Traditional HVAC systems in most commercial buildings today employ Overhead Mixing (Mixed Ventilation, MV) to meet both outdoor air ventilation and space conditioning requirements, providing a mixture of fresh outdoor air and recirculated air to the occupied space. Displacement Ventilation (DV) was first introduced in Europe in the 1970's and more recently has gained popularity in North America as advanced ventilation approaches to meet the Indoor Air Quality (IAQ) requirements of green building strategies and the need to lower energy consumption via the HVAC system gain popularity.

DV systems deliver low velocity (typically 40 fpm average face velocity) conditioned air directly to the occupied space close to floor level, relying on the buoyancy forces of air to drive air motion. As the cool supply air from the displacement unit travels across the floor, it is pulled towards a heat source within the room (such as people, computers and other electronics) and entrained into the thermal plume caused by a low pressure region around the heat source (see **Fig. 1**).

When the cool supply air encounters these heat sources and begins to warm, the thermal plume displaces the warm air upwards towards the exhaust openings located at or near the ceiling, producing a stratified temperature zone divided into two regions. The lower region is referred to as the "occupied zone", where people, office furniture and other equipment reside, and the upper region is referred to as the "unoccupied zone", and is the layer where heat, and subsequently pollutants and contaminates, rise and are exhausted.

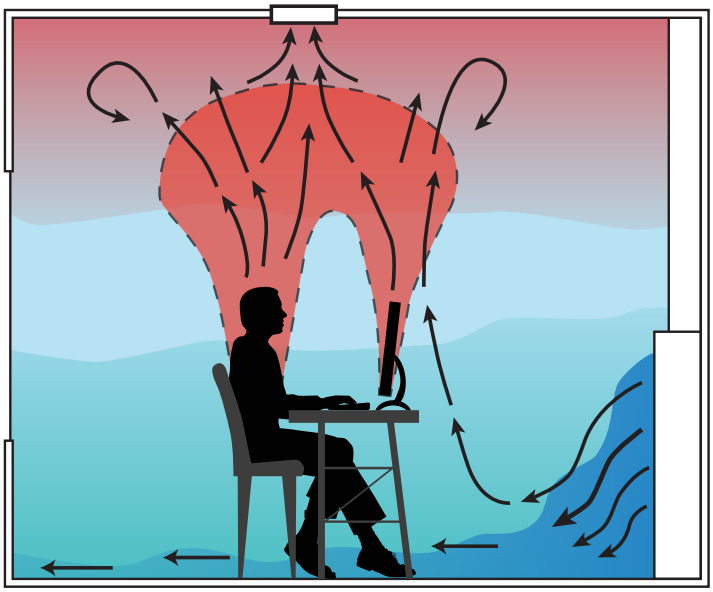


Fig. 1 - Thermal plume around heat sources.

When compared to a conventional MV system, DV uses a combination of warmer supply air and lower pressures, resulting in potential energy savings through longer economizer periods, increased chiller efficiencies and lower horsepower fans. Further fan energy savings may be realized with DV as the supply air volume only has to deal with the load in the occupied zone when stratification is taken advantage of, unlike MV where the whole room is mixed. The occupied zone for DV does not see the load from the light and this load only needs to be dealt with at the AHU. IAQ benefits are achieved through the superior air quality of the breathing zone, quieter operation of DV vs. MV systems and the enhanced thermal comfort of occupants due to less draft and lower percentages of people dissatisfied, as detailed per ASHRAE Standard 55.

Nailor Displacement Diffusers

Additionally, ASHRAE Standard 62.1-2013, Table 6.2.2.2, rates displacement ventilation systems with a Zone Air Distribution Effectiveness (EZ) factor of 1.2. EZ as an indicator of the quality of supply air distribution in ventilated rooms compared to a perfect air mixing condition, which can be used as an indicator of air quality and human exposure. A traditional overhead mixing system can have an EZ between 0.8 – 1.0, depending on supply air temperatures. The higher rating of displacement systems translates to a lower volume of fresh air to meet ASHRAE 62.1 requirements, and can also assist engineers and owners in achieving certain LEED® green building program goals.

Nailor Industries has developed a complete line of engineered Displacement Diffusers with a pleasing aesthetic design to suit any application. Rigorous lab testing combined with the latest in computational theory, high quality manufacturing and the Nailor commitment to providing quality Air Distribution solutions result in one of the industry's finest selection of Displacement Diffusers available on the market today.

DISPLACEMENT VENTILATION

In fluid mechanics, the term displacement refers to a measureable volume of a fluid moved (or displaced) by an object immersed in the body of the fluid. According to Archimedes' Principle, if the object weighs more than the volume of fluid displaced, the buoyancy forces acting on the object by the fluid are less than the weight (due to gravity) of the object, causing the object to sink.

CONSIDER THIS...

What is the driving factor of lift in a hot air balloon? **(Fig. 2)** Buoyancy Forces! When a fluid, air in this case, is heated up, it becomes less dense than the surrounding fluid. The heat causes the molecules to move at a higher rate, increasing the pressure near the top of the inside of the balloon. Once this pressure becomes large enough to overcome the weight due to gravity of the balloon, the buoyancy forces create lift. When the hot air balloon remains at a constant elevation, the pressure inside the balloon is in equilibrium with the surrounding atmosphere. In order for the balloon to descend, the pressure inside the balloon must be reduced until the weight of the balloon overcomes the buoyant force of the air inside **(Fig. 2)**.

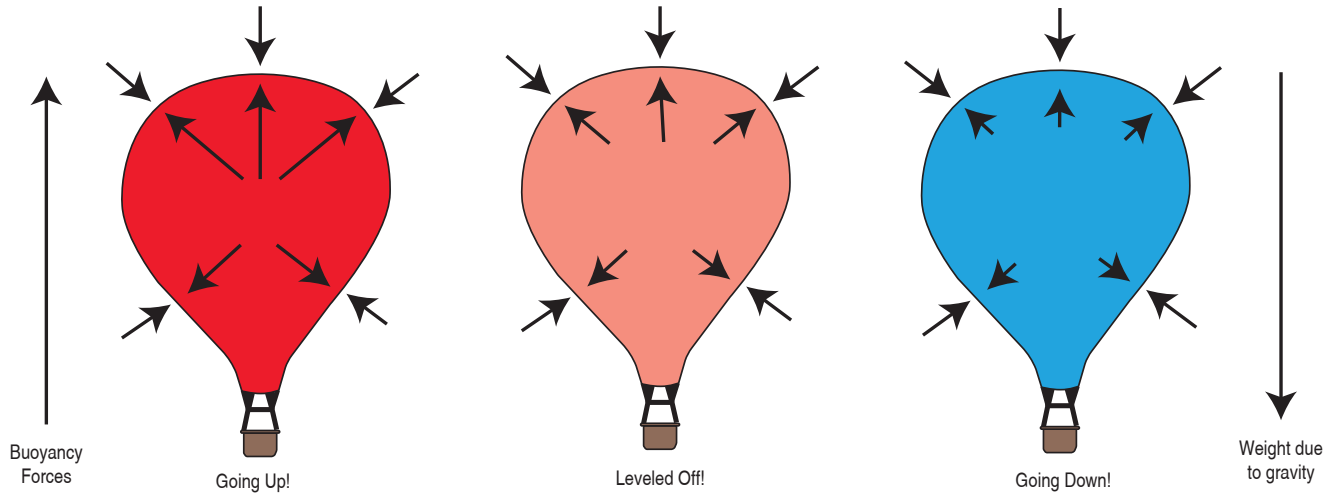


Fig. 2 - Buoyancy forces of air

This can be directly related to Displacement Ventilation. As cool, dense supply air discharges from the diffuser, it is physically heavier than the warmer room air, causing it to sink to the floor. From there, the air travels along the floor as it is drawn towards convective heat sources such as people, computer equipment and lights. Each heat source generates a convective plume, driven by buoyancy forces, creating an upward velocity of warm air around the source **(Fig. 3)**. This velocity creates a low pressure region along the surface of the source creating a constant flow of cool, ventilated supply air entrainment into the plume, effectively cooling the heat source and providing fresh air to the breathing zone.

HOW DISPLACEMENT VENTILATION DIFFERS FROM OVERHEAD MIXING

Overhead mixing systems utilize high velocity supply discharge air, typically delivered and exhausted at or near ceiling level **(Fig. 4)**. This high velocity discharge air creates a low pressure region at the outlet of the diffuser near the ceiling surface, causing induction of room air that mixes with the supply air jet. If designed properly, this constant mixing of room and supply air generates a near constant temperature gradient from floor to ceiling, resulting in a Zone Air Distribution Effectiveness (EZ) of 1.0 per ASHRAE 62.1. If not designed properly, potential disadvantages of all-air overhead mixing systems are:

1. Occupant discomfort due to draft.
2. Poor air contaminant removal efficiency.
3. Excessive energy consumption.

Displacement Ventilation is an air distribution system that utilizes low velocity supply air, typically delivered at, or near, floor level and exhausted at, or near, ceiling level. A short distance from the diffuser face, the air pattern hugs the floor, typically no more than 8 inches (0.2 m) above the floor surface. Heat sources (people, computers, lights, etc...) create heat plumes within the space convectively driving the flow of cool supply air from floor to ceiling as it heats up, utilizing natural buoyancy forces to drive the flow of air through the layers of stratification. This is accomplished with minimal mixing in the occupied space and therefore yields a higher ventilation effectiveness and higher removal efficiency of airborne contaminants from the occupied

space when compared to an overhead mixing system, improving Indoor Air Quality (IAQ) characteristics. When compared to typical overhead mixing systems, Displacement Ventilation systems generally have higher Supply Air Temperature's (SAT) that help prevent occupant dissatisfaction due to draft at or near ankle level where air is supplied. However, the overall temperature gradient within the occupied space must be evaluated to avoid issues of elevated temperatures at or near head level.

