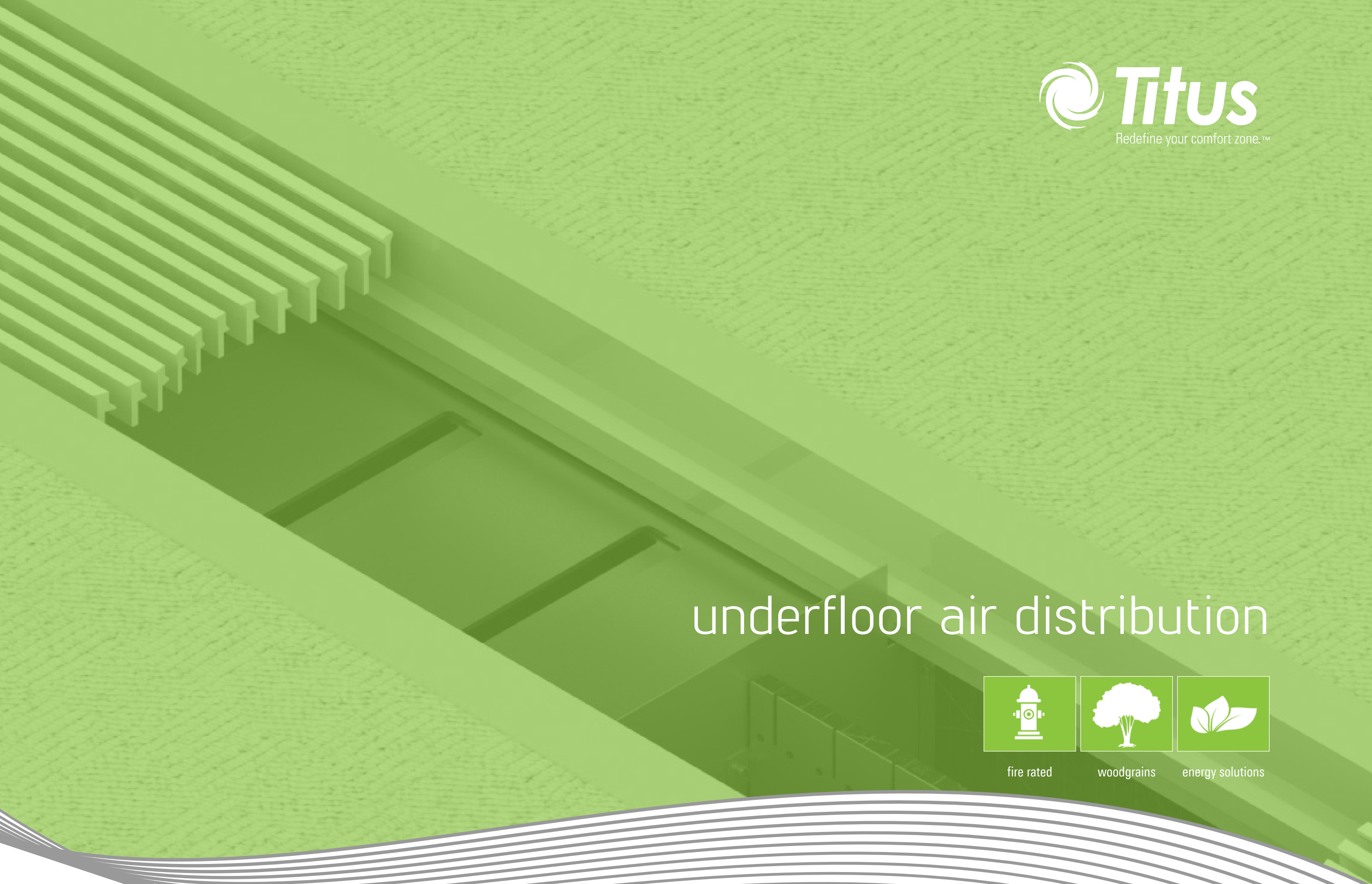


Titus
Redefine your comfort zone.™

underfloor air distribution

fire rated | woodgrains | energy solutions

S

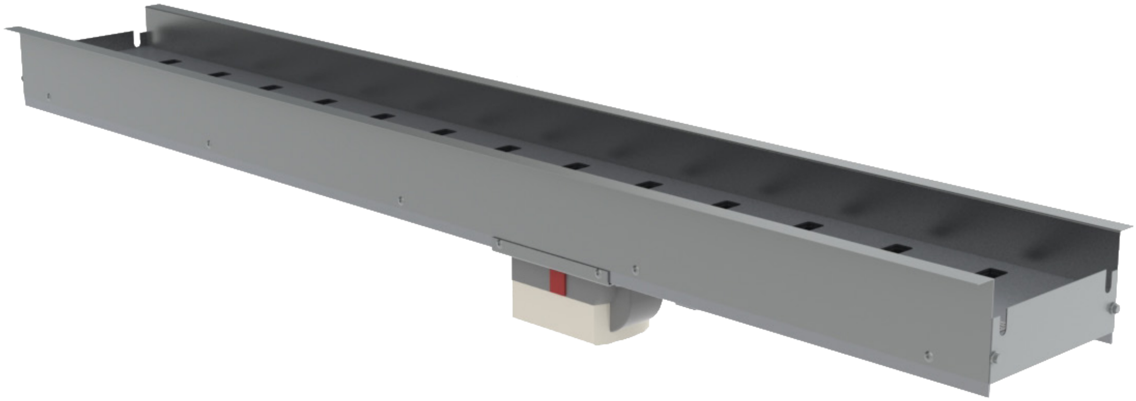


Table of Contents

underfloor air distribution products

overview

underfloor round products

underfloor taf-l perimeter system

underfloor linear products

underfloor fan powered terminal

underfloor fan booster terminal

UnderFloor Air Distribution Products

pages: S19-S29

underfloor round products

TAF-G

GROMMET
- Allows through-the-floor access for power, data and phone cables
- Constructed of a high impact polymeric material designed to resist damage from traffic
- Can be installed after flooring and carpet installation is complete

TAF-R

PRESSURISED UNDERFLOOR APPLICATIONS
- Available in fire-rated polymer construction
- Architecturally appealing face design is available in standard gray or black
- Custom colors available
- Relocation to another area is simply by relocating the floor panel
- 24 VAC integral flow regulator actuator
- RJ-12 connections for easy plug and play installation
- Does not require sheet metal plenum with damper for simpler installation

TAFR-AA

PRESSURISED UNDERFLOOR APPLICATIONS
- Available in fire-rated polymer construction
- Architecturally appealing face design is available in standard gray or black
- Custom colors available
- Relocation to another area is simply by relocating the floor panel
- 24 VAC integral flow regulator actuator
- RJ-12 connections for easy plug and play installation
- Does not require sheet metal plenum with damper for simpler installation

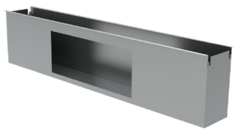
pages: S30-S44

underfloor taf-l perimeter system

TAF-L-E

UNDERFLOOR PERIMETER HEATING APPLICATIONS

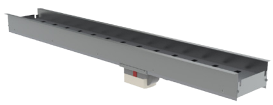
- Designed to be integrated with the CT-TAF-L linear bar grille
- Contains SCR electric fin tube assembly within the plenum
- ETL listed at 120V, 208V, 240V, and 277V



TAF-L-R

UNDERFLOOR PERIMETER RETURN APPLICATIONS

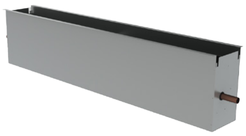
- Designed to be integrated with the CT-TAF-L linear bar grille
- 20" x 8" inlet can be used for ducted or non-ducted applications
- Constructed of galvanized steel



TAF-L-V

UNDERFLOOR PERIMETER SUPPLY APPLICATIONS

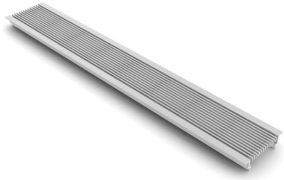
- Designed to be integrated with the CT-TAF-L linear bar grille
- Provides a uniform throw pattern regardless of damper position
- Installs under the CT-TAF-L from the top surface. Removal of the flooring is not required.



TAF-L-W

UNDERFLOOR PERIMETER HEATING APPLICATIONS

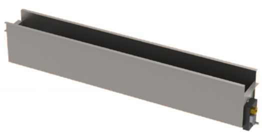
- Designed to be integrated with the CT-TAF-L linear bar grille
- Contains a copper fin tube heater assembly within the plenum
- Installs under the CT-TAF-L from the top surface. Removal of the flooring is not required.



CT-TAF-L

UNDERFLOOR PERIMETER RETURN APPLICATIONS

- Designed to be integrated with all the underfloor plenums
- All deflection bars are fixed and parallel to the long dmension
- Standard finish is #26 white
- CT frame drops into perimeter slot and sits on top of carpeting



TAF-L-F

UNDERFLOOR PERIMETER RETURN APPLICATIONS

- Designed to be integrated with the CT-TAF-L linear bar grille
- 20" x 8" inlet can be used for ducted or non-ducted applications
- Constructed of galvanized steel

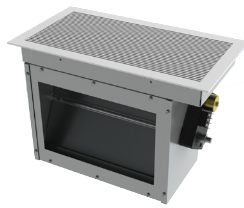
pages: S45-S55

underfloor linear products

TAF-D

UNDERFLOOR APPLICATIONS

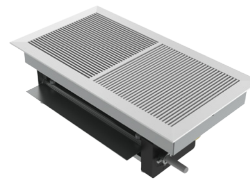
- Heavy gauge steel plenum
- Installs into access flooring from top surface
- Utilized for ducted applications



TAF-HC

UNDERFLOOR APPLICATIONS

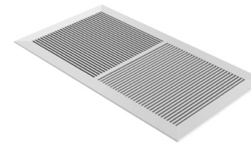
- Utilized as a ducted supply or return
- Heavy gauge steel plenum
- Installs into access flooring from top surface
- Integral heating & cooling
- Available in multi-core option (2-piece & 4-piece)



TAF-V

UNDERFLOOR APPLICATIONS

- Designed for areas with frequent changes in heating loads
- Heavy gauge steel plenum
- Installs into access flooring from top surface
- Available in multi-core option (2-piece & 4-piece)



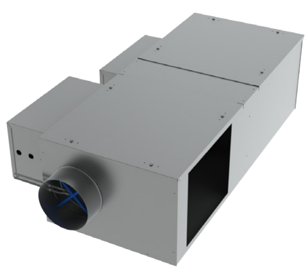
CT-TAF

UNDERFLOOR APPLICATIONS

- Designed to be integrated with all the underfloor linear plenums
- All deflection bars are fixed and parallel to the long dmension
- Standard finish is #26 white
- CT frame drops into plenum slot and sits on top of carpeting

pages: S56-S61

underfloor fan powered terminals



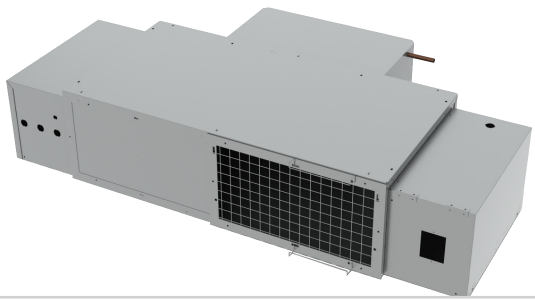
LHK

UNDERFLOOR APPLICATIONS

- Optional ultra-high efficiency ECM motor available
- Top access panels can be removed for service of damper, blower and filter sections
- Leak resistant construction
- Available with hot water or electric re-heat

pages: S62-S67

underfloor fan booster terminals



PFC

UNDERFLOOR APPLICATIONS

- Optional ultra-high efficiency ECM motor available
- Top access to unit high and low voltage controls for easy access from room above
- Single point electrical connections
- Available with hot water or electric re-heat

APPLICATION ICONS KEY

energy solutions	contributes toward energy savings by reducing operating costs of air distribution devices
woodgrains	additional finish options available for HVAC products that resemble realistic woodgrains, and adds high-end detail quality to any application
fire rated	for use in all applications that require UL Fire Resistance products

General

This document provides application and design highlights for underfloor air distribution (UFAD) systems.

Additional information may be found at the Titus website. http://www.titus-hvac.com.

