SAIRAC Technical Talk

Basics of HVAC Commissioning

By: Theo van der Linde

Why is Commissioning important?

Building owners, contractors, and engineers must have proper documentation on how the HVAC systems are functioning. This is so they can pinpoint and resolve issues, and further improve HVAC performance. Also, HVAC commissioning is vital to ensure that the project requirements are met and to avoid the need for repairs and callbacks in the long run

Benefits of HVAC commissioning

- Overall system efficiency is enhanced
- Increased safety within the HVAC framework
- Engineers in the industry recognize your value
- We continue to be authorities in our domain
- We contribute to the creation of more sustainable and superior buildings

Types of project Commissioning

- **Initial Commissioning:**

Such a process is done to HVAC systems that are less than a year old, and those that are first installed in new or existing buildings. This may also refer to post-construction commissioning.

- **Re-Commissioning:**

This happens when the building owner wants to verify, enhance, or document how the current system works. Hence, re-commissioning applies to existing HVAC systems that were commissioned already and need another process of commissioning

What components need commissioning in a system?

- Pumps
- Diffusers – MLM
- Air handing units
- Fans
- Fan coil units
- Air conditioners (DX)
- Cold and Freezer rooms
- Smoke fans
- Chillers

What is the most important when commissioning a system?

- Make sure the installation is done correctly
- Triple check quality as this may impact commissioning data
- Understand your requirements based on the design/drawings
- Understand what system you working with
- Understand how to troubleshoot the type of system you are going to commission
- Prepare and Ask questions - Before you go to site

SAIRAC

Steps to successful and easy commissioning

Preparation and Planning:

1) Develop a commissioning plan outlining goals, procedures, and responsibilities.

2) Review design specifications and ensure they align with project requirements.

3) Schedule commissioning early in the construction phase to identify issues promptly.

Steps to successful and easy commissioning

Equipment Inspection and Installation:

1) Verify that HVAC equipment is installed correctly according to manufacturer's specifications and design drawings.

2) Ensure all components (e.g., ductwork, controls) are installed and connected properly.

3) Conduct pre-start checks to confirm equipment readiness.

Steps to successful and easy commission

Functional Testing:

1) Perform functional tests to validate system operation under various conditions (e.g., heating, cooling, ventilation modes).

2) Test control sequences to ensure they respond correctly to inputs (thermostats, sensors, switches).

3) Verify safety controls and shutdown procedures.

Steps to successful and easy commissioning

Air Balancing:

1)Conduct airflow measurements to ensure proper distribution and velocity in ducts and air handling units.

2)Balance water flow rates in hydronic systems to match design specifications.

3)Adjust dampers, valves, and fans as needed for optimal performance.

SAIRAC

Steps to successful and easy commissioning

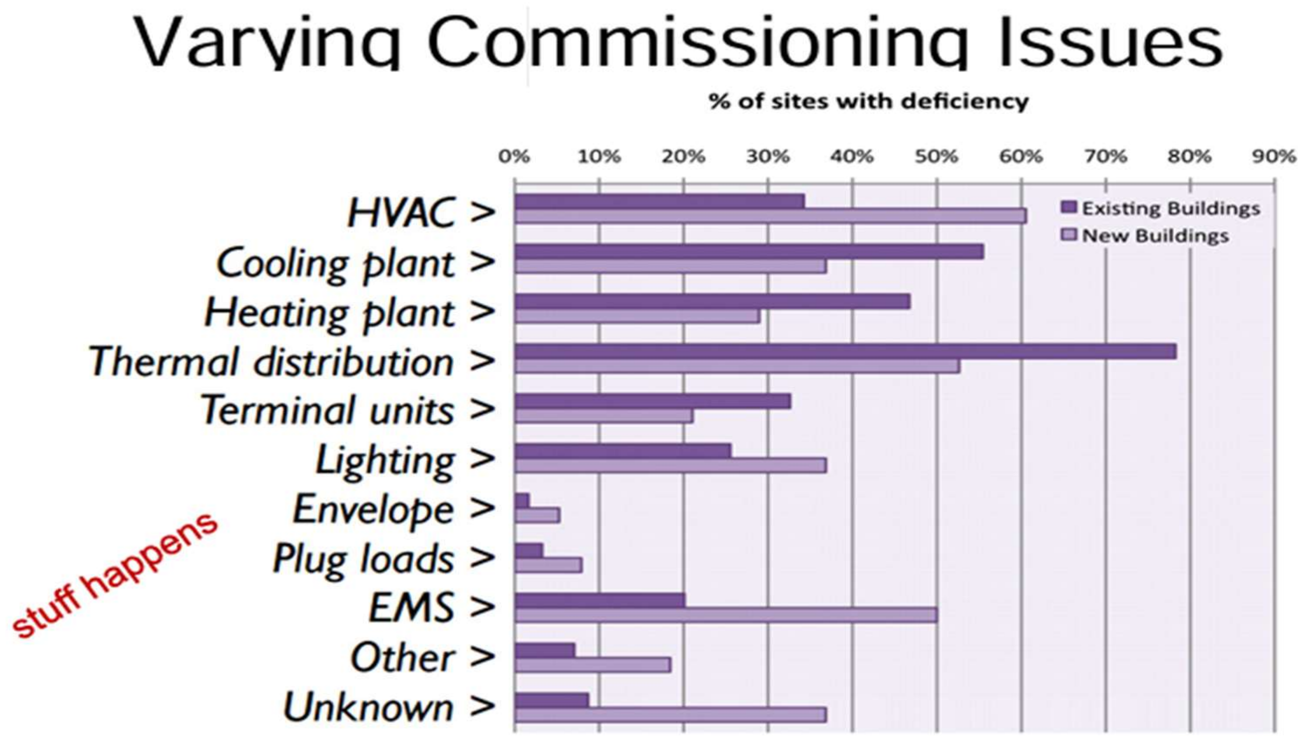
Documentation and Training:

1)C ompile commissioning reports detailing test procedures, results, and any corrective actions taken.

2) Provide training for building operators and maintenance staff on system operation, maintenance tasks, and troubleshooting procedures.

3) Deliver operation and maintenance manuals, including as-built drawings and equipment warranties.

