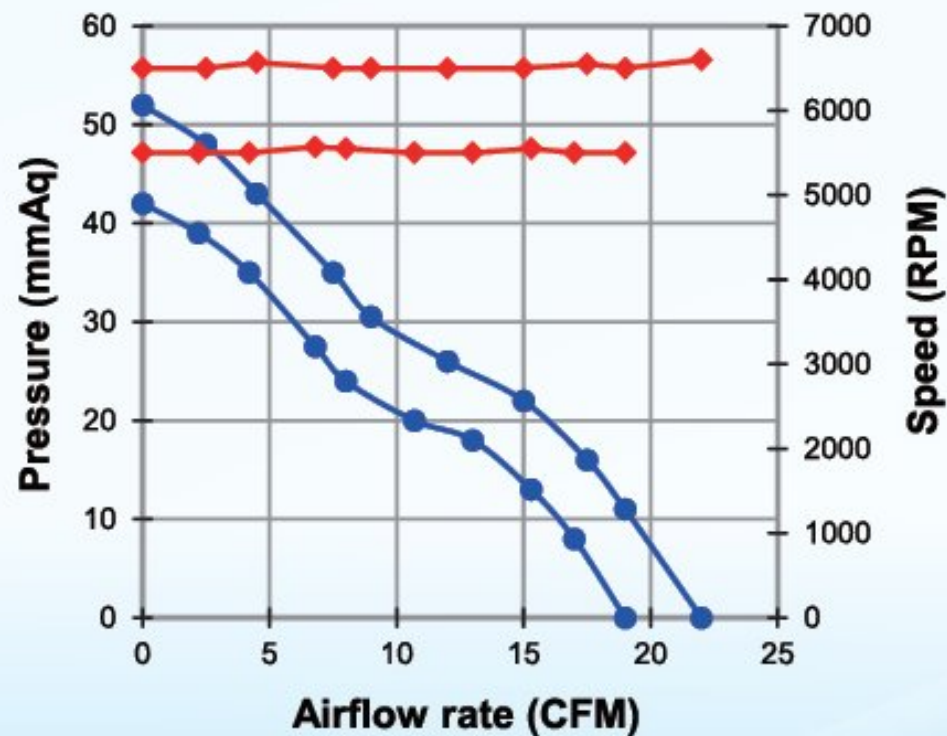
Constant voltage

- Apply certain DC or AC power to specimen.



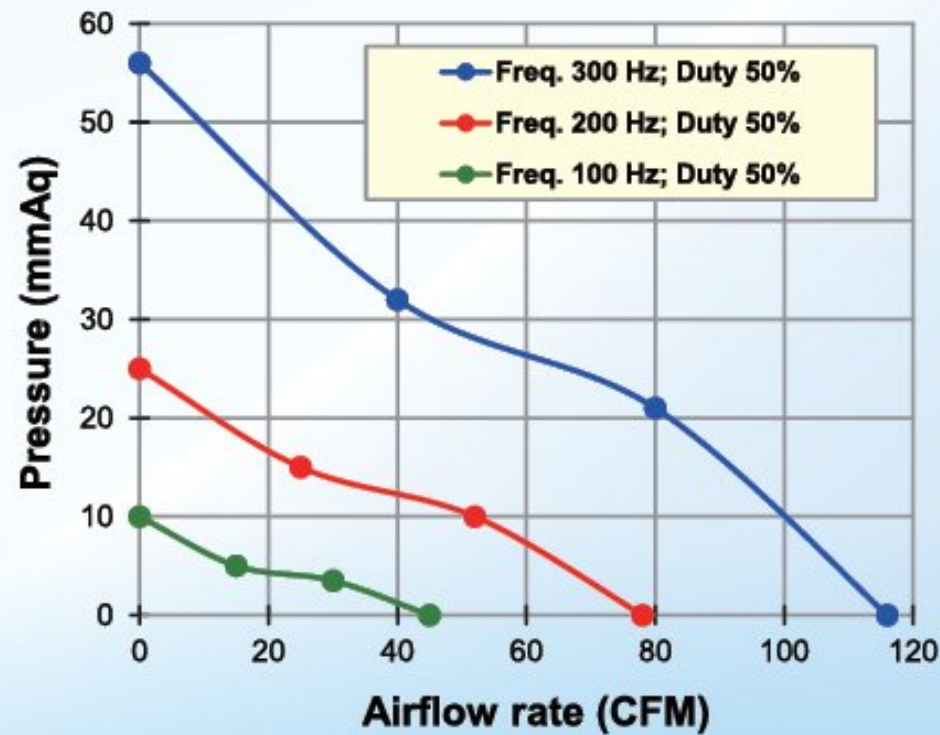
Constant RPM

- RPM can be controlled by DC voltage or PWM.



PWM mode

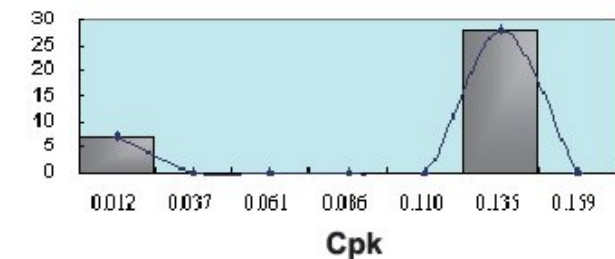
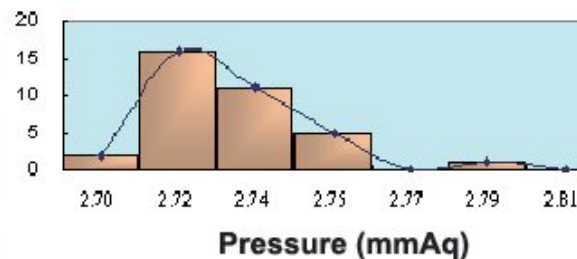
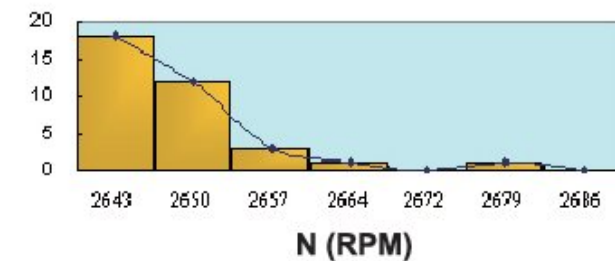
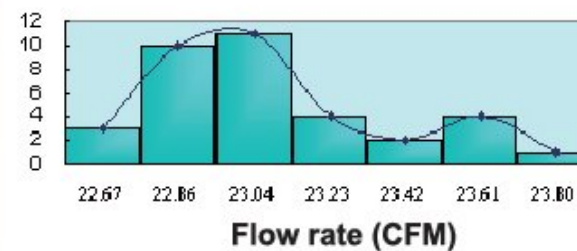
- Adjusting frequency and duty cycle under a constant DC voltage.



Cpk mode

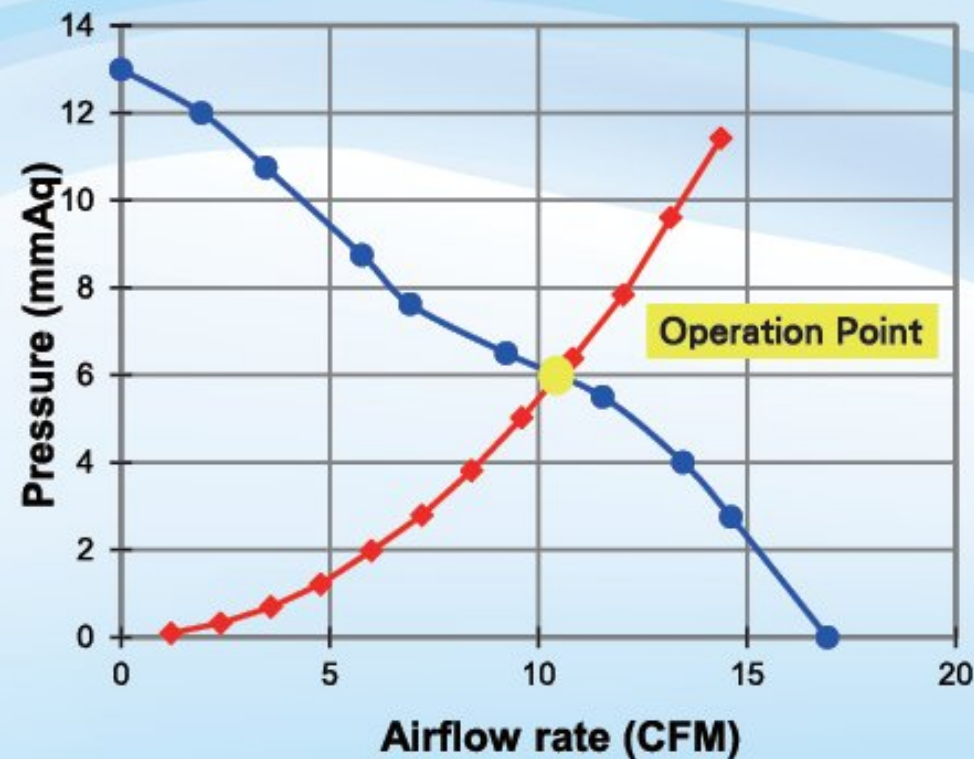
- A statistical method to analyze the mass production performance while doing quality assurance.