Introduction

The interest in underfloor air distribution (UFAD) has increased significantly in the U.S. market over the last fifteen years. There is currently several million square feet of access floor air distribution systems being designed across the country.

In 1997 Titus introduced the TAF-R diffuser and the TAF-G grommet, which were installed in the Owens Corning World Headquarters. Since then, Titus, ASHRAE, and the engineering community have continued to learn about UFAD systems. In the time that Titus has participated in UFAD designs in the US, we have continued to introduce new products to meet the needs of this unique application.

Overview

ASHRAE Applications Handbook (2011) describes Underfloor Air Distribution Systems (UFAD) as Partially Mixed Air Distribution. Where traditional ceiling or high sidewall supply outlets condition the space by creating a thermal mixing zone from the floor (ankle level) to near the ceiling, Underfloor systems create a mixed zone from the floor to the top of the occupied zone (6' above the floor), and let the upper zone be fully stratified. The height of the mixed zone is controlled by the height of the air jet to a velocity of 50 fpm. The ideal throw height of the jet is to 4' – 5' above the floor. Contaminates above the mixed zone will rise through the stratified zone and be carried out of the room through the return.

Where a fully mixed system uses the area within one foot of the interior walls as a mixing zone, a floor outlet uses the area around the outlet where mixed air velocities are greater than 50 fpm. Floor outlets used in the interior area (more than 12'-15' from a perimeter wall) are typically round producing a swirl air pattern. The mixing zone, typically known as the "clear" zone is defined by the manufacturer. It is recommended that occupants not be permanently stationed in the clear zone.

UFAD systems utilize the space under an access floor as an air plenum. Properly designed UFAD systems take advantage of thermal stratification.

ASHRAE recommends that, for comfort, the temperature in the occupied zone be between 73° and 77°F, relative humidity be between less than 60%, and the maximum velocity in occupied zone be 50 fpm in cooling or 30 fpm in heating.

The key to successful access floor systems is the ability of the access floor diffuser to rapidly mix room air into the supply air at low velocities. Because supply air is introduced directly into the occupied zone, it is important that the supply air reach the ASHRAE recommended temperature and velocity, mixing of the supply air into the space should happen rapidly.

The typical application for a UFAD system is the open plan office. Floor space is at a premium in a cubicle so a smaller clear area around the diffuser will allow more usable space in the cubicle. The UFAD diffuser manufacturer defines the required clear area that their diffuser needs to achieve the ASHRAE recommended temperature and velocity.

Originally UFAD systems were for computer rooms. The design intent was to cool computer equipment and not to provide comfort. The computer room design concept typically provides too cold of a space for comfort.

While the early interest in UFAD systems was primarily due to companies' need to easily rearrange office layouts, information and communications based offices, the economics of ownership, and green building programs such as LEED have largely influenced the growth of UFAD.

DESIGN BASICS

PLENUM DESIGN

The raised floor office can be supplied with conditioned air from below the floor in two ways – pressurized plenum or neutral plenum.

PRESSURIZED PLENUMS

The pressurized plenum (the area between the slab and the raised floor) is essentially a large duct maintained at a constant pressure differential to the room above; typically between 0.05 and 0.10 in. pressure (w.g.).

This pressure is maintained through the supply of conditioned air from a number of supply duct terminations. The spacing and location of these ducts are dependent on the air supply requirement and the plenum depth, with shallow plenums and / or high air quantities requiring more air supply duct outlets under the floor. UFAD diffusers are specially designed grilles with a user adjustable or actuated damper to regulate flow.

The advantages of pressurized plenums include low first cost and easily changed layouts. This is the most commonly used plenum design.

NEUTRAL PLENUMS

With the neutral plenum design, the same layout as the pressurized plenum may be used, but the pressure difference between the plenum and the room is kept as close as possible to zero.

Floor diffusers either contain integral fans, are ducted from a central source, or both. In many cases, these closely resemble conventional ceiling supply systems.

Advantages include the possibility of multiple small zones (as with multiple tenants) and insensitivity to construction details. Disadvantages include higher first costs due to ducting and/or fan connections under the floor, lower flexibility as the grilles are individually ducted, and potentially higher noise levels.

This design is rarely used, but may be effective in tenant buildings where the utilities will be paid by the tenant.

PLENUM DETAILS

Plenum heights typically range from 12" to 24". The plenum height is usually determined by the height requirements of other equipment that will be located under the floor. The number of inlets required to supply the plenum with sufficient air to run the diffusers is dependent upon the plenum size and the number of diffusers, which in turn is determined by the load of the space.

As a general rule, the longest distance from the supply air outlet in the plenum and the farthest diffuser should not exceed 35 feet. Distances longer then this are subject to thermal losses created by thermal conductivity of the return air from the floor below through the slab making the discharge temperature of the diffuser be too high. Duct runs in the plenum space known as air highways can be used to transport conditioned air from the main duct to the zone.

If zone control is desired from the underfloor plenum, the plenum can be partitioned into separate zones. The zones in the underfloor plenum should correspond to building zones having similar load requirements. However, it is not necessary to partition the underfloor plenum into zones and doing so can make future office layout changes more difficult. If an office layout must be changed, the partitioned plenum will need to be changed to match the new layout.

Because of the special heating and cooling requirements of the perimeter of the building, it may be necessary to create a perimeter zone in the underfloor plenum to run a separate perimeter system. Typically only the perimeter is zoned from the core. The perimeter will be discussed in more detail next.

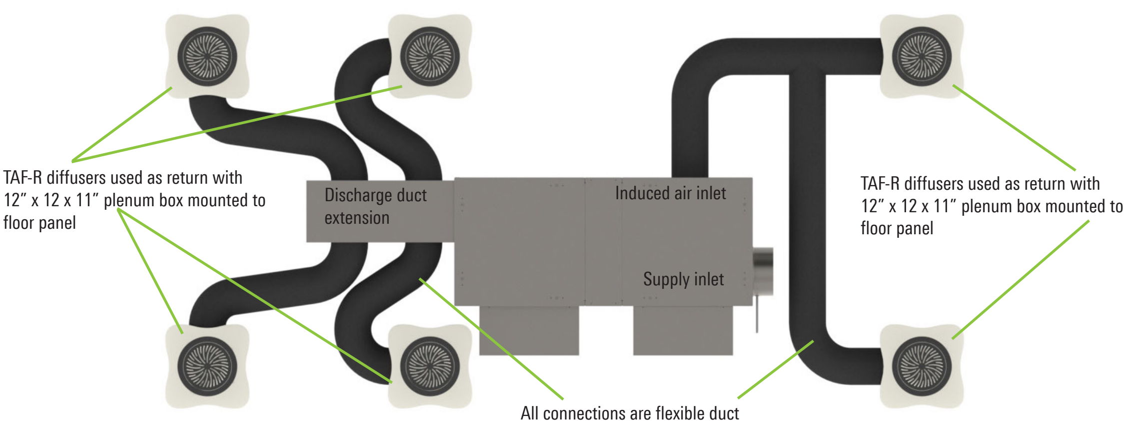
PLENUM LEAKAGE

Sealing the underfloor plenum is critical to optimizing the operation of a UFAD system. Air leaking through the floor tiles into the occupied zone is of minimal concern because it is leaking into the occupied space. Air leaking into the space between the walls, however, is wasted energy. All knockouts and holes in the drywall below the raised floor must be sealed during construction.

While leakage through the floor tile seams into the occupied space is less critical it should not be ignored. Floor leakage can be minimized by applying a gasket between the floor tile and the support stringer. Securing the tile to the structure with bolts will help create a tight seal. Additional floor sealing can be achieved by lapping the floor carpet tile over the tile seams.

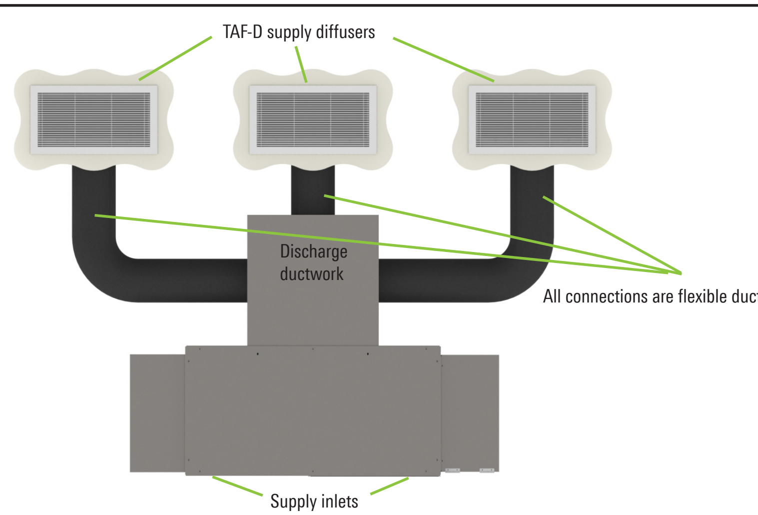
More important is eliminating the leakage that occurs from the plenum through apertures into the vertical walls. Care should be taken to inspect and seal all openings into the walls where electrical, plumbing, or other items may pass from the plenum into the wall. Air leakage through these passages will result in loss of conditioned air that will never pass through the occupied zone. Inspecting these areas during the construction process when they are accessible can eliminate costly repairs during commissioning.

TAF-R(-FR) Diffuser and LHK Layout



Note: Number of TAF-R(-FR) diffusers required depends on the airflow of the LHK

TAF-D Diffuser and PFC Layout



Note: Number of TAF-D diffusers required depends on the airflow of the PFC

INTERIOR (CORE) SPACES

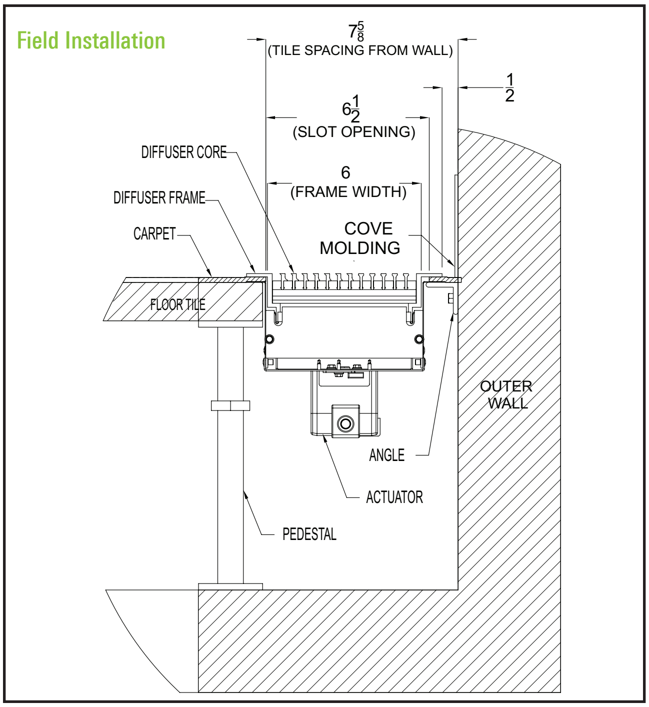
Open plan interior spaces are typically conditioned by placing a round swirl outlet at or near the entrance open to the cubicle or individuals work area. This will allow the cool jet to condition the adjacent space. Individually adjustable outlet dampers allow the occupant to control the comfort in their work zone. Larger common areas can be controlled with a single thermostat operating motorized dampers on multiple outlets.

PERIMETER SYSTEMS

The perimeter is typically the most difficult area of an underfloor system to design. The perimeter is often handling much larger loads and requires the most equipment. In the past, the best way to handle the perimeter was to use fan powered terminals with reheat ducted to linear bar grilles.

There are a couple challenges with this design concept. The throw of a linear bar grille ducted to the discharge of a fan powered terminal is very long, possibly as long as 15-20 feet. Designing long throws at the perimeter contradicts the concept of stratification in a UFAD system. Not only does the long throw from the grille mix the air above the stratified layer into the occupied zone, wasting energy, but it also may roll up the glass and across the ceiling, where it drop into the occupied zone causing discomfort for the occupants.