Industry Stats



http://evanmills.lbl.gov/presentations/cx-business-case.pdf

What equipment do we use to commissioning a system?

- Air handing units – Testo anemometer/hotwire/Balometer, pressure differential meter, multimeter
- Fans - Testo anemometer/hotwire, pressure differential meter, multimeter
- Fan coil units - Testo anemometer/hotwire/Balometer, pressure differential meter, multimeter
- Smoke fans - Testo anemometer/hotwire, pressure differential meter, multimeter

BASIC COMMISSIONING CHECK LIST

Required	Yes	No	Required	Yes	No
Diffusers Installed			Snags completed		
Power to all diffusers			Power on all fans		
Controllers installed with power			Power on all AHU's & AC's		
Ducting installed			Flexible ducts undamaged		
Full system installed as per design			Heaters on all diffusers burned in		
Commissioning booked (Date):					

Sample Construction Checklist

8A. HVAC Piping: Insulation
ASHRAE Guideline 1.1 Example Checklist

Instructions: Step 1: Circle Yes or No and fill in with requested information.
Step 2: Explain all "No" responses at the bottom of the checklist.
Step 3: Samples of installed ductwork will be periodically reviewed to verify compliance.

General Overall (Total Job) HVAC Piping Insulation Requirement

Item			Task Description	Response	
1			**System Checks**		
	A		**Installation Checks**	Submitted	Delivered
		1	Piping is clean, dry and free of damage prior to installation.	Yes	No
		2	Pressure and leakage tests performed and reports have been submitted prior to insulation installation.	Yes	No
		3	All chilled water piping is insulated with 1 1/2 inch thick fiberglass pipe insulation with vapor barrier except runouts to radiant cooling panels located beyond 1'-0" within room being served.	Yes	No
		4	Secondary chilled water, low temperature chilled water (2 1/2 inch thick), fan coil drain piping (1/2" thick), and piping with electric trace freeze protection is insulated in the same manner as the chilled water pipes.	Yes	No
		5	All chilled water pumps are insulated with a 1 1/2 inch thick rectangular box made of Manville 817 rigid fiberglass board having a density of 6 lb/ft^3 with a rated vinyl coated and embossed laminate vapor seal (ASJ) jacket.	Yes	No
		6	The insulation box for the pump is open at top and bottom with a removable top to effect a complete insulation for each base mounted pump.	Yes	No
		7	The pipe insulation sections are firmly butted together and the longitudinal seam of the vapor barrier is cemented with Foster No. 85-75.	Yes	No
		8	End joints are sealed with a minimum of 3 inch wide factory furnished vapor barrier strips cemented with Foster No. 85-75.	Yes	No
		9	All fittings, valves, strainers etc. is insulated as described in the specifications.	Yes	No
		10	Exterior piping has a 0.016 inch aluminum jacket with moisture barrier lock seam and Gasco of equal factory applied fittings in lieu of glass cloth jackets. A sample is submitted.	Yes	No

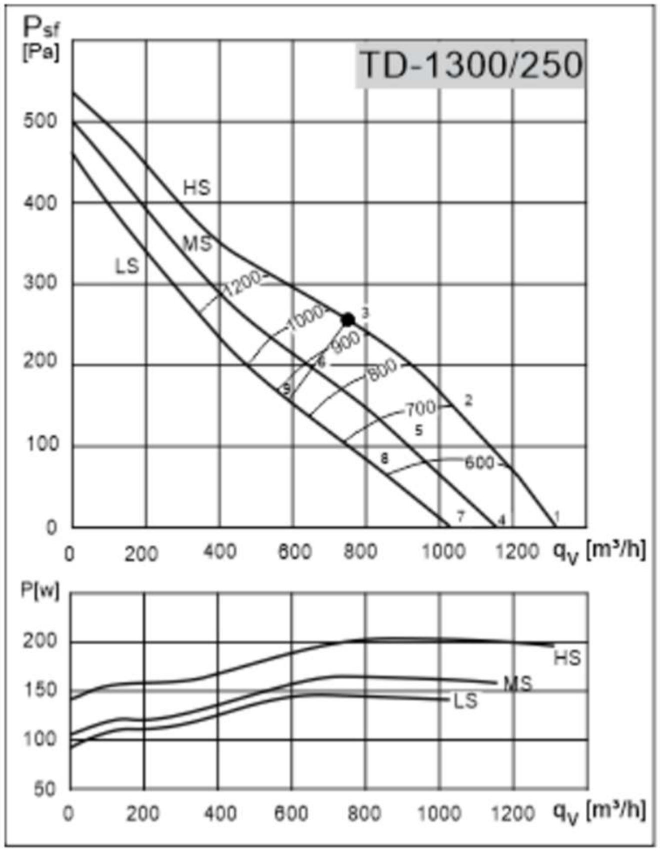
"No" Responses

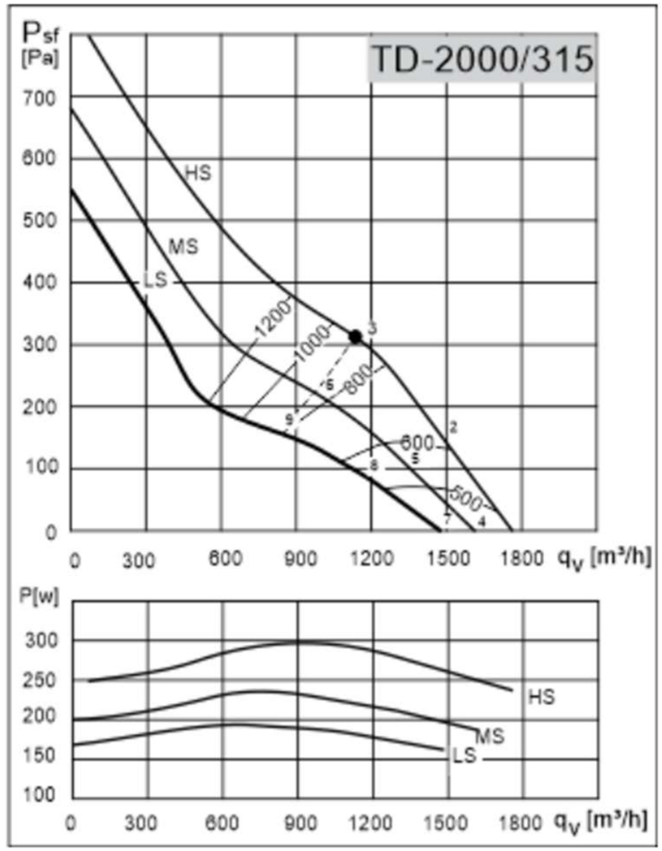
Item	Date	Reason for "No" Response

ASHRAE Guideline 1.1-2007, *HVAC&R Technical Requirements for the Commissioning Process*