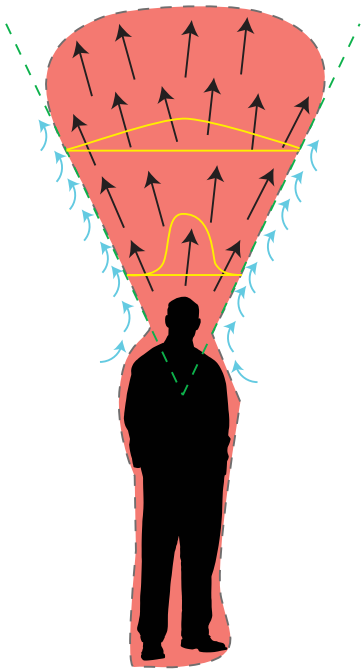


Fig. 3 - Thermal Plume

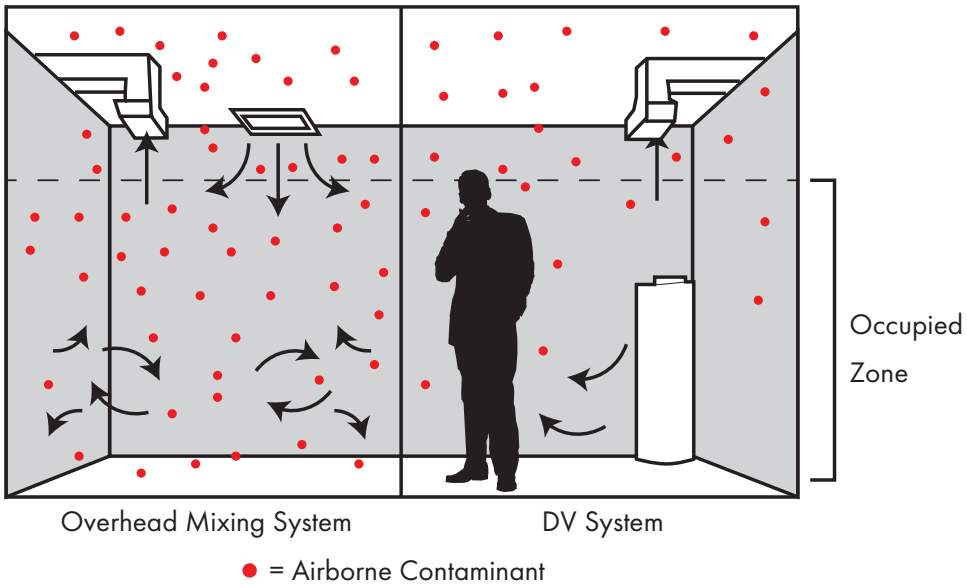


Fig. 4 - Mixing vs DV System

APPLICATION CONSIDERATIONS FOR DISPLACEMENT VENTILATION

Schools, Theaters, Hospitals, Casinos, Restaurants, Industrial Facilities, Grocery Stores, Open-Plan Offices.

1. Ceilings are greater than 8 ft (2.4 m) in height.
2. Exhausts are located at or near the ceiling, typically within 1 ft (30 cm) of maximum ceiling height.
3. Contaminants are lighter and/or warmer than supply air.

Note: if one or more of these are not true, overhead mixing system may be more applicable.

TYPICAL DISPLACEMENT VENTILATION DESIGN CONDITIONS

1. Supply Air Temperature (SAT) ⟶ 63 - 68°F (17 - 20°C).
   a. Transient and high cooling load zones may be suitable for the lower SATs.
2. Exhaust Air Temperature (EAT) ⟶ 78 - 85°F (26 - 29°C).
3. Supply Air Discharge Velocity ⟶ 40 fpm (0.2 m/s) or less.
   a. Increased discharge velocities yield higher sound levels, increased system pressure drop and consequently, elevated energy consumption. This can also affect IAQ by promoting mixing in the space.
   b. Transient and high cooling load zones are suitable for elevated velocities.
4. Maximum Cooling Load (ASHRAE RP-949) ⟶ 38 Btu/h-ft^2 (120 W/m^2).
   a. Buoyancy forces caused by intensity of the heat generation by heat sources can greatly affect the performance of a DV system. The above value was determined by studying typical North American school, office and industrial settings, where metabolic and clothing heat generation rates are well known and studied. This is the suggested maximum cooling capacity of a DV system while maintaining acceptable thermal comfort conditions within the occupied space according to ASHRAE Standards.
5. Zone Air Distribution Effectiveness, Ez (ASHRAE 62.1, Table 6.2.2.2) ⟶ 1.2.

BENEFITS COMPARED TO OVERHEAD MIXING SYSTEM

1. Zone Air Distribution Effectiveness (EZ) of 1.2 requires 20% less ventilation airflow.
2. Improved airborne contaminant removal efficiency, improving IAQ (see **Fig. 3**).
3. LEED® credits applicable to DV.
4. Decreased fan size due to reduced diffuser pressure drops.
5. Increased chiller efficiency realized from elevated supply and exhaust air temperatures.
6. Lower sound levels in the occupied space.

LIMITATIONS OF DISPLACEMENT VENTILATION

1. Requires separate heating system, typically for perimeter zones (warm supply air short circuits directly to the ceiling (see **Fig. 4**).
2. Each diffuser is capable of delivering conditioned air up to 25 - 30 ft (7.6 - 9.1 m) from the diffuser face. If the space is more than 30 ft (9.1 m) in length or there is more than 30 ft (9.1 m) between diffusers, consider adding another diffuser on the opposite wall or centered between diffusers for increased system performance (see **Fig. 5**).
3. Large diffusers can result in potentially obtrusive installations as many are exposed floor standing models (ceiling and internal sidewall models can alleviate this issue).
4. Zones with higher than normal cooling loads are not recommended for DV due to stratification limits set by industry standards (ASHRAE 55 and ISO 7730) and overall system performance characteristics.
5. Because these diffusers are installed near floor level, obstructions such as furniture are more prevalent, resulting in interrupted airflow paths and decreased thermal comfort characteristics.

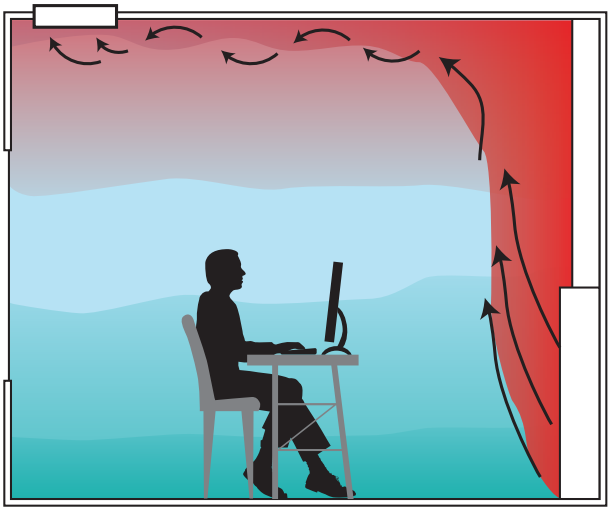


Fig. 4 - DV System heating short circuiting.

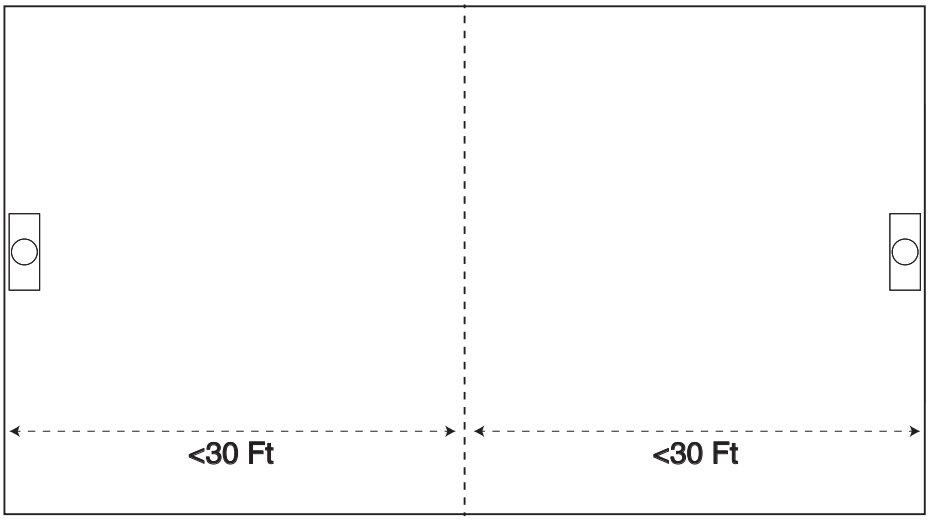


Fig. 5 - 30 ft (9.1m) Limit of DV Diffuser

Displacement Ventilation is a method of air distribution that has been around for many years, primarily in European markets. The Federation of European Heating and Air-conditioning Associations (REHVA) developed and published a design guide for DV systems in 2002 called "Displacement Ventilation in non-industrial premises." This is a comprehensive guidebook constructed on decades of scientific research, experience and case studies that goes through all aspects of system design. It covers the history of displacement, the principles that drive system performance, diffuser characteristics, system design strategies, energy optimization and control considerations.

To adapt this technology to more diverse climates realized in North America, further analysis needed to be considered. The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) sponsored a research project (RP-949) "Performance Evaluation and Development for Design Guidelines for Displacement Ventilation" to accomplish this task. From this study came the ASHRAE design guide for DV published in 2003, "System Performance Evaluation and Design Guidelines for Displacement Ventilation." This all-encompassing guide goes through an extensive literary review and utilized a computational fluid dynamic (CFD) modelling approach developed during the study to help create a step-by-step design process for DV systems in typical North American applications.

