CONTENTS

YOUR VENT-AXIA SYSTEM CALCULATOR

The extensive range of Vent-Axia fans, accessories and controllers, gives the specifier and installer freedom to custom design systems to suit individual applications. The Vent-Axia constant velocity System Calculator has been produced to assist in the design and selection process by ensuring that the correct duct size and components are chosen for a particular requirement and duty. Intended to be used in conjunction with the Vent-Axia Industrial and Domestic & Commercial Range Manuals, which give full product details, it will provide good approximations, which will satisfy a large number of simple ducted systems. For more complex designs beyond the scope of this Calculator, refer to specialist consultants.

Before using the System Calculator we recommend that you spend a few minutes reading the introduction and work through the easy to follow examples. As a result designing a ducted system should no longer be a hit-or-miss affair; the Vent-Axia System Calculator will enable Vent-Axia fans and accessories to be selected with confidence.

The System Calculator can be used in conjunction with the Vent-Axia Fan Selector Program. This not only simplifies correct fan selection, but also provides the fan performance curve, system curves, full sound details, dimensions and full specification. Contact your local Vent-Axia office for details.

WHAT IS VENTILATION ?

Ventilation can be simply described as air circulation, the extraction of stale, overheated and contaminated air and the supply and distribution of fresh air in amounts necessary to provide healthy and comfortable conditions for the occupants of a room. This creates an environment which stimulates the occupants to higher efficiency.

When dealing with a particular ventilation problem, the three following basic decisions have to be made:-

1. **Type of System** - required, ie. extract, intake, or a combination of both, positive or negative pressure.

2. **Ventilation Rate** - Air Changes Per Hour (ACH) necessary for the conditions (see Table 1, page 3).

3. **Provision for air replacement** - will existing openings be sufficient, or are special arrangements necessary?

1. TYPE OF SYSTEM

a) An **Extract system** is designed to remove foul air, usually at high level, unless the fumes are heavier than air, when extraction would take place near floor level.

   This extraction creates an area of **negative pressure** causing the fresher replacement air to flow into the room through doors, windows, or through suitably spaced low level intake grilles.

   This is by far the most common, economical and simplest system for normal ventilation work.

b) An **Intake system** - blows in fresh air, which mixes with the air already in the room and forces its way out to the atmosphere through any available openings. Careful location and speed control of intake fans and evenly distributed air supply diffusers are necessary to prevent draughty conditions. Even in warm weather, incoming air may need to be tempered and/or filtered, in which case careful planning should be given to the position of the diffusers. If filtered air is required, an intake system is essential, and the room should be under a slight **positive pressure,** so that any leakage of air is outwards from the room.

c) **A Combined system** using both extract and supply systems can be more effective than extract only in large offices, as controlled mechanical intake can be used to give positive gentle air movement in warm weather to create a feeling of freshness. It also reduces the number and size of openings required in the structure for replacement fresh air. Heat Recovery units can be incorporated in this type of system for energy saving during the Winter months and under certain conditions, a degree of cooling during spring and early summer. Where buildings are air conditioned, these savings will continue in the summer.

2. VENTILATION RATE

The points which affect this are:-

a) the purpose for which the area to be ventilated is used.

b) the number of occupants.

c) the type of activity they are engaged in.

d) heat gains from other sources eg. electrical equipment and lighting etc.

e) the amount of steam, dust and odours from production processes.

f) Whether there are any particular environmental requirements for the building, such as temperature, humidity, levels of filtration etc.

The **Guide to Ventilation Rates** (See Table 1, page 3) is based on Vent-Axia's extensive experience of all normal conditions in the UK. The figures should be doubled for work in hot climates and increased by 50% if there is a possibility of tobacco smoke.

If in doubt, take the highest ACH figures as control switches can always be used to reduce the ventilation rate.

The Building Regulations, 1991, Approved Document F, 1995 Edition now covers Non Domestic Buildings. We recommend that all ventilation work is designed to conform to the Approved Document.

TABLE 1
GUIDE TO VENTILATION RANGES (ACH) AND COMPONENT VELOCITIES

	ACH	TYPICAL VELOCITIES OF DUCTED SYSTEMS (m/s)			
Location		Main Duct	Branch Duct	Supply Grilles	Exhaust Grilles
Assembly Halls	4 - 8	5 - 8	4 - 6	3 - 5	2 - 3
Bakeries	20 - 30	8 - 11	6 - 8	5 - 8	3 - 4
Banks	4 - 8	5 - 8	4 - 6	3 - 5	2 - 3
Bathrooms	6 - 10	4 - 5	3 - 4	2 - 3	1.5 - 2
Bedrooms	2 - 4	4 - 5	3 - 4	2 - 3	1.5 - 2
Billiard Rooms *	6 - 8	5 - 8	4 - 6	3 - 5	2 - 3
Boiler Rooms	15 - 30	8 - 15	6 - 10	5 - 10	4 - 10
Cafes and Coffee Bars	10 - 12	5 - 8	4 - 6	3 - 5	2 - 3
Canteens	8 - 12	5 - 8	4 - 6	3 - 5	2 - 3
Cellars	3 - 10	5 - 8	4 - 6	3 - 5	2 - 3
Changing Rooms - Main area	6 - 10	4 - 5	4 - 6	3 - 5	2 - 3
Changing Rooms - Shower area	15 - 20	5 - 8	4 - 6	3 - 5	2 - 3
Churches	1 - 3	4 - 5	3 - 4	2 - 3	1.5 - 2
Cinemas and Theatres *	10 - 15	5 - 8	4 - 6	3 - 5	2 - 3
Club rooms	10 - 12	5 - 8	4 - 6	3 - 5	2 - 3
Compressor rooms	10 - 20	8 - 15	6 - 10	5 - 10	4 - 10
Conference rooms	8 - 12	5 - 8	4 - 6	3 - 5	2 - 3
Dance halls	8 - 12	5 - 8	4 - 6	3 - 5	2 - 3
Dental surgeries	12 - 15	5 - 8	4 - 6	3 - 5	2 - 3
Dye works	20 - 30	8 - 15	6 - 10	5 - 10	4 - 10
Electroplating shops	10 - 12	8 - 15	6 - 10	5 - 10	4 - 10
Engine rooms	15 - 30	8 - 15	6 - 10	5 - 10	4 - 10
Entrance Halls & Corridors	3 - 5	5 - 8	4 - 6	3 - 5	2 - 3
Factories and Workshops	8 - 10	8 - 15	6 - 10	5 - 10	4 - 10
Foundries	15 - 30	8 - 15	6 - 10	5 - 10	4 - 10
Garages (Showrooms)	6 - 8	5 - 8	4 - 6	3 - 5	2 - 3
Glasshouses	25 - 60	4 - 5	3 - 4	2 - 3	1.5 - 2
Gymnasiums	6 min				
Hairdressing Salons	10 - 15	5 - 8	4 - 6	3 - 5	2 - 3
Hospitals - Sterilising	15 - 25	5 - 8	4 - 6	3 - 5	2 - 3
- Wards	6 - 8	4 - 5	3 - 4	2 - 3	1.5 - 2
Kitchens - Domestic	15 - 20	4 - 5	3 - 4	2 - 3	1.5 - 2
# - Commercial	20 -30	8 - 11	6 - 8	5 - 8	3 - 4
Laboratories	6 - 15	5 - 8	4 - 6	3 - 5	2 - 3
Launderettes	10 - 15	8 - 11	6 - 8	5 - 8	3 - 4
Laundries	10 - 30	8 - 11	6 - 8	5 - 8	3 - 4
Lavatories	6 - 15	5 - 8	4 - 6	3 - 5	2 - 3
Lecture theatres	5 - 8	4 - 5	3 - 4	2 - 3	1.5 - 2
Libraries	3 - 5	4 - 5	3 - 4	2 - 3	1.5 - 2
Living rooms	3 - 6	4 - 5	3 - 4	2 - 3	1.5 - 2
Mushroom Houses	6 - 10	5 - 8	4 - 6	3 - 5	2 - 3
Offices	6 - 10	5 - 8	4 - 6	3 - 5	2 - 3
Paint shops (not cellulose)	10 - 20	8 - 11	6 - 8	5 - 8	3 - 4
Photo & X-ray darkrooms	10 - 15	5 - 8	4 - 6	3 - 5	2 - 3
Public house bars	10 - 15	5 - 8	4 - 6	3 - 5	2 - 3
Recording studios	10 - 12	4 - 5	3 - 4	2 - 3	1.5 - 2
Recording Control rooms	15 - 25	4 - 5	3 - 4	2 - 3	1.5 - 2
Restaurants	8 - 12	5 - 8	4 - 6	3 - 5	2 - 3
Schoolrooms	5 - 7	5 - 8	4 - 6	3 - 5	2 - 3
Shops and Showrooms	8 - 15	5 - 8	4 - 6	3 - 5	2 - 3
Shower baths	15 - 20	5 - 8	4 - 6	3 - 5	2 - 3
Stores & warehouses	3 - 6	5 - 8	4 - 6	3 - 5	2 - 3
Swimming baths	10 - 15	8 - 11	6 - 8	5 - 8	3 - 4
Toilets	6 - 10	4 - 5	3 - 4	2 - 3	1.5 - 2
Utility rooms	15 - 20	5 - 8	4 - 6	3 - 5	2 - 3
Welding shops	15 - 30	8 - 15	6 - 10	5 - 10	4 - 10

* Increase by 50% where heavy smoking occurs or if the room is underground.
# Some commercial kitchens may require higher ventilation rates, based on cooking equipment in use.

3. PROVISION FOR AIR REPLACEMENT

Whilst in a few cases the normal gaps around doors and windows are sufficient for this purpose, it is more often necessary and advisable to make special provision for replacement fresh air to be brought into the room through grilles, of a suitable size and design, fitted in doors or walls to minimise draughts.

Special provision for air replacement must be considered if:-

a) Windows and doors are draught proofed or double glazed.

b) The location of fans is such that satisfactory coverage of the space by cross-ventilation cannot be made with air pulled in from the available doors and windows.

c) When the fan is installed in a room containing a fuel burning appliance, the installer must ensure that air replacement is adequate for both the fan and the fuel burning appliance.

d) If it is necessary to pass ducting through a fire barrier then provision must be made for fire dampers in ducting, together with any other requirements necessary due to Fire and Buildings Regulations etc.

When considering air replacement, the location of suitable air intake points is as important as the location of the extract fans.

The main points are:-

a) Aim for full **cross-ventilation** of the space.

b) Eliminate 'dead' spots by **preventing short-circuiting** of air flow straight from inlets to extract units without 'sweeping' the room.

c) Use **sufficient correctly sized grilles** to keep supply and extract air velocities between 1.5m/s and 3m/s, if possible. (See Table 1, page 3)

d) If the room is very wide, say over 25m it may be necessary to **extract centrally** and bring in replacement air along each side.

e) Supply and extract points external to the building should be a minimum of **2 metres** apart.

Air replacement should be provided at the minimum rate of 0.087m^2 of free area per 1000m^3/h of air moved. Air replacement grilles usually have a free area of approximately 60%.