Additional challenges on the perimeter may be caused by the radiation effect of the sun shining through the glass and warming the first four to six feet of the plenum and slab beneath the floor. Thermal conduction through the outer wall into the plenum may affect the conditioned plenum air in the perimeter area as well. Applying a spray on thermal coating or other insulation material to the wall and floor of the plenum perimeter can prevent infiltration and minimize these thermal losses. Materials that harbor mold or bacteria growth should be avoided.



Although the concept of UFAD systems is to be modular, the function of handling perimeter loads is not modular. Those loads come with the building envelope, which is always a line of some sort. The TAF-L Perimeter System was designed to address all of these considerations.

PERIMETER COOLING

The perimeter cooling system should combine induction, buoyancy and displacement ventilation models, handles high thermal loads such as 225 CFM per 4' length at 0.07" wg, engage the occupied zone, but not the stratified ceiling layer. This avoids occupant complaints from air rolling back, dumping into interior space and saves energy by not mixing the warm ceiling air into the occupied zone.

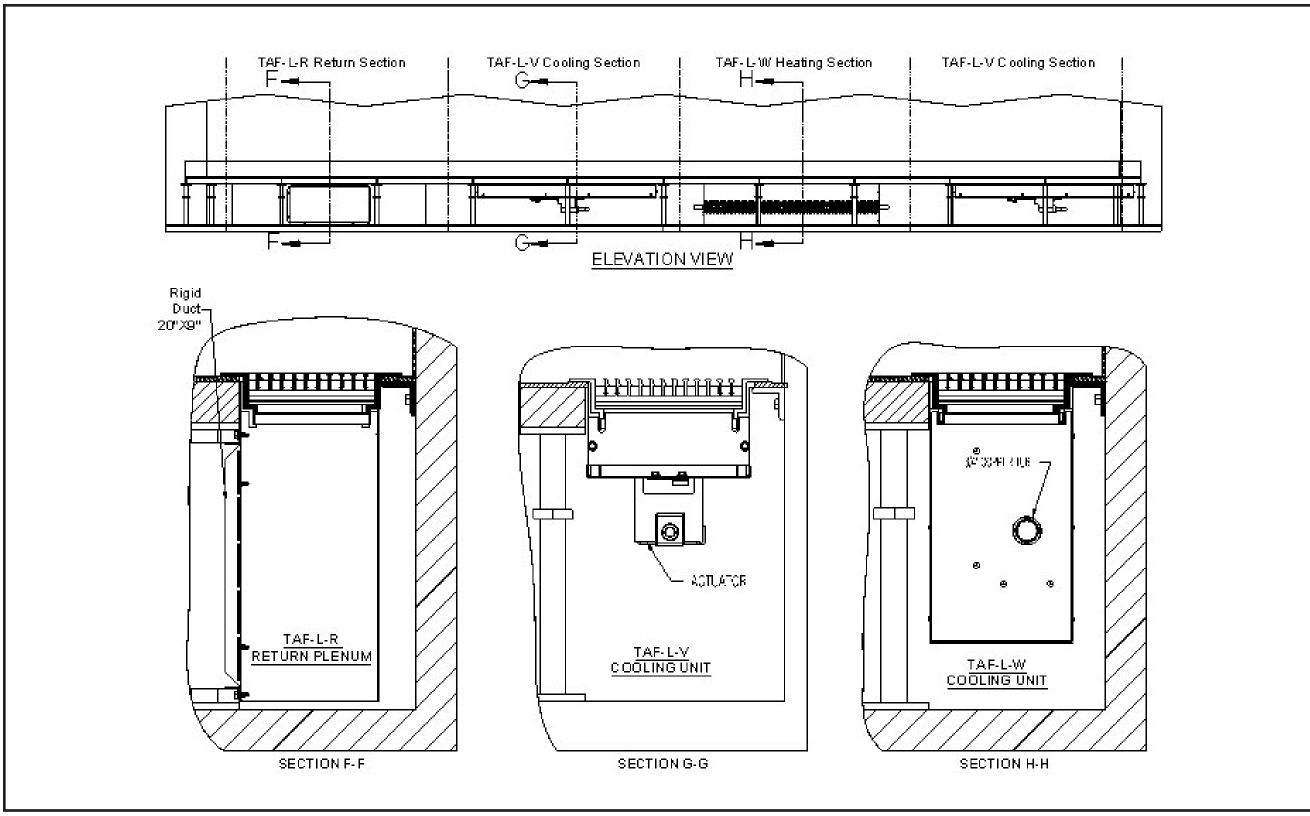
The TAF-L perimeter system provides this ideal air pattern. The TAF-L system consists of a modular cooling plenum, the TAF-L-V, and heating plenum, the TAF-L-W, designed to be integrated with the CT-TAF-L multi-deflection linear bar diffuser.

The TAF-L system provides a continuous look around the perimeter. The TAF-L-V cooling plenum used with the CT-TAF-L has an engineered throw pattern that never breaks through the stratification layer created by the UFAD diffusers in the core. The dual aperture plate design allows the TAF-L-V / CT-TAF-L assembly to maintain this engineered throw pattern while modulating the airflow volume.

PERIMETER HEATING

Perimeter heating cannot be accomplished with the same system as the interior load cooling system. Ideally, since ASHRAE 90.1 states that you should not simultaneously cool and heat, the perimeter heating system should be completely independent of the cooling system. Separate ducting of hot or reheated air, hydronic systems, or perimeter fan powered systems are often used to condition the skin load on the building.

The TAF-L-W, self contained fin tube perimeter heating plenum utilizes



room air to heat the perimeter instead of supply air. The TAF-L-W heating plenum also uses the CT-TAF-L to create a continuous linear look from the occupied space.

The TAF-L-W works by allowing the denser cold air, which create convection currents, to flow down a window or exterior wall into the TAF-L-W plenum while also inducing warmer room air into the plenum. A finned tube heater in the plenum reheats this mixed air and room air, returning the heated air to the window or exterior wall through natural convection.

The TAF-L-E uses the same concept shown above to heat the perimeter with a fin tube electric powered SCR heater. The TAF-L-E is an ETL listed self-contained 4 ft. long sheet metal plenum which attaches to the CT-TAF-L.

The TAF-L perimeter system is modular and allows the designer to use the right number of cooling or heating units required to match the space load requirements. Typically the TAF-L-V, cooling plenums, and TAF-L-(W)(E), heating plenums are alternated as needed throughout the perimeter.

The TAF-L system allows you to remove the fan powered terminals, and their associated energy and maintenance costs, from the UFAD system. However, in the event where the system cannot achieve consistent plenum pressure, a fan powered terminal may be necessary.

The PFC was designed to be used as a booster unit for perimeter applications. The PFC fan powered terminal unit is designed to be installed between the pedestals in an underfloor system and installed in a floor 12" to 18" in height.

The PFC is usually ducted to linear bar diffusers, such as the CT, or diffuser and plenum units, such as the TAF-D. The airflow of the diffusers is directed at the glass like a typical ceiling system.

When fan powered terminals are used with an under floor system, they are typically equipped with ultra-high efficiency ECM motors. ECM motors consume less energy and can be controlled by the unit DDC controller to adjust the fan speed to the required space load conditions.

Modulating the fan speed to vary the amount of air supplied to the zone is the most common control sequence used for the PFC. The PFC controller will determine the speed of the fan based on zone temperature. For example, the fan would run 100% when the zone is 75°F and modulated down to 30% as the zone approaches 70°F.

CONFERENCE ROOMS & OTHER AREAS OF VARYING LOAD

Much like the perimeter, conference rooms must be handled separately to adjust for the varying load conditions. The LHK fan powered terminal was designed for this application. Like the PFC, the LHK fits within the modular pedestal systems of the raised floor and is available in various heights to fit under 12" through 18" raised floors.

With the exception of its unique dimensions, the LHK is like any other series fan powered terminal. The LHK has a supply inlet with a damper

modulated by a controller and actuator. The LHK has an induced air inlet which pulls air from the underfloor plenum or from the room depending on how the LHK is applied.

The LHK supply inlet would be open to the plenum with the induced air inlet ducted to the room as the return. The discharge would then be flex ducted to TAF-R's in the room.

Again to eliminate the fan powered terminal, the TAF-L system can be used to provide comfort conditioning to varying load areas. The CT-TAF-L can be installed in the floor along the wall to provide a clean look. TAF-L-V units can be attached to the CT-TAF-L as required to handle the maximum space load. The space thermostat will operate the unit dampers in response to space load conditions. Unused sections of the CT-TAF-L should be blanked off beneath the floor.

Large space common areas such as break-rooms can be controlled using multiple TAF-R units with electric actuators operated by a common room thermostat.

RETURN AIR

Due to the upward air flow, returns should be located at the ceiling or on a high side wall at least 8' above the floor. This allows the heat from ceiling lights to be returned before it is able to mix with the conditioned air in the occupied zone. There will also be a small amount of "free cooling" due to the natural buoyancy of hot air.

If the system must use 55°F supply air for humidity reasons, some of the return air can be re-circulated from the ceiling to the underfloor plenum to raise the temperature of the air to 63°F to 68°F.

Another option is to take the return air back to the air handling unit where it can be filtered and dehumidified before re-entering the underfloor plenum. With this option, you can more accurately control the air temperature at the diffuser and you gain the cost benefits of the warmer supply air temperature.

HUMIDITY ISSUES

A potential problem with the higher supply temperatures used in underfloor supply systems is the higher potential moisture content of the warmer supply air used in these systems.

The supply system must reduce relative humidity to less than 60% to meet IAQ concerns, and this requires dew points less than 65°F. This implies either reheat or blending of air to achieve a 65°F supply, 55°F dew point condition.

System designs utilizing condenser water reheat; run-around coils, face & bypass, and other strategies can be employed to solve these potential design problems. Other possible solutions include the use of a separate system to dry outside air or the use of desiccant dehumidification.

Climate and building operation are important considerations when designing a UFAD system. In humid climates, it may be necessary to operate the HVAC system 24 hours a day to maintain acceptable humidity levels in the building.

VENTILATION EFFECTIVENESS

ASHRAE Standard 62.1 defines the volume of ventilation air required for a given building space. Table 6-2 shows the adjustment factors to be applied relative to the type of system being employed. For UFAD cooling the factor is 1.0 which is the same as fully mixed overhead cooling and lower than the 1.2 factor applied to Displacement Ventilation applications. ASHRAE research project RP-1373 was funded to compare ventilation effectiveness between UFAD and Displacement Ventilation outlets for several common space applications. The results of the research indicated that when the vertical jet from an UFAD outlet reached a terminal velocity of 50 fpm lower than 5 ft. above the floor, the ventilation effectiveness is equal to DV. When the jet projects to a height higher than 5 ft., the ventilation effectiveness is equal to fully mixed cooling. The results of this data will be published in a future Addenda to Standard 62.1. this change may impact the volume of ventilation air required to satisfy LEED requirements when using UFAD.

SIZING JOBS

The optimum design point for the TAF-is 80 - 100 CFM when a 10°F room / supply differential is used. At this point, the noise is negligible and the pressure required is less than 0.10".

Throw will be less than 5 ft., preserving the desired ceiling stratification layer. Our testing shows that there is 100% mixing in the occupied zone under these conditions.

The stratification in this installation results in a supply - exhaust ∆T similar to the typical 18°F to 20°F ∆T common in most conventional systems.

For example, with 64°F supply air in a 74°F room, the room exhaust, at the ceiling, will probably be about 82°F, for an 18°F ∆T.

This means that one diffuser can handle:

18°F ∆T x 100 CFM x 1.08 = 1944 BTUH or 1944
BTUH ÷ 3.41 = 570 watts of internal load.

Lights are typically 0.75 W/sq.ft, but with ceiling stratification are probably not a part of the room load (but are seen by the air handler). If computers and printers supply about 1W/sq.ft. load and occupants add about 1.2 W/sq.ft, this translates to:

1.0 W/sq.ft. (computers and printers)
+1.2 W/sq.ft. (occupants)
=2.2 W/sq.ft. (room load)

This corresponds to one TAF-R every:

570 Watts of internal heat
÷ 2.2 W/sq.ft. room load
= 260 sq.ft. floor space sensed interior zone load.

As a general rule, one TAF-R should be provided for each occupant.

SYSTEM ECONOMICS

The main economic considerations for a UFAD system are reduced first costs & installation costs, higher HVAC equipment efficiency, lower horsepower fans, better heat and pollutant removal, quick to install and easy to rearrange office layouts, and lower life-cycle building costs.