The following is a simplified interpretation of the steps required to properly design a DV system in typical North American applications determined by ASHRAE RP-949:

1. Calculate peak summer cooling load:

   At minimum, sum the heat generated by the following:

   a. people, desk lamps and electronics, q_{oe} [Btu/h (W)].

   b. conduction and solar radiation through building envelope, q_{ex} [Btu/h (W)].

   c. overhead lighting, q_l [Btu/h (W)].

$$q_{total} = q_{oe} + q_{ex} + q_l$$

2. Calculate airflow rate required to satisfy peak cooling load assuming (if possible) a maximum of 1.2°F/ft temperature gradient in the space and standard air:

$$Q_p = \frac{0.295q_{oe}+0.132q_l+0.185q_{ex}}{60pc_p\Delta T_{hf}} \quad \text{(IP)}$$

$$Q_p = \frac{0.295q_{oe}+0.132q_l+0.185q_{ex}}{pc_p\Delta T_{hf}} \quad \text{(SI)}$$

Qp = airflow required to satisfy peak cooling load, [cfm (m^3/s)]

p = air density, [lb/ft^3 (kg/m^3)]

c_p = specific heat of air at constant pressure, [Btu/lb°F (kJ/kg-K)]

ΔT_{hf} = temperature difference between head and foot height [°F (°C)]

   a. The coefficients for the different heat load values are the fraction of the cooling loads that are entering the space for a seated occupant assuming a maximum of 3.6°F (2°C) temperature gradient from floor to a seated height of 3.6 ft (1.1 m) specified by ASHRAE 55-2010. Because the temperature gradient between the seated occupant and standing occupant, at a height of 5.5 ft (1.7 m), is less than that from the floor to the seated occupant, the given formula should generate a comfortable environment for both seated and standing occupants.

   b. Recent modifications to ASHRAE 55-2013 allows a maximum temperature gradient of 5.4°F (3°C) for seated occupants and 7.2°F (4°C) for standing occupants. Future studies could result in different cooling load fractions based on this new information, but should result in more than adequate levels of comfort based on previous classifications.

3. Calculate minimum ventilation rate to the space required by ASHRAE 62.1-2013 (consult local AHJ for code compliance) and refer to tables 6.2.2.1 and 6.2.2.2 in the standard for details on specific minimum space type requirements:

$$Q_{oz} = \frac{R_p P_z + R_A A_z}{E_z}$$

   a. Q_{oz} = minimum zone outdoor (ventilation) airflow, cfm (m^3/s)(specified at V_{oz} in 62.1)
   b. R_p = outdoor airflow rate per person, cfm (m^3/s)
   c. P_z = typical occupancy, No. of people expected to occupy the zone under normal conditions, [person]
   d. R_A = outdoor air required per unit area, cfm/ft^2 (m^3/s-m^2)
   e. A_z = zone floor area, ft^2 (m^2)
   f. E_z = zone air distribution effectiveness of specific air distribution system, E_z = 1.2 for DV

4. Total supply airflow is the higher of the two airflows determined by steps 2 & 3:

$$Q_t = \text{Max}\ [Q_p, Q_{oz}]$$

5. Calculate supply air temperature:

$$t_s = t_{sp} = \Delta t_{hf} - \frac{q_t}{\frac{2.33Q_t^2}{A_z} + 1.08Q_t} \qquad \text{(IP)}$$

$$t_s = t_{sp} = \Delta t_{hf} - \frac{q_t}{\frac{0.52Q_t^2}{A_z} + 1.21Q_t} \qquad \text{(SI)}$$

   a. t_s = supply air temperature, °F (°C)
   b. t_{sp} = room set point temperature, °F (°C)
   c. Δt_{hf} = head to floor temperature differential, °F (°C)

Note: The given simplified equation assumes the radiative and convective hear transfer coefficients are equal to 1 Btu/h-ft^2-°F (5.678 W/m^2-K). Refer to AHSRAE Fundamentals Handbook for more detailed information.

6. Calculate exhaust air temperature:

$$t_e = t_e + \frac{q_t}{1.08Qt} \qquad \text{(IP)}$$

$$t_e = t_s + \frac{q_t}{1.21Qt} \qquad \text{(SI)}$$

   a. Make sure the vertical temperature gradient is acceptable and supply air temperature does not fall below 63°F (17°C) to avoid issues of over-cooling the zone.

7. Readjust total supply airflow (as required) based on the exhaust temperature found in 6.a.:

$$Q_t = \frac{q_t}{1.08\ (t_e - t_s)} \qquad \text{(IP)}$$

$$Q_t = \frac{q_t}{1.21\ (t_e - t_s)} \qquad \text{(SI)}$$

8. Select appropriate diffuser(s) based on diffuser performance and desired layout:

   a. The industry standard for determining diffuser layout is Adjacent Zone (AZ). This is the point where terminal velocity of the diffuser airflow jet reaches a 40 fpm (0.2 m/s) isovel at 1 inch (25 mm) above the floor.
   b. Ensure sound and pressure drop performance is acceptable.
   c. Consider location of diffusers with respect to occupants and obstructions to maximize thermal comfort acceptance.

DFF SERIES - RECTANGULAR FLOOR STANDING

Model Series DFF Rectangular Floor Standing Displacement Diffusers are designed to integrate into the aesthetic feel of a space while simultaneously providing a quiet, low velocity air pattern necessary for occupant comfort. These diffusers incorporate a steel rectangular perforated face, with an integral plenum and equalization baffle, producing either a 1-way or 3-way air pattern. They are typically mounted against a wall, pillar or in a corner of a room in applications where there are space constraints.

Model DFF1 – 1-Way Pattern, Wall/Pillar Unit
Model DFF3 – 3-Way Pattern, Wall/Pillar Unit
Model DFF1C – 1-Way Pattern, Corner Unit

DFR SERIES - ROUND FLOOR/FREE STANDING

Model Series DFR Round Floor Standing Displacement Diffusers are semi-circular and circular units crafted to enhance the architectural design of any space while providing low turbulence horizontal supply air in a 90°, 180° or 360° pattern. The design incorporates an integral equalization baffle and a round perforated face that supplies low velocity air at a low sound level into the space. They can be mounted against a wall or pillar, or freestanding, providing numerous options for the architectural design team. The 360° model is also available in a duct hanging style, Model DFR360DH.

Model DFR90 – 90° Pattern, Corner Unit
Model DFR180 – 180° Pattern, Wall/Pillar Unit
Model DFR180H – 180° Pattern, Wall/Pillar Unit, High Capacity
Model DFR360 – 360° Pattern, Free Standing
Model DFR360DH – 360° Pattern, Free Standing, Duct Hanging

DW SERIES - WALL MOUNTED

Model Series DW Wall Mounted Displacement Diffusers maximize floor space by seamlessly integrating into the wall, supplying conditioned air to the space perpendicular to the diffuser face. The design features a flat perforated face that creates a low velocity air pattern. The series includes an internal wall mounted type that has a removable face and an integral plenum, a flangeless style that can be easily recessed in a low-wall or stair riser and a flanged grille type that easily mounts to a sidewall where plenums are field fabricated.

Model DWF1 – 1-Way Pattern, Internal Wall Mount, Flat Face
Model DWR1 – 1-Way Pattern, Riser/Recessed Wall Mount, Flat Face
Model DWG1 – 1-Way Pattern, Side Wall Mount, Grille Type, Flat Face

DLF SERIES - FLOOR MOUNTED

Model Series DLF Displacement Linear Floor Grilles provide a low velocity air pattern into a space with minimal turbulence or induction of room air. Model DLFG is available in a single size for common raised floor applications. Model DLFD may be installed with a continuous or segmented look for use in raised floors, floor cavities or on the top of sills. Superior air quality and low noise levels associated with Model Series DLF make it ideal for office spaces, schools, places of worship, museums, galleries or any application that demands a comfortable, quiet space.

Model DLFG – Displacement Linear Floor Grille
Model DLFD – Displacement Linear Floor Diffuser

DCF SERIES - CEILING MOUNTED

Model Series DCF Ceiling Mounted Displacement Diffusers are suitable for Lay-in T-Bar suspended ceiling applications. Constructed of heavy gauge corrosion-resistant steel, the design features an extruded aluminum flat perforated face with mechanically locked mitered corners for added strength. This Lay-in style diffuser installs quickly and easily in a standard T-bar ceiling, ideal in retrofit applications where there is no room for wall or floor mounted diffusers.

Model DCF1, Type L – 1-Way Pattern, Lay-in T-bar, Flat Face

Every HVAC system design begins with an objective approach to problem solving. Designing a system that meets the needs of model building codes, building occupants and budget constraints of the project is an art. Many factors contribute to the choices made during the design phase. More and more today, an integrated approach is utilized to ensure that the design meets the needs of the owner and occupants and the project scope remains on track with the budgets set during the planning stages.

Thermal comfort, energy efficiency, and indoor environmental quality (IEQ) are the driving factors in most commercial HVAC designs. Designers are looking towards newer technologies and better practices to achieve a balance between these factors and operating costs. The development of energy conscious high performance building codes, tightening of building envelopes, advancement of new building products and the drive to align sustainability in terms of social, environmental and financial interests has created a greater demand for more efficient HVAC systems.

A properly designed system utilizing displacement diffusers in the appropriate application can meet this demand. Designers need to be aware of several design and applications considerations and must have a clear objective during the planning stage in order to successfully integrate displacement diffusers into the HVAC system and achieve the goals set forth by the owner and project team.

A typical displacement ventilation system supplies cool conditioned air at, or near, floor level. Underfloor, lay-in and duct mounted diffuser models are also available for various applications. Below we will discuss various types of displacement diffusers and some considerations that should be considered during design and construction. The size and placement of displacement diffusers requires coordination with architectural professionals to ensure successful project integration.

Displacement diffusers can be categorized as follows:

- Floor/Free Standing: Diffusers are mounted on top of the floor, against a wall, pillar or corner of a room.
- Wall Mounted: Diffusers are integrated into the wall or millwork.
- Floor Mounted: Diffusers are installed into a raised floor.
- Ceiling Mounted: Diffusers are installed in a suspended ceiling.
- Industrial: Diffusers are designed to perform at higher velocities and in harsh environments.

FLOOR OR FREE STANDING DIFFUSERS

Floor or Free standing displacement diffusers can be rectangular or round and are typically mounted against a wall or partition, in a corner of the room or free standing toward the middle of a space, and are designed to handle large volumes of air. Depending on the unit's configuration, they can provide a 1-way, 3-way or radial air pattern (see **Fig. 2**).

The configuration of the unit is driven as much by the architectural consideration as it is by the diffusers performance characteristics. Occupancy types, occupant behavior, space limitations and diffuser location must be carefully contemplated during the design phase, as well as concessions and trade offs for performance versus aesthetics be weighted. In applications and designs that are limited in wall space, such as a classroom or commercial office, corner type floor standing diffusers may be an ideal solution. In applications that have a large volume of space and highly transient pedestrian traffic, such as airports, free standing centrally located diffusers may be an ideal solution.