| Engineering Specification | | | | |
|---------------------------|---------|---------|---------|---------|
| | A | B | C | D |
| product spec | 23.385E | 2.72773 | 2648.09 | 0.114 |
| + Tolerance | 0.02445 | 0.06015 | 23.6424 | 0.17102 |
| - Tolerance | 0.02445 | 0.06015 | 23.6424 | 0.17102 |
| USL | 24.014 | 2.78788 | 2671.73 | 0.28502 |
| LSL | 22.1051 | 2.66758 | 2624.44 | -0.057 |
| Actual Data | | | | |
| | A | B | C | D |
| X bar | 23.385 | 2.72773 | 2647.07 | 0.114 |
| Sigma | 0.01265 | 0.02034 | 0.95565 | 0.05789 |
| Median | 23.025 | 2.72 | 2646 | 0.142 |
| Mode | #N/A | 2.72 | 2645 | 0.142 |
| Max | 23.705 | 2.8 | 2682.5 | 0.147 |
| Min | 22.5752 | 2.69 | 2639 | 0 |
| 1 Sigma | 23.4022 | 2.74777 | 2653.07 | 0.17104 |
| 2 Sigma | 23.7145 | 2.76811 | 2663.07 | 0.22066 |
| 3 Sigma | 24.0265 | 2.78845 | 2671.06 | 0.23752 |
| 1 Sigma | 22.7765 | 2.70709 | 2639.08 | 0.05616 |
| 2 Sigma | 22.4642 | 2.68675 | 2631.08 | -0.0017 |
| 3 Sigma | 22.1516 | 2.6664 | 2623.09 | -0.0585 |
| CP | 0.93561 | 0.9856 | 0.94541 | 0.93561 |
| CPL | 0.93061 | 0.9856 | 0.94541 | 0.93061 |
| CPU | 0.93561 | 0.9856 | 0.94541 | 0.93561 |
| S. CP | 0.93561 | 0.9856 | 0.94541 | 0.93561 |
| Ca | 3.8815 | 0 | 0.1428 | 2E 16 |
| Cpk | 0.93561 | 0.9856 | 0.94541 | 0.93561 |



Operation Point (OP) check

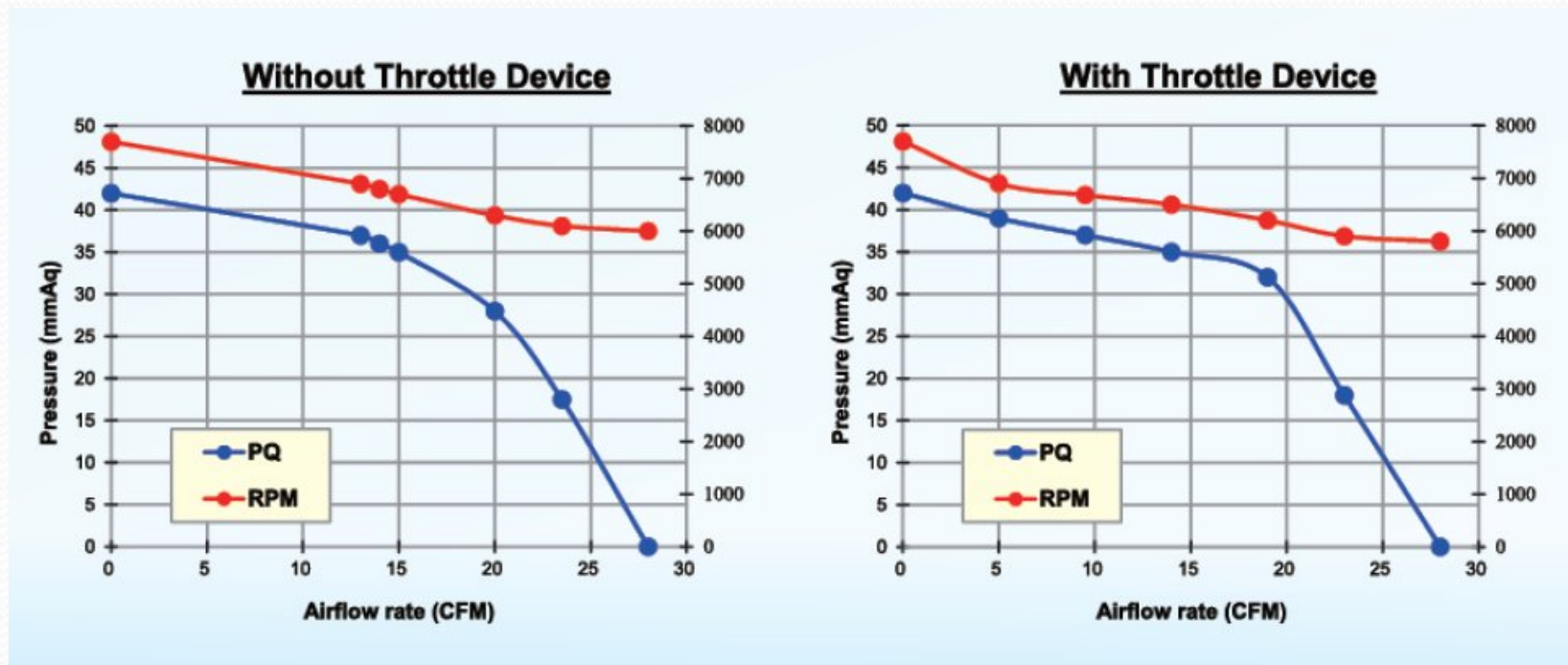
- Providing a required flow rate (Q):
Static pressure (P_s) > OP : The fan is OK.
(OP - Uncertainty) < P_s : The fan is NG.



控制點測試應用

| | |
|--|--|
| <input type="radio"/> Assign Ps, Check Q <input type="radio"/> Assign Pstp, Check Q | Ps(mmAq) <input type="text" value="1.00"/> <input type="text" value="2.00"/> <input type="text" value="3.00"/> <input type="text" value="4.00"/> <input type="text" value="5.00"/> Number of Average <input type="text" value="1"/> |
| <input type="radio"/> Assign Q, Check Ps | Q(CFM) <input type="text" value="2.00"/> <input type="text" value="4.00"/> <input type="text" value="6.00"/> Number of Average <input type="text" value="1"/> |
| <input type="radio"/> Assign Volt, Check Q | Ps(mmAq) <input type="text" value="0.00"/> Start Step Stop DC Voltage <input type="text" value="8.00"/> <input type="text" value="1.00"/> <input type="text" value="12.00"/> |
| <input type="radio"/> Fixed Ps | Ps(mmAq) <input type="text" value="6.50"/> Step Time(min) <input type="text" value="20"/> |
| <input type="button" value="OK"/> | |