TECHNICAL DATA

Model TD Silent	r.p.m.	dB(A)	W	A	m^3/hr	°C	Kg
1300/250	2570/2190	35/31	197/145	0.83/0.61	1270/1070	-40/+60	20
2000/315	2680/2300	39/33	297/191	1.28/0.79	1760/1500	-40/+60	25





- New Filter –75Pa
- Loaded filter – 130pa

- Grille - +-50pa

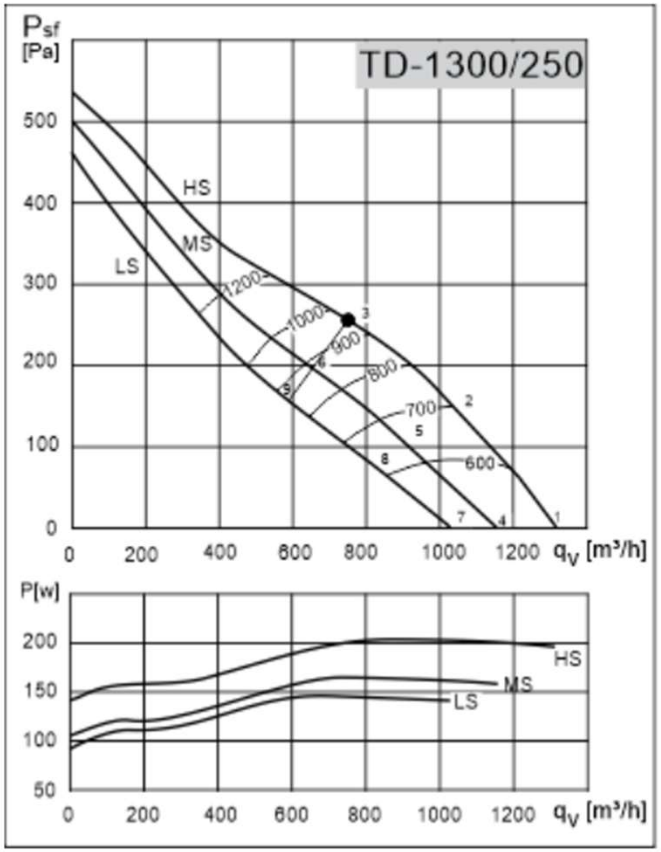
$$m^3|h_r > {}^{l}/_{s}$$

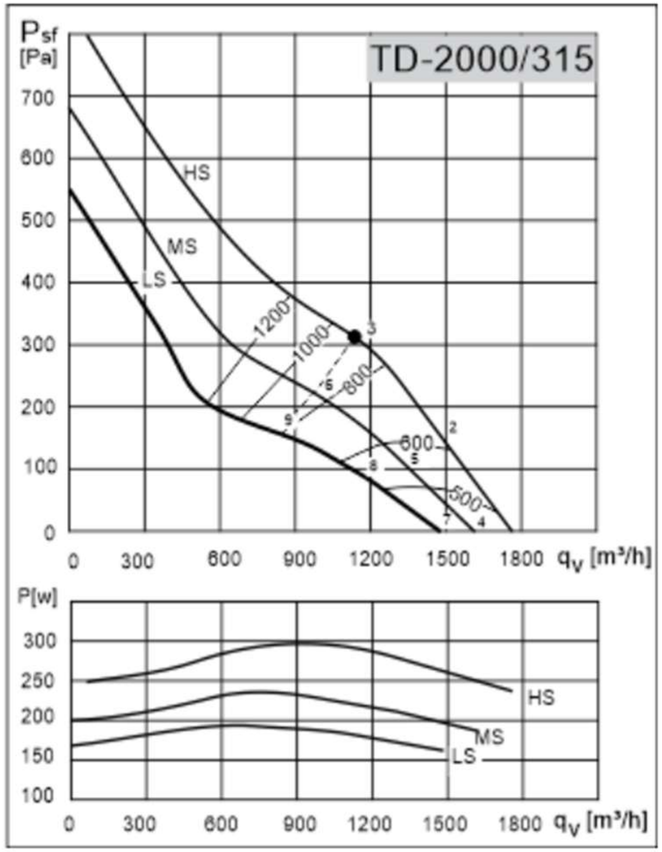
/3.6

<u>Pressure drop inverse proportional to grille/filter size.</u>
<u>Larger Filter and Grille = Lower pressure drop</u>

TECHNICAL DATA

Model TD Silent	r.p.m.	dB(A)	W	A	m^3/hr	°C	Kg
1300/250	2570/2190	35/31	197/145	0.83/0.61	1270/1070	-40/+60	20
2000/315	2680/2300	39/33	297/191	1.28/0.79	1760/1500	-40/+60	25