Since displacement diffusers are usually within reach of room occupants, special considerations should be taken to protect them from incidental damages. They can be elevated from the floor, usually set on factory furnished bases, to prevent damage from cleaning equipment. The finish of the diffuser should be rugged enough to prevent damage from contact, and the construction should be concealed and tamper proof to prevent occupant mishandling.

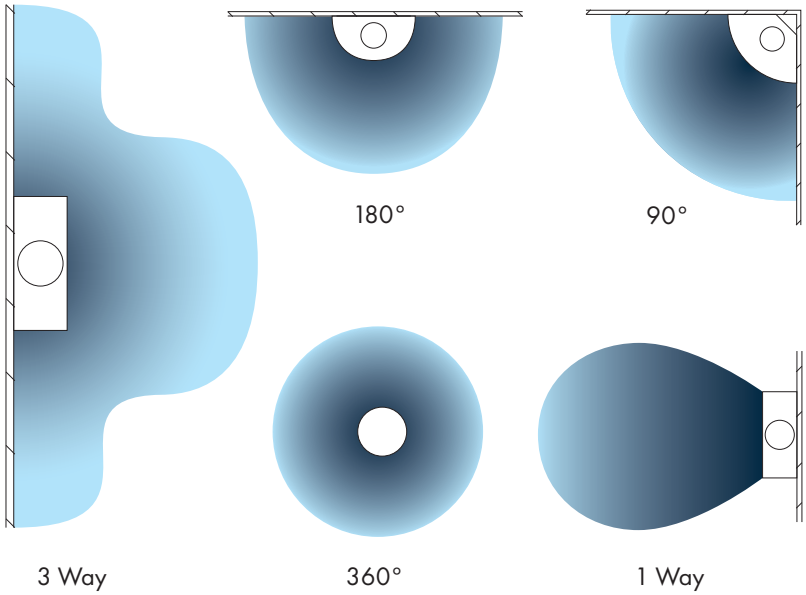


Fig. 2 - Floor/free standing diffuser air patterns.

WALL MOUNTED DIFFUSERS

Wall mounted displacement diffusers can be square or rectangular and mounted flush into the wall, usually between studs, or surface mounted, and provide a 1-way air pattern perpendicular to the wall. The most common wall mounted diffusers feature a small integral plenum with a rectangular inlet to accommodate a duct connection. They are typically mounted at a sidewall at a specified distance away from occupants who should be positioned no closer than the adjacent zone of the diffuser.

Example of an internal wall mounted diffuser.

A recessed or riser mounted displacement diffuser does not have a plenum or typical inlet, it is designed for use in field supplied plenum fed applications such as a stair riser, wall or cabinet. Surface mounted displacement diffusers feature a steel perforated face and grille flanged style frame, easily suited for low sidewall mounting.

Coordination with the Architectural, Plumbing and Electrical design teams will be required to ensure that integrated wall mounted diffusers do not interfere with other elements of the building construction. As these diffusers are usually become part of the wall construction, a stable occupancy type should be considered as a layout featuring these diffusers may not be adaptable to diverse occupant needs. Wall mounted diffusers may not be effective for "cookie cutter" commercial or industrial lease spaces, especially if tenant requirements are unknown to the design team and there is little interaction between the design team, building owner and building occupants before, during and after the design and construction phases.

FLOOR MOUNTED DIFFUSERS

Floor mounted linear displacement diffusers, a traditional linear bar grille with a perforated baffle, are designed for integration into a raised floor air distribution system. Particularly suited for applications with an emphasis on aesthetic appeal, a linear displacement floor diffuser can provide a continuous look while delivering a quiet, low velocity airflow pattern.

Floor mounted linear displacement diffusers handle regular foot traffic and do not intrude on wall space, making them well suited for offices, lobbies and educational facilities with raised floors where floor and wall space is at a premium. Load bearing requirements, installation constraints, and frame type and core styles should all be considered during the design phase. All cabling, piping and wiring is done under the floor, keeping the installation and any subsequent access and maintenance clean and simplified. Floor mounted linear displacement diffusers are an ideal solution for custom applications incorporating raised floor or trench systems.

Example of a floor mounted diffuser.

CEILING MOUNTED DIFFUSERS

Ceiling mounted displacement diffusers can be square or rectangular, featuring a flat perforated face ideal for suspended lay-in T-bar applications, particularly suited for retrofit applications when replacing a traditional overhead mixing system. The diffuser is designed to produce a low velocity vertical air pattern supplying air evenly across the perforated face with minimal turbulence or induction of room air. The cool supply air falls slowly to the floor and gradually fills the space.

These diffusers are available in round neck configurations and the frame is designed to easily drop into a standard ceiling tee. The standard finish is Appliance White to match the T-bar, however, custom finishes are available to match any architectural concept.

INDUSTRIAL APPLICATIONS

Displacement diffusers are ideal for industrial and manufacturing applications and can cover relatively large cooling capacities, providing significantly better conditions than mixing ventilation systems. Industrial displacement diffusers are designed to handle higher volumes of air which allows thermal loads and noxious matter to be systematically removed from the space. Accurate calculation of the equipment load in an industrial application is one of the most crucial steps during the design phase.

KEY TERMINOLOGY:

Adjacent Zone: Simply defined as the exclusion zone in front of the diffuser where a draft may occur and where the occupants should not be located. The portion of the room where discharge velocities exceed 40 fpm at a height of 1" above the floor. A common metric used to evaluate the performance of Displacement Diffusers.

Buoyancy: The vertical force exerted on a volume of air that has different density than the ambient air in the space.

Draft: Unwanted localized cooling caused by the movement of air. Typically a problem when occupants are located within the adjacent zone of a diffuser.

Face Velocity: Average air discharge velocity from the face of a diffuser usually expressed in feet per minute (fpm).

Isovel: The boundary line of points of equal mean velocity.

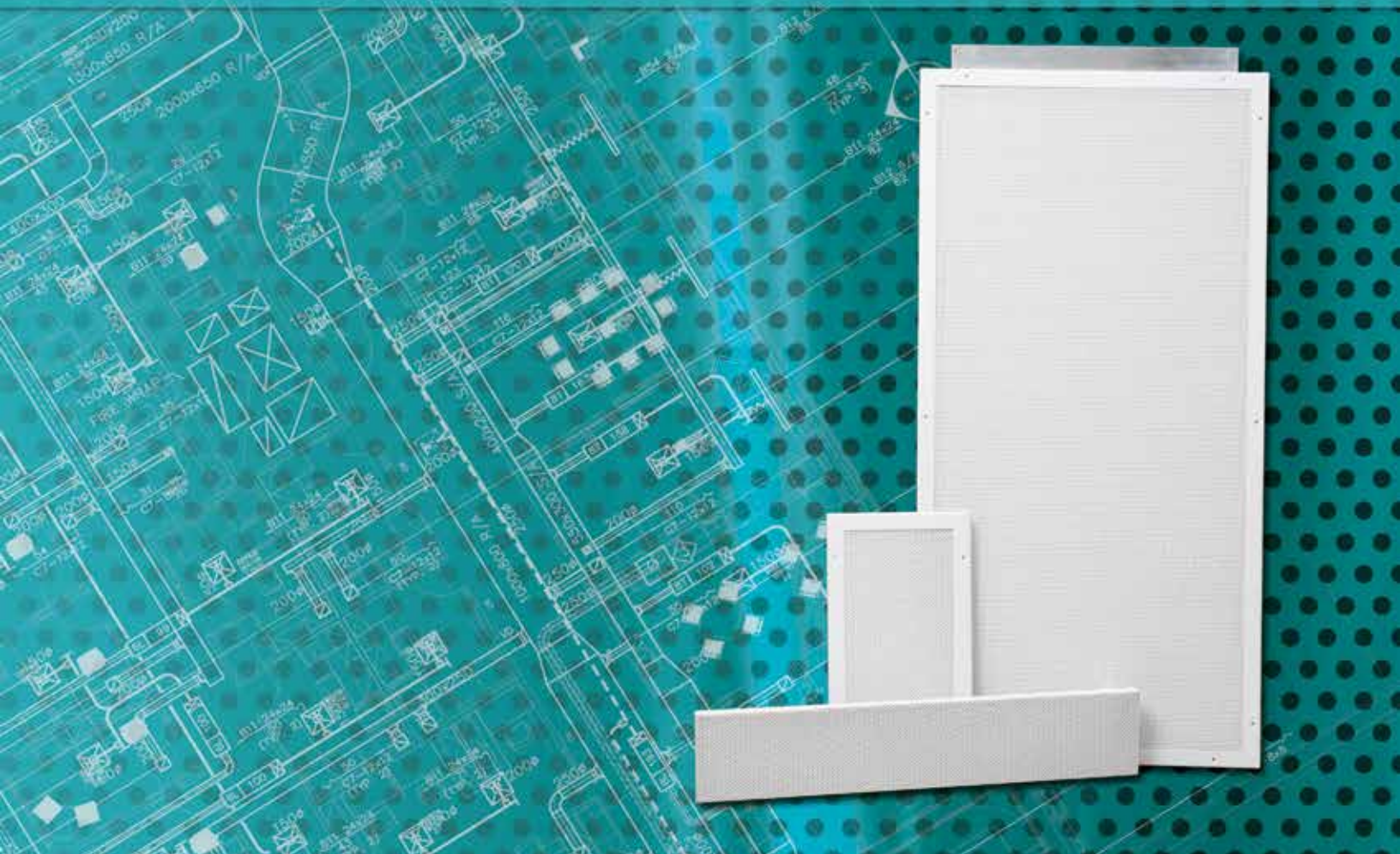
Occupied Zone: Distance at which discharge air from the diffuser reaches 40 fpm (at 1" off the floor). The minimum distance a stationary occupant should be positioned from the diffuser face.

Stratification: The layering of air into the occupied zone by means of a diffuser. Stratification allows for the buoyant forces of air to drive the displacement system.

Thermal Plume: The vertical column of air resulting from cold supply air meeting warmer ambient air and thermal loads within the occupied zone.

Nailor® Industries Inc.

DW SERIES



Nailor

DWF1

- RECTANGULAR
- INTERNAL WALL MOUNT
- REMOVABLE FACE
- 1-WAY DISCHARGE

Model DWF1 rectangular displacement diffusers are intended for in-wall applications, designed to integrate between studs and finish flush to the wall. Features include an integral low profile inlet plenum with a removable flat perforated face that creates a 1-way discharge pattern which provides cool air along and near the floor. An equalization baffle behind the diffuser face ensures an even distribution of low velocity supply air. The DWF1 can be utilized in high occupancy areas such as classrooms, theaters, lobbies and convention centers where floor space is at a premium. The diffuser is available with a rectangular top inlet as standard. Additional inlet locations, finishes and accessories are also available.