FIRST COSTS & INSTALLATION COSTS

UFAD systems can be designed with plenum returns using the same floor to floor height as conventional systems by shifting the occupied zone up into where the ceiling plenum would normally be.

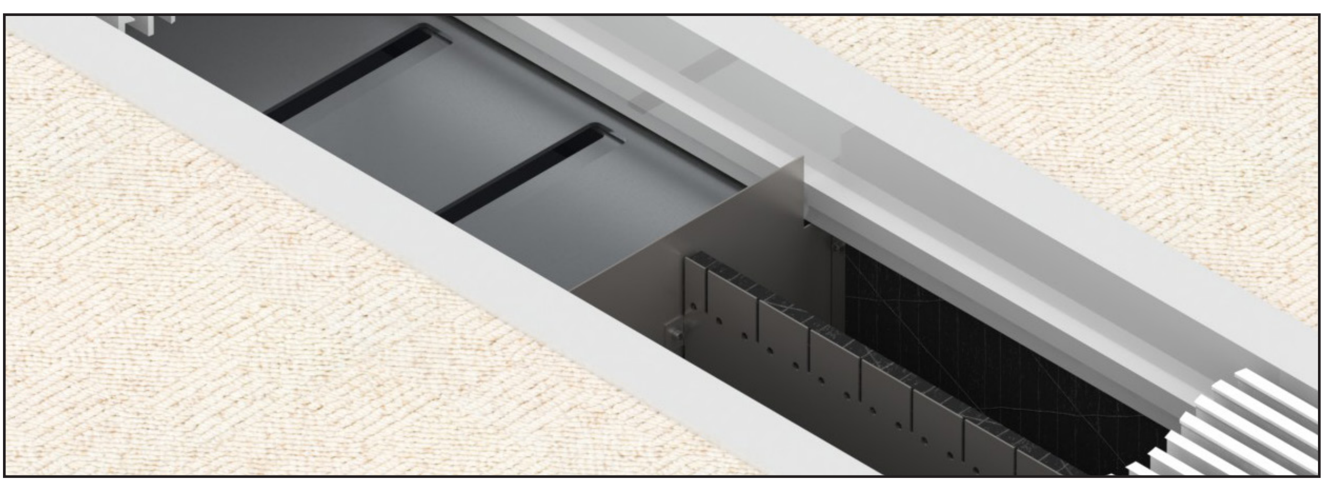
The cost of the raised floor, typically $5-7 per sq.ft., is offset by the fact that less ductwork is required. The installation costs are usually lower because the HVAC and data / power work is done at floor level.

In a conventional system, ductwork must go to every diffuser. UFAD systems use a pressurized plenum to supply each diffuser, so less ductwork is required. In a UFAD system, the only ducting in the underfloor plenum is the ductwork required to supply the diffusers that are more than 35 feet away from the dampers or the separation for the perimeter.

HIGHER HVAC EQUIPMENT EFFICIENCY

In an UFAD system, supply air enters directly into the occupied zone at the floor level. In a conventional system, the supply air temperature is usually 55°F because it must mix with the warm air at the ceiling before it enters the occupied zone.

UFAD systems typically use 63-68°F supply air temperatures. This warmer supply air can reduce energy consumption of the HVAC equipment. Some DX equipment cannot supply air at this high temperature, so this must be considered when selecting the HVAC equipment.



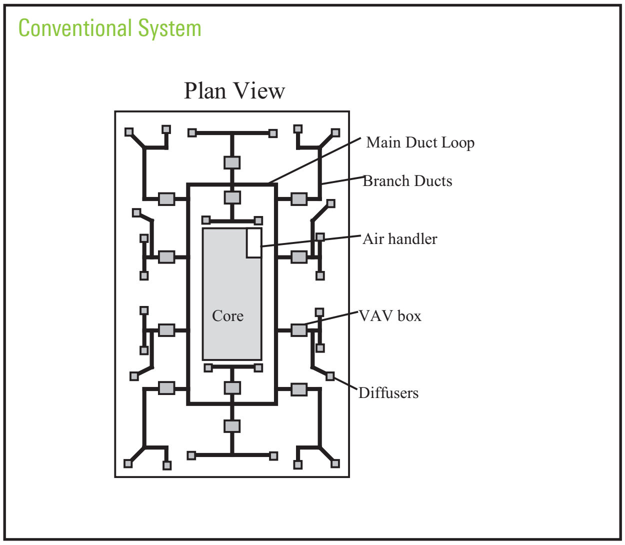


Figure 1. Conventional System Ductwork

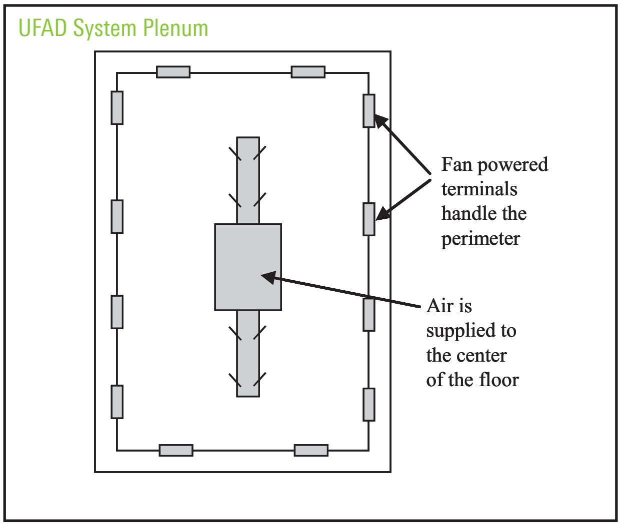


Figure 2. UFAD System Plenum

LOWER HORSEPOWER FANS

UFAD systems move a larger volume of air with overall lower pressure drops. The diffusers used in UFAD systems operate with less than 0.1" wg, so lower horsepower fan can be used, reducing energy costs.

BETTER HEAT AND POLLUTANT REMOVAL

Heat from overhead ceiling lights is removed before it enters the occupied zone and lateral mixing in the occupied zone is reduced. A Lawrence Berkeley National Laboratory field study found that pollutant removal efficiency for carbon dioxide was 13% higher than expected in a space with well-mixed air, suggesting a 13% reduction in exposures to occupant generated pollutants.

EASY INSTALLATION AND RELOCATION

UFAD diffusers are installed through the floor panel after flooring and carpet installation is complete. Little attention needs to be placed on diffuser location until office furniture layout is finalized.

To maximize flexibility of furniture location during initial installation and re-location during churn, it is recommended that the TAFR diffuser be located at an off center location in the floor tile. This will allow the tile to be installed in the floor stringer with four choices of diffuser location but merely turning the tile.

Typical churn in an office is 33%, meaning that everyone moves every three years. Diffusers are rearranged by moving entire floor panel to a new location. This reduces the time and labor costs of relocation and renovation in an office.

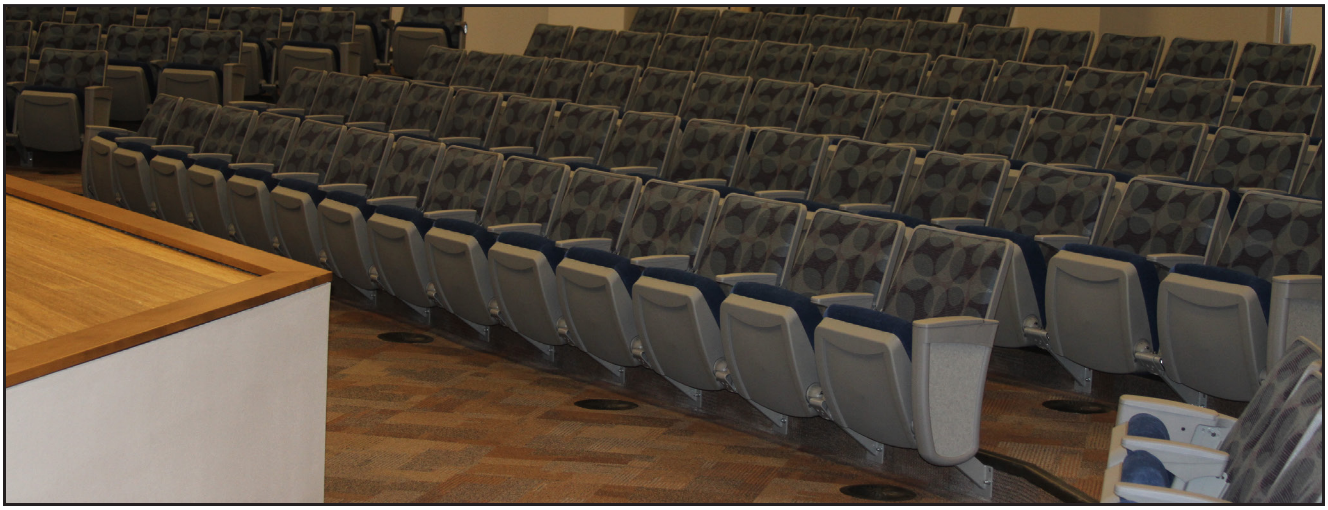
LOWER LIFE CYCLE COSTS

Several factors of the UFAD system contribute to potential life cycle savings. The building should have an energy savings from the use of lower horsepower fans. The owner should see reduced costs for office layout changes.

In addition to these, the concrete structural slab can be used to lower peak cooling demand. The use of the underfloor plenum as a supply duct allows the use of the thermal mass of the structure as an energy "flywheel".

By ventilating the underfloor plenum with cool air at night, the structure can be cooled to the point where the load during the early part of the day is significantly lowered. A number of strategies can be employed to take advantage of the potential for stored "cool", resulting in lowered energy use and off-peak energy use. However, there is a potential for overcooling the occupied space during the night requiring addition morning warm up, costing energy.

CRITERIA CLASSIFICATION	POINTS
ENERGY & ATMOSPHERE	
Optimize Energy Performance	Up to 20
INDOOR ENVIRONMENTAL QUALITY	
Thermal Comfort	1



There are also costs savings associated with increased thermal comfort for occupants. Because the diffusers are occupant adjustable, the facility staff should see fewer complaints about thermal comfort.

Increased employee satisfaction potentially results in increased productivity. Labor costs are typically 10 times the cost of property. A 1% productivity improvement is the equivalent of 22 hours, or almost three days, of gained productivity.

For a company with 115 employees earning $35,000 a year, 30 employees earning $60,000 a year, and 5 employees earning $80,000 a year, a 1% improvement would worth be almost $70,000. This is a substantial payback for a building owner.

UFAD AND LEED

The United States Green Building Council (USGBC) developed the Leadership in Energy & Environmental Design (LEED™) Green Building Rating System™. The LEED council is a voluntary, consensus-based national standard board for developing high-performance, sustainable buildings. USGBC members represent all segments of the building industry and update the program continuously.

The growing interest in green buildings and LEED certification has increased the interest in UFAD systems. The table below shows the LEED credits that could be achieved with UFAD systems.

OPTIMIZE ENERGY

The intent of this credit is to reduce the energy usage of the building below the ASHRAE Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings, prerequisite requirement.

There are two methods of achieving this credit. The first, and currently most common, method is based on percentage of reduction and range from 5% reduction (1 Point) to 50% reduction (18 Points) for new construction. Two additional points can be achieved for healthcare buildings. The percent reduction is determined by completing a whole building energy simulation.

The second method of achieving this credit is to comply with the Prescriptive Compliance Path in the ASHRAE Advanced Energy Design Guide. Using this method, you can achieve up to 6 points.

ECM motors are another option that should be considered for the Optimize Energy Performance credit. The ECM motor has efficiencies of up to 70% across its entire operating range (300-1200 rpm) and 80% over 400 rpm. The ECM motor is available in the Titus LHK and PFC UFAD fan-powered terminals. See the ECM Application Guide, AG-ECM, for more information.

UNDERFLOOR AIR DISTRIBUTION SYSTEMS

One way to achieve energy optimization credit is with an underfloor air distribution (UFAD) system. UFAD systems may have higher HVAC equipment efficiency as access floor air systems use warmer supply air (60° to 65°F) than conventional systems that use 55°F supply air. Raising the discharge temperature of many system types reduces energy consumption.