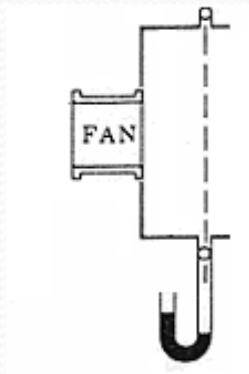
高靜壓風扇測試 – 阻流裝置



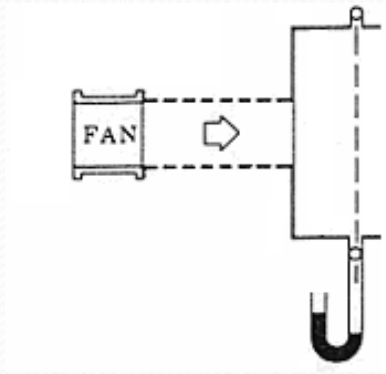
摘要

1. AMCA 210 標準簡介
2. 流量量測原理
3. 校正流程
4. 風洞特點
5. 風扇PQ比較
6. 應用案例

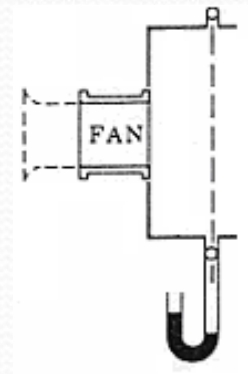
風扇測試 – 安裝模式



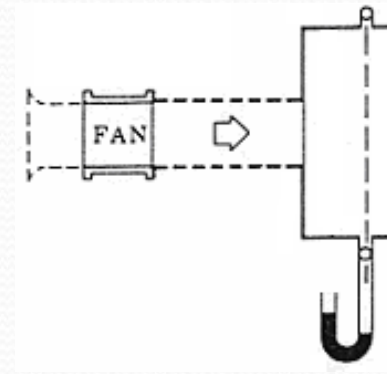
Type A
Free Inlet,
Free Outlet



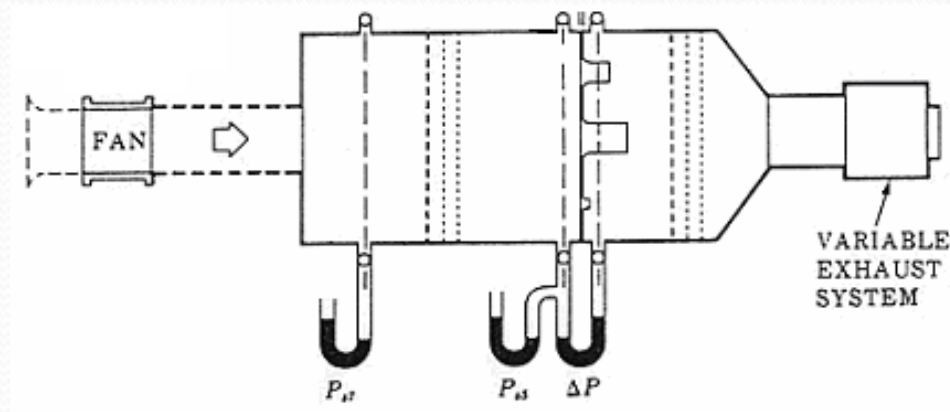
Type B
Free Inlet,
Ducted Outlet



Type C
Ducted Inlet,
Free Outlet

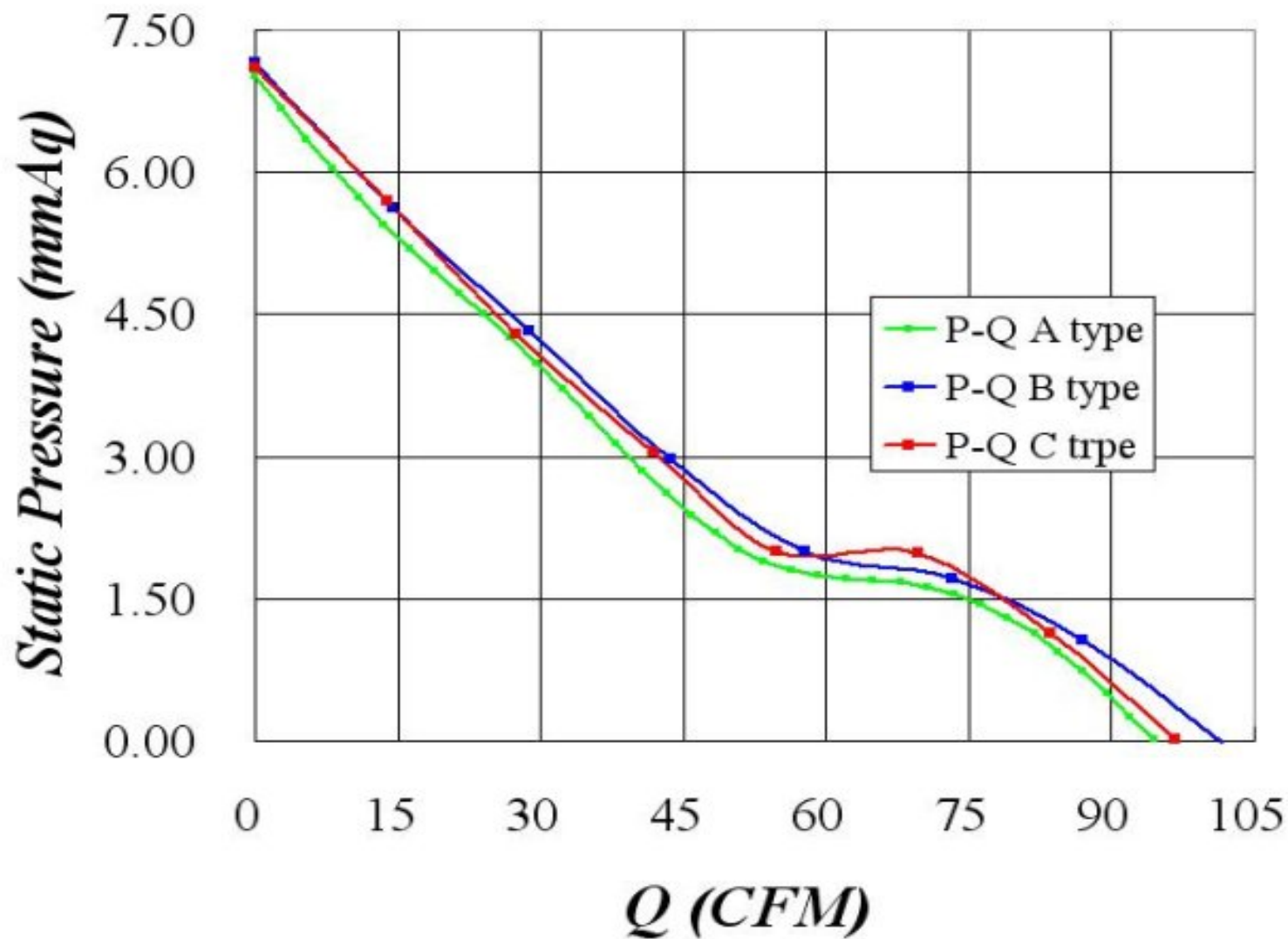


Type D
Ducted Inlet,
Ducted Outlet



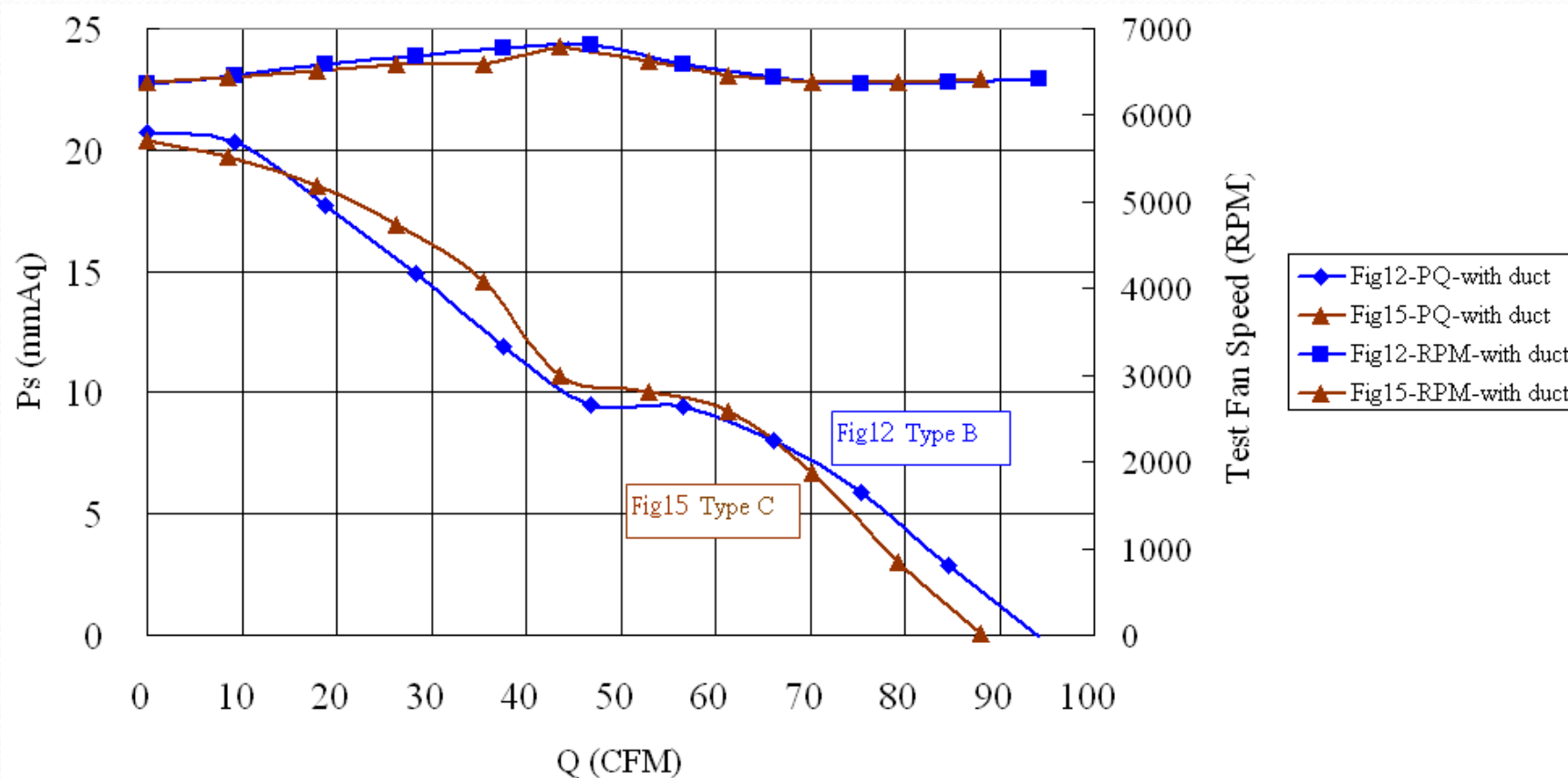
風扇測試 – 安裝模式

Fig.12 12025 DC12V with Different Type



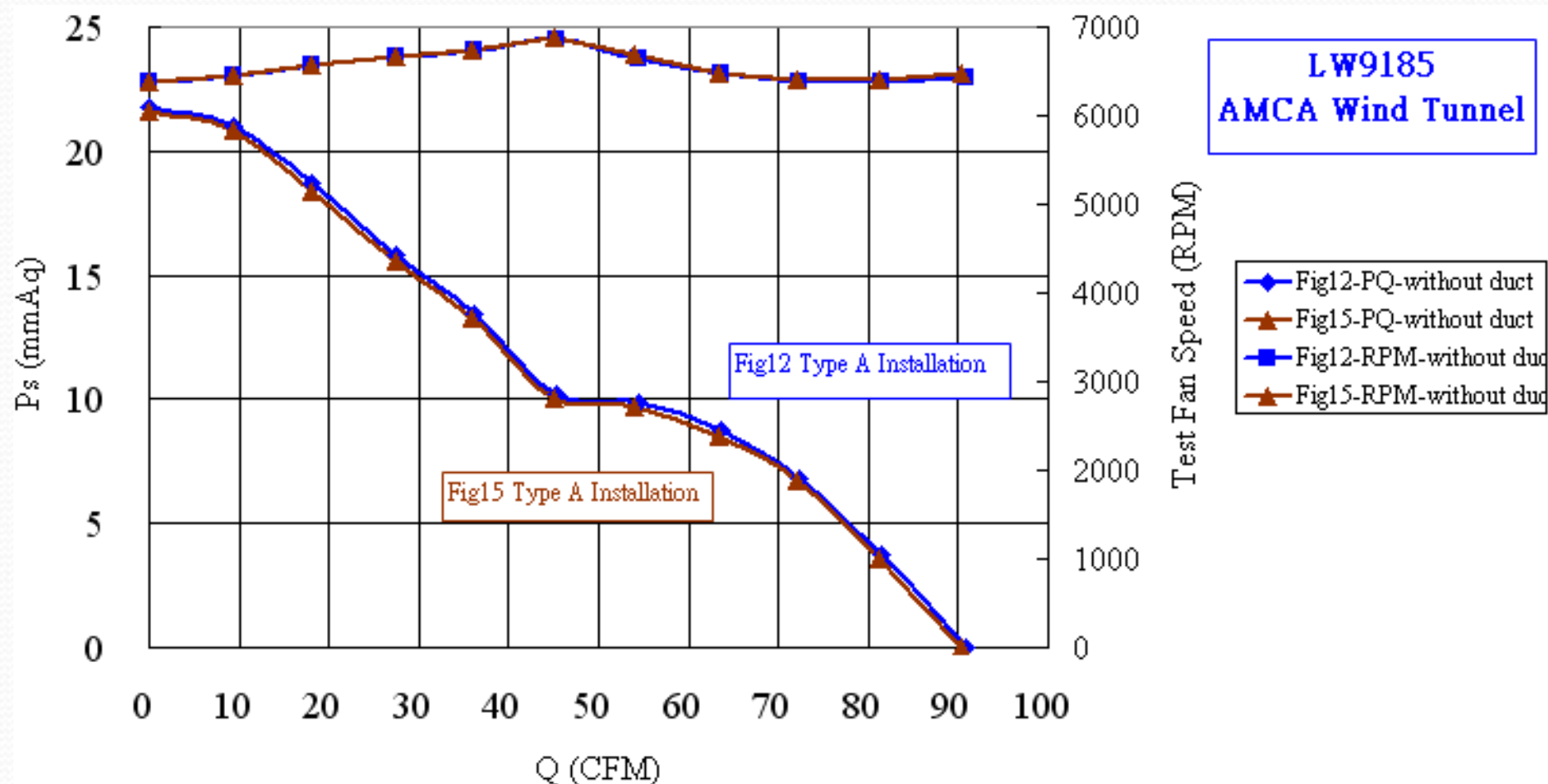
風扇測試 – 安裝模式

Fig.12/15 8038 DC12V with Different Type



風扇測試 – 安裝模式

Fig.12/15 8038 DC12V with Type A



風扇測試 – STP標準狀態轉換

Parameter 1 : Test Condition

| Test Condition | | | | | | | | | |
|--|----------------------|-------------------|---------------------|---------------------|---------------------|---------------------|-----------|-------|----------------|
| Td | Tw | RH | T5 | T7 | T8 | Pb | Pmax | Qmax | Note |
| °C | °C | % | °C | °C | °C | mmHg | mmAq | CFM | |