STANDARD CONSTRUCTION:

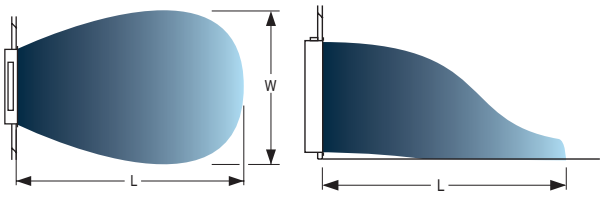
PLENUM: Heavy gauge corrosion resistant steel plenum.

FACE: Removable extruded aluminum frame mechanically interlocked with reinforced mitered corners with an 18 ga. (1.3) galvanized steel perforated face; 3/32" (2.4) dia. holes on 3/16" (4.8) staggered centers; 23% free area. Removable face for easy installation. Surface mount frame has 1 1/4" (32) face border with a 1" (25) drywall overlap margin.

INLET: Rectangular. Top inlet standard.

FINISH: Appliance White polyester powder coat.

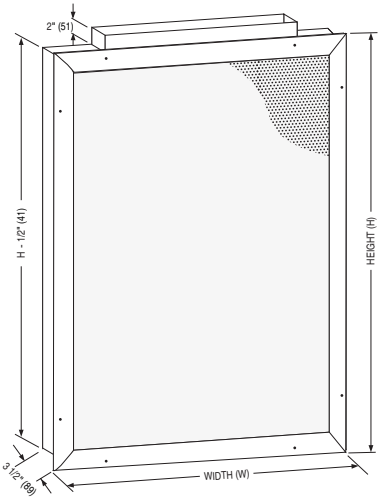
AIR PATTERNS:

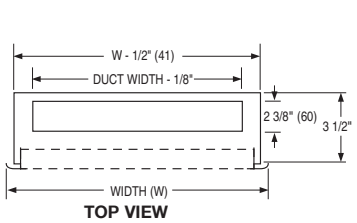


DIMENSIONAL DATA:

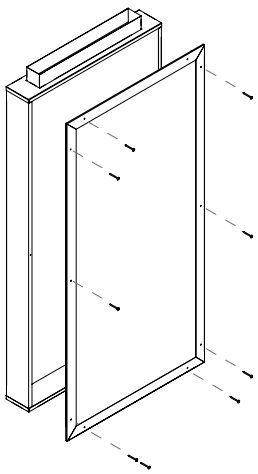
Unit Size		Inlet Size	Nom. Studs OC
Width [W]	Height [H]		
15 (381)	**24 – 48** (610 – 1219)	**12 x 2.5** (305 x 64)	**16** (406)
24 (610)	**24 – 48** (610 – 1219)	**18 x 2.5** (457 x 64), **20 x 2.5** (508 x 64)	**25** (635)
30 (762)	**24 – 48** (610 – 1219)		**31** (787)
36 (914)	**24** (610)		**37** (787)
48 (1219)	**24** (610)		**49** (1245)

Dimensions are shown in **inches** (mm).
Heights are availble in 6" (152) increments where a range is indicated.
For a complete list of standard sizes and inlets, visit www.nailor.com.





TOP VIEW



REMOVABLE FACE

COMMON OPTIONS:

- Variety of powder coat colors and custom color matching available.

PERFORMANCE DATA • MODEL DWF1

Unit Size [W x H] inches (mm)	Inlet Size inches (mm)	Core Area ft² (m²)	Face Velocity (fpm)	Airflow (cfm)	Total Pressure (in. w.g.)	Static Pressure (in. w.g.)	Noise Criteria NC	Adjacent Zone ΔT= 5°F Length (ft)	Adjacent Zone ΔT= 10°F Length (ft)
24 x 24 (610 x 610)	**18 x 2.5** (457 x 64)	**3.2** (0.30)	20	64	0.01	—	—	7	8
			30	96	0.02	0.02	—	9	10
			40	128	0.04	0.03	—	11	12
			50	161	0.06	0.04	—	13	14
24 x 30 (610 x 762)	**18 x 2.5** (457 x 64)	**4.1** (0.38)	20	82	0.01	—	—	7	9
			30	123	0.03	0.02	—	10	11
			40	164	0.05	0.03	—	12	13
			50	205	0.07	0.04	17	13	14
24 x 36 (610 x 914)	**18 x 2.5** (457 x 64)	**5.0** (0.63)	20	100	0.01	—	—	8	9
			30	150	0.03	0.01	—	10	11
			40	200	0.05	0.03	—	12	13
			50	250	0.08	0.04	21	14	15
24 x 48 (610 x 1219)	**20 x 2.5** (508 x 64)	**6.8** (0.63)	20	136	0.01	—	—	9	11
			30	204	0.03	0.01	—	12	13
			40	272	0.06	0.02	18	14	15
			50	340	0.09	0.03	25	15	17
30 x 24 (762 x 610)	**18 x 2.5** (457 x 64)	**4.1** (0.38)	20	82	0.01	—	—	7	8
			30	123	0.03	0.02	—	9	10
			40	164	0.05	0.03	—	11	12
			50	205	0.08	0.05	16	13	14
36 x 24 (914 x 610)	**18 x 2.5** (457 x 64)	**5.0** (0.46)	20	100	0.01	0.01	—	7	8
			30	150	0.03	0.02	—	9	10
			40	200	0.05	0.03	—	11	12
			50	250	0.08	0.04	21	13	14
48 x 24 (1219 x 610)	**24 x 2.5** (610 x 64)	**6.8** (0.63)	20	136	0.02	0.01	—	8	9
			30	204	0.03	0.01	—	10	11
			40	272	0.05	0.03	18	12	13
			50	340	0.08	0.04	25	14	15

Notes:

1. Dimensions are shown in **imperial** (metric).
2. Face velocity is in feet per minute (fpm).
3. Airflow is in cubic feet per minute (cfm).
4. Pressure is in inches water gauge (in. w.g.).
5. NC (Noise Criteria) values are based on 10 dB room absorption, re 10^{-12} watts.
6. Blanks (—) indicate an NC below 15 or a pressure below 0.01 in.w.g.
7. Adjacent Zone size represents the throw distance in feet to a terminal velocity of 40 fpm measured at **1"** (25) above the floor.
8. ΔT is the temperature difference between the supply air and the room temperature measured at **43"** (1092) above the floor.
9. Data derived from tests conducted in accordance with ANSI/ASHRAE Standard 70-2006 and the Nordtest Low Velocity Method NT VVS 083.

Nailor

DWR1

- RECTANGULAR
- RISER/RECESSED MOUNT
- CONCEALED FASTENERS
- 1-WAY DISCHARGE

Model DWR1 rectangular displacement diffusers are designed for flush mount riser or recessed in-wall applications, designed to integrate into the wall, stair riser or in a toe kick, with no visible fasteners. Features include a flat perforated face that creates a 1-way air discharge pattern which provides cool air along and near the floor. An equalization baffle behind the diffuser face ensures an even distribution of low velocity supply air. The diffuser is supplied with a mounting frame for spring clip mounting into a contractor-supplied plenum. The DWR1 is ideal for use in classrooms, theaters, lobbies and convention centers where floor space is at a premium. The diffuser is available with a rectangular inlet as standard. Additional finishes and accessories are also available.

STANDARD CONSTRUCTION:

FRAME: Heavy gauge corrosion resistant steel plenum.

FACE: 18 ga. (1.3) galvanized steel perforated face; 3/32" (2.4) dia. holes on 3/16" (4.8) staggered centers; 23% free area.

INLET: Rectangular.

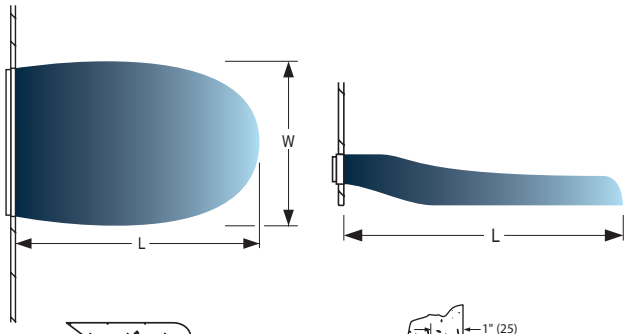
FINISH: Appliance White polyester powder coat.

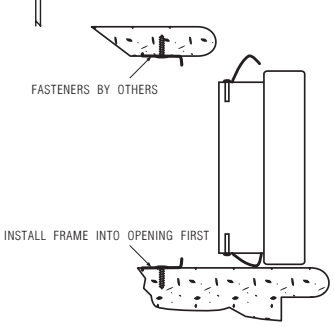
DIMENSIONAL DATA:

Model DWR1 (W x H):	
Minimum	Maximum
6 x 4 (152 x 102)	**60 x 36** (1524 x 914)

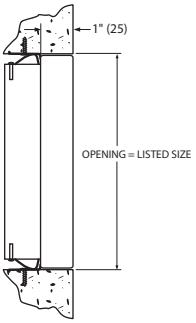
Dimensions are shown in **inches** (mm).
For a complete list of standard sizes and inlets, visit www.nailor.com.

AIR PATTERNS:





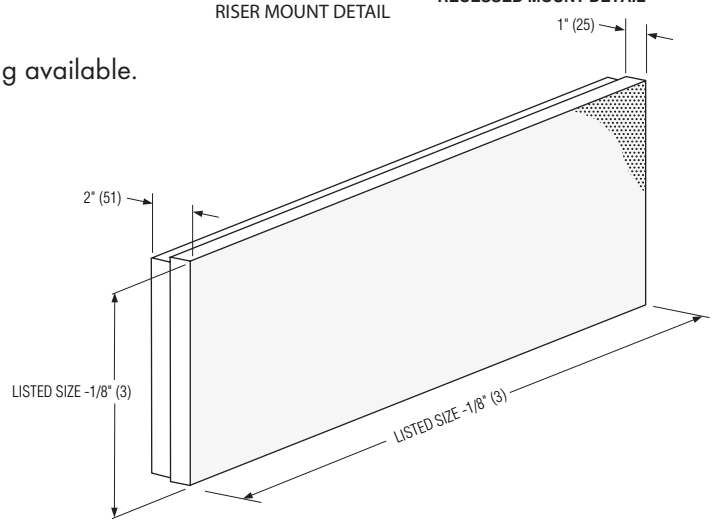
RISER MOUNT DETAIL



RECESSED MOUNT DETAIL

COMMON OPTIONS:

- Plaster/mud frame (aluminum extrusion).
- Variety of powder coat colors and custom color matching available.