UFAD systems can move a larger volume of air with overall lower pressure drops. The underfloor plenum needs less than 0.1 inch of water pressure for proper diffuser performance. This results in less fan horsepower needed for UFAD systems resulting in lower energy usage.

The energy savings of an UFAD system should be considered as part of the system to receive an Optimize Energy Performance credit.

CONTROLLABILITY OF SYSTEMS

Thermal Comfort. The intent of this Credit is to provide individual comfort controls for 50% of the building occupants to enable adjustments to suit individual task needs and preferences.

The credit states that, "Individual adjustments may involve individual thermostat controls, local diffusers at floor,..." as potential strategies to achieve this credit. VAV diffusers, such as the Titus T3SQ would also qualify for this credit as well as access floor diffusers such as the TAF-R.

THERMAL COMFORT

Thermal Comfort - Design requires that the building comply with ASHRAE Standard 55-2010, for thermal comfort standards.

ASHRAE Standard 55-2010, Thermal Environmental Conditions for Human Occupancy specifies the combinations of indoor space environment and personal factors that will produce thermal environmental conditions acceptable to 80% or more of the occupants within a space. The environmental factors addressed in the standard are temperature, thermal radiation, humidity, and air speed; the personal factors are those of activity and clothing.

It has been shown that individual comfort is maintained when the following conditions are maintained in a space:

- Air temperature maintained between 73-77°F
- Relative humidity maintained between < 60%
- Maximum air motion in the occupied zone
- 50 fpm in cooling
- 30 fpm in heating
- Ankle to neck level, 5.4°F maximum temperature gradient

The ASHRAE comfort standard states that no minimum air movement is necessary to maintain thermal comfort, provided the temperature is acceptable. To maximize energy conservation, we should attempt to maintain proper temperatures at the lowest possible air speed. The ASHRAE comfort charts, Figures 3 and 4 show the relationship between local air velocity and temperature difference in the ankle and neck regions.

Air Diffusion Performance Index (ADPI) is the best way of assuring that a space will meet the ASHRAE Standard 55 requirement for 5.4°F maximum temperature gradient. ADPI is a single-number means of relating temperatures and velocities in an occupied zone to occupants' thermal comfort. To calculate the ADPI of a space, you need to measure the temperature and velocities at points throughout the occupied space. The occupied space is defined by ASHRAE as being the area from the floor to the six foot height, one foot from the walls (or in the case of UFAD diffusers, outside of the clear zone of the diffuser). The effective draft temperature is then calculated for each point.

The effective draft temperature (Θ) is equal to the room temperature (t_x) minus the local temperature (t_c) minus 0.07 times the local velocity (V_x) minus 30.

$$\Theta = (t_x - t_c) - 0.07(V_x - 30)$$

The ADPI value is the percentage of the points where Θ is between -3 and +2 F inclusive, with a room velocity of 70 fpm or less. ASHRAE guidelines state that the ADPI of greater than or equal to 80 is considered acceptable.

There is currently no method to calculate the ADPI for a UFAD system outside of conducting field measurements per ANSI/ASHRAE Standard 113-2009, Appendix B, Method of Testing for Room Air Diffusion.

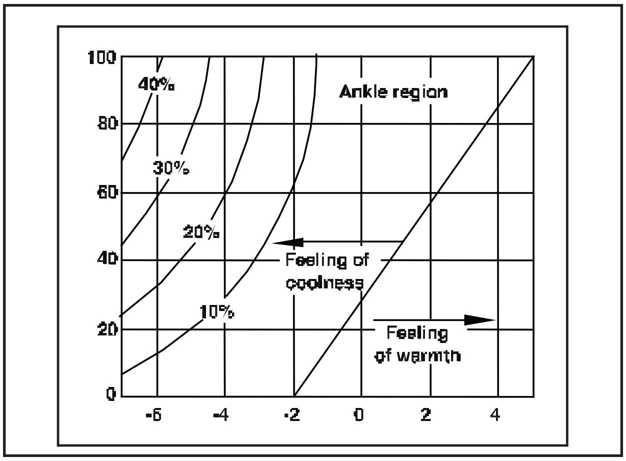


Figure 3. Ankle Region Comfort Chart

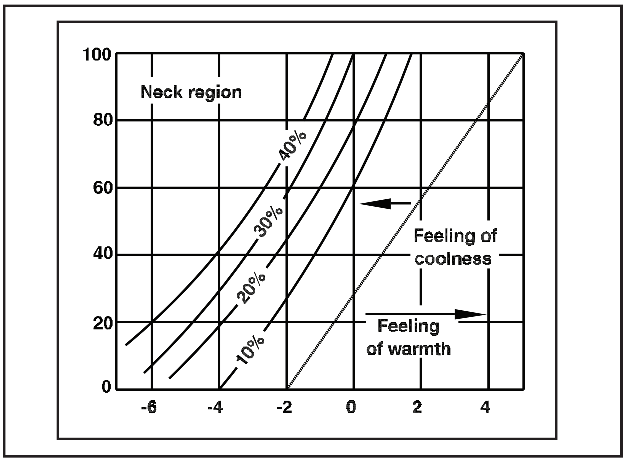


Figure 4. Neck Region Comfort Chart

ABBREVIATIONS

The following table lists abbreviations used within this document.

Abbreviation	Term
ADPI	Air Diffusion Performance Index
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
UFAD	UnderFloor Air Distribution
LEED	Leadership in Energy & Environmental Design
USGBC	U. S. Green Building Council

TAF-R / TAF-R-FR

- Designed for applications in pressurized underfloor air distribution systems
- Constructed of a high impact, polymeric material, durable enough to resist foot traffic. Exceeds NFPA 90B requirements.
- External Open/Close indicator coupled with the internal Open/Close stop allow visual determination of damper position
- Architecturally appealing face design is available in standard gray or black color. Optional colors may be specified to match any building interior's color scheme.
- The trim ring's extra wide flange is designed to prevent carpet from pulling away from the diffuser
- Relocation to another area is simply by relocating that floor panel. Removal of the diffuser from the access floor panel is not required.
- Diffuser can be installed after flooring and carpet installation are complete
- Simply converts to a TAF-G without moving floor panels or trim and retainer ring
- TAF-R-FR is UL Listed and meets NFPA 90A

TAF-R / TAF-R-FR

- The spring clip attached to the trim ring is designed for rapid & secure press fit without the use of tools

fire rated   energy solutions

See website for Specifications

AVAILABLE MODELS:

TAF-R
TAF-R-FR

FINISHES

Standard Finish - #84 Black or light gray
Optional Finish - Custom colors may be specified to match building's interior color scheme

OVERVIEW

The TAF-R is designed for application in underfloor air distribution systems. All components are constructed of a high-impact polymer material that is designed to resist damage from traffic. The TAF-R diffuser is also a GreenSpec Listed product and is available in standard light gray or black. Additional colors may be specified to match any building's interior scheme. This model can contribute toward achieving LEED Credits.

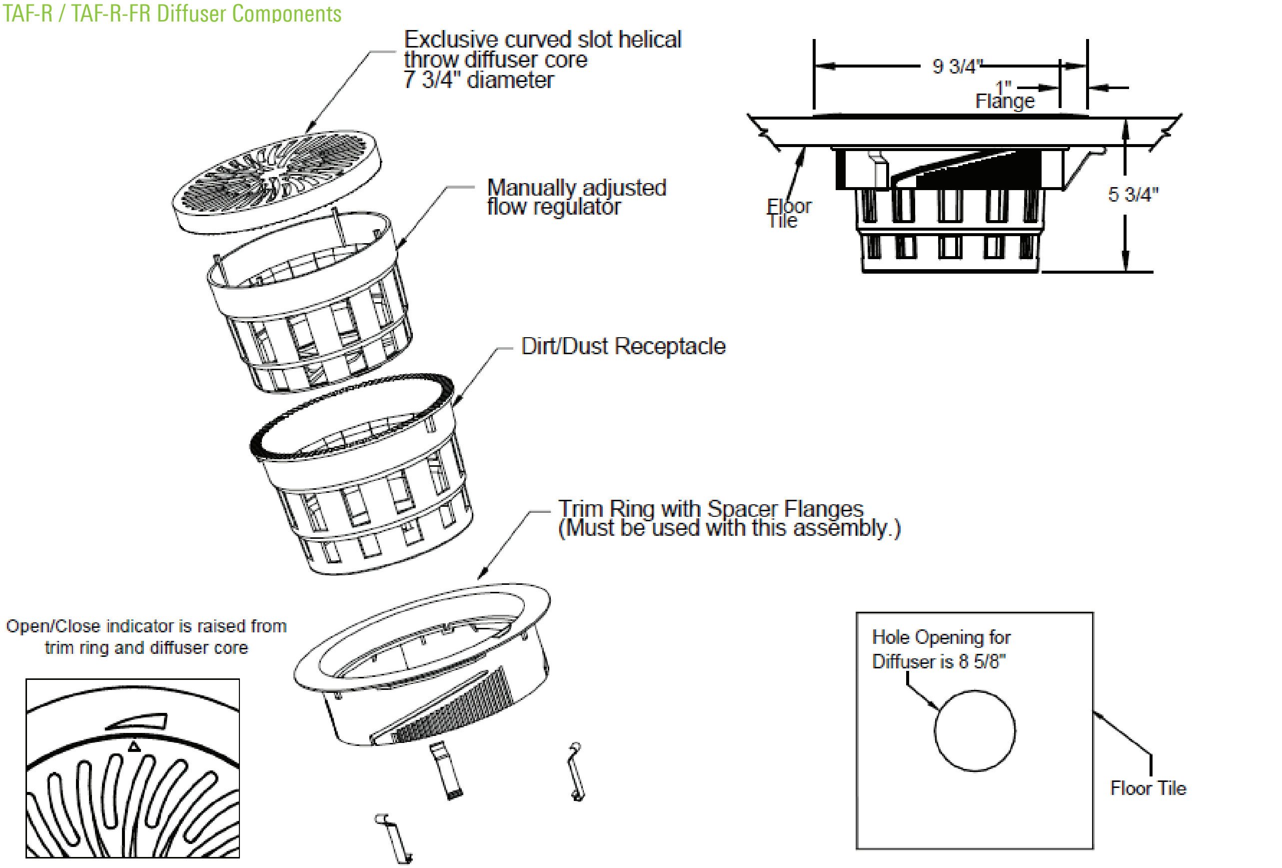
ADVANTAGES

- The actuated option for the TAF-R & TAF-R-FR can have a maximum of six daisy chain units together utilizing the standard 12ft. plenum cable. This allows for a maximum of 12 units per power supply with six unit on each side of the power supply.
- High induction helical air pattern creates ideal circulation without excess inlet pressure requirements
- Removable flow regulator is manually operated without removing the core
- Dirt / dust collection receptacle can be easily removed for cleaning

