waterloo

Waterloo technical note

Basic systems overview

1. Air Terminal Devices - ATDs

1.1 General

Air Terminal Device, or ATD, is a generalised term used mainly for grilles, diffusers, weather louvres, displacement units and chilled beams that are commonly used to supply, extract or transfer air in a building.

ATDs are mounted in any of the surfaces of a room with the function of directing supply or exhaust air in such a way that comfortable and adequate air distribution is achieved. The purpose is threefold:

- to provide an acceptable thermal environment,
- to provide fresh air for respiration,
- to remove contaminated air.

This requires that the correct quantity of air is supplied and exhausted, and it is distributed properly so that the exhaust air carries away any contamination.

The proper selection of ATDs is therefore critical to the attainment of the desired thermal and air movement environment in a conditioned space.

Several general terms are used to describe different ATDs.

1.2 Diffusers

Generally refers to ceiling or floor mounted air terminals which distribute the supply air by diffusing it along adjacent surfaces. The rate and extent of this diffusion has the effect of inducing (or entraining) the surrounding room air. High induction devices such as swirl or barrel slot diffusers have a greater than average ability to induce room air to provide rapid mixing.

There are however certain types of terminal such as the jet nozzle and laminar flow panel which are termed diffusers but actually have the aerodynamic characteristics of grilles. To maintain architectural continuity diffusers can also be used as extract terminals.

Different type of diffusers include:

- Square diffusers
- Multicone diffusers
- Circular diffusers
- Jet diffusers
- Swirl diffusers
- Floor diffusers
- Luminaire diffusers
- Linear or slot diffusers
- Toilet valves
- Perforated face diffuser
- Polymer diffuser
- High capacity diffuser

1.3 Grilles

Originally defined as a lattice or screen, in the early days of forced ventilation systems a grille was used as a decorative covering rather than a functional air terminal. Modern types of grille are in general used as sidewall, sill or floor mounted devices and depending on the type, they may incorporate sets of adjustable vanes or have various fixed blade profiles. Grilles can in general be used for supply or exhaust applications, although certain types of grille are specifically designed for exhaust or transfer use.

Different types of grilles include:

- Single deflection grilles
- Double deflection grilles
- Linear grilles
- Fire rated grilles
- Door grilles
- Security grilles (also known as cell grilles or prison grilles)
- Exhaust grilles
- Floor grilles
- Polymer grilles

1.4 Dampers

Air dampers are used in conjunction with grilles and diffusers to provide a means of balancing or regulating the air flowing through the terminal. Various types are available to suit round, square, or rectangular terminal necks.

1.5 Plenums

These are used as a means of conveying air from the system ducting to the grille or diffuser and are essentially sheet steel shrouds attached to the neck of the terminal. Plenum selection is very important and the type and size are generally matched to certain types of product to ensure that the exiting flow distribution is suitable. This always assumes that the duct inlet conditions are adequately controlled. Any device added that affects the duct inlet condition will have an effect on the performance of the product.

1.6 Weather louvres

Louvres are installed externally on a building to allow air into or out of the building whilst offering weather protection. They can be made in either single panel louvres (up to 2m x 2m), or where a bank or row of louvres is required they can be supplied as either:

- mullion type louvres, where a series of louvre panels are installed individually next to each other) or,
- continuous louvre screen, where a series of panels are installed next to each other but visually resemble one continuous louvre.

Depending on specification, they are available for use in sheltered applications or for more exposed applications.

Where they are installed as an enclosure on a roof of a building they are commonly referred to as penthouse louvres.

1.7 VAV & CAV Units

In addition to the above there are also "system" based air terminal devices called Variable Air Volume, or VAV, and Constant Air Volume or CAV. These units either provide a variable volume or a constant volume of air into the ductwork that supplies the grilles, diffusers and in some cases the chilled beam units.