For example - a 300mm square grille will have a face area of 300 x 300 = 0.09m^2, therefore 60% of 0.09 = **0.054m^2 free area.** This means that this grille will provide air replacement for the rate of $\frac{.054}{.087} \times 1000 =$ **620m^3/h**

4. SELECTING THE FAN

A fan is simply a machine for moving air and other gases by means of a rotating impeller. Vent-Axia manufactures three main types of impeller - Axial, Mixed Flow and Centrifugal. There are four main types of unit available in the Vent-Axia industrial fan range - In-Line Centrifugal Duct fans, In-Line Slim & Long Cased Axial fans, In-Line Powerflow Duct fans, In-Line Mixed Flow fans and High Performance Acoustic fans. The benefits of each of these fans are listed below and will help you to determine which unit is appropriate for your system.

a) **Metal In-Line Centrifugal Duct fans (sizes 100 to 315mm ducting)**
- Medium air volumes up to 1650m^3/h (0.458m^3/s)
- Medium pressure development up to 500 Pascals (Pa)
- Non-overloading fan characteristics
- Suitable where noise is not a priority

b) **In-Line Powerflow Duct fans (sizes 100 to 315mm ducting)**
- Medium air volumes up to 1510m^3/h (0.42m^3/s)
- Medium pressure development up to 500 Pa
- Medium sound levels
- Lighter weight
- Low profile for concealed applications

c) **In-Line Mixed Flow fans (sizes 100 to 400mm ducting)**
- High air volumes up to 4300m^3/h (1.202m^3/s)
- Medium pressure development up to 240 Pa
- Energy efficient
- Medium sound levels
- Compact in size

d) **Acoustic fans (sizes 100 to 400 ducting)**
- Medium air volumes up to 3700m^3/h (1.04m^3/s)
- Medium pressure development up to 400 Pa
- Quiet operating sound levels

e) **Slim & Long Cased Axial fans (sizes 250 to 400 ducting)**
- High air volumes up to 10,300m^3/h (2.88m^3/s)
- Low to medium pressure development ranging from 60 Pa to 300 Pa
- Energy efficient
- Medium sound levels

DESIGN OF A DUCTED SYSTEM

It is very important that ventilation systems comply with any Fire Regulations, Building Regulations, Codes of Practice etc, relevant to the installation and the components being used.

As much information as possible must be obtained from the customer or other sources regarding the application of these regulations to the building and/or area to be ventilated before attempting to design a system.

Our recommended procedure for designing a ducted system is as follows:

a) Calculate the **Room Volume** to be ventilated Width x Length x Height = m^3 (cubic metres).

b) Calculate the **Air Volume** requirement by multiplying the **Room Volume** by the **Air Change Rate** per hour (See Table 1, page 3) = m^3/h.

c) Decide on the best position for the intake and the extract outlets to the atmosphere and the best route for duct runs. The design should provide good air distribution in the room, whilst keeping the duct layout as simple as possible.

d) Determine each section of main and branch duct, the size and shape of each grille and duct bend.

There are several ways of approaching designing and sizing ducted systems. The simplest is the velocity method, which involves selecting main and branch air velocities (See Table 1, page 3) used in conjunction with trial calculations.

e) Sizing the duct(s)
A calculation is necessary to establish a duct size, which will provide the Air velocity which equates most closely to the velocities given in Table 1.

Substitute the Air volume for the room (m^3/h) you have previously calculated, and the velocity (from Table 1) in the equation below.

$$\text{DUCT CROSS SECTION AREA} = \frac{\text{VOLUME } (m^3/h)}{\text{VELOCITY } (m/s) \times 3600 \text{ (FACTOR)}} = m^2$$

Select the next size up duct dia from (Table 2, page 7) and calculate the exact velocity in the duct in the equation below.

$$\text{VELOCITY } (m/s) = \frac{\text{VOLUME } (m^3/h)}{\text{AREA } (m^2) \times 3600} = m/s$$

<u>or</u>

$$\text{VELOCITY } (m/s) = \frac{\text{VOLUME } (m^3/s)}{\text{AREA } (m^2)} = m/s$$

If the resultant velocity is too high (See Table 1, page 3), then the duct diameter is too small, the system is likely to be noisy and it is unlikely that there is a fan in the Vent-Axia range to suit.

If the resultant Velocity is lower than recommended, the system will be extremely quiet but the ducts oversized and the overall cost may rise unnecessarily.

The Gross Cross Section are in m^2 for Circular Ducting is as follows:-

Table 2

Duct Diameter	=	Free Area (m^2)
100mm	=	$0.00785m^2$
125mm	=	$0.01227m^2$
150mm	=	$0.01767m^2$
200mm	=	$0.03142m^2$
250mm	=	$0.04909m^2$
315mm	=	$0.07794m^2$
355mm	=	$0.09898m^2$
400mm	=	$0.12566m^2$

f) In order to proceed to the next stage you need the following information: (See example 1)

i. The preferred duct diameter (calculation e)

ii. The air velocity m/s (calculation e)

iii. A list of Vent-Axia components including duct length and the number of bends (see catalogue for components). Select the correct duct diameter and component resistance chart and list the resistance in Pa (Pascals) against each items shown (see pages 10 to 16).

Add up all of the component resistances for the Total System Static Resistance.

Then using the current Vent-Axia Catalogue or Fan Selector Programme, select a fan that has the same duct diameter as per your system, ensuring that the fan produces a higher performance than required, as a speed controller can be used to reduce the fans performance to the correct level.

100mm DIA COMPONENT SYSTEM RESISTANCES

DUCT VELOCITY

Ducting Component		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Volume	(l/s)	16	24	31	39	47	55	63	71	79
	(m^3/s	0.0157	0.02355	0.0314	0.03925	0.0471	0.05495	0.0628	0.07065	0.0785
	(m^3/h)	57	85	113	141	170	198	226	254	283
	(cfm)	33	50	67	83	100	116	133	150	166
Flexible Ducting - 1 metre of fully extended flexible		-	2.5 Pa	4 Pa	6 Pa	9 Pa	13 Pa	16 Pa	20 Pa	26 Pa
90˚ Flexible Bend		-	3.5 Pa	4 Pa	6.5 Pa	10 Pa	14 Pa	20 Pa	23 Pa	26 Pa
45˚ Flexible Bend		-	4 Pa	3.5 Pa	5.5 Pa	8 Pa	11 Pa	15 Pa	19 Pa	23 Pa
Rigid Ducting, per 1 metre (spirally wound)		0.5 Pa	1.2 Pa	2.1 Pa	3.3 Pa	4.8 Pa	6.5 Pa	8.4 Pa	10.7 Pa	13.2 Pa
90˚ Bend, Rigid Ducting	Plain	0.5 Pa	1.1 Pa	2 Pa	3 Pa	4.3 Pa	6 Pa	8 Pa	10.7 Pa	13.2 Pa
	Segmented	1 Pa	2 Pa	4 Pa	6 Pa	8 Pa	11 Pa	14 Pa	17 Pa	21 Pa
45˚ Bend, Rigid Ducting	Plain	0.2 Pa	0.5 Pa	1 Pa	1.5 Pa	2.2 Pa	3 Pa	4 Pa	5 Pa	6 Pa
	Segmented	0.4 Pa	1 Pa	2 Pa	3 Pa	4 Pa	6 Pa	7 Pa	9 Pa	11 Pa
Duct Air Heater		1.5 Pa	3 Pa	5 Pa	7.5 Pa	11 Pa	15 Pa	20 Pa	25 Pa	30 Pa
Filter Cassette - (Clean)		23 Pa	30 Pa	50 Pa	65 Pa	80 Pa	95 Pa	120 Pa	-	-
Bag Filter Cassette - (Clean)		10 Pa	22 Pa	38 Pa	60 Pa	86 Pa	118 Pa	154 Pa	-	-
Duct Attenuator	600 Long	1 Pa	2 Pa	3 Pa	4 Pa	5 Pa	7 Pa	9 Pa	11 Pa	14 Pa
Backdraught Shutters		20 Pa	22 Pa	24 Pa	26 Pa	30 Pa	35 Pa	42 Pa	50 Pa	60 Pa
3-Way Splitters		2 Pa	3 Pa	4 Pa	6 Pa	8 Pa	12 Pa	16 Pa	20 Pa	24 Pa
4-Way Diffusers	230 sq. in.	SEE RELEVANT PAGE IN THE VENT-AXIA PRODUCT RANGE MANUAL								
Louvre Shutters		5 Pa	9 Pa	12 Pa	20 Pa	26 Pa	35 Pa	46 Pa	58 Pa	72 Pa
Wall Terminal		4 Pa	8 Pa	14 Pa	21 Pa	31 Pa	43 Pa	54 Pa	-	-
Roof Terminal		4 Pa	9 Pa	15 Pa	22 Pa	32 Pa	42 Pa	54 Pa	-	-

125mm DIA COMPONENT SYSTEM RESISTANCES

DUCT VELOCITY

Ducting Component		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Volume	(l/s)	25	37	49	61	74	86	98	110	123
	(m^3/s)	0.0245	0.03681	0.0491	0.06135	0.0736	0.08589	0.0982	0.11043	0.1227
	(m^3/h)	88	133	177	221	265	309	353	398	442
	(cfm)	52	78	104	130	156	182	208	234	260
Flexible Ducting - 1 metre of fully extended flexible		-	2 Pa	3.5 Pa	5 Pa	7 Pa	10 Pa	13 Pa	16 Pa	20 Pa
90˚ Flexible Bend		-	2.5 Pa	4 Pa	6.5 Pa	9.5 Pa	14 Pa	17 Pa	21 Pa	26 Pa
45˚ Flexible Bend		-	2 Pa	3.5 Pa	5.2 Pa	7.5 Pa	11 Pa	15 Pa	19 Pa	23 Pa
Rigid Ducting, per 1 metre (spirally wound)		0.4 Pa	0.8 Pa	1.4 Pa	2.3 Pa	3.2 Pa	4.4 Pa	5.8 Pa	7.3 Pa	9 Pa
90˚ Bend, Rigid Ducting	Plain	0.5 Pa	1.1 Pa	2 Pa	3 Pa	4.3 Pa	6 Pa	8 Pa	10 Pa	12 Pa
	Segmented	1 Pa	2 Pa	4 Pa	6 Pa	8 Pa	11 Pa	14 Pa	17 Pa	21 Pa
45˚ Bend, Rigid Ducting	Plain	0.2 Pa	0.5 Pa	1 Pa	1.5 Pa	2.2 Pa	3 Pa	4 Pa	5 Pa	6 Pa
	Segmented	0.4 Pa	1 Pa	2 Pa	3 Pa	4 Pa	6 Pa	7 Pa	9 Pa	11 Pa
Duct Air Heater		1.5 Pa	3 Pa	5 Pa	7.5 Pa	11 Pa	15 Pa	20 Pa	25 Pa	30 Pa
Filter Cassette - (Clean)		23 Pa	30 Pa	50 Pa	65 Pa	80 Pa	95 Pa	120 Pa	-	-
Bag Filter Cassette - (Clean)		10 Pa	22 Pa	38 Pa	60 Pa	86 Pa	118 Pa	154 Pa	-	-
Duct Attenuator	600 Long	1 Pa	2 Pa	3 Pa	4 Pa	5 Pa	7 Pa	9 Pa	11 Pa	14 Pa
Backdraught Shutters		20 Pa	22 Pa	24 Pa	26 Pa	30 Pa	35 Pa	42 Pa	50 Pa	60 Pa
3-Way Splitters		2 Pa	3 Pa	4 Pa	6 Pa	8 Pa	12 Pa	16 Pa	20 Pa	24 Pa
4-Way Diffusers		SEE RELEVANT PAGE IN THE VENT-AXIA PRODUCT RANGE MANUAL								
Louvre Shutters		5 Pa	9 Pa	12 Pa	20 Pa	26 Pa	35 Pa	46 Pa	58 Pa	72 Pa
Wall Terminal		4 Pa	8 Pa	14 Pa	21 Pa	31 Pa	43 Pa	54 Pa	-	-
Roof Terminal		4 Pa	9 Pa	15 Pa	22 Pa	32 Pa	42 Pa	54 Pa	-	-