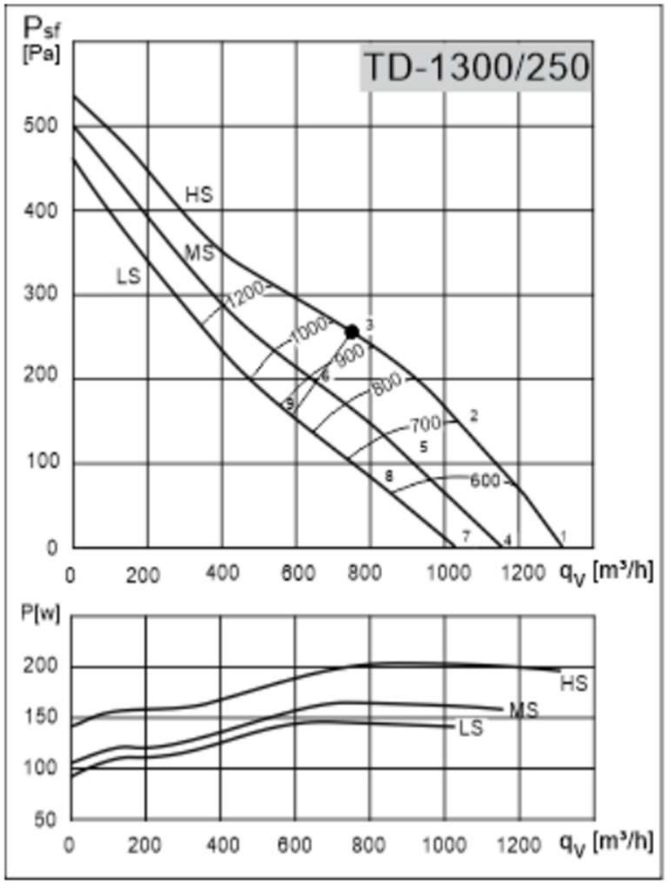
<u>Exercise</u>

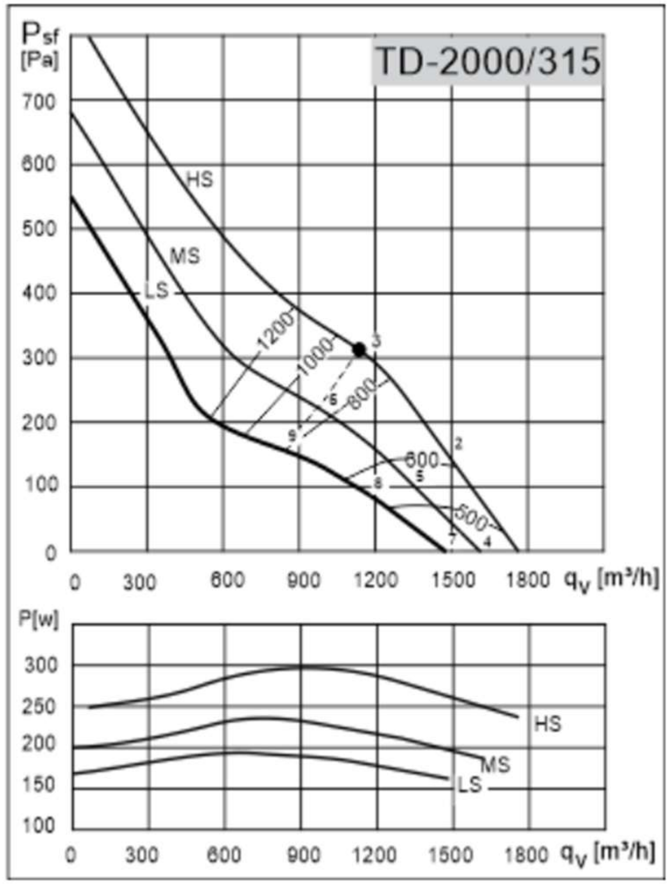
Plot on the curve TD 2000/315

- Pressure drop at 900m^3/hr HS and MS

TECHNICAL DATA

Model TD Silent	r.p.m.	dB(A)	W	A	m³/hr	°C	Kg
1300/250	2570/2190	35/31	197/145	0.83/0.61	1270/1070	-40/+60	20
2000/315	2680/2300	39/33	297/191	1.28/0.79	1760/1500	-40/+60	25