2. Air diffusion terminology

Air flow rate: The volumetric quantity of air passing through the air terminal normally expressed in m^3/hr or l/s

Air velocity: An engineering term used to describe the speed of an air stream in a room or of the air flowing through a duct, expressed in m/s

Throw and projection: The distance that an air jet will travel from the diffuser before its velocity (speed) decays to a predetermined value known as the terminal velocity. This is used as the basic method of selecting terminal type and size. The term projection is used specifically where the air jet is discharged vertically. Throw is expressed in metres measured from the centerline of the discharge face.

Pressure Loss: The resistance to the flow of air through the device at a specified volumetric flow rate expressed in Pa

Regenerated noise: The noise produced by air passing through the device at a specified volumetric flow rate. This can be expressed as overall values of sound pressure in NR, power in dBA, or alternatively as a spectrum.

3. Principles of air diffusion schemes

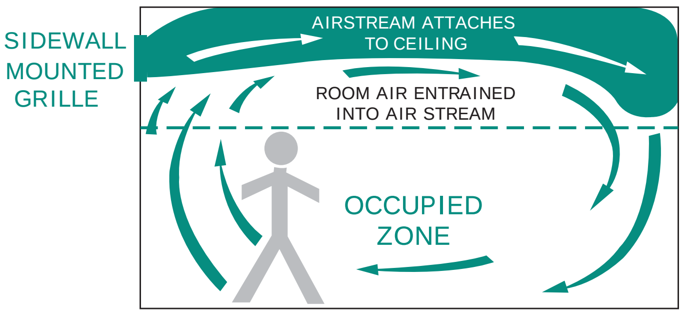
3.1 General

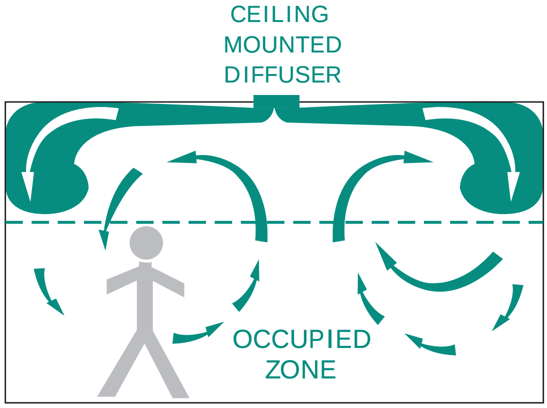
One of the principle requirements of any air terminal device is to introduce the air into a treated space without causing uncomfortable draughts. In most situations with mixed flow systems, this means positioning the terminal outside the occupied zone, which is practically any part of the room above standing head level. (1.8 m from floor level).

However, this is no guarantee of producing a satisfactory room environment and many other factors may have to be taken into consideration when selecting an appropriate scheme. Fortunately, in most cases it is possible to make use of a physical principle known as the Coanda or ceiling effect (attributed to the Hungarian aerodynamicist of that name), which in basic terms states that a moving airstream will under prescribed conditions have a tendency to be drawn towards and adhere to an adjacent surface.

Therefore, as the air leaves the terminal, the boundary of the jet will start to drag the adjacent stationary room air with it. The net result being that in moving across the ceiling the jet velocity (speed) will gradually be reduced, at the same time mixing with the room air to either heat or cool it.

This process is known as entrainment and is illustrated for sidewall mounted grilles and ceiling mounted diffusers in the following sketches.