150mm DIA COMPONENT SYSTEM RESISTANCES

DUCT VELOCITY

Ducting Component		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Volume	(l/s)	35	53	71	88	106	124	141	159	177
	(m^3/s)	0.0353	0.05301	0.0707	0.08835	0.106	0.12369	0.1414	0.15903	0.1767
	(m^3/h)	127	191	254	318	382	445	509	573	636
	(cfm)	75	112	150	187	225	262	300	337	374
Flexible Ducting - 1 metre of fully extended flexible		-	1.5 Pa	3 Pa	4.5 Pa	6 Pa	8 Pa	11 Pa	15 Pa	17 Pa
90° Flexible Bend		-	2.5 Pa	4 Pa	6.5 Pa	9.5 Pa	14 Pa	17 Pa	21 Pa	26 Pa
45° Flexible Bend		-	2 Pa	3.5 Pa	5.2 Pa	7.5 Pa	11 Pa	15 Pa	19 Pa	23 Pa
Rigid Ducting, per 1 metre (spirally wound)		0.3 Pa	0.6 Pa	1.2 Pa	1.8 Pa	2.6 Pa	3.5 Pa	4.6 Pa	5.8 Pa	7.2 Pa
90° Bend, Rigid Ducting	Plain	0.5 Pa	1.1 Pa	2 Pa	3 Pa	4.3 Pa	6 Pa	8 Pa	10 Pa	12 Pa
	Segmented	1 Pa	2 Pa	4 Pa	6 Pa	8 Pa	11 Pa	14 Pa	17 Pa	21 Pa
45° Bend, Rigid Ducting	Plain	0.2 Pa	0.5 Pa	1 Pa	1.5 Pa	2.2 Pa	3 Pa	4 Pa	5 Pa	6 Pa
	Segmented	0.4 Pa	1 Pa	2 Pa	3 Pa	4 Pa	6 Pa	7 Pa	9 Pa	11 Pa
Duct Air Heater		1.5 Pa	3 Pa	5 Pa	7.5 Pa	11 Pa	15 Pa	20 Pa	25 Pa	30 Pa
Filter Cassette - (Clean)		23 Pa	30 Pa	50 Pa	65 Pa	80 Pa	95 Pa	120 Pa	-	-
Bag Filter Cassette - (Clean)		10 Pa	22 Pa	38 Pa	60 Pa	86 Pa	118 Pa	154 Pa	-	-
Duct Attenuator	600 Lomg	1 Pa	2 Pa	3 Pa	4 Pa	5 Pa	7 Pa	9 Pa	11 Pa	14 Pa
Backdraught Shutters		20 Pa	22 Pa	24 Pa	26 Pa	30 Pa	35 Pa	42 Pa	50 Pa	60 Pa
3-Way Splitters		2 Pa	3 Pa	4 Pa	6 Pa	8 Pa	12 Pa	16 Pa	20 Pa	24 Pa
4-Way Diffusers	230 sq. in.	SEE RELEVANT PAGE IN THE VENT-AXIA PRODUCT RANGE MANUAL								
Louvre Shutters		5 Pa	9 Pa	12 Pa	20 Pa	26 Pa	35 Pa	46 Pa	58 Pa	72 Pa
Wall Terminal		4 Pa	8 Pa	14 Pa	21 Pa	31 Pa	43 Pa	54 Pa	-	-
Roof Terminal		4 Pa	9 Pa	15 Pa	22 Pa	32 Pa	42 Pa	54 Pa	-	-

200mm DIA COMPONENT SYSTEM RESISTANCES

DUCT VELOCITY

Ducting Component		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Volume	(l/s)	63	94	126	157	189	220	251	283	314
	(m^3/s)	0.0628	0.09426	0.1257	0.1571	0.1885	0.21994	0.2514	0.28278	0.3142
	(m^3/h)	226	339	452	566	679	792	905	1018	1131
	(cfm)	133	200	266	333	399	466	533	599	666
Flexible Ducting - 1 metre of fully extended flexible		-	1Pa	2 Pa	3 Pa	4 Pa	5.5 Pa	7 Pa	9 Pa	12 Pa
90˚ Flexible Bend		-	2.5 Pa	4 Pa	6.5 Pa	9.5 Pa	14 Pa	17 Pa	21 Pa	26 Pa
45˚ Flexible Bend		-	2 Pa	3.5 Pa	5.2 Pa	7.5 Pa	11 Pa	15 Pa	19 Pa	23 Pa
Rigid Ducting, per 1 metre (spirally wound)		0.2 Pa	0.5 Pa	0.9 Pa	1.4 Pa	1.9 Pa	2.6 Pa	3.5 Pa	4.4 Pa	5.4 Pa
90˚ Bend, Rigid Ducting	Plain	0.5 Pa	1.1 Pa	2 Pa	3 Pa	4.3 Pa	6 Pa	8 Pa	10 Pa	12 Pa
	Segmented	1 Pa	2 Pa	4 Pa	6 Pa	8 Pa	11 Pa	14 Pa	17 Pa	21 Pa
45˚ Bend, Rigid Ducting	Plain	0.2 Pa	0.5 Pa	1 Pa	1.5 Pa	2.2 Pa	3 Pa	4 Pa	5 Pa	6 Pa
	Segmented	0.4 Pa	1 Pa	2 Pa	3 Pa	4 Pa	6 Pa	7 Pa	9 Pa	11 Pa
Duct Air Heater		1.5 Pa	3 Pa	5 Pa	7.5 Pa	11 Pa	15 Pa	20 Pa	25 Pa	30 Pa
Filter Cassette - (Clean)		23 Pa	30 Pa	50 Pa	65 Pa	80 Pa	95 Pa	120 Pa	-	-
Bag Filter Cassette - (Clean)		10 Pa	22 Pa	38 Pa	60 Pa	86 Pa	118 Pa	154 Pa	-	-
Duct Attenuator	600 Long	1 Pa	2 Pa	3 Pa	4 Pa	5 Pa	7 Pa	9 Pa	11 Pa	14 Pa
Heat Exchange	105 38 290 + 105 77 315 + 105 78 315	SEE RELEVANT PAGE IN THE VENT-AXIA PRODUCT RANGE MANUAL								
Backdraught Shutters		20 Pa	22 Pa	24 Pa	26 Pa	30 Pa	35 Pa	42 Pa	50 Pa	60 Pa
3-Way Splitters		2 Pa	3 Pa	4 Pa	6 Pa	8 Pa	12 Pa	16 Pa	20 Pa	24 Pa
4-Way Diffusers		SEE RELEVANT PAGE IN THE VENT-AXIA PRODUCT RANGE MANUAL								
Louvre Shutters		5 Pa	9 Pa	12 Pa	20 Pa	26 Pa	35 Pa	46 Pa	58 Pa	72 Pa
Wall Terminal		4 Pa	8 Pa	14 Pa	21 Pa	31 Pa	43 Pa	54 Pa	-	-
Roof Terminal		4 Pa	9 Pa	15 Pa	22 Pa	32 Pa	42 Pa	54 Pa	-	-

250mm DIA COMPONENT SYSTEM RESISTANCES

DUCT VELOCITY

Ducting Component		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Volume	(l/s)	98	147	196	245	295	344	393	442	491
	(m^3/s)	0.0982	0.14727	0.1964	0.24545	0.2945	0.34363	0.3927	0.44181	0.4909
	(m^3/h)	353	530	707	884	1060	1237	1414	1591	1767
	(cfm)	208	312	416	520	624	728	832	936	1040
Flexible Ducting - 1 metre of fully extended flexible		-	1Pa	1.5 Pa	2.2 Pa	3.1 Pa	4.2 Pa	5.2 Pa	7 Pa	8.5 Pa
90˚ Flexible Bend		-	2.5 Pa	4 Pa	6.5 Pa	9.5 Pa	14 Pa	17 Pa	21 Pa	26 Pa
45˚ Flexible Bend		-	2 Pa	3.5 Pa	5.2 Pa	7.5 Pa	11 Pa	15 Pa	19 Pa	23 Pa
Rigid Ducting, per 1 metre (spirally wound)		0.2 Pa	0.4 Pa	0.7 Pa	1 Pa	1.5 Pa	2.1 Pa	2.7 Pa	3.4 Pa	4.2 Pa
90˚ Bend, Rigid Ducting	Plain	0.5 Pa	1.1 Pa	2 Pa	3 Pa	4.3 Pa	6 Pa	8 Pa	10 Pa	12 Pa
	Segmented	1 Pa	2 Pa	4 Pa	6 Pa	8 Pa	11 Pa	14 Pa	17 Pa	21 Pa
45˚ Bend, Rigid Ducting	Plain	0.2 Pa	0.5 Pa	1 Pa	1.5 Pa	2.2 Pa	3 Pa	4 Pa	5 Pa	6 Pa
	Segmented	0.4 Pa	1 Pa	2 Pa	3 Pa	4 Pa	6 Pa	7 Pa	9 Pa	11 Pa
Duct Air Heater		1.5 Pa	3 Pa	5 Pa	7.5 Pa	11 Pa	15 Pa	20 Pa	25 Pa	30 Pa
Filter Cassette - (Clean)		23 Pa	30 Pa	50 Pa	65 Pa	80 Pa	95 Pa	120 Pa	-	-
Bag Filter Cassette - (Clean)		10 Pa	22 Pa	38 Pa	60 Pa	86 Pa	118 Pa	154 Pa	-	-
Duct Attenuator	600 Long	1 Pa	2 Pa	3 Pa	4 Pa	5 Pa	7 Pa	9 Pa	11 Pa	14 Pa
Heat Exchange	105 38 290 + 105 77 315 + 105 78 315	SEE RELEVANT PAGE IN THE VENT-AXIA PRODUCT RANGE MANUAL								
Backdraught Shutters		20 Pa	22 Pa	24 Pa	26 Pa	30 Pa	35 Pa	42 Pa	50 Pa	60 Pa
3-Way Splitters		2 Pa	3 Pa	4 Pa	6 Pa	8 Pa	12 Pa	16 Pa	20 Pa	24 Pa
4-Way Diffusers	230 sq. in.	SEE RELEVANT PAGE IN THE VENT-AXIA PRODUCT RANGE MANUAL								
Louvre Shutters		5 Pa	9 Pa	12 Pa	20 Pa	26 Pa	35 Pa	46 Pa	58 Pa	72 Pa
Wall Terminal		4 Pa	8 Pa	14 Pa	21 Pa	31 Pa	43 Pa	54 Pa	-	-
Roof Terminal		4 Pa	9 Pa	15 Pa	22 Pa	32 Pa	42 Pa	54 Pa	-	-

315mm DIA COMPONENT SYSTEM RESISTANCES

DUCT VELOCITY

Ducting Component		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Volume	(l/s)	156	234	312	390	468	546	624	701	779
	(m^3/s)	0.1559	0.23382	0.3118	0.3897	0.4676	0.54558	0.6235	0.70146	0.7794
	(m^3/h)	561	842	1122	1403	1684	1964	2245	2525	2806
	(cfm)	330	495	661	826	991	1156	1321	1486	1652
Flexible Ducting - 1 metre of fully extended flexible		-	0.5 Pa	1.1 Pa	1.8 Pa	2.5 Pa	3.2 Pa	4 Pa	5 Pa	6.5 Pa
90˚ Flexible Bend		-	2.5 Pa	4 Pa	6.5 Pa	9.5 Pa	14 Pa	17 Pa	21 Pa	26 Pa
45˚ Flexible Bend		-	2 Pa	3.5 Pa	5.2 Pa	7.5 Pa	11 Pa	15 Pa	19 Pa	23 Pa
Rigid Ducting, per 1 metre (spirally wound)		0.1 Pa	0.3 Pa	0.6 Pa	0.9 Pa	1.3 Pa	1.8 Pa	2.3 Pa	2.9 Pa	3.6 Pa
90˚ Bend, Rigid Ducting	Plain	0.5 Pa	1.1 Pa	2 Pa	3 Pa	4.3 Pa	6 Pa	8 Pa	10 Pa	12 Pa
	Segmented	1 Pa	2 Pa	4 Pa	6 Pa	8 Pa	11 Pa	14 Pa	17 Pa	21 Pa
45˚ Bend, Rigid Ducting	Plain	0.2 Pa	0.5 Pa	1 Pa	1.5 Pa	2.2 Pa	3 Pa	4 Pa	5 Pa	6 Pa
	Segmented	0.4 Pa	1 Pa	2 Pa	3 Pa	4 Pa	6 Pa	7 Pa	9 Pa	11 Pa
Duct Air Heater		1.5 Pa	3 Pa	5 Pa	7.5 Pa	11 Pa	15 Pa	20 Pa	25 Pa	30 Pa
Filter Cassette - (Clean)		23 Pa	30 Pa	50 Pa	65 Pa	80 Pa	95 Pa	120 Pa	-	-
Bag Filter Cassette - (Clean)		10 Pa	22 Pa	38 Pa	60 Pa	86 Pa	118 Pa	154 Pa	-	-
Duct Attenuator	600 Long	1 Pa	2 Pa	3 Pa	4 Pa	5 Pa	7 Pa	9 Pa	11 Pa	14 Pa
Heat Exchange	105 38 290 + 105 77 315 + 105 78 315	SEE RELEVANT PAGE IN THE VENT-AXIA PRODUCT RANGE MANUAL								
Backdraught Shutters		20 Pa	22 Pa	24 Pa	26 Pa	30 Pa	35 Pa	42 Pa	50 Pa	60 Pa
3-Way Splitters		2 Pa	3 Pa	4 Pa	6 Pa	8 Pa	12 Pa	16 Pa	20 Pa	24 Pa
4-Way Diffusers		SEE RELEVANT PAGE IN THE VENT-AXIA PRODUCT RANGE MANUAL								
Louvre Shutters		5 Pa	9 Pa	12 Pa	20 Pa	26 Pa	35 Pa	46 Pa	58 Pa	72 Pa
Wall Terminal		4 Pa	8 Pa	14 Pa	21 Pa	31 Pa	43 Pa	54 Pa	-	-
Roof Terminal		4 Pa	9 Pa	15 Pa	22 Pa	32 Pa	42 Pa	54 Pa	-	-