PERFORMANCE DATA • MODEL DWR1

Unit Size [W x H] inches (mm)	Core Area ft² (m²)	Face Velocity (fpm)	Airflow (cfm)	Total Pressure (in. w.g.)	Static Pressure (in. w.g.)	Noise Criteria NC	Adjacent Zone ΔT= 5°F Length (ft)	Adjacent Zone ΔT= 10°F Length (ft)
24 x 4 (610 x 102)	**0.6** (0.06)	20	13	—	—	—	3	4
		30	19	—	—	—	5	6
		40	26	0.01	0.01	—	7	8
		50	32	0.02	0.02	—	9	10
24 x 6 (610 x 152)	**1.0** (0.09)	20	19	—	—	—	3	5
		30	29	—	—	—	6	7
		40	39	0.01	0.01	—	8	9
		50	49	0.02	0.02	—	9	10
24 x 8 (610 x 203)	**1.3** (0.12)	20	26	—	—	—	4	5
		30	39	—	—	—	6	7
		40	52	0.01	0.01	—	8	9
		50	65	0.02	0.02	—	10	11
30 x 4 (762 x 102)	**0.8** (0.07)	20	16	—	—	—	3	4
		30	24	—	—	—	5	6
		40	32	0.01	0.01	—	7	8
		50	40	0.02	0.02	—	9	10
30 x 6 (762 x 152)	**1.2** (0.11)	20	24	—	—	—	4	5
		30	37	—	—	—	6	7
		40	49	0.01	0.01	—	8	9
		50	61	0.02	0.02	—	10	11
30 x 8 (762 x 203)	**1.6** (0.15)	20	33	—	—	—	4	6
		30	49	—	—	—	7	8
		40	65	0.01	0.01	—	9	10
		50	82	0.02	0.02	—	10	11
36 x 6 (914 x 152)	**1.5** (0.14)	20	29	—	—	—	4	5
		30	44	—	—	—	6	7
		40	59	0.01	0.01	—	8	9
		50	73	0.02	0.02	—	10	11
36 x 8 (914 x 203)	**2.0** (0.19)	20	39	—	—	—	5	6
		30	59	—	—	—	7	8
		40	78	0.01	0.01	—	9	10
		50	98	0.02	0.02	—	11	12

Notes:

1. Dimensions are shown in **imperial** (metric).
2. Data is based upon pressurized plenum application (non ducted) with no plenum effect for pressure or sound. Plenums should be sized to achieve even velocity across the diffuser face. Keep duct inlet velocities below 700 fpm in order to maintain catalogued performance.
3. Face velocity is in feet per minute (fpm).
4. Airflow is in cubic feet per minute (cfm).
5. Pressure is in inches water gauge (in. w.g.).
6. NC (Noise Criteria) values are based on 10 dB room absorption, re 10^{-12} watts.
7. Blanks (—) indicate an NC below 15 or a pressure below 0.01 in.w.g.
8. Adjacent Zone size represents the throw distance in feet to a terminal velocity of 40 fpm measured at **1"** (25) above the floor.
9. ΔT is the temperature difference between the supply air and the room temperature measured at **43"** (1092) above the floor.
10. Data derived from tests conducted in accordance with ANSI/ASHRAE Standard 70-2006 and the Nordtest Low Velocity Method NT VVS 083.

DWG1

- RECTANGULAR
- SIDEWALL MOUNT
- GRILLE TYPE
- 1-WAY DISCHARGE

Model DWG1 rectangular displacement diffusers are designed for sidewall plenum mounted applications. Features include a flat perforated face that creates a 1-way discharge pattern which provides cool air along the floor. An equalization baffle behind the diffuser face ensures an even distribution of low velocity supply air. The diffuser is supplied with an extruded aluminum frame for surface mounting into a contractor-supplied plenum. The DWG1 is ideal for use in classrooms, theaters, lobbies and convention centers where floor space is at a premium. Additional finishes and accessories are also available.

STANDARD CONSTRUCTION:

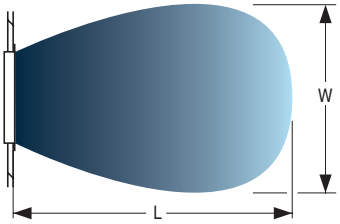
FRAME: Heavy gauge corrosion resistant steel plenum.

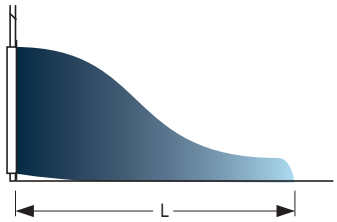
FACE: Removable extruded aluminum frame mechanically interlocked with reinforced mitered corners with an 18 ga. (1.3) galvanized steel perforated face; 3/32" (2.4) dia. holes on 3/16" (4.8) staggered centers; 23% free area.

INLET: Rectangular.

FINISH: Appliance White polyester powder coat.

AIR PATTERNS:

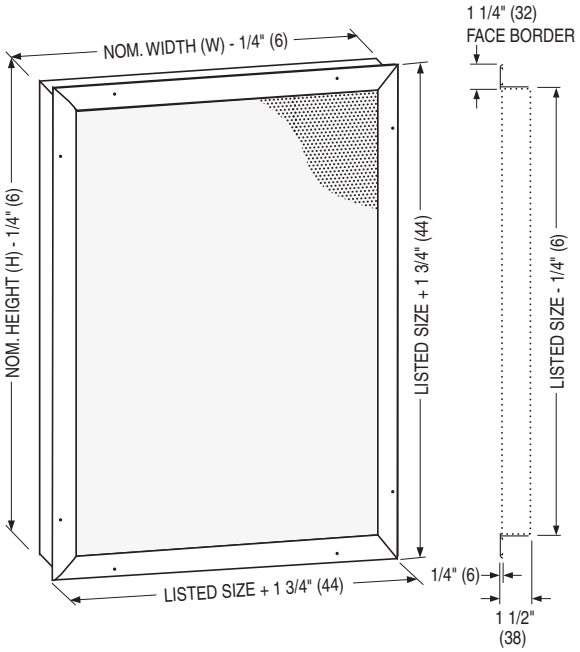




DIMENSIONAL DATA:

Unit Size	
Width [W]	**Height [H]**
15 (381)	**18 – 48** (457 – 1219)
24 (610)	**18 – 72** (457 – 1829)
30 (762)	**18 – 36** (457 – 914)
36 (914)	**18 – 60** (457 – 1524)
48 (1219)	**18 – 36** (457 – 914)
60 (1524)	**18 – 36** (457 – 914)

Dimensions are shown in **inches** (mm).
Heights are availble in 6" (152) increments.
For a complete list of standard sizes and inlets, visit www.nailor.com.



COMMON OPTIONS:

- Variety of powder coat colors and custom color matching available.

PERFORMANCE DATA • MODEL DWG1

Unit Size [W x H] inches (mm)	Core Area ft.² (m²)	Face Velocity (fpm)	Airflow (cfm)	Total Pressure (in. w.g.)	Static Pressure (in. w.g.)	Noise Criteria NC	Adjacent Zone	
							ΔT = 5°F	ΔT = 10°F
							Length (ft.)	Length (ft.)
24 x 24 (610 x 610)	**3.8** (0.35)	20	77	—	—	—	7	8
		30	115	—	—	—	9	10
		40	153	0.01	0.01	—	11	12
		50	192	0.02	0.01	—	13	14
24 x 30 (610 x 762)	**4.8** (0.45)	20	96	—	—	—	7	9
		30	144	—	—	—	10	11
		40	193	0.01	0.01	—	12	13
		50	241	0.02	0.01	—	13	14
24 x 36 (610 x 914)	**5.8** (0.54)	20	116	—	—	—	8	9
		30	174	—	—	—	10	11
		40	232	0.01	0.01	—	12	13
		50	290	0.02	0.01	—	14	15
24 x 48 (610 x 1219)	**7.8** (0.72)	20	155	—	—	—	9	11
		30	233	—	—	—	12	13
		40	310	0.01	0.01	—	14	15
		50	388	0.02	0.01	—	15	17
30 x 24 (762 x 610)	**4.8** (0.45)	20	96	—	—	—	7	8
		30	144	—	—	—	9	10
		40	193	0.01	0.01	—	11	12
		50	241	0.02	0.01	—	13	14
36 x 24 (914 x 610)	**5.8** (0.54)	20	116	—	—	—	7	8
		30	174	—	—	—	9	10
		40	232	0.01	0.01	—	11	12
		50	290	0.02	0.01	—	13	14
48 x 24 (1219 x 610)	**7.8** (0.72)	20	155	—	—	—	8	9
		30	233	—	—	—	10	11
		40	310	0.01	0.01	—	12	13
		50	388	0.02	0.01	—	14	15

Notes:

1. Dimensions are shown in **imperial** (metric).
2. Data is based upon pressurized plenum application (non ducted) with no plenum effect for pressure or sound. Plenums should be sized to achieve even velocity across the diffuser.
3. Face velocity is in feet per minute (fpm).
4. Airflow is in cubic feet per minute (cfm).
5. Pressure is in inches water gauge (in. w.g.).
6. NC (Noise Criteria) values are based on 10 dB room absorption, re 10^{-12} watts.
7. Blanks (—) indicate an NC below 15 or a pressure below 0.01 in.w.g.
8. Adjacent Zone size represents the throw distance in feet to a terminal velocity of 40 fpm measured at **1"** (25) above the floor.
9. ΔT is the temperature difference between the supply air and the room temperature measured at **43"** (1092) above the floor.
10. Data derived from tests conducted in accordance with ANSI/ASHRAE Standard 70-2006 and the Nordtest Low Velocity Method NT VVS 083.