| Dry-Bulb Temperature | Wet-Bulb Temperature | Relative Humidity | Plane 5 Temperature | Plane 7 Temperature | 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 °C | | | | | | | 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)

風扇測試 – STP標準狀態轉換

Method of Test Condition to STP Condition.

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

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

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

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

Q_c / P_{sc} : Nominal Values

$$\left(\frac{K_p}{K_{pc}} \right) \propto 1 \quad \text{Compressibility factor ratio}$$

From AMCA 210-99 Eq. 8.59~8.62

風扇測試 – STP標準狀態轉換

| 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 |

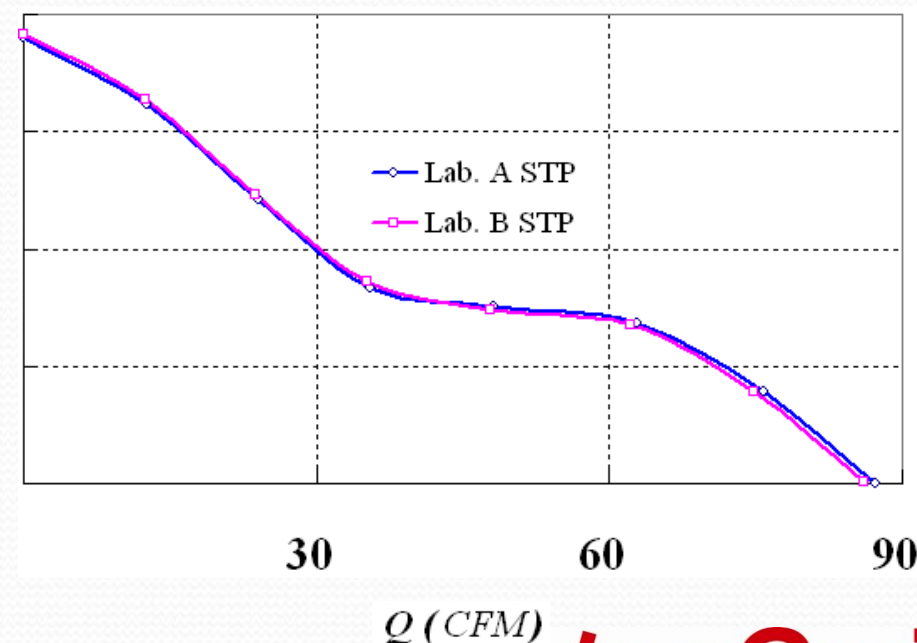
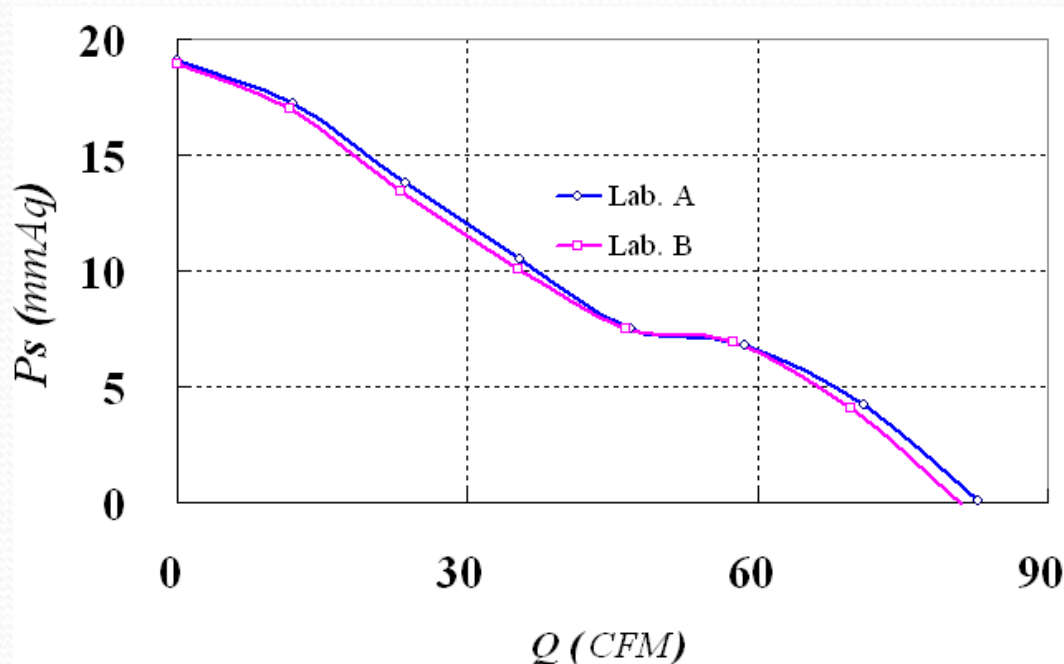
From Test Condition Convert to Nominal Values (STP).

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

風扇測試 – STP標準狀態轉換

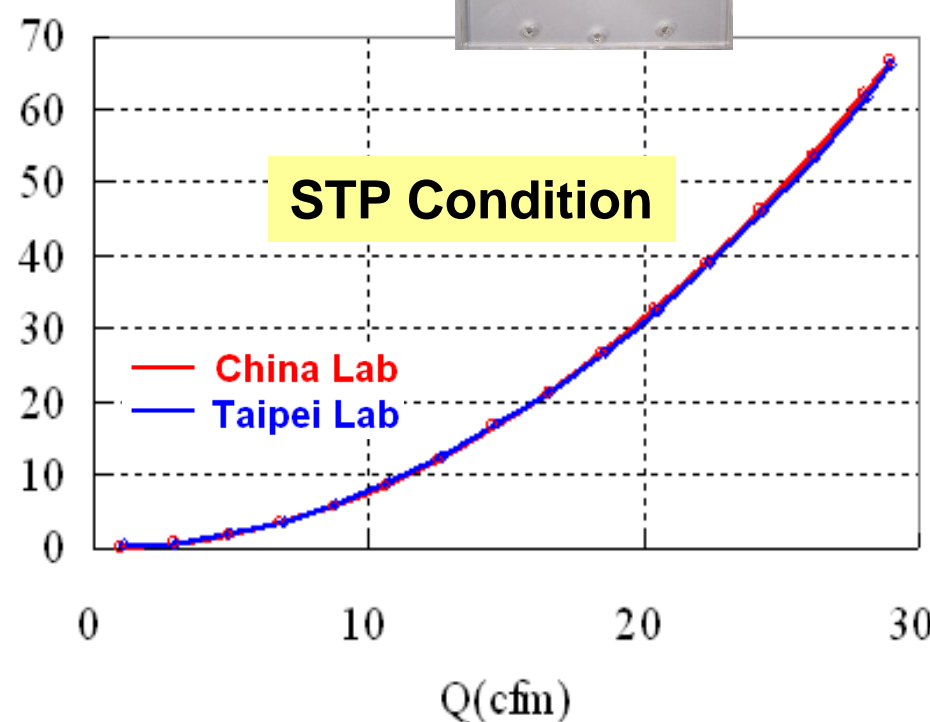
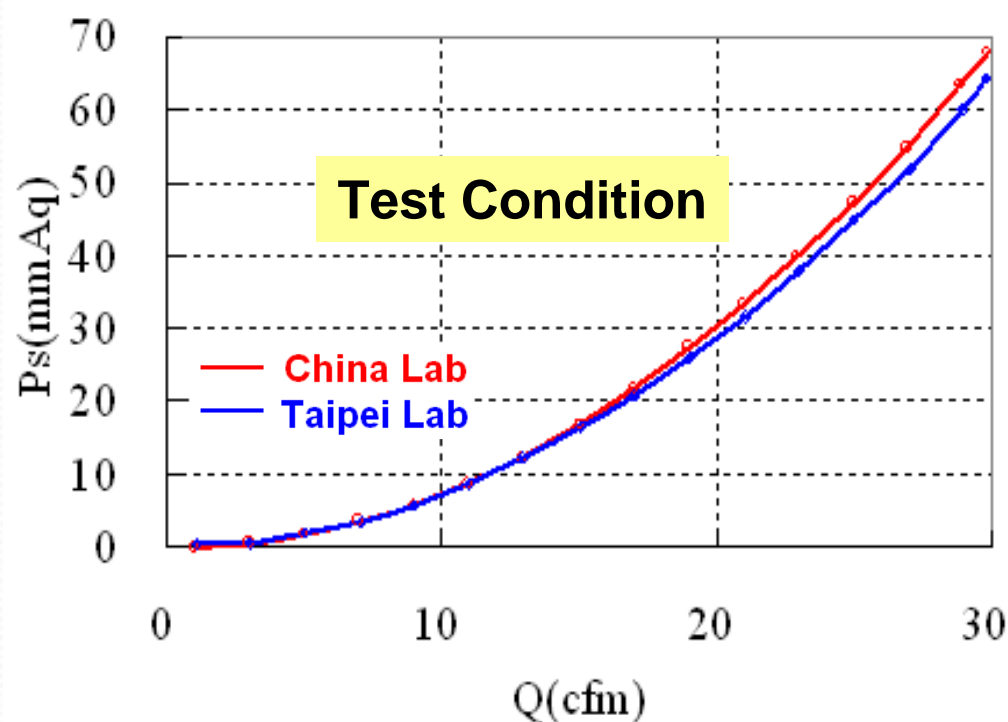
| Td | Tw | RH | T5 | T7 | T8 | Pb | |
|------|------|------|------|------|------|-------|---------|
| °C | °C | % | °C | °C | °C | mmHg | |
| 23.8 | 20.4 | 73.7 | 23.9 | 24.2 | 23.8 | 760.5 | F |
| 19.7 | 16.5 | 72.1 | 19.3 | 19.2 | 19.5 | 742.6 | LongWin |