TAF-R diffusers installed in a government facility

TAF-R / TAF-R-FR DIMENSIONS

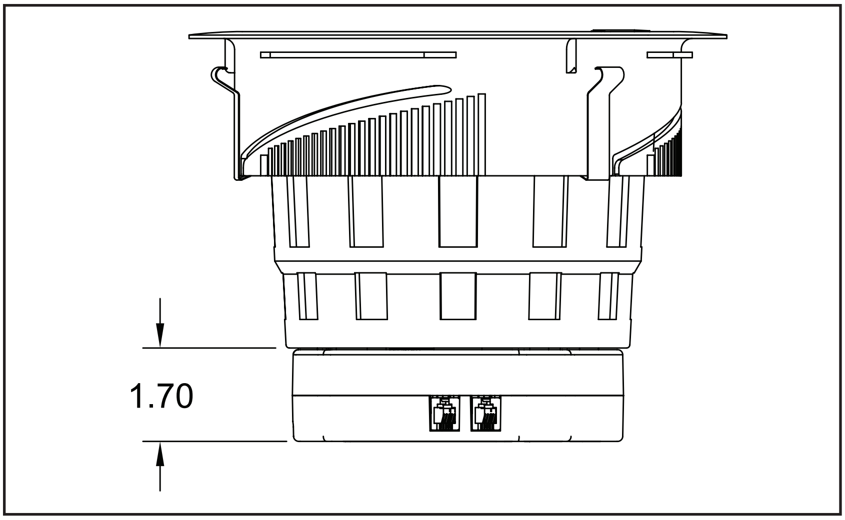
TAF-R / TAF-R-FR Diffuser Components



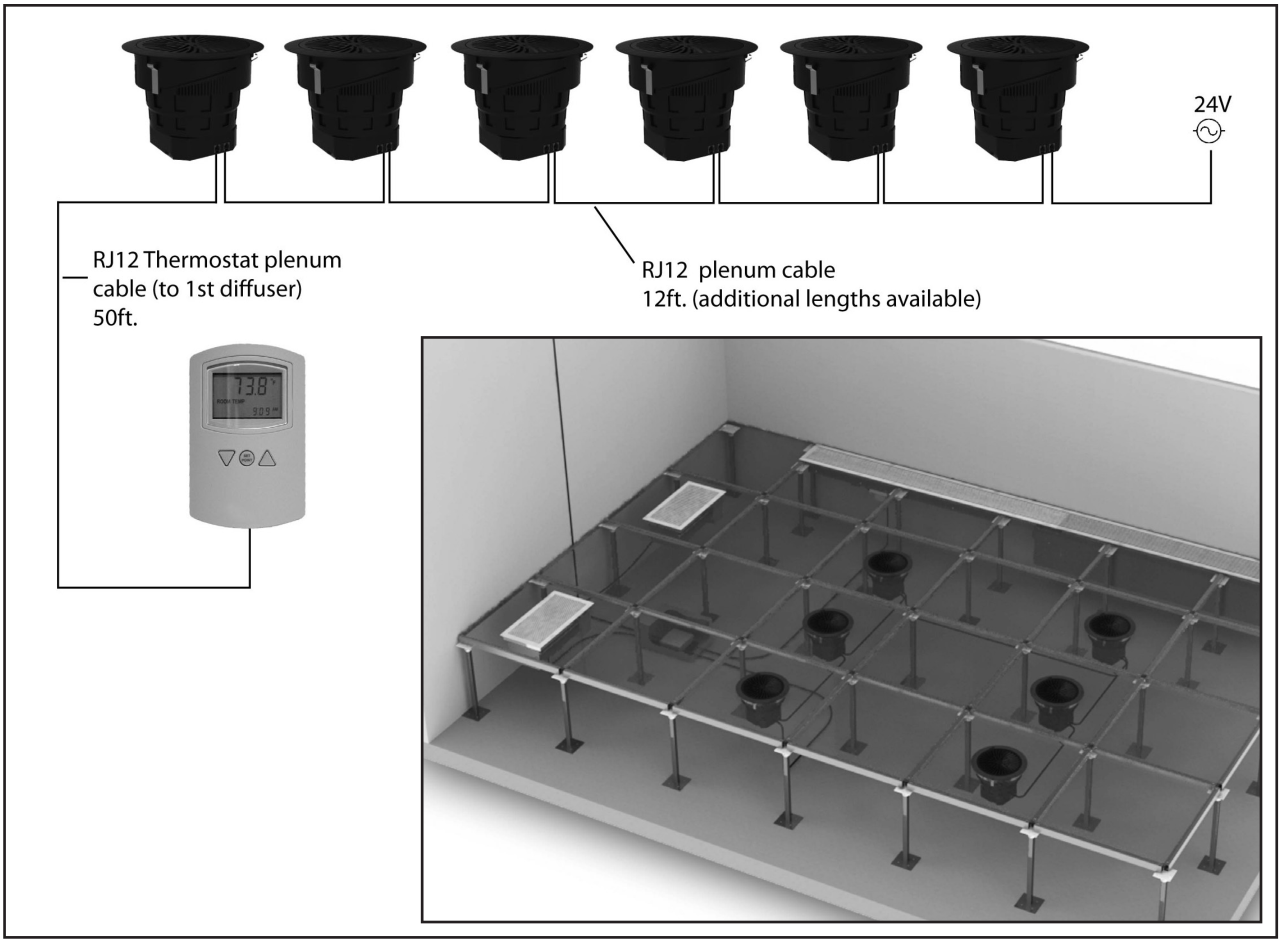
All dimensions are in inches

ACTUATED FLOW REGULATOR

- 24VAC electric flow regulator actuator is integral part of the assembly
- RJ12 cable connections for easy plug and play installation between units
- UL Rated
- 24VAC actuator is direct drive 0-10 VDC control signal
- Room sensor equipped with digital display for setpoint adjustment & PC data connection



TAF-R ACTUATED DAISY CHAIN



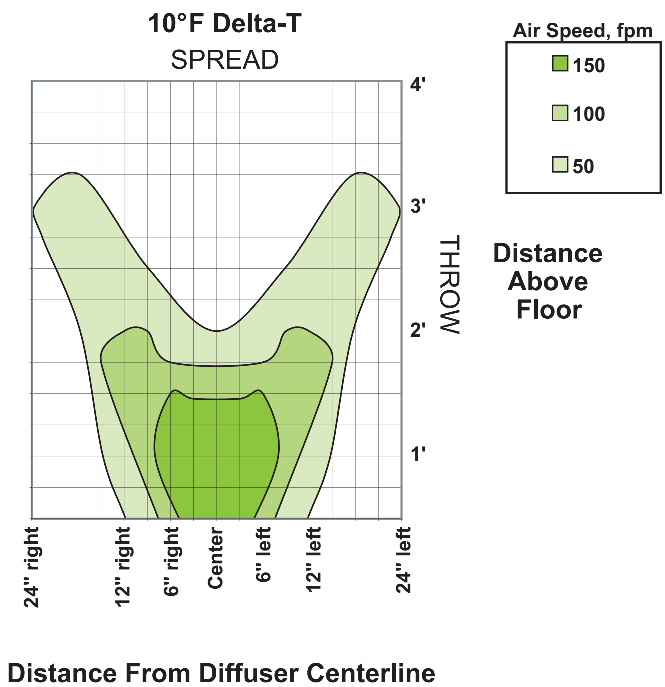
System Overview:

The actuated TAF-R & TAF-R-FR can have a maximum of six units daisy chained to each other utilizing the standard 12 ft. plenum cable. This allows for a maximum of 12 units per power supply with six units on each side of the power supply.

The TAF-R(-FR) can supply 100 cfm at 0.10-inch wg. of plenum pressure and generates a low NC of 19. The following charts show a favorable terminal velocity and temperature gradient in the comfort zone (range = 4 to 4.5 feet).

The HVAC system should be designed to operate at reduced capacity to avoid over cooling and excessive temperature swings. Significant 'passive' cooling may be experienced with underfloor air distribution systems.

Centerline Velocity Profile

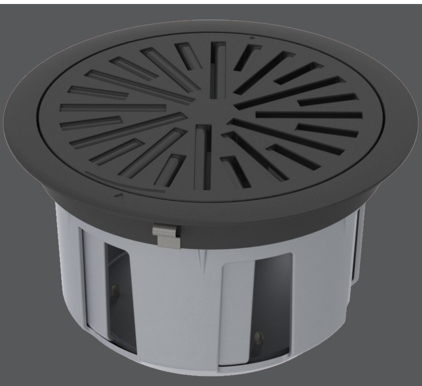


	TAF-R										
	NC	-	-	10	12	14	16	17	19	20	21
	Airflow (cfm)	54	62	70	76	83	89	94	100	105	109
	Plenum Pressure (wc)	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.1	0.11	0.12
10° F	Throw (ft)@ 150-100-50 fpm	1.2-1.8-3.2	1.4-2.1-3.4	1.6-2.3-3.7	1.7-2.5-3.8	1.8-2.8-4	2-2.9-4.1	2.1-3-4.2	2.2-3.1-4.4	2.3-3.2-4.5	2.4-3.2-4.6
ΔT	Spread ft @ 50 fpm	2.5	2.8	3.2	3.5	3.8	4	4.3	4.5	4.8	5

- NC values are based on octave band 2-7 sound power levels minus a room absorption of 10dB
- Dash (-) in space denotes an NC value of less than 10
- Data obtained from test conducted in accordance with ANSI/ ASHRAE Standard 70-2006
- Spread is the total width of the 50 fpm isovel. Projection is the maximum distance above the floor where the indicated terminal velocity was observed.
- Spread and Projection data is determined in a room with a 9-foot ceiling, and 10° ΔT between the supply and average occupied zone temperatures
- Ventilation efficiency (E_z) is 1.2 for floor supply of cool air and ceiling return, provided low-velocity displacement ventilation achieves unidirectional flow and thermal stratification or underfloor air distribution systems where the vertical throw is less than or equal to 50 fpm (0.25 m/s) at a height of 4.5 (1.4m) above the floor per ASHRAE 62.1-2010 Addenda a

TAFR-AA

- Designed for applications in pressurized underfloor air distribution systems
- All aluminum construction, durable enough to resist foot traffic. Exceeds NFPA 90B requirements
- External Open/Close indicator coupled with the internal Open/Close stop allow visual determination of damper position
- Architecturally appealing face designs are available in standard black or gray color. Optional special colors are available upon request. Woodgrain finish options also available.
- The trim ring's extra wide flange is designed to prevent carpet from pulling away from the diffuser
- Relocation to another area is simple by relocating that floor panel. Removal of the diffuser from the access floor panel is not required.
- Diffuser can be installed after flooring and carpet installation are complete
- Converts easily from a swirl pattern to a displacement pattern (and vice versa) without moving floor panels or trim rings
- TAFR-AA is UL Listed and meets NFPA 90A



TAFR-AA

- The spring clip and mounting gasket attached to the trim ring is designed for rapid & secure press fit without the use of tools

woodgrains energy solutions

AVAILABLE MODELS:

TAFR-AA / Swirl Patteren
TAFR-AA / Displacement Pattern

FINISHES

Standard Finish - #84 Black or light gray
Optional Finish - Custom colors may be specified to match building's interior color scheme

OVERVIEW

The TAFR-AA is designed for application in underfloor air distribution systems. All components are constructed of aluminum, including the basket portion, making it ideal for all levels of office traffic. The TAFR-AA diffuser is also a GreenSpec Listed product and is available in standard black or light gray. Additional colors may be specified to match any building's interior scheme. This model can contribute toward achieving LEED Credits.

ADVANTAGES

- The TAFR-AA, both swirl and displacement versions, are completely aluminum, including the basket under the floor
- The actuated option for the TAFR-AA can have a maximum of six daisy chain units together utilizing the standard 12ft. plenum cable. This allows for a maximum of 12 units per power supply with six units on each side of the power supply.
- The high induction helical air pattern of the swirl diffuser creates ideal circulation without excess inlet pressure requirements