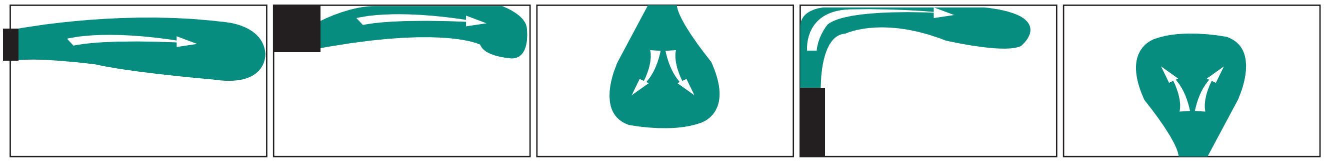




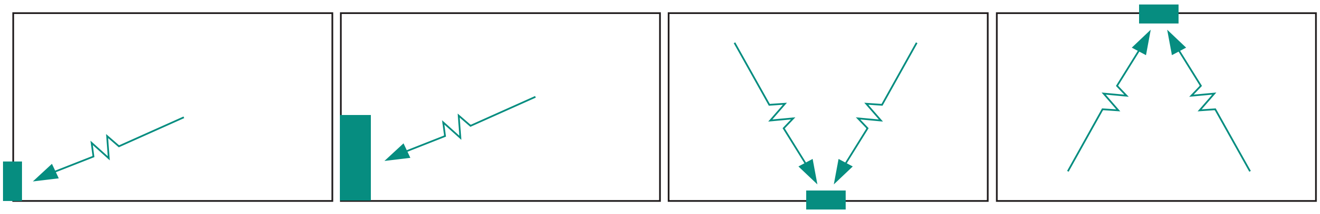
3.2 Methods of supplying or extracting air from buildings

Air terminal devices can be used to supply or exhaust air in a number of ways, but more often than not the chosen method and the type of terminal will be dictated by design or by physical and architectural constraints. The diagrams below show the various types of device, and their principle use:

SUPPLY AIR GRILLES

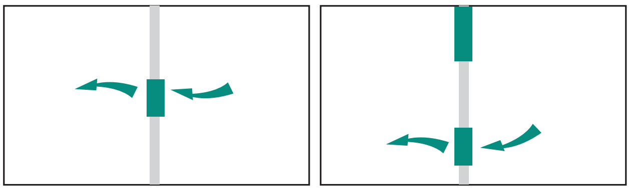


SIDEWALL BULKHEAD CEILING CILL FLOOR



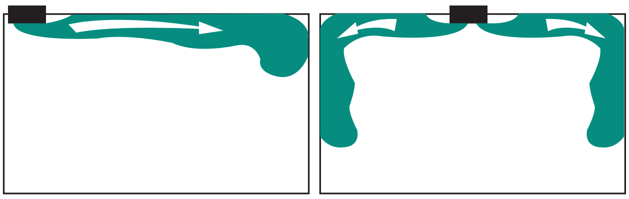
SIDEWALL CILL FLOOR CEILING

AIR TRANSFER GRILLES



WALL MOUNTED DOOR MOUNTED

CEILING MOUNTED SUPPLY AIR DIFFUSERS



SINGLE DIRECTIONAL MULTI-DIRECTIONAL

3.3 Manufacturing and finishing methods

The majority of products within the grille, diffuser and damper ranges are manufactured from aluminium extrusions. These offer many advantages over other materials in the manufacturing process.

Jointing techniques rely on the corner cleating process, whereby a feature in the extrusion is deformed around a corner insert. Welding or soldering is also used on joints where strength is an important factor.

Grilles which feature non-adjustable blades are assembled using a technique known as tube expansion, which provides a quick and cost effective assembly method. With this system, the individual blades are cut to length and pre-punched to accept the assembly tube, which is then expanded internally to lock the blades at the required pitch.

The standard form of paint applied to all products is a matt polyester powder coating which produces a high quality, long lasting finish suitable for most application.

4. Displacement ventilation and chilled beams

A system located in the occupied zone that introduces air in an even pattern in order to generate displacement of the existing room air.

This air is brought into areas around the building at very low velocity, through floor terminals, or low-level wall terminals. Low velocities (less than 0.25 m/s) are needed to ensure that occupants don't feel a draught.

The cool supply air pools in a layer near the floor. Body heat from occupants, and heat loads from equipment such as PCs as well as solar effects warms this pool of air which then rises. Fresh cool air is therefore drawn upwards, cooling the office and drawing out sources of pollution such as CO_2. The displaced warm air and the pollutants are generally extracted at high level.