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



風扇測試 – STP標準狀態轉換

Orifice Plate SRC Test



風扇測試 – STP標準狀態轉換

風扇比較方法

1. 確認為相同安裝模式 **Installation Type.**
2. 轉換PQ測試結果：測試狀態→STP標準狀態
Test Condition to STP Condition.
3. 轉換PQ測試結果：根據Fan Law轉換為指定RPM

Fan law : $Q \sim \text{RPM}$, $P \sim (\text{RPM})^2$

規格

| | | | | | | | | | | |
|---|---|---|---|---|-------------------------|-------------------------|-------------------------|------------------------|------------------------|-------------------------|
|  |  |  |  |  | | | | | | |
| 9014 | 9081 | 9015 | 9185 | 9120 | | | | | | |
|  |  |  |  |  | | | | | | |
| 9293 | 9545 | 9347 | 9266 | 9348 | | | | | | |
| 型號 | 9014 | 9081 | 9015 | 9185 | 9120 | 9293 | 9545 | 9347 | 9266 | 9348 |
| 根據AMCA 210-07 | 圖 12 & 15 二合一結構 | | | | | | | 圖12結構 | | |
| 流量 (CFM) | 0.2~18 | 1.6~60 | 2.4~250 | 2.9~1000 | 100~5000 | 230~30100 | 9~2000 | 0.2~18 | 2.4~250 | 4~1000 |
| 壓力 (mmAq) * 含高靜壓阻流閥 | 0~30 0~200* | 0~30 0~200* | 0~30 0~200* | 0~30 0~200* | 0~150 | 0~150 | 0~800 | 0~20 | 0~20 0~100* | 0~20 0~100* |
| 最大測試物開口 (cm) | 8 x 8 | 8 x 8 | 30 x 30 | 30 x 30 | 60 x 60 | 100 x 100 | 60 x 60 | 8 x 8 | 24 x 24 | 40 x 40 |
| 熱傳測試段RQ實驗 | -- | 選配 | 選配 | 選配 | -- | -- | -- | -- | -- | -- |
| 高靜壓阻流閥 | 選配 | 選配 | 選配 | 選配 | -- | -- | -- | -- | 選配 | 選配 |
| 多風扇測試模組 | 選配 | 選配 | 選配 | 選配 | -- | -- | -- | 選配 | 選配 | 選配 |
| PWM 訊號產生器 | 內含 | 內含 | 內含 | 內含 | 內含 | -- | 內含 | 選配 | 選配 | 選配 |
| 軸向力及扭矩量測 | -- | -- | -- | 選配 | 選配 | 選配 | 選配 | -- | -- | -- |
| 長 x 寬 x 高 (cm) | 250 x 60 x 160 | 250 x 60 x 160 | 360 x 85 x 180 | 460 x 180 x 190 | 800 x 260 x 230 | 1200 x 350 x 260 | 450 x 180 x 200 | 160 x 60 x 140 | 220 x 70 x 160 | 260 x 80 x 190 |
| 淨重 (kg) | 370 | 370 | 750 | 1500 | 2800 | 9000 | 2600 | 380 | 400 | 550 |
| 使用電力 | AC 220V 5 Amp 單相 | AC 220V 5 Amp 單相 | AC 220V 5 Amp 單相 | AC 220V 20 Amp 三相 | AC 220V 40 Amp 三相 | AC 380V 60 Amp 三相 | AC 380V 50 Amp 三相 | AC 220V 5 Amp 單相 | AC 220V 5 Amp 單相 | AC 220V 10 Amp 三相 |

規格

| 型號 | 9015 | 9185 | 9120 | 9293 | 9545 |
|------------------------|------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| 根據AMCA 210-07 | 圖 12 & 15 二合一結構 | | | | |
| 流量 (CFM) | 2.4~250 | 2.9~1000 | 100~5000 | 230~30100 | 9~2000 |
| 壓力 (mmAq) * 含高靜壓阻流閥 | 0~30 0~200* | 0~30 0~200* | 0~150 | 0~150 | 0~800 |
| 最大測試物開口 (cm) | 30 x 30 | 30 x 30 | 60 x 60 | 100 x 100 | 60 x 60 |
| 熱傳測試段RQ實驗 | 選配 | 選配 | -- | -- | -- |
| 高靜壓阻流閥 | 選配 | 選配 | -- | -- | -- |
| 多風扇測試模組 | 選配 | 選配 | -- | -- | -- |
| PWM 訊號產生器 | 內含 | 內含 | 內含 | -- | 內含 |
| 軸向力及扭矩量測 | -- | 選配 | 選配 | 選配 | 選配 |
| 長 x 寬 x 高 (cm) | 360 x 85 x 180 | 460 x 180 x 190 | 800 x 260 x 230 | 1200 x 350 x 260 | 450 x 180 x 200 |
| 淨重 (kg) | 750 | 1500 | 2800 | 9000 | 2600 |
| 使用電力 | AC 220V 5 Amp 單相 | AC 220V 20 Amp 三相 | AC 220V 40 Amp 三相 | AC 380V 60 Amp 三相 | AC 380V 50 Amp 三相 |

規格

| 型號 | 9347 | 9266 | 9348 |
|------------------------|------------------------|------------------------|-------------------------|
| 根據AMCA 210-07 | 圖12結構 | | |
| 流量 (CFM) | 0.2~18 | 2.4~250 | 4~1000 |
| 壓力 (mmAq) * 含高靜壓阻流閥 | 0~20 | 0~20 0~100* | 0~20 0~100* |
| 最大測試物開口 (cm) | 8 x 8 | 24 x 24 | 40 x 40 |
| 熱傳測試段RQ實驗 | — | -- | — |
| 高靜壓阻流閥 | — | 選配 | 選配 |
| 多風扇測試模組 | 選配 | 選配 | 選配 |
| PWM 訊號產生器 | 選配 | 選配 | 選配 |
| 軸向力及扭矩量測 | — | -- | — |
| 長 x 寬 x 高 (cm) | 160 x 60 x 140 | 220 x 70 x 160 | 260 x 80 x 190 |
| 淨重 (kg) | 380 | 400 | 550 |
| 使用電力 | AC 220V 5 Amp 單相 | AC 220V 5 Amp 單相 | AC 220V 10 Amp 三相 |



LW-9014 (18CFM)& 9081 (60CFM)



LW-9015 (250 & 400CFM)



LW-9185 (800&1000 CFM)



LW-9185 (1500 CFM)



LW-9120 (2000~8000 CFM)



LW-9293 (20,000~30,000 CFM)



LW-9545 (2100 CFM, Ps~800mmAq)



LW-9266 (~250 CFM)



LW-9348 (~1000 CFM)

摘要

1. AMCA 210 標準簡介
2. 流量量測原理
3. 校正流程
4. 風洞特點
5. 風扇PQ比較
6. 應用案例

應用

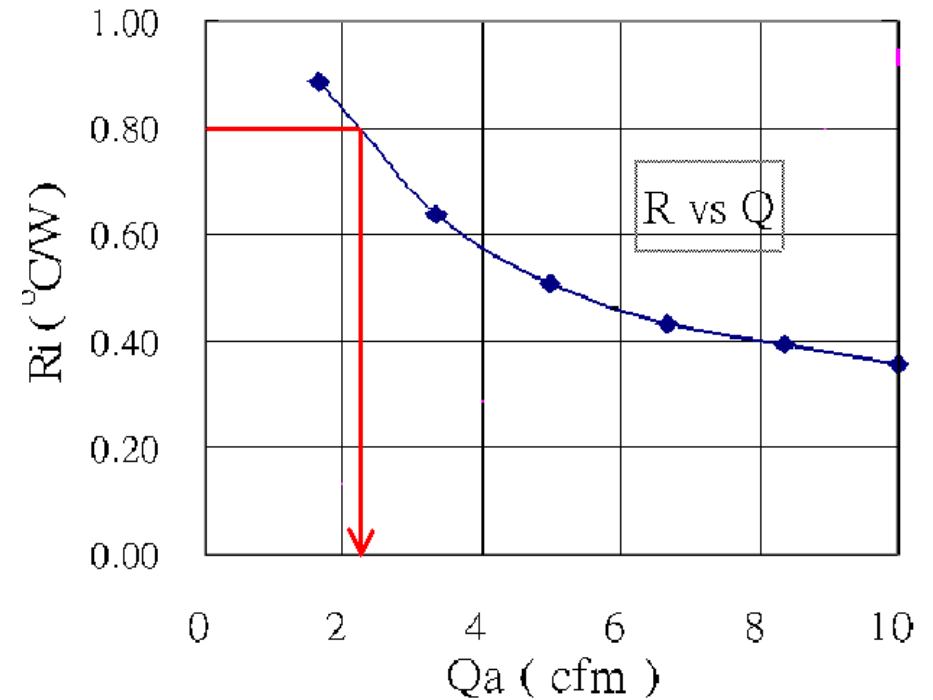
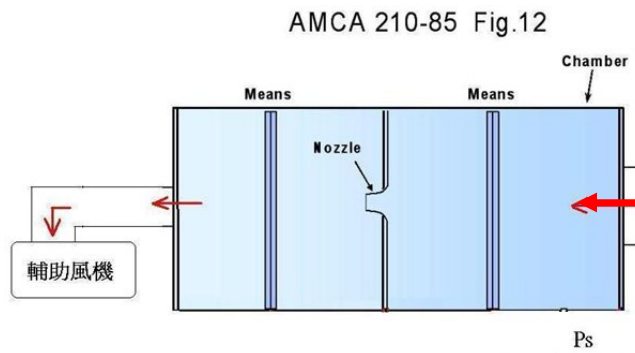
NB Thermal Design