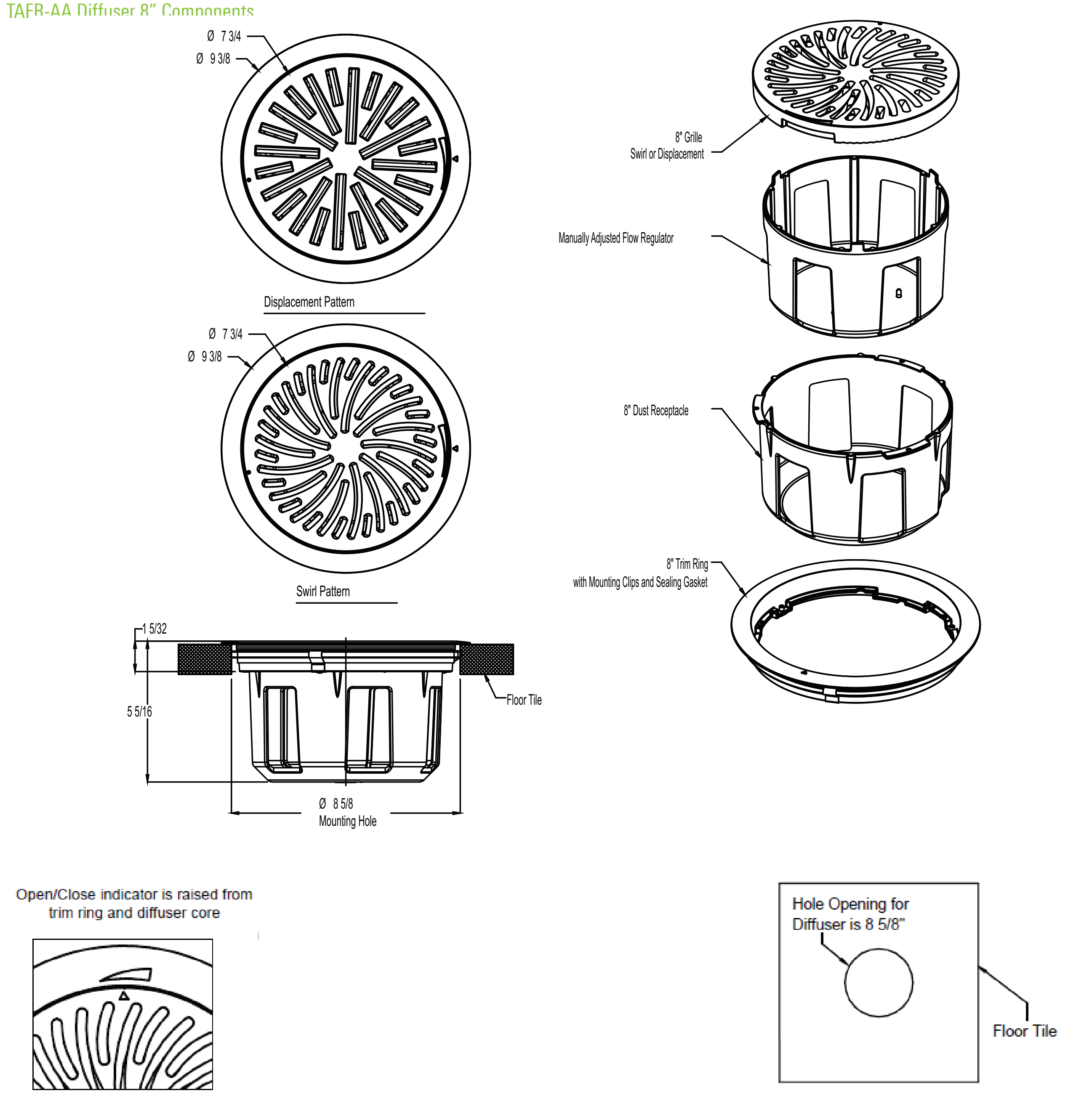
See website for Specifications

Exploded view of the TAFR-AA diffuser

- The horizontal air pattern of the displacement diffuser creates low velocity, non-mixing supply air that reduces occupant discomfort, allowing it to be placed closer to the occupant
- Removable flow regulator is manually operated without removing the core
- Dirt / dust collection receptacle can be easily removed for cleaning

TAFR-AA DIMENSIONS

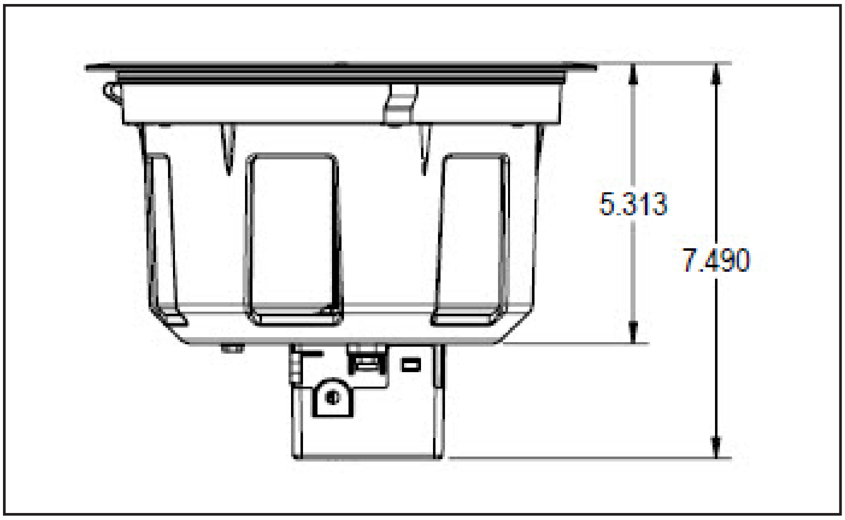
TAFR-AA Diffuser 8" Components



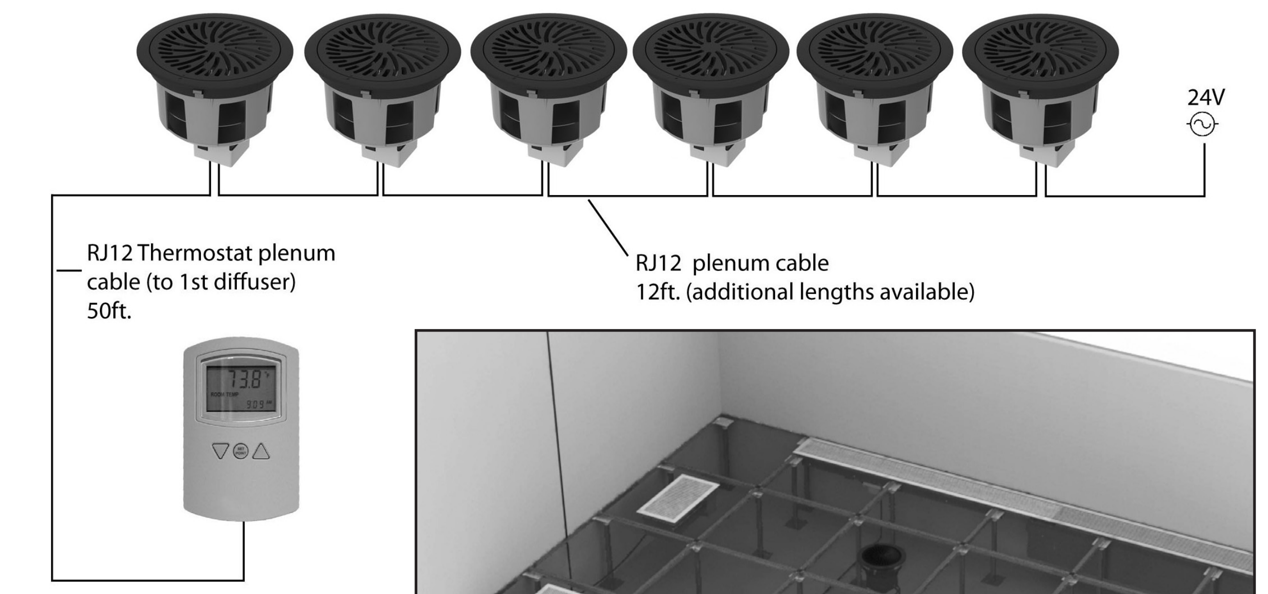
All dimensions are in inches

ACTUATED FLOW REGULATOR

- 24VAC electric flow regulator actuator is integral part of the assembly
- RJ12 cable connections for easy plug and play installation between units
- UL Rated
- 24VAC actuator is direct drive 0-10 VDC control signal
- Room sensor equipped with digital display for setpoint adjustment & PC data connection



TAFR-AA ACTUATED DAISY CHAIN



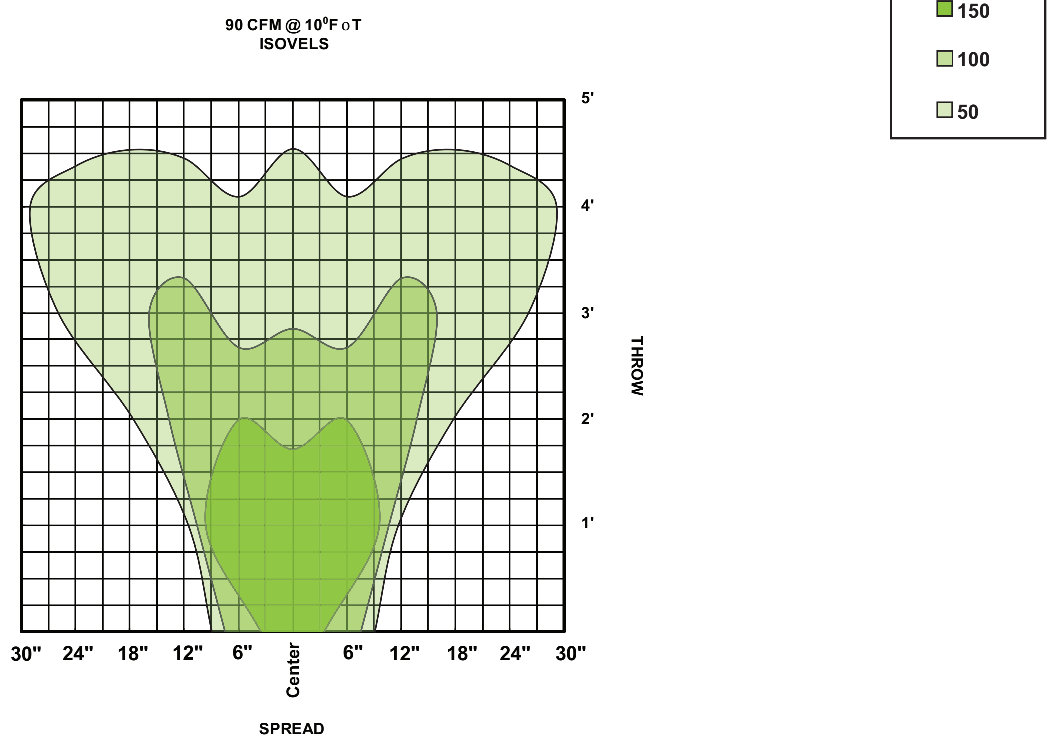
System Overview:

The actuated TAFR-AA can have a maximum of six units daisy chained to each other utilizing the standard 12 ft. plenum cable. This allows for a maximum of 12 units per power supply with six units on each side of the power supply.

The TAFR-AA can supply 100 cfm at 0.10-inch wg. of plenum pressure and generates a low NC of 19. The following charts show a favorable terminal velocity and temperature gradient in the comfort zone (range = 4 to 4.5 feet).

The HVAC system should be designed to operate at reduced capacity to avoid over cooling and excessive temperature swings. Significant 'passive' cooling may be experienced with underfloor air distribution systems.

Centerline Velocity Profile



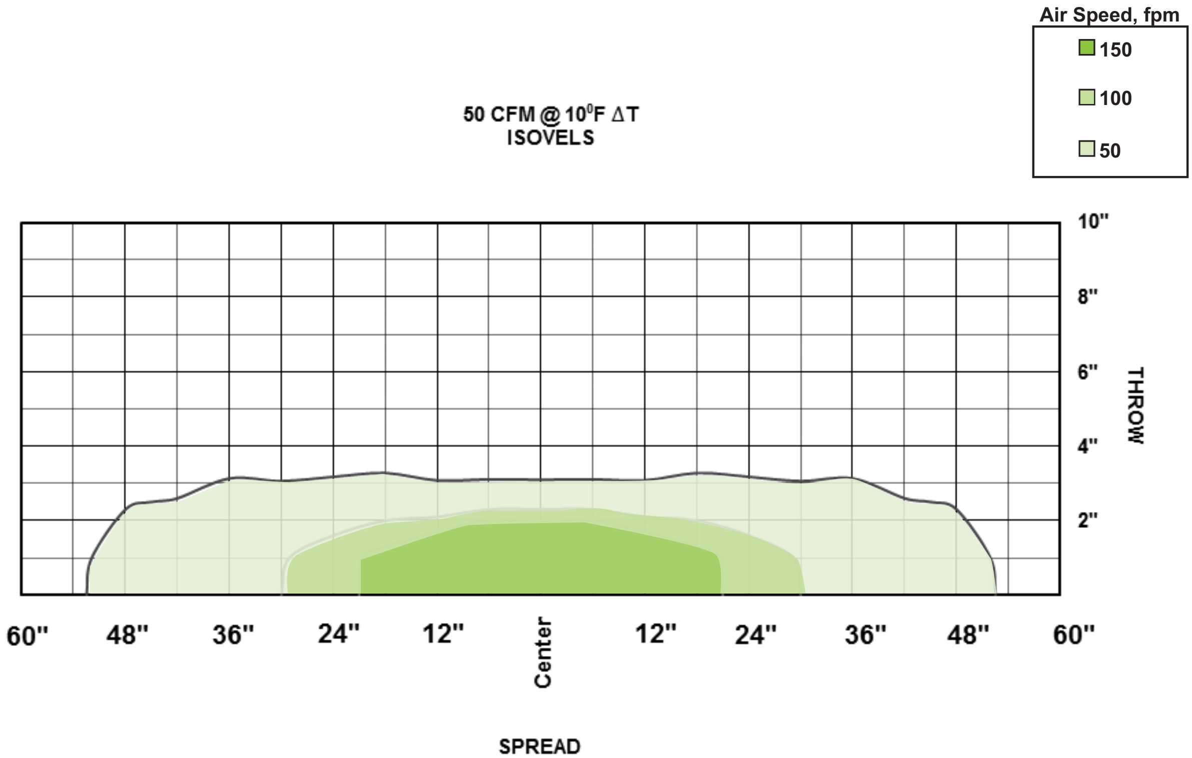
	TAFR-AA 8" Swirl Diffuser										
	NC	-	-	-	-	-	15	16	18	19	20
	Airflow (cfm)	49	56	63	69	75	80	85	90	94	98
	Plenum Pressure (wc)	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.1	0.11	0.12
10° F	Throw (ft)@ 150-100-50 fpm	1.1-1.6-3.2	1.2-1.8-3.4	1.4-2.1-3.6	1.5-2.2-3.8	1.6-2.4-3.9	1.7-2.6-4	1.8-2.8-4.2	1.9-2.9-4.3	2-3.1-4.4	2.1-3.2-4.5
ΔT	Spread ft @ 50 fpm	2.7	3.1	3.5	3.9	4.2	4.5	4.6	4.8	4.9	5