Due to the heavy heat loads found in today's offices, the displacement ventilation system is often teamed with passive chilled beams to enhance the cooling effect. These consist of an aluminium-finned copper coil mounted above the ceiling or in a casing. Spacing above the coil allows rising warm air to pass over the coil. As the warm air comes into contact with the cool surfaces of the coil, the air is cooled and passes through the coil and back down to the occupied level of the room.

Passive chilled beams are a simple technology which is cost effective to run. But there are a few challenges to overcome. Firstly, the chilled water in the coil should not fall below 14°C, or condensation can occur. Secondly if the cooled air falls away from the beam too quickly this can cause draughts for occupants sitting below the beam. Finally, passive beams only provide static cooling, so extra fresh air must be introduced to the occupied space to meet minimum requirements.

One way to do this is to use floor outlets to provide the necessary fresh air requirement.

5. VAV Systems

5.1 General

Centralized air conditioning systems are found in larger buildings, where there is a general need to ensure occupant comfort in offices. These systems provide filtered air, humidification or dehumidification as well as cooling. Central plant is positioned in a ground-floor plant room or in packaged units on the rooftop.

Occupants need to be able to adjust temperatures in different areas of the building in order to match their particular requirements. Management of temperatures in different parts of a building with a centralized air conditioning system can be controlled in a number of ways. Two of these are:

- Variable Air Volume (VAV) systems
- Constant volume systems

5.2 Variable air volume (VAV)

Air conditioning systems are some of the most common found in UK commercial office properties today. In a VAV system the supply air is kept at a steady temperature and internal temperatures are controlled by varying the volume of air supplied to a space. The air volume is usually controlled by dampers or by the use of variable speed fans (which are also energy efficient).

The VAV system offers a number of benefits, including:

- Relatively rapid control of temperatures in occupied zones, giving greater occupant comfort and control.
- Good energy efficiency levels are achievable if the system is designed well, as VAV systems have minimal simultaneous heating and cooling.

It is important when designing a VAV system that positive building static pressure is maintained. This is done by regulating the airflow of the supply and return fans. In some VAV setups, the central air handling unit fan speed is controlled to maintain a constant duct pressure. An interlock is arranged between the supply and extract fans.

Although VAV air conditioning systems are effective and efficient, they are also relatively complex. VAV systems need controls to alter air temperature and volume. The fan is controlled by a speed modulator. Alternatively the volume of air can be altered through a damper which restricts the air flow. Zone temperature sensors are used to control a damper which allows maximum air flow when heating or cooling loads are high, and then adjusts to minimum airflow when these loads are low.

Good design, installation and maintenance are required to ensure that the VAV system continues to perform effectively. If airflows are low this can lead to deterioration of indoor air quality, or poor mixing with the air in the room. Low airflow can also cause air to drop directly from the supply diffuser causing discomfort for anyone sitting directly below it.

Regular maintenance of the variable volume dampers is also required if the VAV system is to achieve its energy saving potential. If the air supply volume to different spaces is not correctly adjusted, individual rooms or floors can become uncomfortable so rebalancing the system regularly is also recommended.

5.3 Typical VAV System

Chilled air enters the room and mixes with the existing room air, causing a temperature drop. This is detected by a room thermostat sensor which if required sends a signal to the VAV controller to change the position of the damper in the VAV terminal. The damper adjusts, thereby altering the amount of chilled air entering the room.

At the same time, as the VAV dampers close, the air flow from the air handling unit (AHU) is restricted so pressure in the duct will rise. The supply duct pressure sensor reduces the speed of the supply fan to maintain constant pressure.

VAV units can also be fitted with heaters for use in areas where heating is required, for example at the perimeter of large open plan offices with large areas of glazing.

5.4 Constant volume

With a VAV system, the room temperature is controlled by varying the amount of air entering a room. Sometimes it is desirable to maintain constant ventilation rates, while also offering temperature control. This can be achieved using a constant volume system.