Step1 :

Worst case

Define mini air flow rate

NB
Power ON



Offer Air Flow Q_{air}



Temperature
Data Log

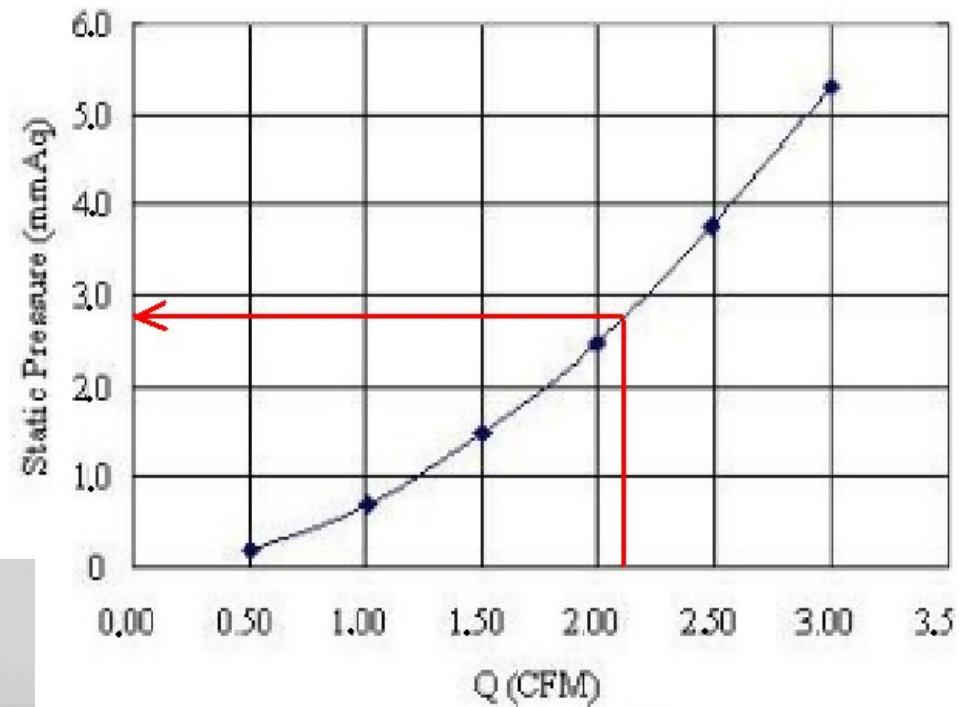
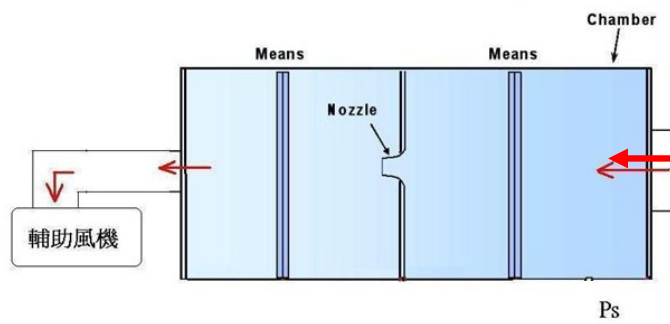
應用

NB Thermal Design

Step2 :

NB
Flow Impedance

AMCA 210-85 Fig.12



應用

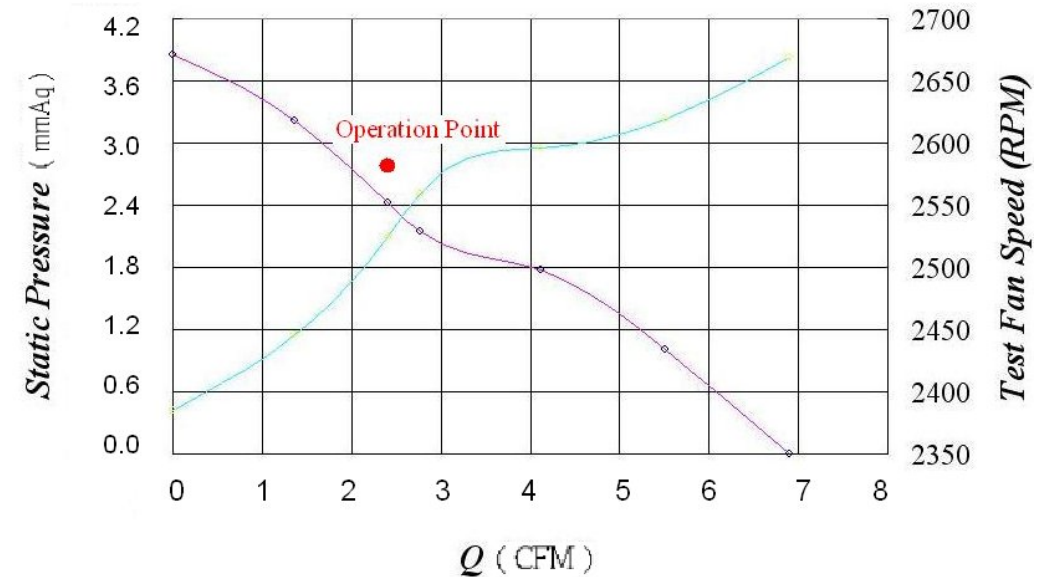
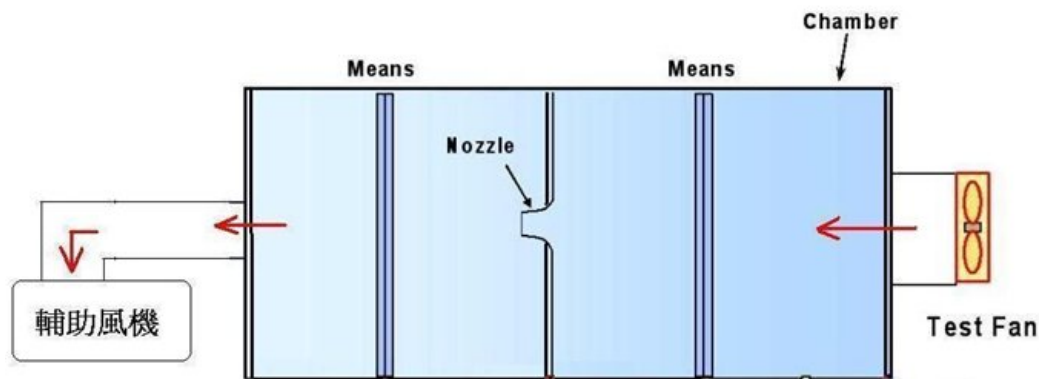
NB Thermal Design

Step3 :