<u>Exercise</u>

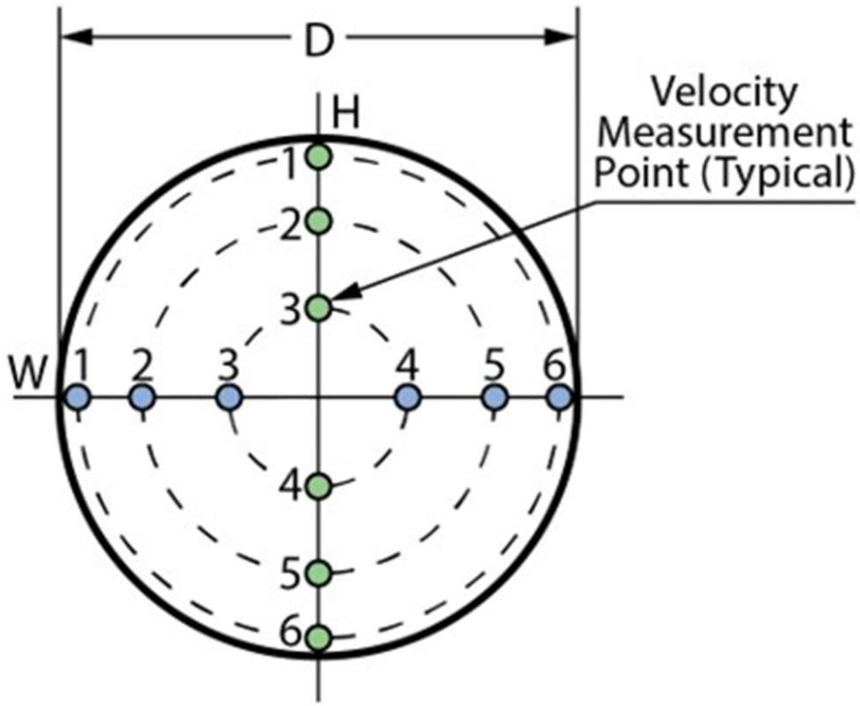
Plot on the curve TD 2000/315

- Pressure drop at 900m^3/hr HS and MS

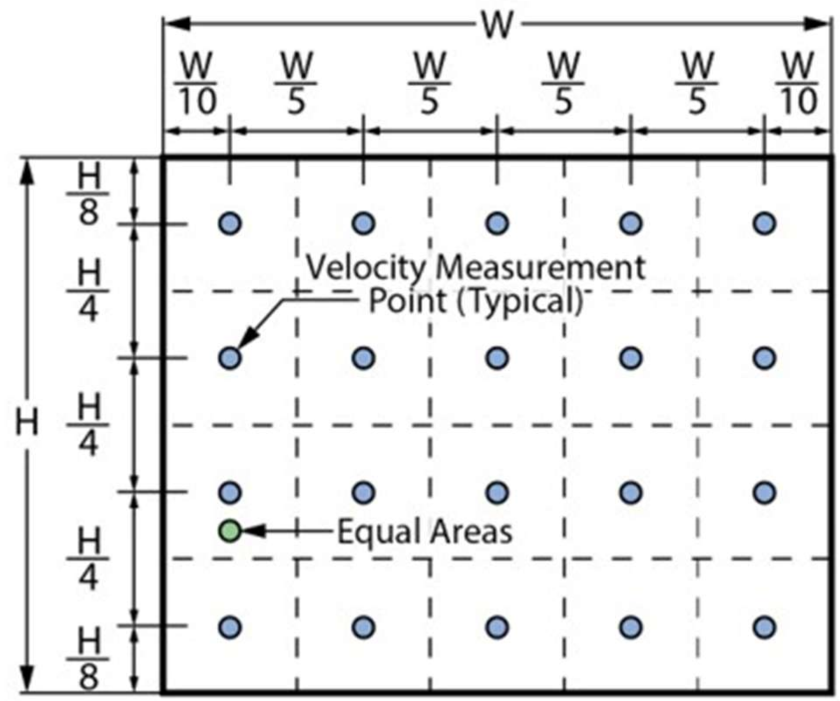
MS – 220Pa

HS – 380Pa

Where to take measurements?



Round duct example for duct with diameter 9 inches or less.



Rectangular duct example for duct with width greater than 24 inches and height less than or equal to 24 inches.

Recommended Airflow and duct velocities

https://www.youtube.com/watch?v=vw-bAbjPTd8

VAV - Variable Air Volume Systems

Recommended velocities

- **Outdoor air intakes**: 300 ft/min (1.5 m/s)
- **Filters**: 250–300 ft/min (1.3–1.5 m/s)
- **Heating coils**: 450–600 ft/min (2.3–3.1 m/s)
- **Cooling coils**: 450–600 ft/min (2.3–3.1 m/s)
- **Air washers**: 500 ft/min (2.5 m/s)
- **Fan outlets**: 1000–2400 ft/min (5.1–12.2 m/s)
- **Main ducts**: 700–1800 ft/min (3.6–9.1 m/s)
- **Branch ducts**: 600–1000 ft/min (3.1–5.1 m/s)
- **Branch risers**: 500–1000 ft/min (2.5–5.1 m/s)

Maximum velocities

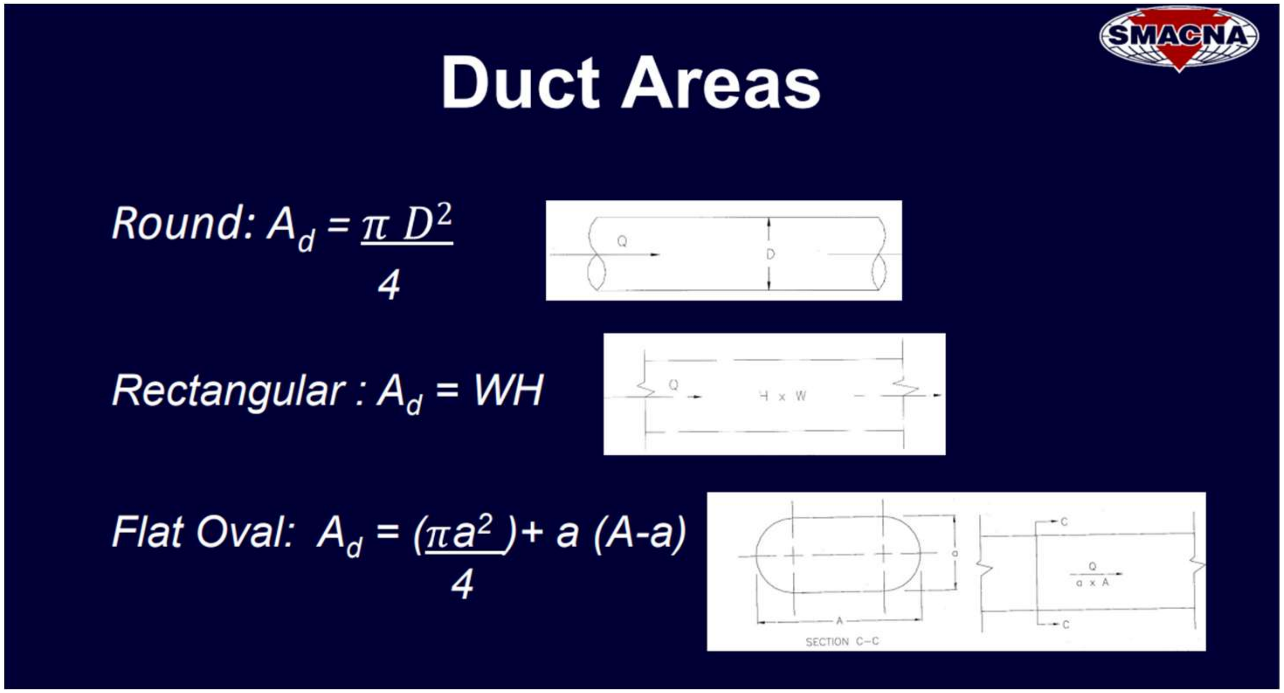
- **Supply diffusers or return grilles**: 1.8–3.8 m/s, depending on the design criteria

Duct velocities in offices

- For operative temperatures above 77.9°F (25.5°C), the upper limit is 160 ft/min (0.8 m/s)
- For operative temperatures below 72.5°F (22.5°C), the limit is 30 ft/min (0.15 m/s)

Duct velocities above 2500 ft/min (12.7 m/s) can cause unwanted noise and pressure.