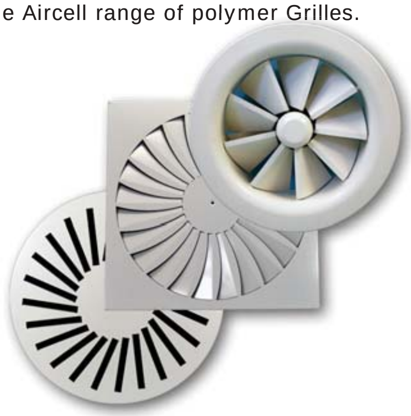
These are also known as dual duct systems, since they require either two air handling units or one unit which can produce chilled and heated air simultaneously. Two sets of ductwork carry these airstreams to mixing units in the various rooms or offices. Room temperatures are controlled by varying the mix of hot and cold air from the air handling units. If cooling is required a damper will allow more chilled air into the room, and vice versa.

While the system does give good control of temperatures, it is not considered to be one of the most energy efficient methods.

Waterloo Product Range

GRILLES

A complete range of products suitable for all wall, ceiling and floor applications. Most grilles are made from aluminium and have a range of fixed or moveable blades designed to give performance whilst remaining aesthetically pleasing to the eye. Grilles are made to customer specified sizes and colours (PPM/G); standard colour PPM9010 (20% Gloss White). The range is complemented by the Aircell range of polymer Grilles.



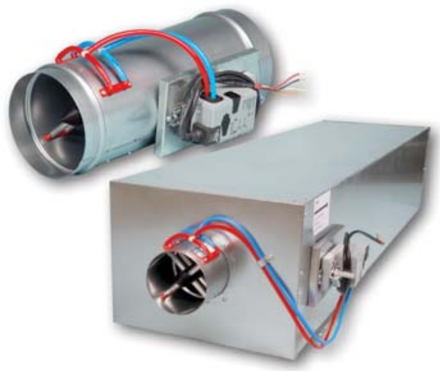
DIFFUSERS

Designed to be installed in various ceiling systems, we have a complete range to suit both performance and aesthetical requirements. Most diffusers are made from aluminium and can be ordered with or without plenum boxes for easy duct work. Diffusers can be ordered in customer specified colours (PPM/G); standard colour is PPM 9010 (20% Gloss White). This range is complemented by the Aircell range of polymer Diffusers.

ACTIVE AND PASSIVE CHILLED BEAMS

The finest quality range of high output active beams, used for ventilated heating and cooling applications. These units have 4 pipe coils to allow heating and cooling circuits to run simultaneously, giving constant and responsive control. The design allows a large optimum capacity and also allows the customer to specify the nozzle type and pitch for individual circumstances.

Active beams are made from steel to a large range of customer specified sizes and as such are suitable for various different ceiling systems. Standard finish is PPM 9010, however other (PPM/G) colours are available on request.



AIR VOLUME CONTROL DAMPERS

Pressure independent Variable Air Volume and Constant Air Volume dampers made from zintec plate. Most volume dampers are regulated with an electronic motor and sensors and are calibrated to customer specifications before delivery.

The Constant Air Volume damper requires no power source as it is controlled via a mechanical device and calibrated before delivery. All volume dampers can be ordered with a single or double (insulation) skin.

EXTERNAL LOUVRES

A quality range of products for external wall applications. Made from aluminium, with birdscreen or insect screen options. All louvres are made to customer specified sizes and (PPM/G) colours; standard colour is PPM 9006.

DISPLACEMENT

A full range of recessed, semi-recessed, floor, wall and corner units providing high ventilation efficiency and excellent comfort. The very low pressure involved also offer quiet installations. Displacement units are available as wall or floor mounted, or indeed integrated within the architectural design.

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Waterloo Air Products plc

Head Office:

Mills Road, Aylesford,
Maidstone, Kent ME20 7NB
Tel: +44 (0)1622 711 500
Fax: +44 (0)1622 710 648
email: sales@waterloo.co.uk
internet: www.waterloo.co.uk

Northern Office:

Hyde Park House, Cartwright Street,
Newton, Hyde SK14 4EH
Tel: +44 (0)161 367 1264
Fax: +44 (0)161 367 1262
email: sales@waterloo.co.uk
internet: www.waterloo.co.uk

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