Step 3

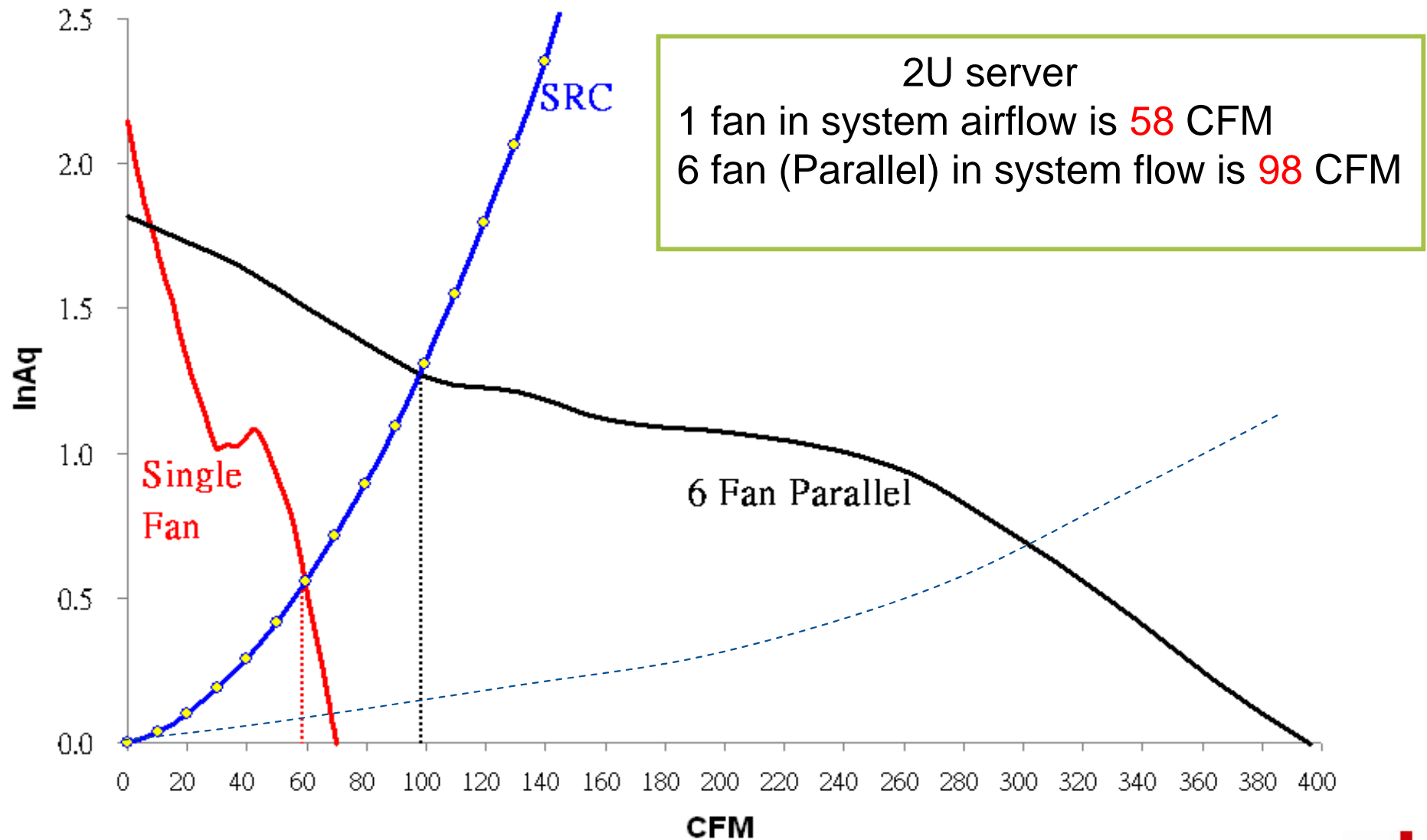
NB
Blower

AMCA 210-85 Fig.12



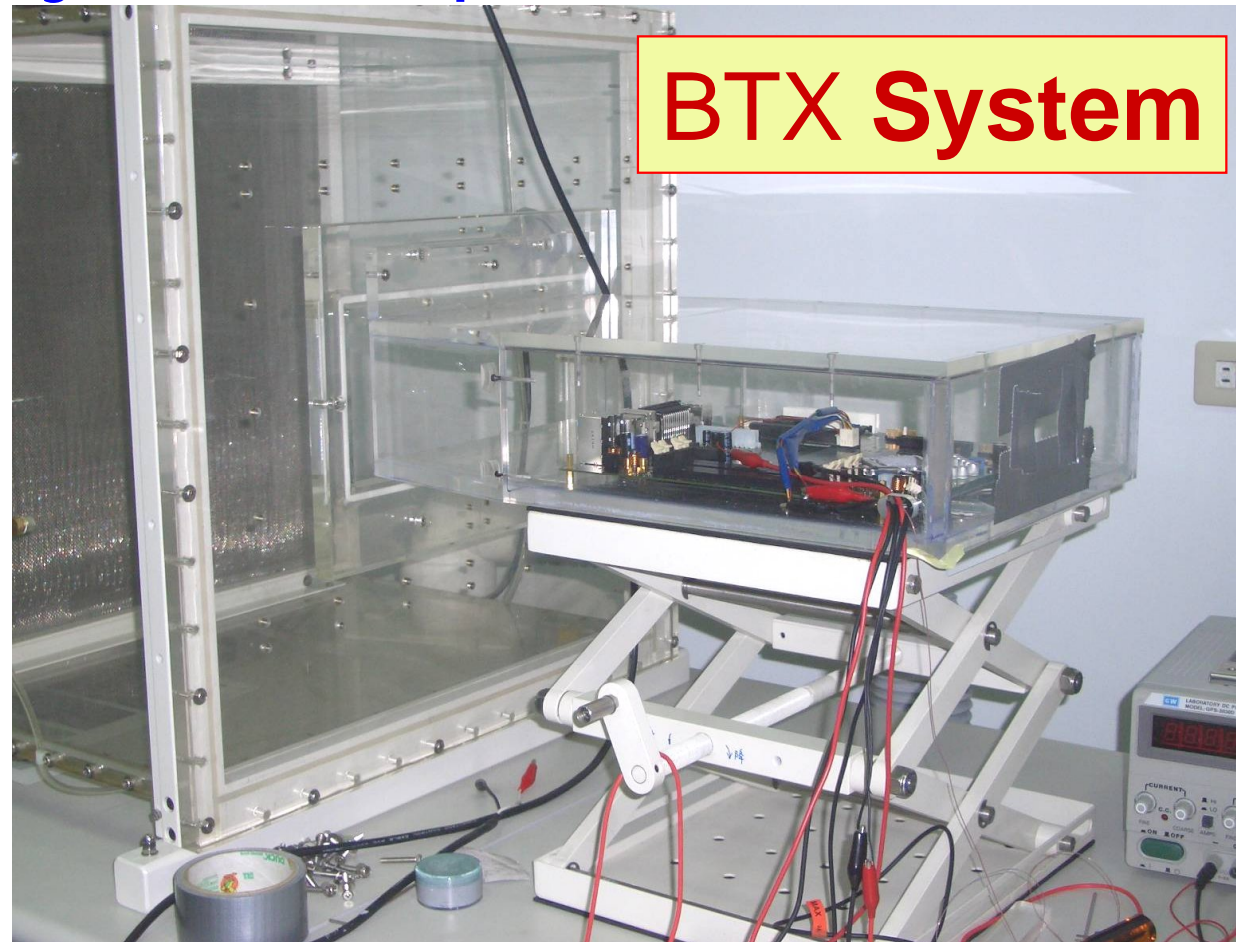
應用

Server fan tray case study



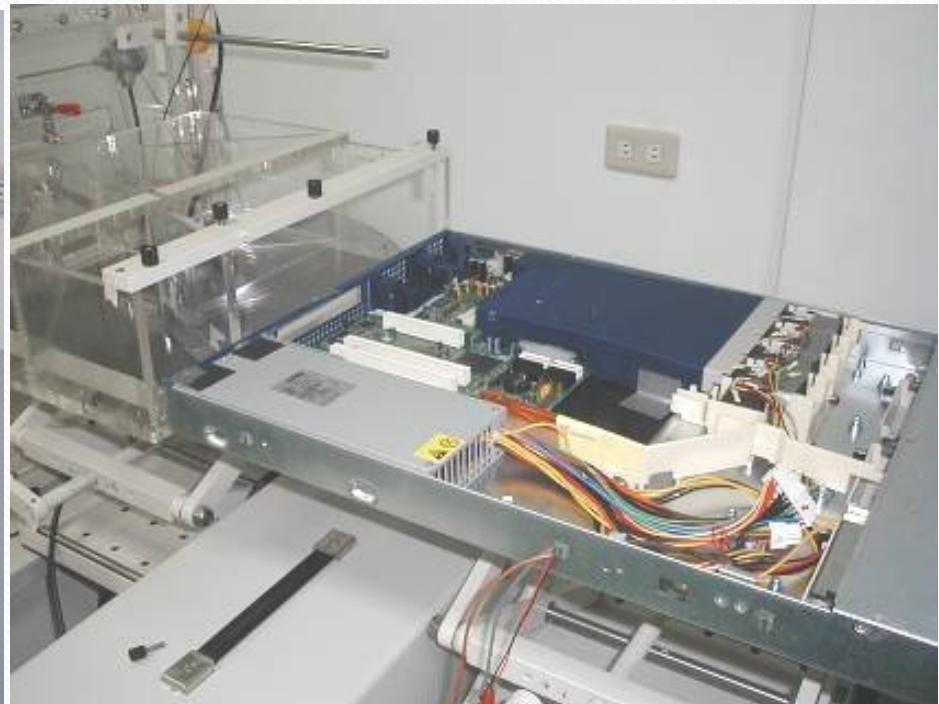
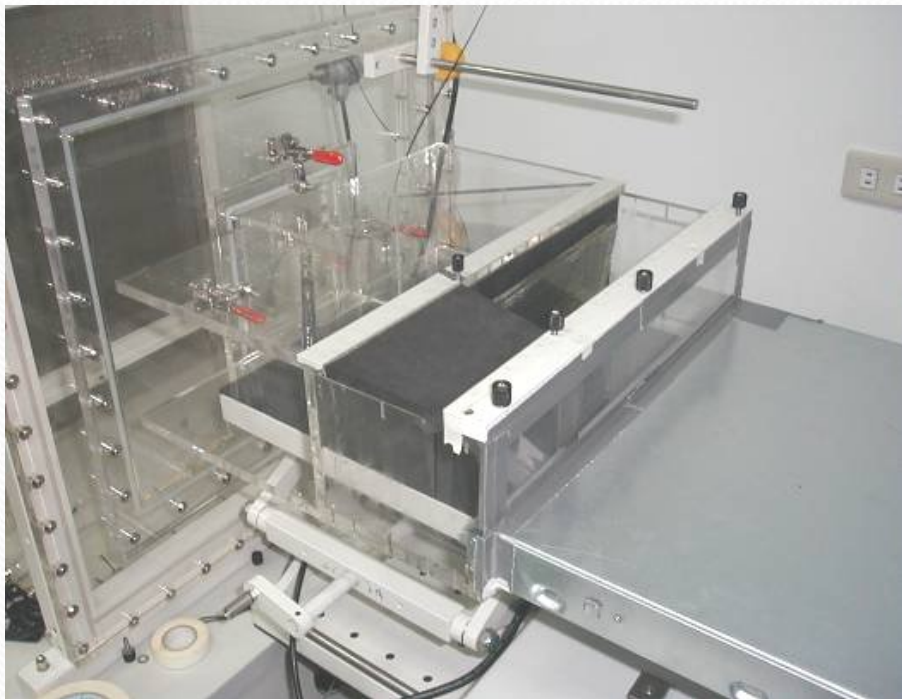
應用