400mm DIA COMPONENT SYSTEM RESISTANCES

DUCT VELOCITY

Ducting Component		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Volume	(l/s)	198	297	396	495	594	693	792	891	990
	(m^3/s)	0.198	0.29694	0.3959	0.4949	0.5939	0.69286	0.7918	0.89082	0.9898
	(m^3/h)	713	1069	1425	1782	2138	2494	2851	3207	3563
	(cfm)	419	629	839	1049	1258	1468	1678	1888	2097
Flexible Ducting - 1 metre of fully extended flexible		-	0.1Pa	0.8 Pa	1.4 Pa	1.9 Pa	2.5 Pa	3 Pa	4 Pa	5 Pa
90˚ Flexible Bend		-	2.5 Pa	4 Pa	6.5 Pa	9.5 Pa	14 Pa	17 Pa	21 Pa	26 Pa
45˚ Flexible Bend		-	2 Pa	3.5 Pa	5.2 Pa	7.5 Pa	11 Pa	15 Pa	19 Pa	23 Pa
Rigid Ducting, per 1 metre (spirally wound)		0.1 Pa	0.2 Pa	0.4 Pa	0.6 Pa	0.9 Pa	1.2 Pa	1.6 Pa	2.0 Pa	2.5 Pa
90˚ Bend, Rigid Ducting	Plain	0.5 Pa	1.1 Pa	2 Pa	3 Pa	4.3 Pa	6 Pa	8 Pa	10 Pa	12 Pa
	Segmented	1 Pa	2 Pa	4 Pa	6 Pa	8 Pa	11 Pa	14 Pa	17 Pa	21 Pa
45˚ Bend, Rigid Ducting	Plain	0.2 Pa	0.5 Pa	1 Pa	1.5 Pa	2.2 Pa	3 Pa	4 Pa	5 Pa	6 Pa
	Segmented	0.4 Pa	1 Pa	2 Pa	3 Pa	4 Pa	6 Pa	7 Pa	9 Pa	11 Pa
Duct Air Heater		1.5 Pa	3 Pa	5 Pa	7.5 Pa	11 Pa	15 Pa	20 Pa	25 Pa	30 Pa
Filter Cassette - (Clean)		23 Pa	30 Pa	50 Pa	65 Pa	80 Pa	95 Pa	120 Pa	-	-
Bag Filter Cassette - (Clean)		10 Pa	22 Pa	38 Pa	60 Pa	86 Pa	118 Pa	154 Pa	-	-
Duct Attenuator	600 Long	1 Pa	2 Pa	3 Pa	4 Pa	5 Pa	7 Pa	9 Pa	11 Pa	14 Pa
Heat Exchange	105 38 290 + 105 77 315 + 105 78 315	-	-	-	-	-	-	-	-	-
Backdraught Shutters		20 Pa	22 Pa	24 Pa	26 Pa	30 Pa	35 Pa	42 Pa	50 Pa	60 Pa
3-Way Splitters		2 Pa	3 Pa	4 Pa	6 Pa	8 Pa	12 Pa	16 Pa	20 Pa	24 Pa
4-Way Diffusers		SEE RELEVANT PAGE IN THE VENT-AXIA PRODUCT RANGE MANUAL								
Louvre Shutters		5 Pa	9 Pa	12 Pa	20 Pa	26 Pa	35 Pa	46 Pa	58 Pa	72 Pa
Wall Terminal	(12" Commercial Accessory)	4 Pa	8 Pa	14 Pa	21 Pa	31 Pa	43 Pa	54 Pa	-	-
Roof Terminal	(12" Commercial Accessory)	4 PA	9 Pa	15 Pa	22 Pa	32 Pa	42 Pa	54 Pa	-	-

EXAMPLE 1

Example 1 is based on a typical, simple extract office scheme as per Fig 1.10 (page 22).

First calculate the volume of the room (height x width x length) and multiply by the Air Changes per Hour. This equals the minimum air volume required per hour:-

Height x width x length x ACH = m^3/h
2.4m x 4m x 5m x 10 = $480m^3/h$

Calculate the duct size, which will provide the air velocity which equates most closely to the velocity given in Table 1

$$\text{AREA} = \frac{\text{VOLUME } (m^3/h)}{\text{VELOCITY m/s (see page 5)} \times 3600} = m^2$$

$$\frac{480m^3/h}{6 \times 3600} = 0.0222m^2$$

Select the next size up duct dia from Table 2 (page 9), which in this case is 200mm diameter. (Gross cross section area = $0.03142m^2$).

Select a suitable duct fan, which will cope with the calculated volume figure with a reasonable pressure development (eg. 100 to 150Pa) at the required air volume (in this case $480m^3/h$), which selects a ACH200-12, In-Line Centrifugal fan or ACM200-12 Mixed Flow fan.

Design the ducted system (see Fig 1.10, page 22) for the room, bearing in mind the type of system (extract, intake or a combination of both), the provision for air replacement (will existing openings be sufficient, or are special arrangements necessary ?) and the location of grilles for intake and extract.

Once you have decided on the system and selected the accessories required, you need to list the components.

Calculate the velocity through the 200mm dia system at an air volume of 480m3/h (as per Calculation 1) to establish that it complies with Vent-Axia's recommended duct velocities (See Table 1, page 3).

$$\text{MAIN DUCT VELOCITY (m/s)} = \frac{\text{VOLUME } (m^3/h)}{\text{Cross Sectional Area } (m^2) \times 3600}$$

(See Table 2 on page 9)

$$m/s = \frac{480m^3/h}{0.03142m^2 \times 3600} = \frac{480}{113.11} = \mathbf{4.24m/s}$$

Select the component resistance chart appropriate to the fan diameter (ie. 200mm) and round to the next highest velocity (in this case 5m/s) for main duct components and 3m/s for branch duct components in this case, to obtain the individual resistance of each component.

An appropriate starting point for calculating your System Resistance should be the extract (or supply) diffuser point in the room.

As you can see by Fig 1.10 (page 22), there are two extract points in the office with, therefore, an equal amount of air from each grille, which will be:-

$$\frac{480m^3/h}{2} = 240m^3/h$$

The volume through the two intake grilles and subsidiary ducts will be: 240m³/h.

$$\text{Branch Duct Velocity (m/s)} = \frac{240m^3/h}{0.03142m^2 \times 3600} = \frac{240}{113.11}$$

$$= 2.12m/s$$

As can be seen from Fig 1.20, the pressure loss of each 200mm grille @ 240m³/h is 30Pa. When setting the grille up on site the grille is to be unscrewed 15 full turns from fully closed to obtain the correct air volume.

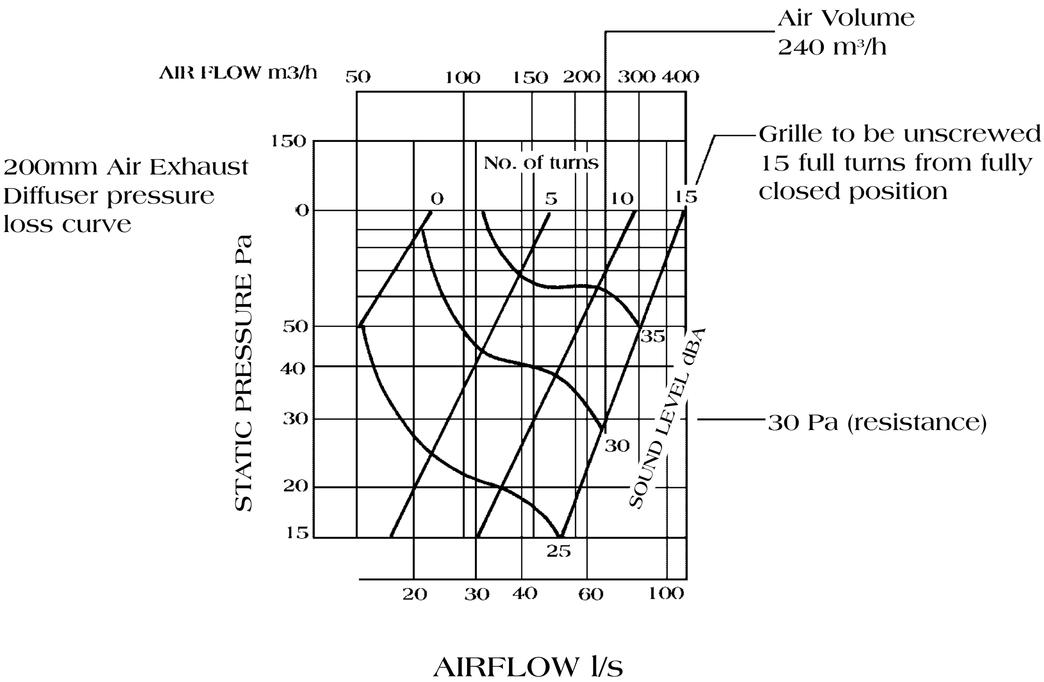


FIG. 1.20

Next calculate the pressure loss of the Ducting. The resistance of the Ducting at different velocities can be found on the 200mm dia Component System Resistance Chart.

eg. 1 metre of 200mm dia Flexible Ducting, at a velocity of 4.24m/s, gives a pressure loss of 3 Pa per metre.
1 metre of 200mm Flexible Ducting, at a velocity of 2.12m/s, gives 1.0 Pa per metre.
A 90° flexible bend, at a velocity of 2.12m/s, gives 2.5 Pa per bend.

Lastly, calculate the resistance of the 3-Way Splitters and Wall Grilles, which can be found on the System Resistance Chart.

eg. The pressure loss through a 3-Way Splitter, at a velocity of 4.24m/s, is 6 Pa.

The pressure loss through a 200mm dia. Wall Termination, at a velocity of 4.24m/s equals 21 Pa.

For systems using 2 similar branch ducts, only the pressure loss of one branch need be calculated, for dissimilar branch ducts, the branch with the highest pressure loss should be used.

So the Total Static System Resistance of Example 1 is:-

1-off 200mm dia Circular Diffusers (30 Pa)	= 30 Pa
Flexible ducting (1-Branch)	
1-off 90° flexible bends at 2.12m/s	
Resistance = 1 x 2.5 Pa	= 2.5 Pa
Straight duct 1.85 + 0.15 = 2m at 2.12m/s	
Resistance = 2 x 1 Pa	= 2 Pa
Resistance of 3-Way Splitter at 4.24m/s	= 6 Pa
Flexible ducting (main duct 0.25 + 0.75 = 1m at 4.24m/s	
Resistance = 1 x 3 Pa	= 3 Pa
Resistance of 200mm Wall Termination	= 21 Pa
Total Static System Resistance	**= 64.5 Pa**

Therefore, the most appropriate In-Line Duct Fan for this office system (as you can see in Fig 1.30) is the ACM200-12 Mixed Flow Fan, which is dimensionally compact, highly efficient, excellent performance for minimal cost, low noise development and has non-overloading characteristics.