HOW TO ORDER OR TO SPECIFY

MODEL SERIES: DW, RECTANGULAR WALL MOUNTED DISPLACEMENT DIFFUSERS
EXAMPLE: DWF1 - 24 - 36 - REC - T - 18 X 2.5 - AW

1. **Model**
   - DWF1 1-Way, Internal
   - DWR1 1-Way, Riser / Recessed
   - DWG1 1-Way, Grille Type

2. **Width** (inches)
   DWF1:
   15", 24", 30", 36", 48"
   DWG1:
   15", 24", 30", 36", 48", 60"
   DWR1:
   6" - 60"

3. **Height** (inches)
   DWF1:
   24", 30", 36", 48"
   DWG1:
   18", 24", 30", 36", 48", 60", 72"
   DWR1:
   4" - 36"

4. **Inlet Type**
   - REC Rectangular (default)

5. **Inlet Location**
   (DWF1 only)
   - T Top (default)
   - B Bottom

6. **Inlet Size** (inches)
   Rectangular (DWF1 only)
   - 1225 12" x 2.5"
   - 1825 18" x 2.5"
   - 2025 20" x 2.5"

7. **Finish**
   - AW Appliance White (default)
   - AL Aluminum
   - BK Black
   - BW British White
   - SP Special custom color

OPTIONS & ACCESSORIES:

8. **Protective Film**
   - NONE None (default)
   - PFC Protective film cover on face and inlet

9. **Plaster Frame** (DWR1 only)
   - NONE None (default)
   - PMF Plaster / Mud Frame

Note:

1. Check individual model for limitations as to width, height and inlet size combinations.

SUGGESTED SPECIFICATION:

Provide and install, as shown on plans and/or schedules, Displacement Diffusers as manufactured by Nailor Industries, Inc. which meet or exceed the following criteria:

Diffuser plenum shall be constructed of heavy gauge corrosion resistant steel with an 18 ga. (1.3) perforated face having 3/32" (2.38) dia. holes on 3/16" (4.8) centers, providing 23% free area. A heavy gauge corrosion resistant perforated equalization baffle behind the diffuser face shall provide uniform, low velocity, distribution of supply air. Plastic nozzle arrays or any plastic components are unacceptable. Both the equalization baffle and diffuser face shall be securely retained in the diffuser frames.

The diffuser shall be available for duct connection at the top or bottom of the diffuser with a rectangular inlet. Finish shall be Appliance White polyester powder coat. Epoxies and their derivatives are unacceptable. Visible non-metallic components are unacceptable.

Standard of acceptance shall be Nailor Model Series DW Rectangular Wall Mounted Displacement Diffusers.

FMSD

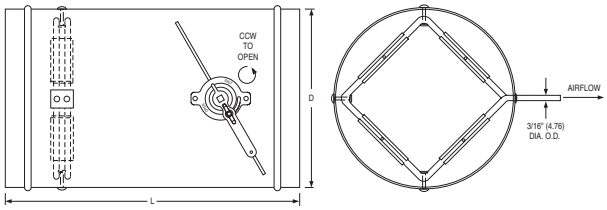
FLOW MEASURING STATION WITH BALANCING DAMPER

The Nailor 36FMSD Flow Measuring Station is a multi-point averaging airflow sensor combined with an integral balancing damper. The 36FMSD allows the field balancer to accurately measure and adjust the airflow to a diffuser located downstream.

A factory provided chart affixed to the unit provides information to the balancer for airflow vs. signal differential pressure. Model 36FMSD is shipped loose for field installation.

STANDARD CONSTRUCTION:

- 22 ga. (0.86) corrosion-resistant steel casing with hand locking quadrant and blade up to 12" (305) dia., 20 ga. (1.0) over 12" (305).
- Inlet and outlet stiffening beads provide means for secure duct connection.
- Diamond Flow Sensor: Aluminum construction.
- Sensor design minimizes pressure drop and regenerated noise.
- Sized to fit nominal round duct sizes: 4" – 18" (102 – 457).



BD

BALANCING DAMPER

Nailor option BD is a manual balancing damper suitable for all types of round ductwork applications and is designed for use in the majority of low pressure and velocity commercial HVAC systems. Option BD installs easily in round spiral ductwork and supplied as standard with a hand locking quadrant. Not intended to be used in applications as a positive shut-off or automatic control damper. Option BD ships loose for field installation.

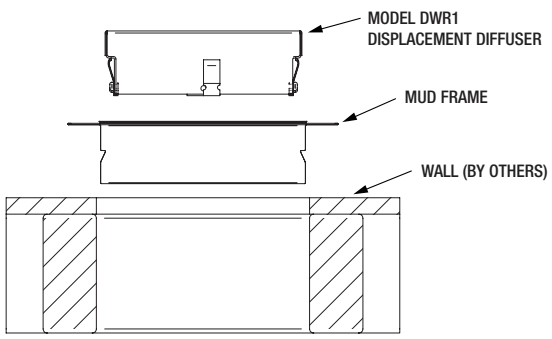
STANDARD CONSTRUCTION:

- 22 ga. (0.86) corrosion-resistant steel blade and frame up to 12" (305) dia., 20 ga. (1.0) over 12" (305).
- Inlet and outlet stiffening beads provide means for secure duct connection.
- ¼" (6) dia. plated steed drive axle bolted to blade.
- Plated steel hand locking quadrant.

PMF

PLASTER/MUD FRAME

A plaster/mud frame is available for Model DWR1 Rectangular Riser/Recessed Mount Wall Mount Diffusers. The PMF provides a quick and tidy installation, resulting in a clean architectural finished appearance. The PMF is constructed of heavy gauge extruded aluminum and shipped complete with die-formed corner gussets, ready for field installation, saving time and labor cost.



DC

DUCT COVERS

Nailor Duct Covers provide a consistent and appealing architectural look from floor to ceiling by concealing attached ductwork. They are available in corrosion-resistant solid steel, or perforated steel to match the diffuser face. When using a perforated duct cover, the ductwork can be painted black to conceal it and create a finished look.

Duct covers are supplied in varying lengths to accommodate any ceiling height and widths to match the overall size of the diffuser, and can be split into multiple sections to create a symmetrical look. They are ideal for top ducted diffusers where exposed duct work is not desired, such as in lobbies, boardrooms and restaurants. Covers are shipped loose and field installed where required. Duct covers are available for Nailor Model Series DFF rectangular floor standing and DFR round floor displacement diffusers only.

FEATURES:

- 20 ga. (1.0) corrosion-resistant steel.
- Support extrusion, where required, is aluminum.
- Width, radius/diameter and depth are based on the corresponding displacement diffuser selected.
- Standard heights available: 12" – 96" (305 – 2438).
- Appliance White polyester powder coat finish standard, optional finishes available.
- Custom duct covers available, contact factory.

DB

DUCT BASES

Duct bases are available for Nailor Model Series DFF rectangular and DFR round displacement diffusers. This allows the diffuser to be installed above floor level, maintaining the architectural feel of base board and molding heights. Duct bases can be removable to provide access to bottom ducted units for easier installation. A base provides protection from damage while cleaning and can prevent exposure to excessive moisture and chemicals.

The base is inset by 1" (25) from the face of the diffuser and is constructed to match the dimensions of the corresponding diffuser model selected. Bases are shipped loose and field installed where required.

FEATURES:

- 20 ga. (1.0) corrosion-resistant steel.
- Standard heights available: 2" – 6" (51 – 152).
- Width, radius/diameter and depth are based on the corresponding displacement diffuser selected.
- Appliance White polyester powder coat finish standard, optional finished available.
- Custom duct bases available, contact factory.

HOW TO ORDER OR TO SPECIFY

DISPLACEMENT DIFFUSER ACCESSORIES

DFF SERIES DIFFUSER BASES

1. **Model**
   - DFF1DB Diffuser Base
   - DFF3DB Diffuser Base
   - DFF1CDB Diffuser Base
2. **Width** (inches)
   24", 30", 36", 48", 60"
3. **Height** (inches)
   2", 3", 4", 5", 6"
4. **Depth**
   13", 16", 17"
   (DFF1DB and DFF3DB only)
5. **Finish**
   - AW Appliance White
   - AL Aluminum
   - BK Black
   - BW British White
   - SP Special custom color

Note:

1. See page D3 for available combinations of unit width and depth for DFF Series Diffuser Bases

DFR SERIES DIFFUSER BASES

1. **Model**
   - DFR90DB Diffuser Base
   - DFR180DB Diffuser Base
   - DFR180HDB Diffuser Base
   - DFR360DB Diffuser Base
2. **Diameter** (inches)
   12", 18", 24", 30", 36", 42", 48"
3. **Height** (inches)
   2", 3", 4", 5", 6"
4. **Finish**
   - AW Appliance White
   - AL Aluminum
   - BK Black
   - BW British White
   - SP Special custom color

DFF SERIES DUCT COVERS

1. **Model**
   - DFF1DC Duct Cover
   - DFF3DC Duct Cover
   - DFF1CDC Duct Cover
2. **Width** (inches)
   24", 30", 36", 48", 60"
3. **Height** (inches)
   Specify in inches
   Minimum 12"/Maximum 96"
4. **Depth** (inches)
   13", 16", 17"
   (DFF1DC and DFF3DC only)
5. **Material**
   - DCS Solid Panels
   - DCP Perforated Panels
6. **Finish**
   - AW Appliance White
   - AL Aluminum
   - BK Black
   - BW British White
   - SP Special custom color

DFR SERIES DUCT COVERS

1. **Model**
   - DFR90DC Duct Cover
   - DFR180DC Duct Cover
   - DFR180HDC Duct Cover
2. **Diameter** (inches)
   12", 18", 24", 30", 36", 42", 48"
3. **Height** (inches)
   Specify in inches
   Minimum 12"/Maximum 96"
4. **Material**
   - DCS Solid Panels
   - DCP Perforated Panels
5. **Finish**
   - AW Appliance White
   - AL Aluminum
   - BK Black
   - BW British White
   - SP Special custom color