System Impedance Test

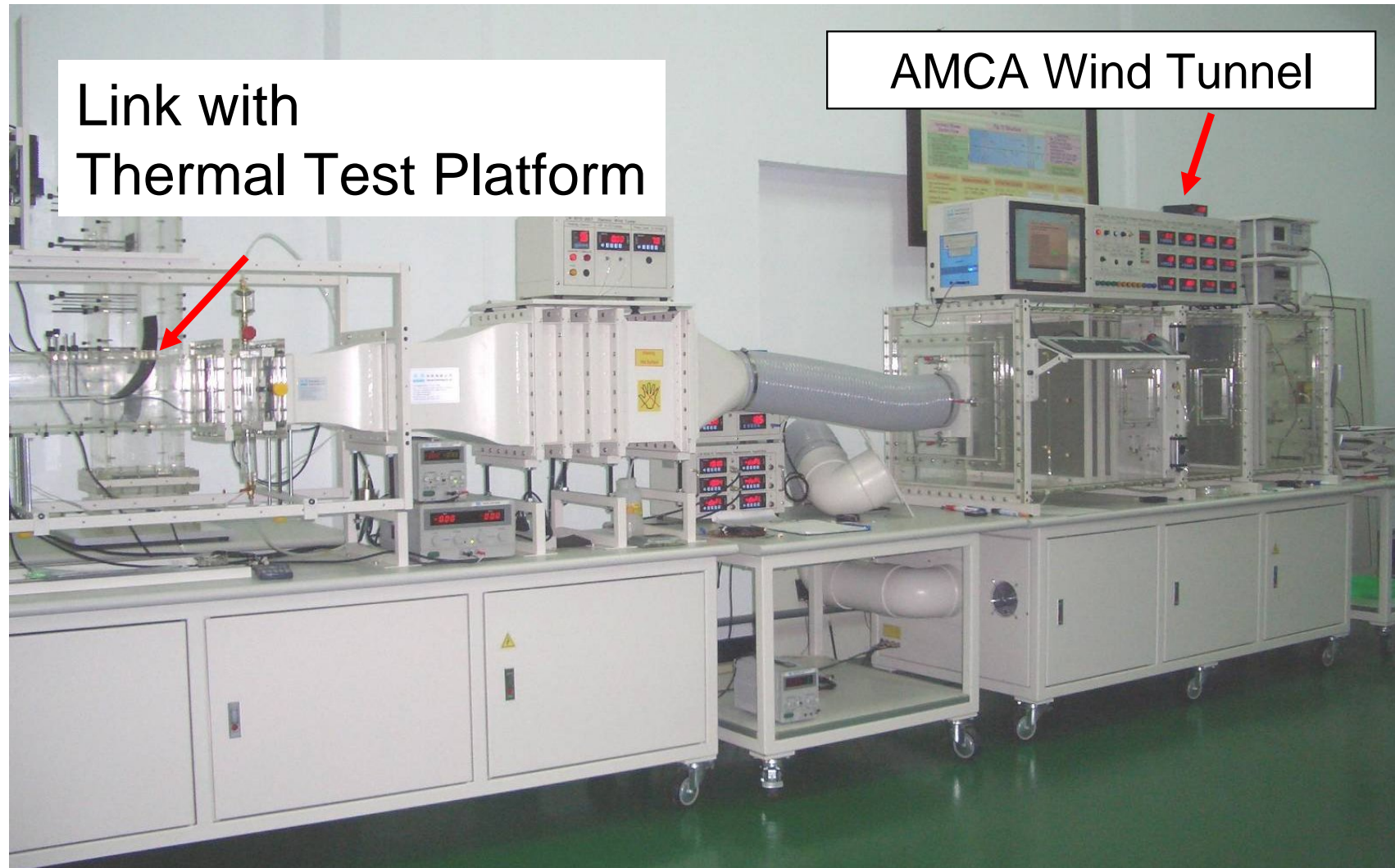


應用

Server Thermal Test , Impedance Test, Airflow Test

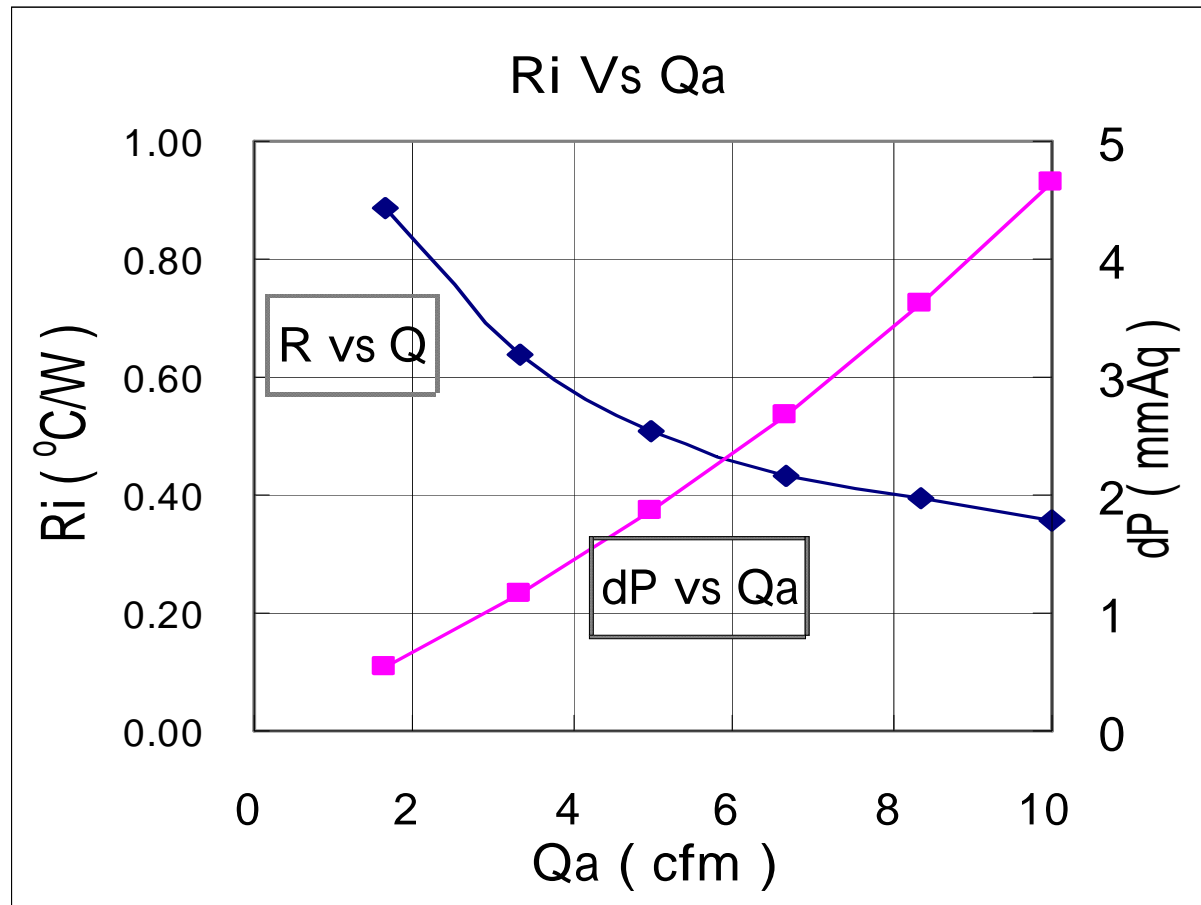


應用



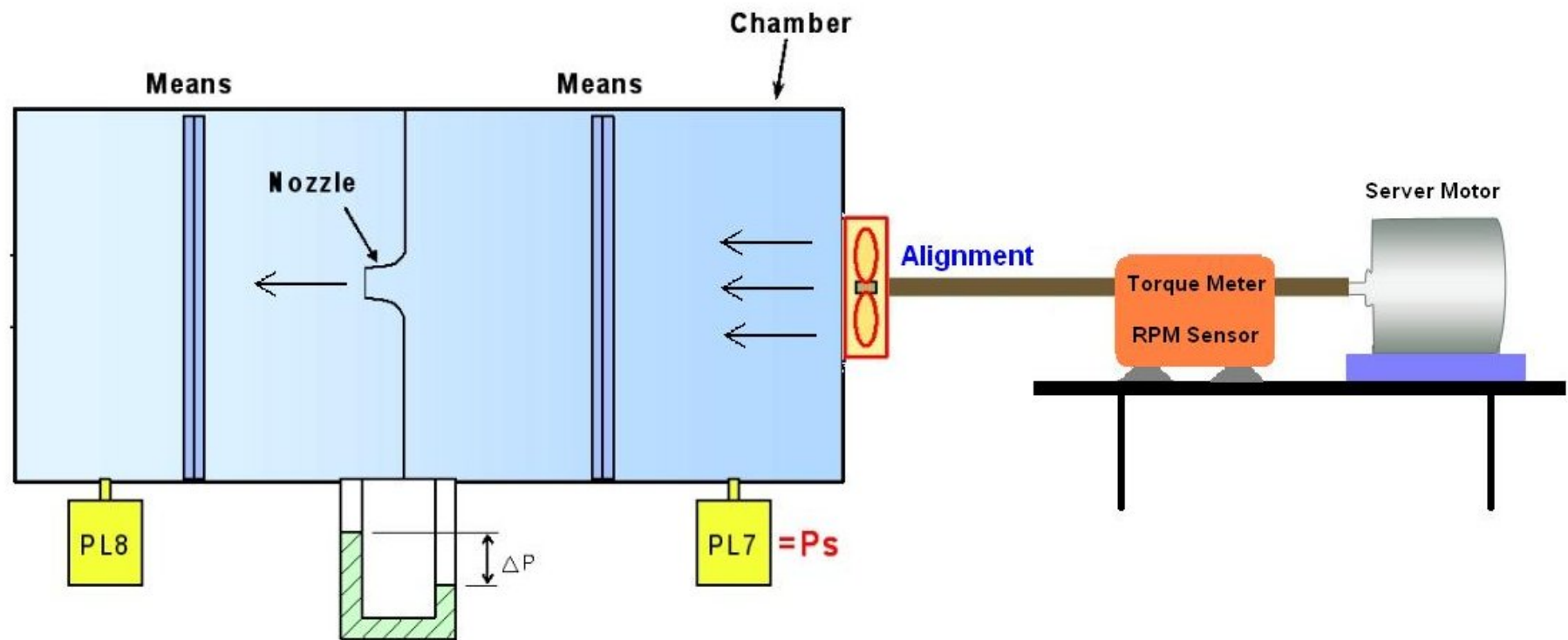
應用

Thermal Module - Thermal Resistance Curve Test



應用

AMCA 210-99 Fig.12





Thank you !