AIRFLOW FORMULAS



<u>Airflow Formula</u>

Q = A x V

Area = m^2

Velocity = m/s

AxV = m^3/s

π = 3.14159

Exercises - AIRFLOW

Airflow Formula

Q = A x V

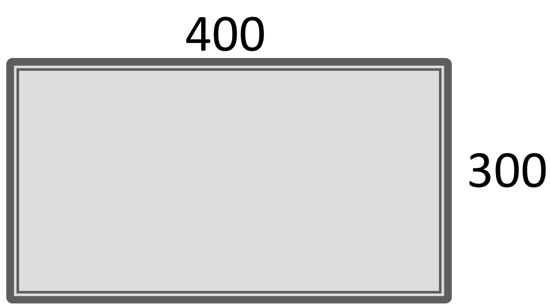
Units in Airflow

m^3/s On Specs and Data Sheets
m^3/hr
L/s

m^3/s to L/s = Value x 1000
m^3/hr to m^3/s = Value / 3600
m^3/hr to L/s = Value / 3.6

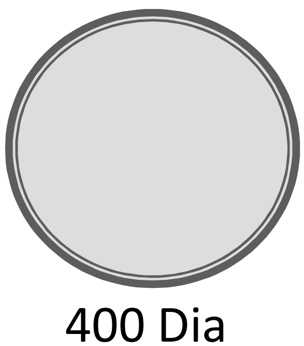
Calculation Exercises

1) V= 5m/s



A = 0.4 x 0.3
=0.12m^2

A = 0.12 x V
= 0.12 x 5
= 0.6m^3/s



$A = \pi r^2$
$= \pi(0.2)^2$
= 3.14159 x $(0.2)^2$
= 0.126m^2

A = 0.12 x V
= 0.126 x 5
= 0.63m^3/s

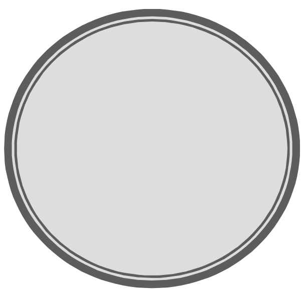
TEST Calculation Exercises (Velocity V – 6m/s)