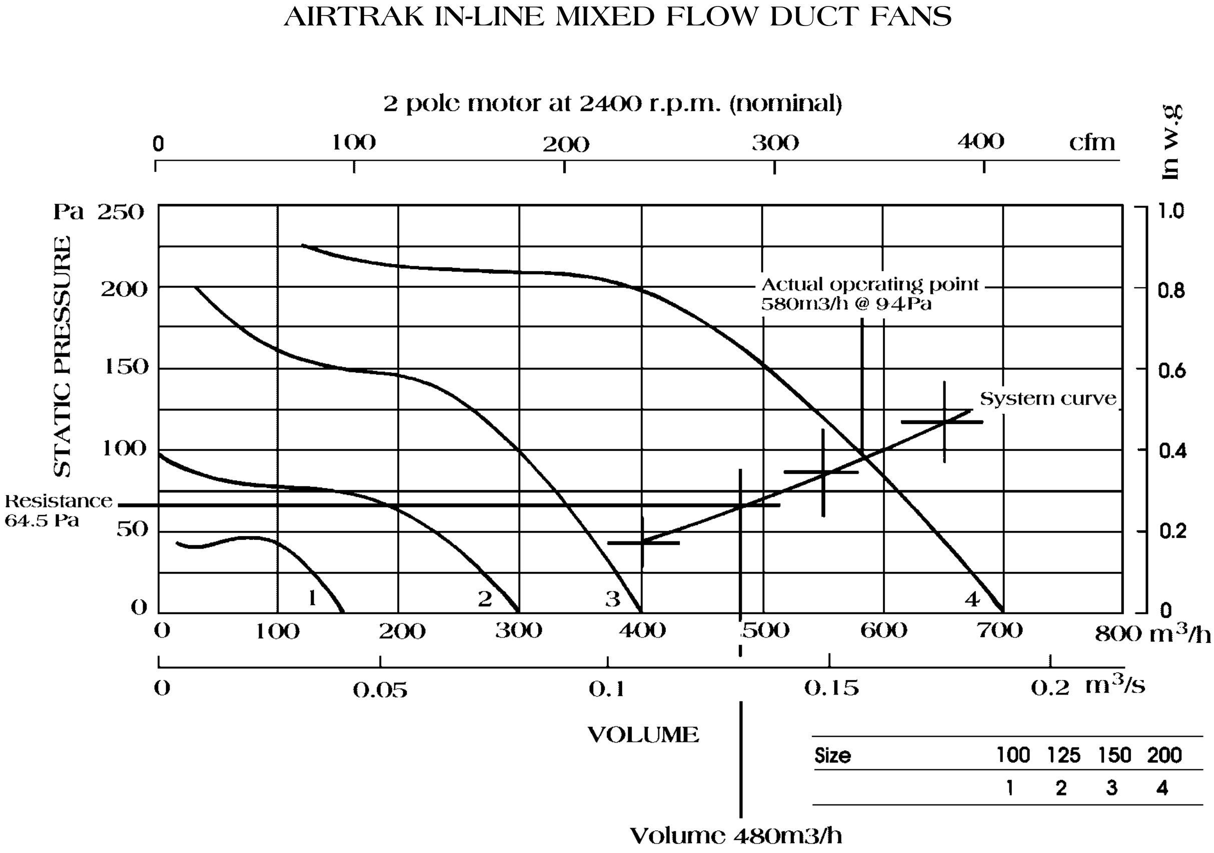


FIG. 1.30

System Resistance Curve Calculation

So far we have determined the fan performance against the resistance of the ductwork, ie. 480m³/h at 64.5 Pa on figure 1.30 the intersection of these two lines is below the fan curve for the ACM200-12. To assess more accurately the fan performance it is necessary to calculate a system curve.

There are certain laws that govern the relative performance of fans, when calculating the actual performance point the system curve will bisect the fans operating curve.

The resistance varies as the square of the change in the air velocity: $R \propto V^2$. As velocity varies directly proportionally to volume, we can say that the Resistance varies as the square of the volume. The equation then becomes

$$\text{NEW RESISTANCE} = \left(\frac{\text{NEW VOLUME } (m^3/h)}{\text{OLD VOLUME } (m^3/h)}\right)^2 \text{ X OLD RESISTANCE}$$

Given the system resistance of 64.5 Pa at 480m^3/h, what will be the resistance if
a) 650m^3/h, b) 550m^3/h and c) 400m^3/h are used?

a) New Resistance = $\left(\frac{650}{480}\right)^2$ X 64.5 = 118 Pa

b) New R = $\left(\frac{550}{480}\right)^2$ X 64.5 = 85 Pa

c) New R = $\left(\frac{400}{480}\right)^2$ X 64.5 = 45 Pa

If these three points are plotted on Fig. 1.30 (page 20), a curve can be drawn through the three new and original points. This curve illustrates the air volume at differing resistances. Where the fan curve and system curve intersect is the operating point for the ACM200-12 in the Example 1 system, offering 580m^3/h at approx. 94 Pa.

Air Replacement
In this instance a pair of 350mm x 350mm non vision grille with approximately 40% Free Area will be suitable to provide a good rate of air replacement.

0.350 x 0.350 = 0.1225m2 Face Area

0.1225 x 40% = 0.049m2 Free Area

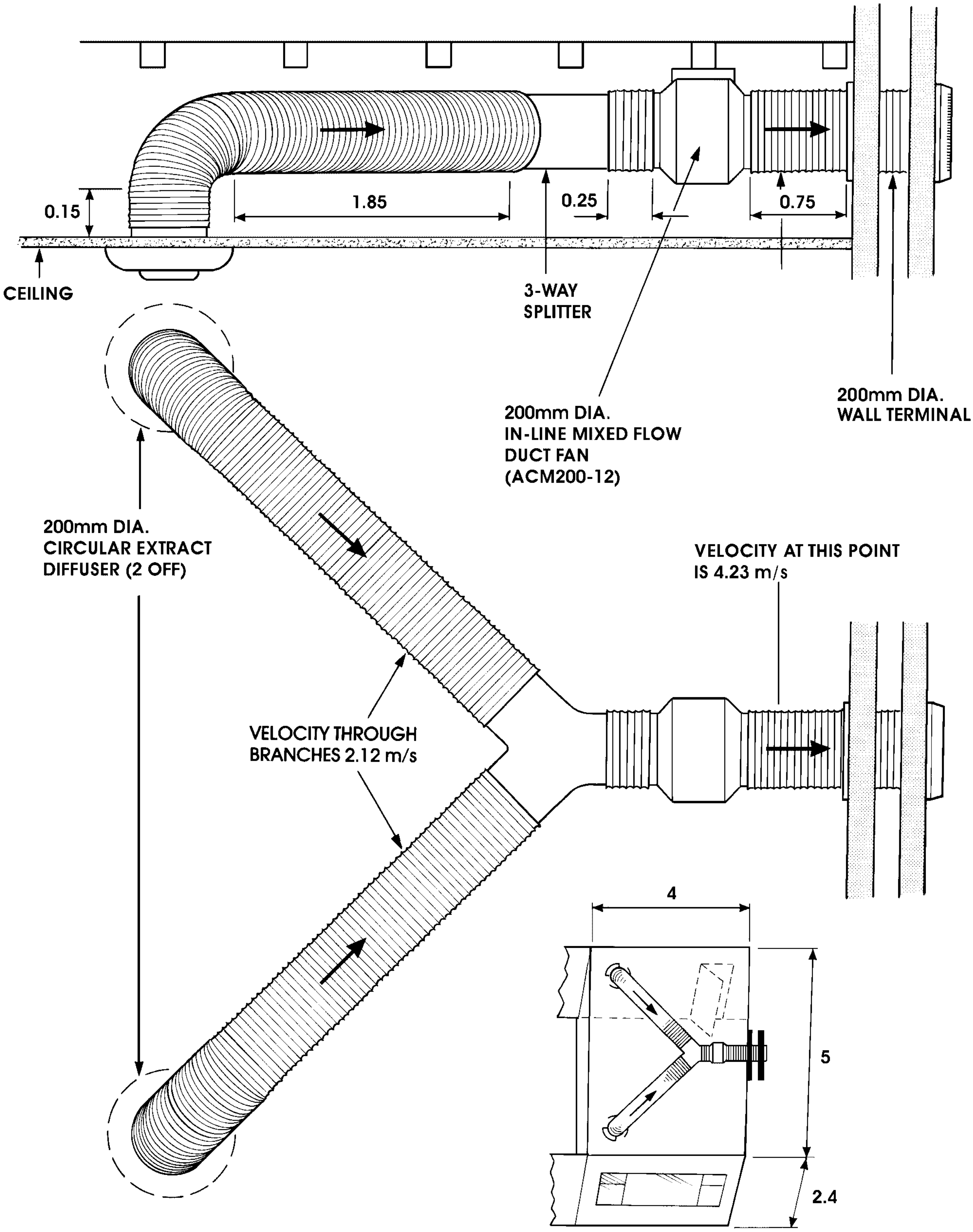
$\frac{0.049m^2}{0.087}$ x 1000 = **563m^3/h**

NOTE:- If the door or wall has a Fire Rating, a Fire Damper will have to be installed with suitable grilles to meet Fire Regulations.

EXAMPLE 1

(Refer to pages 17-21)

FIG. 1.10



ROOM SIZE:- H(height) 2.4 METRES x W(width) 5 METRES x L(length) 6 METRES
TYPE OF ROOM:- OFFICE, ONE PERSON, NON-SMOKER.
AIR CHANGES PER HOUR:- 10

EXAMPLE 2

The second example is a Conference Room using a combined system as per Fig 2.10 (page 28).

Volume of Air required:-
Height x width x length x ACH = m^3/h
2.4m x 7.5m x 7m x 12 = $1512 m^3/h$

As this is a combined system it will be required to supply and extract air at this rate ie. $1512 m^3/h$ for the supply and $1512 m^3/h$ for the extract.

Determine main ducting size:

$$\text{AREA} = \frac{1512 \text{ m}^3/\text{h}}{8 \text{ m/s} \times 3600} = 0.0525\text{m}^2$$

Select the next largest duct diameter from Table 2 and calculate the exact velocity in the duct in the equation below, in this case 315mm diameter ducting with an area of $0.07994 m^2$.

$$\text{Velocity (m/s)} = \frac{1512 \text{ m}^3/\text{h}}{0.07794\text{m}^2 \times 3600} = 5.39\text{m/s}$$

As the conference room is not centrally heated and to provide a nominal temperature of eg. 20°C (68°F), a duct air heater has been incorporated into the system.

The duct air heater must be thermostatically controlled. When a Duct Air Heater is used the fan should be wired through a Vent-Axia electric heater controller which includes an overrun timer so that when the heater is shut down the fan will cool the heating elements and remove residual heat.

It is advisable to mount the duct air heater downstream of the supply fan to avoid heated air being pulled through the fan.

The most effective method of cross ventilating the conference room is to use the 4-Way Diffusers. To select the most appropriate size refer to the relevant page in the Vent-Axia Industrial Range manual.

From Fig 2.10 (page 28) you can see the two diffusers for supply and two for extract have been selected for full and effective cross ventilation.

$$\text{Air requirement per supply diffuser} = \frac{1512}{2} = 756\text{m}^3/\text{h}$$

$$\text{Air requirement per extract diffuser} = \frac{1512}{2} = 756\text{m}^3/\text{h}$$

In this case 350mm square 4-Way Diffusers with 315mm diameter neck adapters would be suitable.

Subsidiary duct velocity:

$$\text{Velocity (m/s)} = \frac{756m^3/h}{0.0779m^2 \times 3600} = 2.69m/s$$

For systems using 2 similar branch ducts only the pressure loss of one branch need be calculated, for dissimilar branch ducts the branch with the highest pressure loss should be used.

Calculate the total static resistance of the **supply system**, starting with the diffusers.