DISPLACEMENT DIFFUSER CROSS REFERENCE

New Nailor Model	Description	PRICE	TITUS	TROX	HALTON
DFF1	Rectangular 1-Way Pattern • Floor Standing • Flat Face	DF1	DVRI	QL-WR-RO	AFA
DFF1C	Rectangular 1-Way Pattern • Floor Standing • Flat Face • Corner	DF1C	DVC1	—	—
DFF3	Rectangular 3-Way Pattern • Floor Standing • Flat Face	DF3	DVR3	QL-WFM-E	AFF
DFR90	Quarter Round 90° • Floor Standing • Corner	DR90	DVVC	QL-WV-RO	AFQ
DFR180	Half Round 180° • Floor Standing • Wall/Pillar	DR180	DV180	QL-WS-RO	AFP
DFR180H	U-Shaped 180° • Floor Standing • Wall/Pillar • High Capacity	DR180U	DVHC	QL-WH-RO	AFB
DFR360	Full Round 360° • Floor Standing • Free Standing	DR360	DVCP	QL-WR-RO	AFC
DFR360DH	Full Round 360° • Duct Hanging Option	DR360-DH	—	—	—
DWF1	Rectangular 1-Way • Internal Wall Mount • Flat Face	DF1W	DV1R	QL-WE-E	AFE
DWR1	Rectangular 1-Way • Riser/Recessed Wall Mount • Flat Face	DF1R	DVR1	—	—
DWG1	Rectangular 1-Way • Side Wall Mount • Grille Type	—	—	—	—
DLFG	Square • Floor Mount • Linear Bar Type	DFG	—	—	—
DFLD	Continous • Floor Mount • Linear Bar Type	DFGL	—	—	—
DCF1 Type L	Rectangular 1-Way • Ceiling Mount • Type L Lay-in T-Bar	DF1L	—	—	—

Note: Cross references are equivalent to rather than equal to the general design of the diffuser in many cases. Caution should therefore be exercised when reading specifications, comparing performance data, seeking approval and/or seeking an alternate approval.

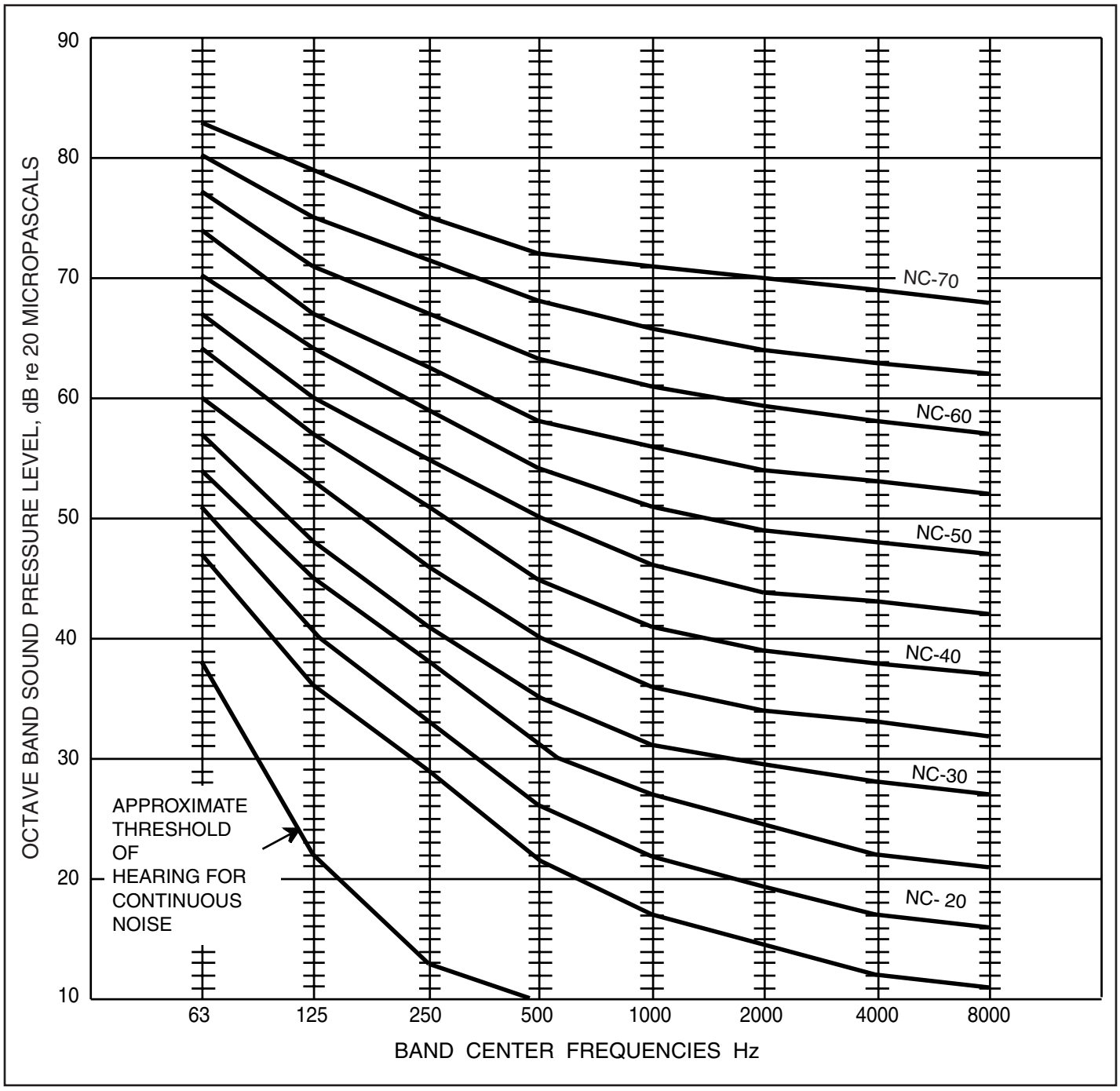
DEFINITIONS AND FORMULAE

CFM	=	Cubic Feet per Minute	CFM	=	FPM	X	Ak
FPM	=	Feet per Minute (Velocity)	FPM	=	CFM	/	Ak
Ak	=	Area Factor Expressed in Square Feet	VP	=	TP	-	SP
TP	=	Total Pressure Expressed in Inches of Water Gauge	TP	=	SP	+	VP
SP	=	Static Pressure Expressed in Inches of Water Gauge	SP	=	TP	-	VP
VP	=	Velocity Pressure Expressed in Inches of Water Gauge	ΔP_T	=	TP_1	-	TP_2
VP	=	$(FPM \div 4005)^2$	ΔP_S	=	SP_1	-	SP_2
ΔP	=	Differential Pressure					
ΔP_S	=	Static Differential Pressure					
ΔPT	=	Total Differential Pressure					

ALTERNATE NC NOISE CRITERIA CURVES

Noise Criteria, or NC, provide a single number method of specifying a noise spectrum. To determine an NC, the Sound Pressure Level in each octave band is plotted on an NC Chart. The resulting NC is the number of the maximum NC curve on the chart, tangent to the plotted data.

NC CURVES



NOISE CRITERIA CURVES FOR SPECIFYING DESIRED SOUND LEVELS.

METRIC GUIDE CONVERSION FACTORS

Quantity	Imperial Unit	Metric Unit		From Imperial To Metric Multiply By:	From Metric To Imperial Multiply By:
Area	square foot	square meter	(m^2)	0.0929	10.764
	square inch	square millimeter	(mm^2)	645.16	.00155
Density	pounds per cubic foot	kilograms per cubic meter	(kg/M^3)	16.018	.0624
Energy	British thermal unit (BTU)	joule	(J)	1055.056	.000948
	kilowatt hour	megajoule	(MJ)	3.6	.2778
	watts per second	joule	(J)	1.0	1.0
	horsepower hour	megajoule	(MJ)	2.6845	.3725
Force	ounce force	newton	(N)	.278	3.597
	pound force	newton	(N)	4.4482	.2248
	kilogram force	newton	(N)	9.8067	.102
Heat	BTU per hour	watt	(W)	.2931	3.412
	BTU per pound	joules per kilogram	(J/kg)	2326.0	.00043
Length	inch	millimeter	(mm)	25.4	.0394
	foot	millimeter	(mm)	304.8	.00328
	foot	meter	(m)	.3048	3.2808
	yard	meter	(m)	.9144	1.0936
Mass (weight)	ounce (avoirdupois)	gram	(g)	28.350	.0353
	pound (avoirdupois)	kilogram	(kg)	.4536	2.2046
Power	horsepower	kilowatt	(kW)	.7457	1.341
	horsepower (boiler)	kilowatt	(kW)	9.8095	.1019
	foot pound - force per minute	watt	(W)	.0226	44.254
	ton of refrigeration	kilowatt	(kW)	3.517	.2843
Pressure	inch of water column	kilopascal	(kPa)	.2486	4.0219
	foot of water column	kilopascal	(kPa)	2.9837	.3352
	inch of mercury column	kilopascal	(kPa)	3.3741	.2964
	ounces per square inch	kilopascal	(kPa)	.4309	2.3206
	pounds per square inch	kilopascal	(kPa)	6.8948	.145
Temperature	Fahrenheit	Celsius		°C 5/9(°F -32)	(9/5°C)+32
Torque	ounce - force inch	millinewton-meter	(mN.m)	7.0616	.1416
	pound - force inch	newton-meter	(N.m)	.1130	8.8495
	pound - force foot	newton-meter	(N.m)	1.3558	.7376
Velocity	feet per second	meters per second	(m/s)	.3048	3.2808
	feet per minute	meters per second	(m/s)	.00508	196.85
	miles per hour	meters per second	(m/s)	.44704	2.2369
Volume (capacity)	cubic foot	liter	(l)	28.3168	.03531
	cubic inch	cubic centimeter	(cm^2)	16.3871	.06102
	cubic yard	cubic meter	(m^3)	.7646	1.308
	gallon (U.S.)	liter	(l)	3.785	.2642
	gallon (imperial)	liter	(l)	4.546	.2120
Volume (flow)	cubic feet per minute (cfm)	liters per second	(l/s)	.4719	2.119
	cubic feet per minute (cfm)	cubic meters per second	(m^3/s)	.0004719	2119.0
	cubic feet per hour (cfh)	milliliters per second	(ml/s)	7.8658	.127133
	gallons per minute (U.S.)	liters per second	(l/s)	.06309	15.850
	gallons per minute (imperial)	liters per second	(l/s)	0.07577	13.198