600

400

$A = 0.6 \times 0.4$
$= 0.24 m^2$

$Q = 0.24 \times 6$
$= 1.44 m^3/s$ OR 1440 L/s

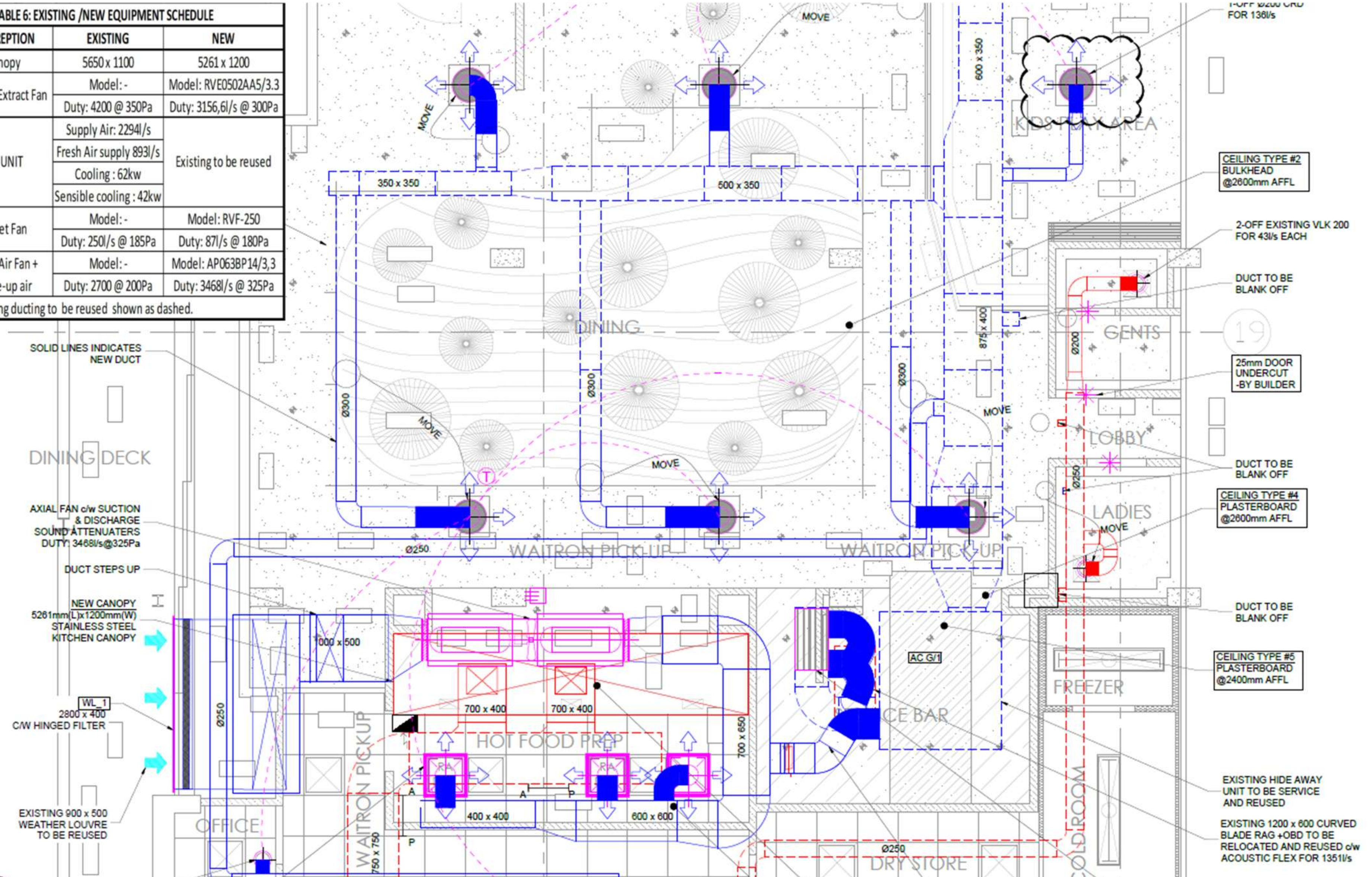


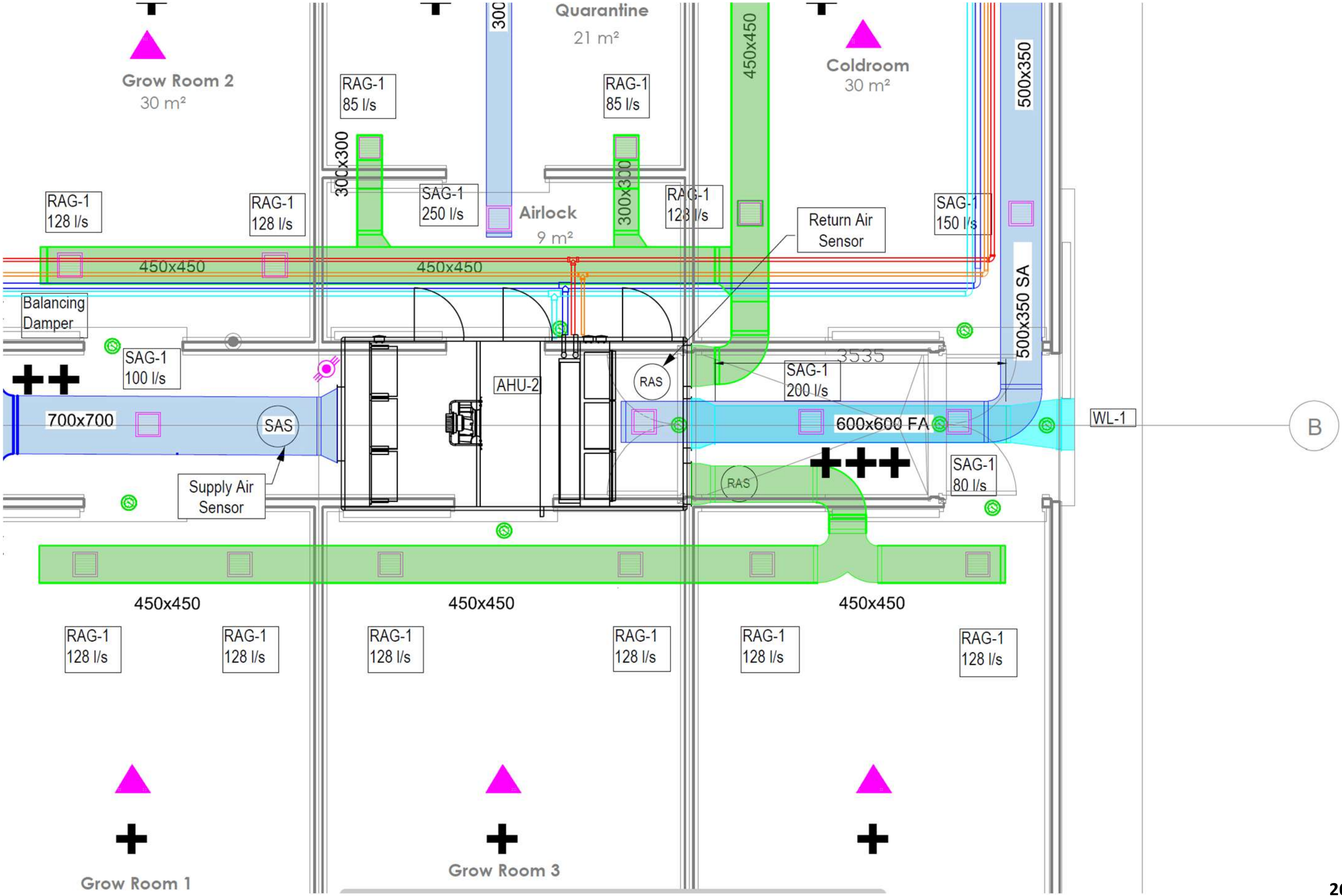
700 Dia

$A = \pi r^2$
$= \pi (0.35)^2$
$= 3.14159 \times (0.35)^2$
$= 0.385 m^2$

$Q = 0.385 \times 6$
$= 2.31 m^3/s$ OR 2310L/s

TABLE 6: EXISTING /NEW EQUIPMENT SCHEDULE			
ITEM	DISCREPTION	EXISTING	NEW
1	Canopy	5650 x 1100	5261 x 1200
2	Canopy Extract Fan	Model: -	Model: RVE0502AA5/3.3
		Duty: 4200 @ 350Pa	Duty: 3156,6l/s @ 300Pa
3	AC UNIT	Supply Air: 2294l/s	Existing to be reused
		Fresh Air supply 893l/s	
		Cooling : 62kw	
		Sensible cooling : 42kw	
4	Toilet Fan	Model: -	Model: RVF-250
		Duty: 250l/s @ 185Pa	Duty: 87l/s @ 180Pa
5	Fresh Air Fan + Make-up air	Model: -	Model: AP063BP14/3,3
		Duty: 2700 @ 200Pa	Duty: 3468l/s @ 325Pa
6	All existing ducting to be reused shown as dashed.		




Quarantine
21 m²
Grow Room 2
30 m²
Coldroom
30 m²
Airlock
9 m²
RAG-1
85 l/s
RAG-1
85 l/s
RAG-1
128 l/s
RAG-1
128 l/s
SAG-1
250 l/s
RAG-1
128 l/s
SAG-1
150 l/s
Return Air
Sensor
Balancing
Damper
SAG-1
100 l/s
SAG-1
200 l/s
AHU-2
RAS
SAS
700x700
600x600 FA
500x350 SA
500x350
450x450
300x300
WL-1
B
3535
Supply Air
Sensor
SAG-1
80 l/s
RAG-1
128 l/s
Grow Room 1
Grow Room 3