Supply Diffuser totals:-	
1 off diffusers with an air volume of 756m³/h at a resistance of 14 Pa per diffuser	
Resistance = 1 x 14 Pa =	14 Pa
Flexible Ducting totals:-	
1 off 315mm dia, 90° Bends @ 2.69m/s (velocity)	
Resistance = 1 x 2.5 Pa =	2.5 Pa
1 metre of 315 dia x 1 = 1m @ 2.69m/s (velocity)	
Resistance = 1 x 0.5 Pa =	0.5 Pa
1 metre of 315 dia x 4 = 4m @ 5.39m/s (velocity)	
Resistance = 4 x 2.5 Pa =	10 Pa
3 Way Splitter (size 400) totals:-	
1 at a velocity of 5.39m/s	
Resistance - 1 x 8 Pa =	8 Pa
315mm dia Pre Filter Cassette totals:-	
1 at a velocity of 5.39m/s	
†Resistance **(Clean)** = 1 x 80 Pa	80 Pa
315mm dia Duct Air Heater totals:-	
1 at a velocity of 5.39m/s	
Resistance = 1 x 11 Pa =	11 Pa
315mm dia Wall Termination Set totals:-	
1 at a velocity of 5.39m/s	
Resistance = 1 x 31 Pa	31 Pa
	Total 157 Pa

NB. The 4.5kW Duct Air Heater will give an approximate 13°C (23°F) temperature rise above Ambient. The 4-Way Diffusers will give a throw of 3.3m at an angle of 155°. This information is obtained from the relevant pages of the Vent-Axia Industrial Product Range Manual.

† Resistance figure is for a clean or new filter. As the filter is used, the trapped particles will affect the resistance. It is important to check and clean or replace filters regularly.

Now that we know the Air Volume (1512m³/h) and the Total Supply System Static Resistance (157 Pa) required, we need to select an Airtrak Fan that has quiet operating characteristics. The most suitable in-line duct fan for this system would be the ACQ315-14A Acoustic Fan (see Fig 2.20).

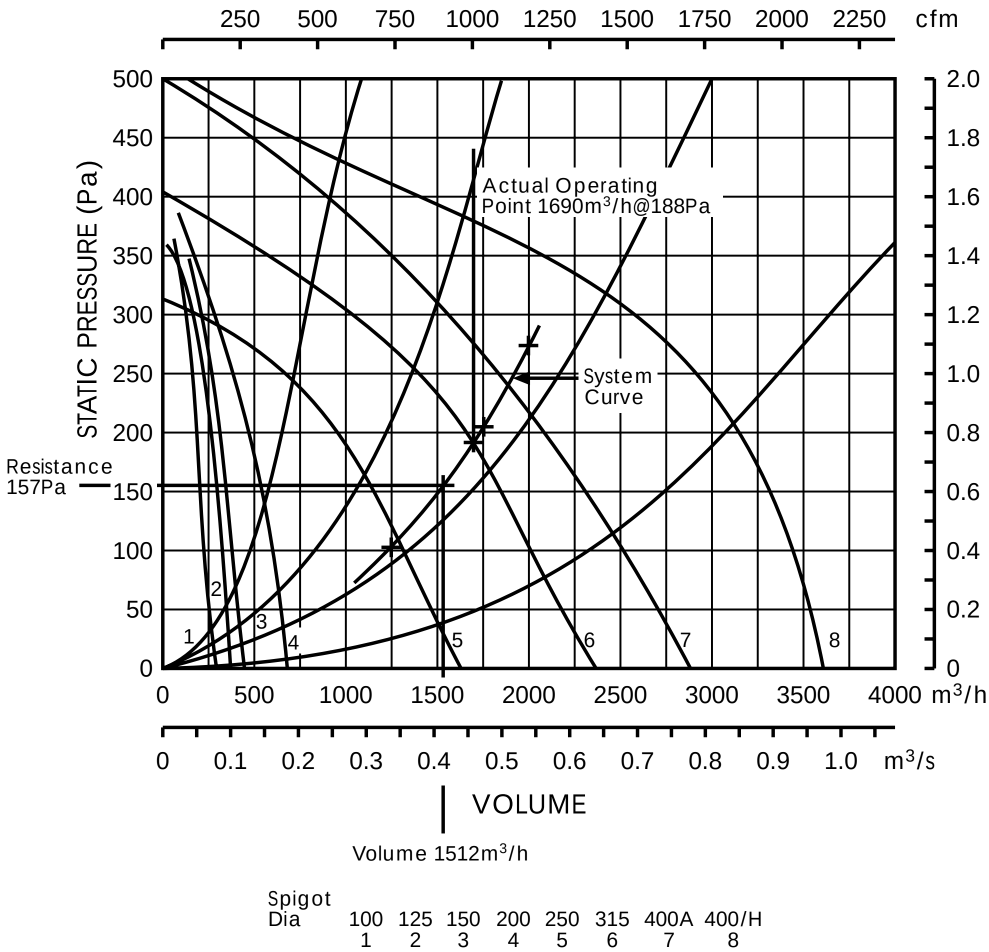


FIG. 2.20

SUPPLY SYSTEM RESISTANCE CURVE CALCULATION

We have determined the fan performance against the resistance of the ductwork, ie. 1512m³/h at 157 Pa. To assess more accurately the fan performance it is necessary to calculate a system curve using the following calculation to determine the resistance at: a) 1750m³/h, b) 2000m³/h and c) 1250m³/h

a) New Resistance = $\left(\frac{1750}{1512}\right)^2 \times 157$ Pa = 210 Pa

b) New R = $\left(\frac{2000}{1512}\right)^2 \times 157$ Pa = 274 Pa

c) New R = $\left(\frac{1250}{1512}\right)^2 \times 157$ Pa = 107 Pa

If these three points are plotted on Fig 2.20, a curve can be drawn through the three new and original points. Where the fan curve and system curve intersect is the operating air volume for the supply system in the Example 2, 1690m³/h at 188 Pa. A speed controller would be recommended.

Now calculate the Total Static Resistance of the **extract** system, starting as before with the grilles.

Extract Diffusers totals:-
1 off diffusers with an air volume of 756m³/h
at a resistance of 14 Pa per diffuser
Resistance = 1 x 14 Pa — 14 Pa

Flexible Ducting totals:-
1 off 315mm dia, 90° Flexible Bend @ 2.69m/s
Resistance = 1 x 2.5 Pa = — 2.5 Pa
1 metre of 315 dia x 1 = 1m @ 2.69m/s
Resistance = 0.5 Pa = — 0.5 Pa
1 off 315mm dia, 90° Flexible Bend @ 5.39 m/s
Resistance = 1 x 10 Pa = — 10 Pa
4 metres of 315 dia @ 5.39m/s
Resistance = 4 x 2.5 Pa = — 10 Pa

3 Way Splitter (size 400) totals:-
1 at a velocity of 5.39m/s
Resistance = 1 x 8 Pa = — 8 Pa

Roof Termination totals:-
1 at a velocity of 5.39m/s
Resistance = 1 x 32 Pa = — 32 Pa

Total 77 Pa

NB. Again an ACQ315-14 would be the most appropriate extract fan to use (see Fig 2.30).

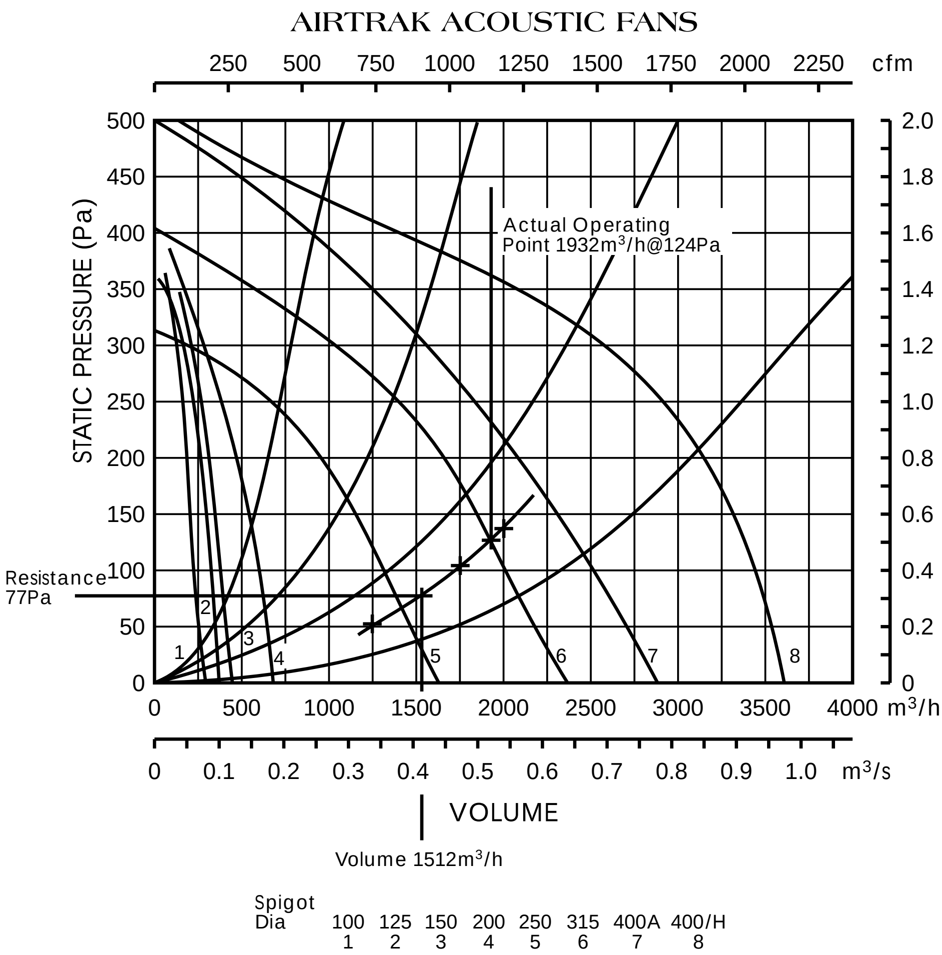


FIG. 2.30

EXTRACT SYSTEM RESISTANCE CURVE CALCULATION:

We have determined the fan performance against the resistance of the ductwork, ie. 1512m³/h at 77 Pa. To assess more accurately the fan performance, it is necessary to calculate a system curve using the following calculation to determine the resistance at: a) 1750m³/h, b) 2000m³/h and c) 1250m³/h.

a) New R = $\left(\frac{1750}{1512}\right)^2 \times 77 \text{ Pa} = 103 \text{ Pa}$

b) New R = $\left(\frac{2000}{1512}\right)^2 \times 77 \text{ Pa} = 135 \text{ Pa}$

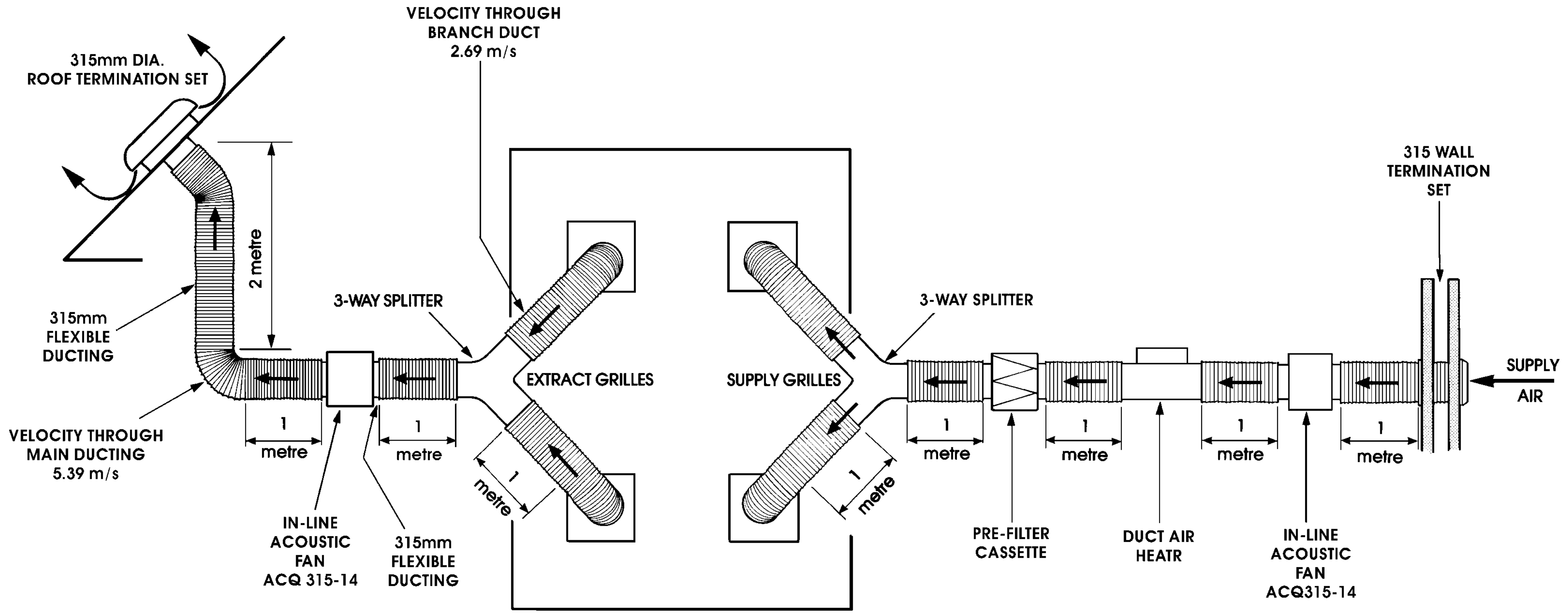
c) New R = $\left(\frac{1250}{1512}\right)^2 \times 77 \text{ Pa} = 53 \text{ Pa}$

If these three points are plotted on Fig 2.30, a curve can be drawn through the three new and original points. Where the fan curve intersect is the operating air volume for the extract system in the Example 3, 1932m³/h at 124 Pa. A speed controller would be recommended.