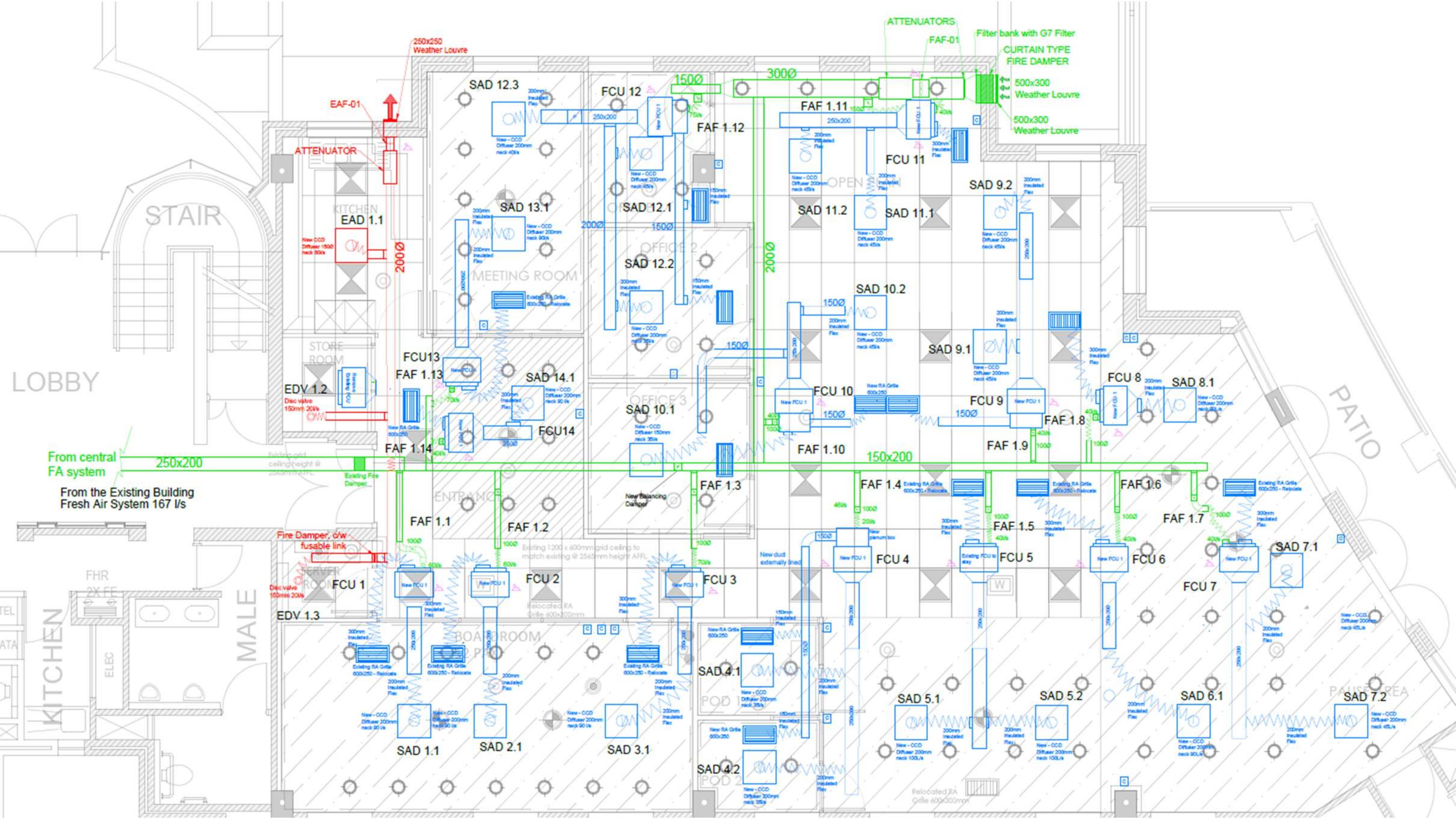
How do I prevent turbulent airflow readings?

1. Avoid readings close to bends/ sharp transition pieces. Measure 5 times the diameter of the duct away from a bend ending
2. Avoid readings on a fan without a grille
3. Measure 150-300mm away if you are measuring on an open fan
4. Do readings on intake grilles – what goes in must come out

HOW DO WE PRESENT DATA?

FCU Details			
	FCU 2		
FCU Make:	IntraMech		
FCU Model:	HC_L_30		
Fan Direct/Belt Drive:	Direct		
Rated Motor Capacity (W):	30		
Total Amps(A):	4.65		
Voltage/Phase/Hz:	230/1/50		
Airflow(l/s):	100 l/s		
Motor (Running @):	High speed		
Control Logic(On/Off/VSD/Timer):	On/Off		
VSD (Yes/No):	N/A		
VSD Make:	N/A		
Reference Number	2023 - P0106325		
Commissioning Data			
	FCU 2		
Measured Airflow (l/s):	109%	98	
Design Airflow (l/s):	90		
Measured Voltage (V):	227		
Measured Current (A):	0.4		
Airflow Measurements			
Item No.	Terminal Ref	Design Air Flow (l/s)	Actual Air Flow(l/s)
1	SAD 2.1	90	98
Total:		**90**	**98**
Notes:			
Commissioning has been done in high-speed mode			

SAIRAC


ATTENUATORS
FAF-01
Filter bank with G7 Filter
CURTAIN TYPE FIRE DAMPER
500x300 Weather Louvre
500x300 Weather Louvre
250x250 Weather Louvre
EAF-01
ATTENUATOR
STAIR
KITCHEN
EAD 1.1
STORE ROOM
LOBBY
EDV 1.2
From central FA system
250x200
From the Existing Building Fresh Air System 167 l/s
Fire Damper, c/w fusable link
SERVER ROOM
EDV 1.3
FHR 2X FE
KITCHEN
ELEC
MALE
SAD 12.3
SAD 13.1
MEETING ROOM
FCU13
FAF 1.13
FAF 1.14
FCU14
SAD 14.1
ENTRANCE
FAF 1.1
FAF 1.2
FCU 1
FCU 2
FCU 3
BOARDROOM
SAD 1.1
SAD 2.1
SAD 3.1
FCU 12
FAF 1.12
SAD 12.1
OFFICE 2
SAD 12.2
OFFICE 3
SAD 10.1
New Balancing Damper
FAF 1.3
150Ø
300Ø
200Ø
FAF 1.11
FCU 11
OPEN
SAD 11.2
SAD 11.1
SAD 10.2
SAD 9.2
SAD 9.1
FCU 10
FAF 1.10
150x200
FCU 9
FAF 1.8
FAF 1.9
FCU 8
SAD 8.1
PATIO
FAF 1.4
FAF 1.5
FAF 1.6
FAF 1.7
FCU 4
FCU 5
FCU 6
FCU 7
SAD 7.1
SAD 4.1
POD 1
SAD 4.2
POD 2
SAD 5.1
SAD 5.2
SAD 6.1
SAD 7.2
PAUSE AREA

SAIRAC

If an airflow system is under performing, where do I look?

1. Start at the source – Fan, AHU, FCU or AC Unit
2. Look for restrictions – Filters, Blocked ducting, faulty diffusers, faulty fan
3. Ensure you take main duct readings where possible BEFORE you start measuring down stream
4. Ensure you system parameters are as required – check design

OTHER UNcommon oversights

SAIRAC

Questions

Thank you