EXAMPLE 2

(Refer to pages 23-27)

FIG. 2.10



ROOM SIZE:- H(height) 2.4 METRES x W(width) 7.5 METRES x L(length) 7 METRES
TYPE OF ROOM:- CONFERENCE ROOM, NON-SMOKING
AIR CHANGES PER HOUR:- 12

SIDE ELEVATION THROUGH ROOF

PLAN VIEW OF OFFICE

EXAMPLE 3

The third example is a prestige office as per Fig. 3.10 (page 35).

Volume of air required:-

Height x width x length x ACH = m^3/h
2.4m x 5.5m x 7m x 8 = $740m^3/h$

A combined system will be required to supply and extract air both at a rate of $740m^3/h$. As can be seen from Fig 3.10, 315mm diameter duct has been selected, so a heat exchange unit can be used in this system.

$$\text{Duct Velocity} = \frac{740m^3/h}{0.07794 \times 3600} = 2.64m/s$$

The office is not centrally heated, therefore to provide a nominal temperature of eg. 20°C, (68°F) a duct air heater has been incorporated together with a heat exchanger. This will reduce running costs when the room is at a set temperature.

The Duct Air Heater must be thermostatically controlled. When using a Duct Air Heater the fan should be wired through a Vent-Axia electric heater controller which includes an overrun timer so when the heater is shut down the fan will cool the heating element and remove residual heat. Mount the Duct Air Heater downstream of the supply fan to avoid heated air being pulled through the fan.

In this installation the fan is mounted a considerable distance from the source of heat and therefore the air will be slightly cooler.

The most effective way of cross ventilating the office would be to use the 4-Way Diffusers. To select the most appropriate size refer to the relevant page in the Vent-Axia Industrial Range Manual.

From Fig 3.10 it can be seen that two diffusers for supply and two for extract have been selected for full and effective cross ventilation.

$$\text{Air requirement per supply diffuser} = \frac{740m^3/h}{2} = 370m^3/h$$

$$\text{Air requirement per extract diffuser} = \frac{740m^3/h}{2} = 370m^3/h$$

In this case 300mm square 4-Way Diffusers with 250mm diameter neck adapters would be suitable.

$$\text{250mm dia subsidiary duct velocity} = \frac{370m^3/h}{0.04909 \times 3600} = 2.09m/s$$

For systems using 2 similar branch ducts only the pressure loss of one branch need be calculated, for dissimilar branch ducts the branch with the highest pressure loss should be used.

Calculate the total resistance of the supply system, starting with the diffusers.

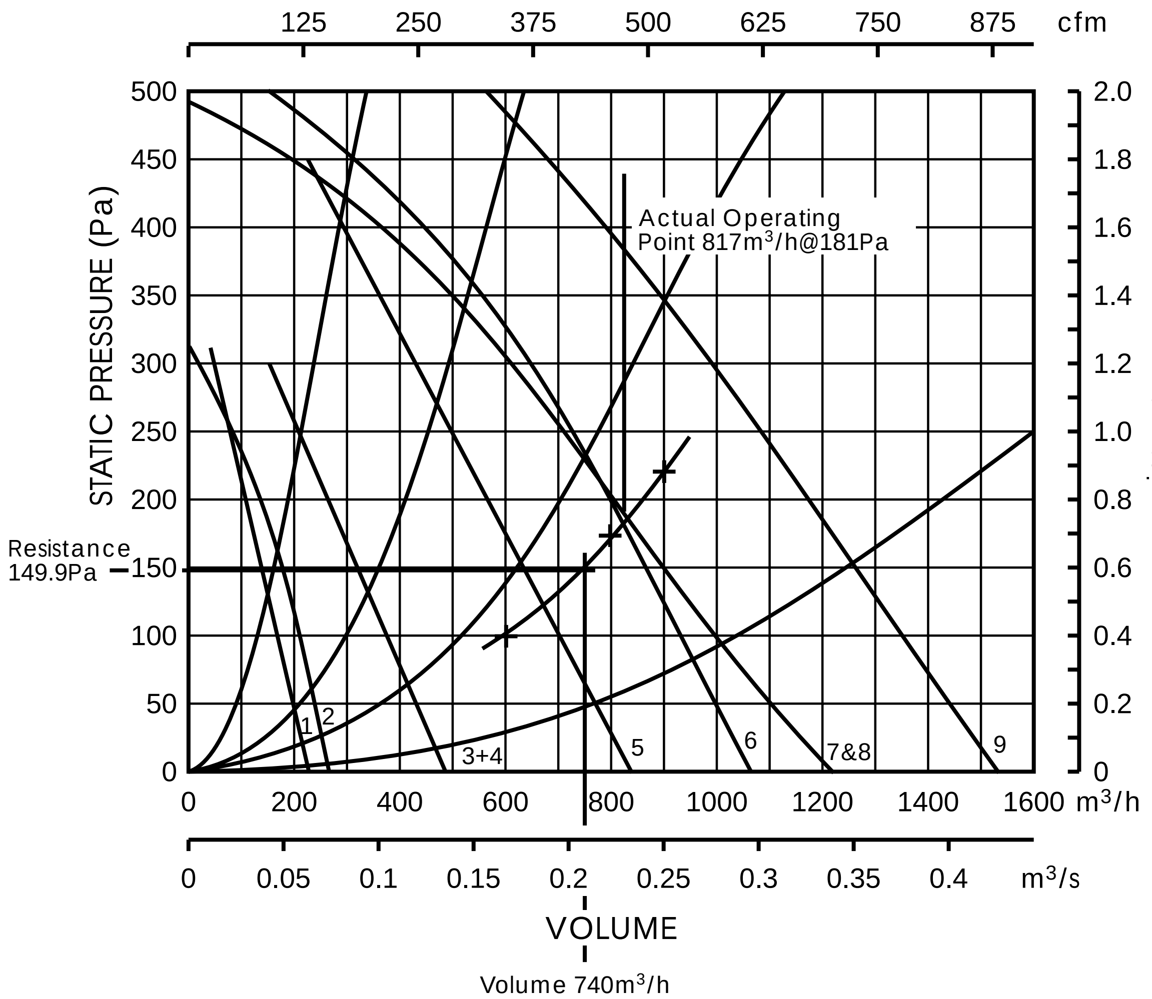
Supply Diffuser totals:-	
1 off Diffuser with an air volume of 370m³/h at a resistance of 4 Pa per Diffuser	
Resistance = 1 x 4 Pa =	4 Pa
Flexible Ducting totals:-	
1 off 250 dia 90˚ Bend 2.09m/s (velocity)	
Resistance = 1 x 2.5 Pa =	2.5 Pa
1 metre of 250 dia x 0.5 @ 2.09 m/s (velocity)	
Resistance = 0.5 x 1 Pa	0.5 Pa
1 off 315 dia 90˚ Bend @ 2.6m/s (velocity)	
Resistance = 1 x 3.5 Pa =	3.5 Pa
1 metre of 315 dia x 4.75 = 4.75m @ 2.6 m/s (velocity)	
Resistance = 4.75 x 0.5 Pa	2.4 Pa
3 Way Splitter (size 400) totals:-	
1 at a velocity of 2.6 m/s	
Resistance = 1 x 3 Pa =	3 Pa
Heat Exchange Unit totals:-	
1 off at an Air volume of 740m³/h which has a resistance of 90 Pa =	90 Pa
Pre-Filter Cassette totals:- (clean)	
1 at a velocity of 2.6 m/s	
Resistance = 1 x 30 Pa =	30 Pa
Duct Air Heater totals:-	
2 at a velocity of 2.6 m/s	
Resistance = 2 x 3 Pa	6 Pa
Wall Terminal Set totals:-	
1 at a velocity of 2.6 m/s	
Resistance = 1 x 8 Pa =	8 Pa
Total Supply System Resistance =	**150 Pa**

NB. The Duct Air Heater will give an approximate 20˚C (36˚F) temperature rise above ambient. The Heat Exchanger Unit will provide up to 70% Heat Recovery from extracted air. 4-Way Diffusers will give a throw of 2.2 metres at an angle of 160˚.

This information is obtained from the relevant pages of the Vent-Axia Industrial Product Range Manual.

Knowing the Air Volume (740m³/h) and the Total Supply System Static Resistance (149.9 Pa) required, select an Airtrak fan. The most appropriate fan to use in this instance is the Powerflow fan (ACP315-12A), which has been designed to work in conjunction with the heat exchanger and also offers low noise levels and non-overloading characteristics (See Fig 3.20).

AIRTRAK POWERFLOW



Size	100	125	150	160	200	250	300	315A	315/H
	1	2	3	4	5	6	7	8	9

FIG. 3.20

SUPPLY SYSTEM RESISTANCE CURVE CALCULATION

We have determined the fan performance against the resistance of the ductwork, ie. 740m³/h at 149.9 Pa. To assess more accurately to the fan performance it is necessary to calculate a system curve using the following calculation to determine the resistance at:

a) 800m³/h, b) 900m³/h and c) 600m³/h

a) New R = $\left(\frac{800}{740}\right)^2 \times 149.9$ Pa = 175 Pa

b) New R = $\left(\frac{900}{740}\right)^2 \times 149.9$ Pa = 222 Pa

c) New R = $\left(\frac{600}{740}\right)^2 \times 149.9$ Pa = 99 Pa

If these three points are plotted on Fig 3.20 a curve can be drawn through the three new and original points. Where the fan curve and system curve intersect is the operating air volume for the supply system in the Example 3, 817m³/h at 181 Pa.

We now need to calculate the Total Resistance of the **extract** system, starting as before with the grilles.

Extract Diffuser total:-	
1 off Diffusers with an air volume of 370m3/h at a Resistance of 4 Pa per Diffuser	
Resistance = 1 x 4 Pa =	4 Pa
Flexible Ducting totals:-	
1 off 250 dia, 90° Flexible Bend @ 2.09 m/s (velocity)	
Resistance = 1 x 2.5 Pa =	2.5 Pa
1 metre of 250 dia x 0.5 = 1m @ 2.09 m/s (velocity)	
Resistance = 0.5 x 1 Pa =	0.5 Pa
2 off 315 dia, 90° Flexible Bends @ 2.6 m/s (velocity)	
Resistance = 2 x 2.5 Pa =	5 Pa
1 metre of 315 dia x 5.25m (total) @ 2.6 m/s (velocity)	
Resistance = 5.25 x 0.5 Pa =	2.6 Pa
3 Way-Splitters (size 400) totals:-	
1 at a velocity of 2.6 m/s	
Resistance = 1 x 3 Pa =	3 Pa

Heat Exchanger Unit total:-
1 off at an air volume of 740m3/h
which has a resistance of 90 Pa — 90 Pa

Roof Termination Set total:-
1 at a velocity of 2.6 m/s
Resistance = 1 x 9 Pa — 9 Pa

Total Extract System Resistance — **116 Pa**

AIRTRAK POWERFLOW

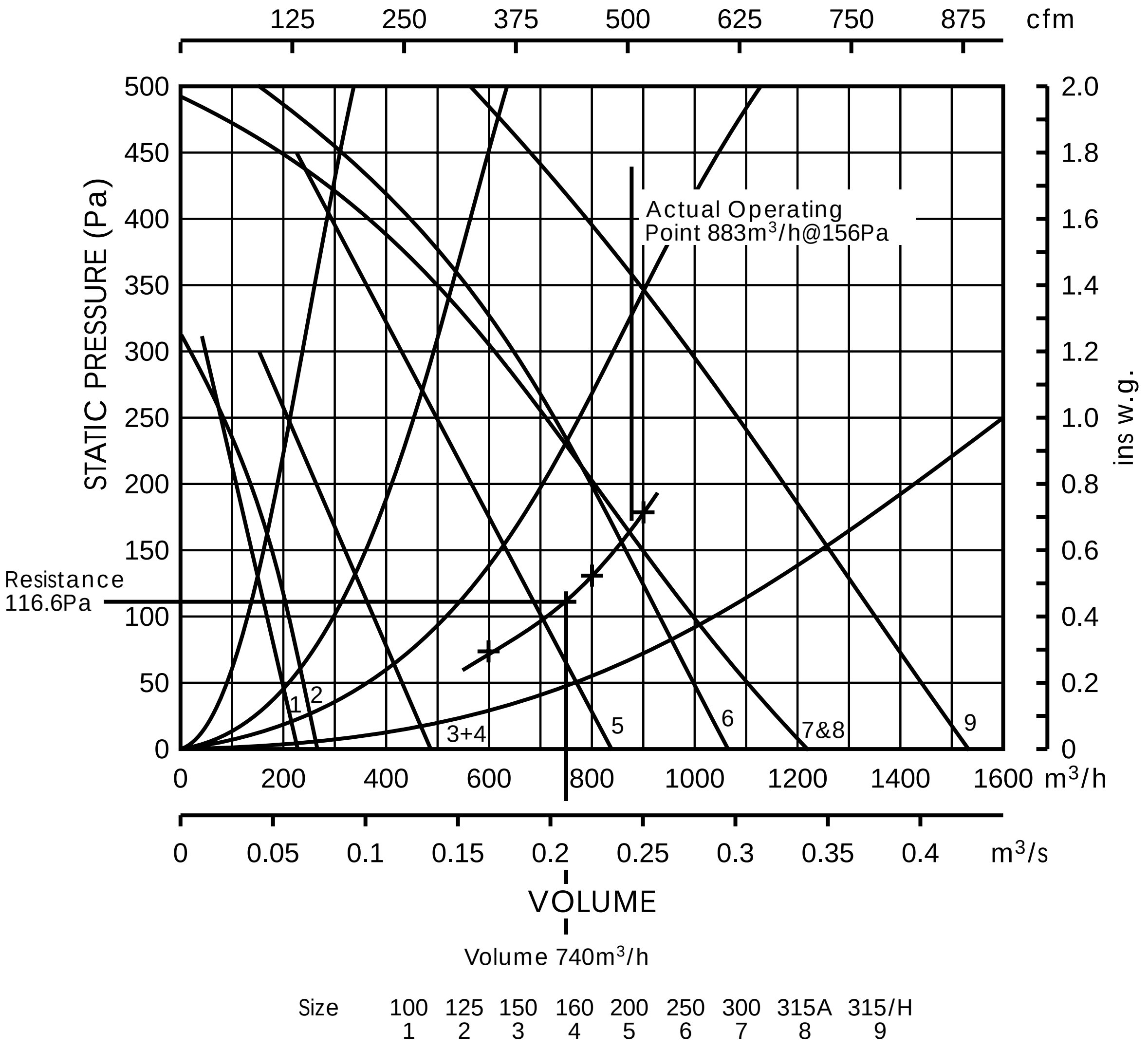


FIG. 3.30

EXTRACT SYSTEM RESISTANCE CURVE CALCULATION:

We have determined the fan performance against the resistance of the ductwork, ie. 740m³/h at 116.6 Pa. To assess more accurately to the fan performance it is necessary to calculate a system curve using the following calculation to determine the resistance at:

a) 800m³/h, b) 900m³/h and c) 600m³/h

a) New R = $\left(\frac{800}{740}\right)^2 \times 116.6 \text{ Pa} = 136 \text{ Pa}$

b) New R = $\left(\frac{900}{740}\right)^2 \times 116.6 \text{ Pa} = 172 \text{ Pa}$

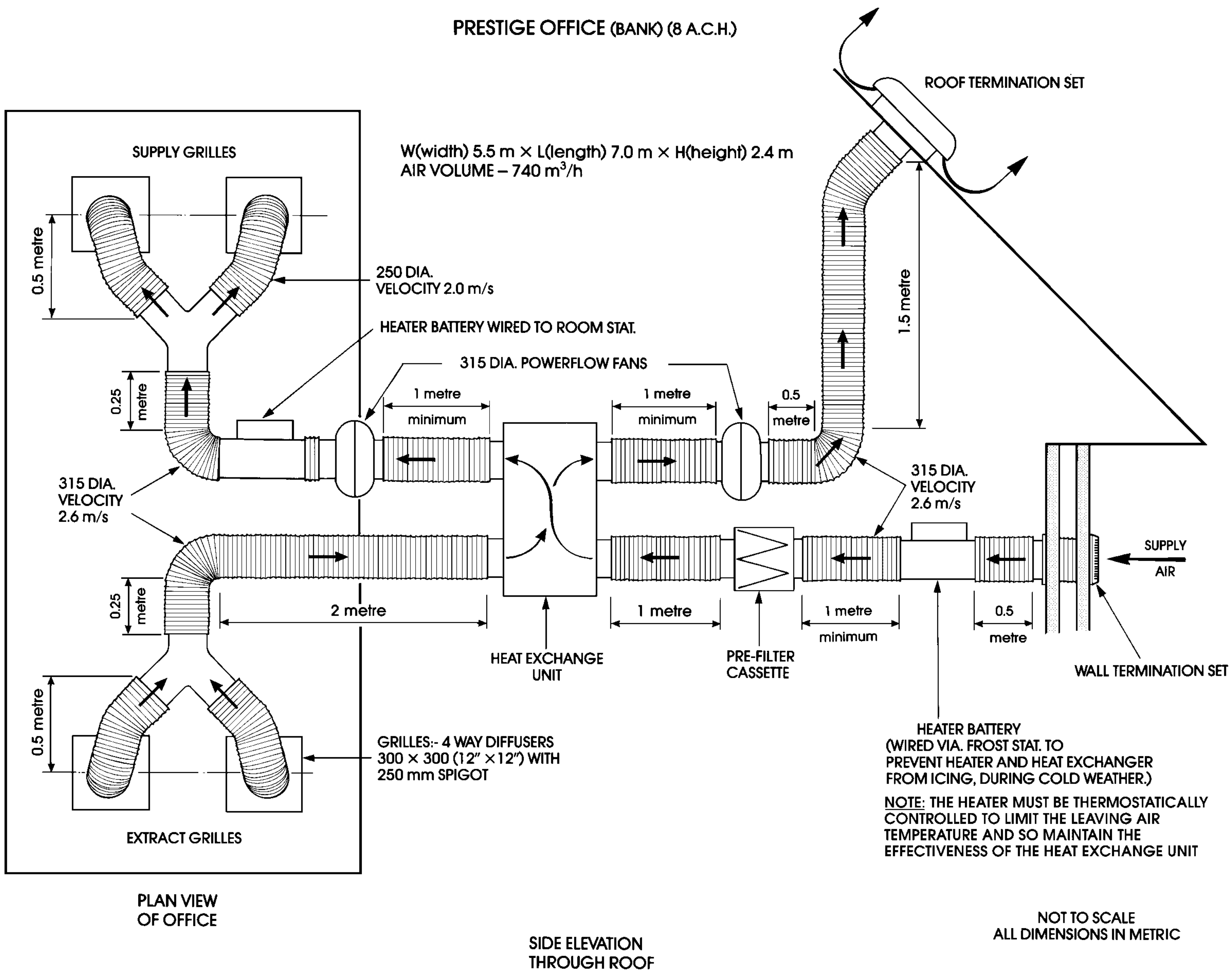
c) New R = $\left(\frac{600}{740}\right)^2 \times 116.6 \text{ Pa} = 76 \text{ Pa}$

If these three points are plotted on Fig 3.30 (page 33) a curve can be drawn through the three new and original points. Where the fan curve and system curve intersect is the operating air volume for the Extract system in the Example 3, 883m³/h at 156 Pa.

EXAMPLE 3

(Refer to pages 29-34)
FIG. 3.10

PRESTIGE OFFICE (BANK) (8 A.C.H.)



The Local Fire Officer must be consulted and all recommendations adhered to, before quoting either verbally or in writing for systems that breach separate firebreak walls and partitions or require fire resistant ducting.

Whilst every care has been taken to ensure that this calculator is accurate and free from errors or omissions, no liability whatsoever can be accepted by Vent-Axia Ltd where it has been used wholly or in part for calculations involved in the precise design of ducted system.

AUTHOR D J CLARK, 1990
REVISED DJC, PK, BEC, 1997

Vent-Axia®

SALES CENTRES

SCOTLAND
12 Lambhill Quadrant, Scotland Street Trading Estate,
Kinning Park, Glasgow G41 1SB
Tel: 0141 429 1166 Fax: 0141 429 6616

NORTH WEST
Unit 2, Caledonia Way, Stretford Motorway Estate,
Barton Dock Road, Manchester M32 0ZH
Tel: 0161 865 8421 Fax: 0161 865 0098

NORTH EAST
5 Dolly Lane, Leeds LS9 7TT
Tel: 0113 245 2985 Fax: 0113 242 4430

MIDLANDS
70 Albert Road, Stechford, Birmingham B33 9AH
Tel: 0121 783 8601 Fax: 0121 784 7506

SOUTH WEST
4 Dowry Square, Bristol BS8 4SS
Tel: 0117 927 7567 Fax: 0117 922 5631

EASTERN
Newton Road, Crawley, West Sussex RH10 2JA
Tel: 01293 530202 Fax: 01293 565169

LONDON
Newton Road, Crawley, West Sussex RH10 2JA
Tel: 0181 549 2271 Fax: 01293 565169

SOUTH EAST
Newton Road, Crawley, West Sussex RH10 2JA
Tel: 01293 530202 Fax: 01293 565169

NORTHERN IRELAND
11 Sydenham Road, Belfast BT3 9DH
Tel: 01232 455528 Fax: 01232 452529

REPUBLIC OF IRELAND
Vent-Axia Ventilation Ltd
921 Western Industrial Estate, Naas Road, Dublin 12
Republic of Ireland
Tel: 01 450 4133 Fax: 01 450 4570

HEAD OFFICE/EXPORT SALES
Vent-Axia Ltd
Fleming Way, Crawley, West Sussex RH10 2NN
Tel: 01293 526062 Fax: 01293 551188

Internet site at: http://www.vent-axia.com
email: fan@mail.vent-axia.co.uk

As part of the policy of continuous product improvement Vent-Axia reserves the right to alter specifications without notice. For current details please contact your nearest Vent-Axia Sales Centre. All sales made by Vent-Axia Limited are made only upon the terms of the Company's Conditions of Sales, a copy of which may be obtained on request.

SYS.CALC/762/0697

By Appointment to H.M. The Queen
Suppliers of Unit Ventilation Equipment
Vent-Axia, Crawley, West Sussex

Vent-Axia®

SYSTEM CALCULATOR