- NC values are based on octave band 2-7 sound power levels minus a room absorption of 10dB
- Dash (-) in space denotes an NC value of less than 10
- Data obtained from test conducted in accordance with ANSI/ ASHRAE Standard 70-2006
- Spread is the total width of the 50 fpm isovel. Projection is the maximum distance above the floor where the indicated terminal velocity was observed.
- Spread and Projection data is determined in a room with a 9-foot ceiling, and 10° ΔT between the supply and average occupied zone temperatures
- Ventilation efficiency (E_z) is 1.2 for floor supply of cool air and ceiling return, provided low-velocity displacement ventilation achieves unidirectional flow and thermal stratification or underfloor air distribution systems where the vertical throw is less than or equal to 50 fpm (0.25 m/s) at a height of 4.5 (1.4m) above the floor per ASHRAE 62.1-2010 Addenda a

The following charts show a favorable terminal velocity and temperature gradient in the comfort zone.

The HVAC system should be designed to operate at reduced capacity to avoid over cooling and excessive temperature swings. Significant 'passive' cooling may be experienced with underfloor air distribution systems.

Centerline Velocity Profile

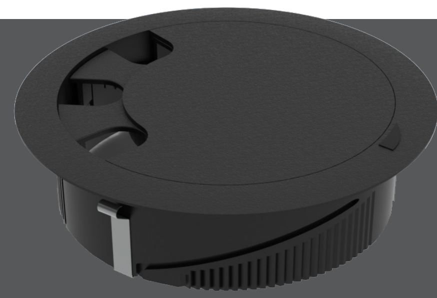


	TAFR-AA 8" Displacement Diffuser										
	NC	-	-	-	16	18	20	21	23	24	26
	Airflow (cfm)	28	32	36	39	42	45	48	51	53	55
	Plenum Pressure (wc)	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12
5°F ΔT	Spread ft @ 50 fpm	6.1	7	7.9	8.6	8.9	9.3	9.6	9.9	10.1	10.2
10°F ΔT	Spread ft @ 50 fpm	6.2	6.7	7.1	7.4	7.7	7.9	8.2	8.5	8.6	8.8

- NC values are based on octave band 2-7 sound power levels minus a room absorption of 10dB
- Dash (-) in space denotes an NC value of less than 10
- Data obtained from test conducted in accordance with ANSI/ ASHRAE Standard 70-2006
- Spread is the total width of the 50 fpm isovel. Projection is the maximum distance above the floor where the indicated terminal velocity was observed.
- Spread and Projection data is determined in a room with a 9-foot ceiling, and 10° ΔT between the supply and average occupied zone temperatures
- Ventilation efficiency (E_z) is 1.2 for floor supply of cool air and ceiling return, provided low-velocity displacement ventilation achieves unidirectional flow and thermal stratification or underfloor air distribution systems where the vertical throw is less than or equal to 50 fpm (0.25 m/s) at a height of 4.5 (1.4m) above the floor per ASHRAE 62.1-2010 Addenda a

TAF-G

- Designed for use in underfloor systems
- It allows “through-the-floor” power/data/phone cable access
- All components are constructed of a high impact polymeric material designed to resist damage from traffic
- Architecturally appealing face complements Titus diffuser Model TAF-R and is available in standard light gray or black color. Optional colors may be specified to match any building interior’s scheme
- The TAF-G installs into the same trim ring and mounting ring as the TAF-R
- The trim ring’s extra wide flange is designed to prevent carpet from pulling away from the grommet
- With the grommet installed in the floor panel, relocation to another zone is simply done through relocating the floor panel
- Grommet can be installed after flooring and carpet installation is complete
- The spring clip attached to the trim ring is designed for rapid & secure press fit without the use of tools



TAF-G

S

AVAILABLE MODEL:

TAF-G / Grommet

FINISHES

Standard Finish - #84 Black or light gray
Optional Finish - Custom colors may be specified to match building’s interior color scheme

OVERVIEW

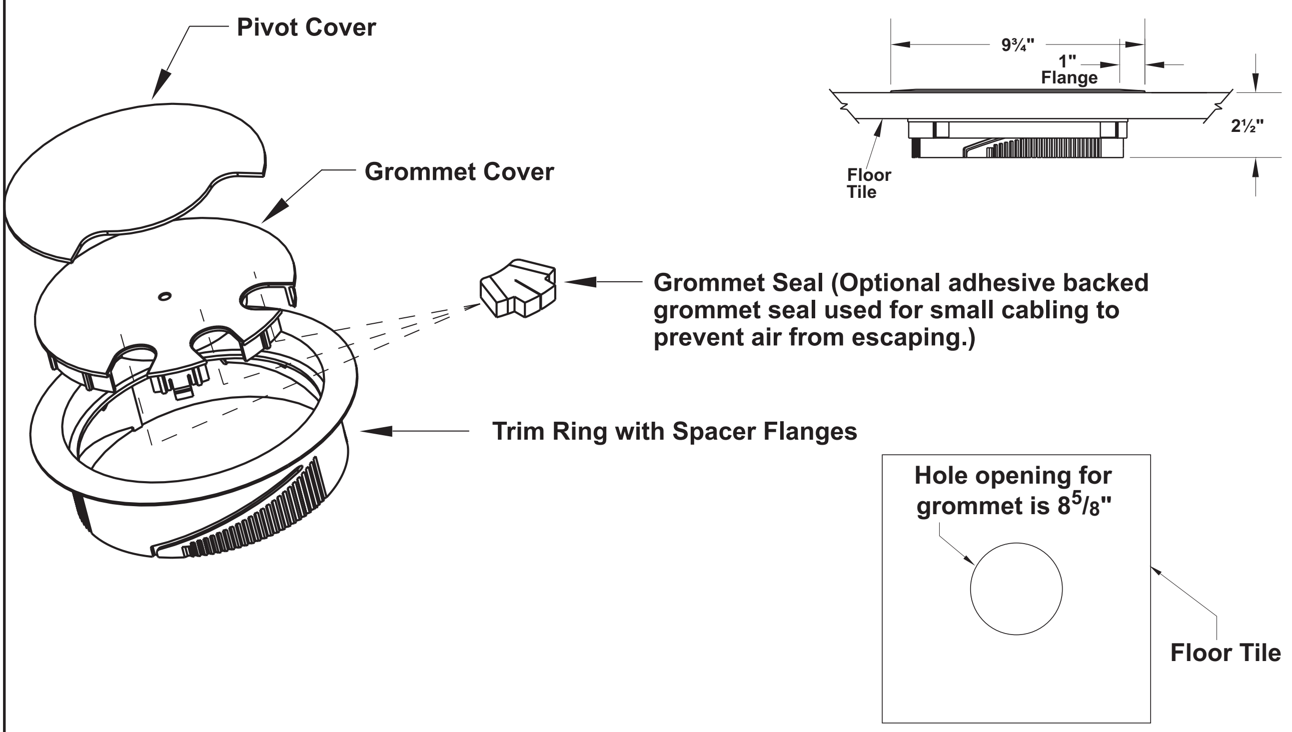
The TAF-G is designed for the use in underfloor systems. It allows “through-the-floor” power/data/phone cable access. All components are constructed of a high impact polycarbonate material designed to resist damage from traffic.

See website for Specifications

Above: Installed TAF-G in an office environment

TAF-G DIMENSIONS

TAF-G Diffuser Components

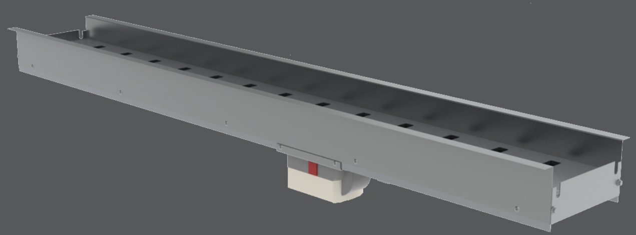


All dimensions are in inches

UnderFloor TAF-L Perimeter System

TAF-L-V

- Titus TAF-L-V is a variable linear bar diffuser plenum for underfloor perimeter supply applications
- Designed to be integrated with the CT-TAF-L linear bar grille (see CT-TAF-L for more information)
- The TAF-L-V, when used with the CT-TAF-L is designed to provide a uniform throw pattern throughout its operating range, regardless of damper position
- Active four (4) foot sections of TAF-L-V can be placed anywhere within the continuous CT-TAF-L linear bar grille
- 24 Volt electric damper actuator is supplied with the assembly
- Installs into the CT-TAF-L from the top surface. Removal of the flooring is not required.



TAF-L-V

energy solutions

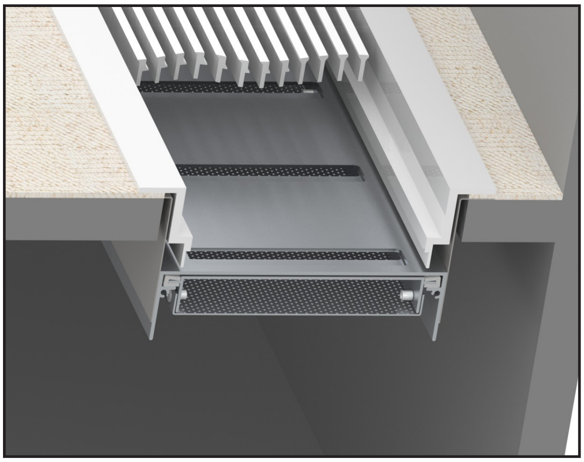
See website for Specifications

AVAILABLE MODEL:

TAF-L-V / Linear Diffuser Plenum with Variable Aperture Plate

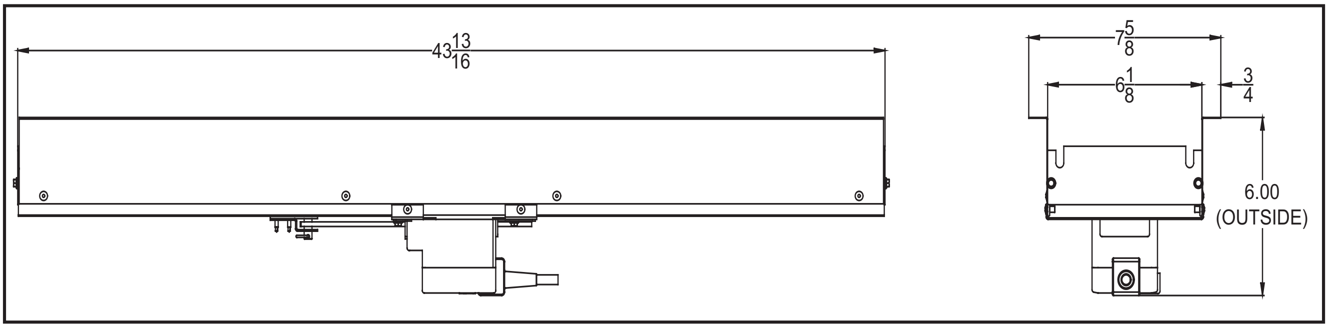
OVERVIEW

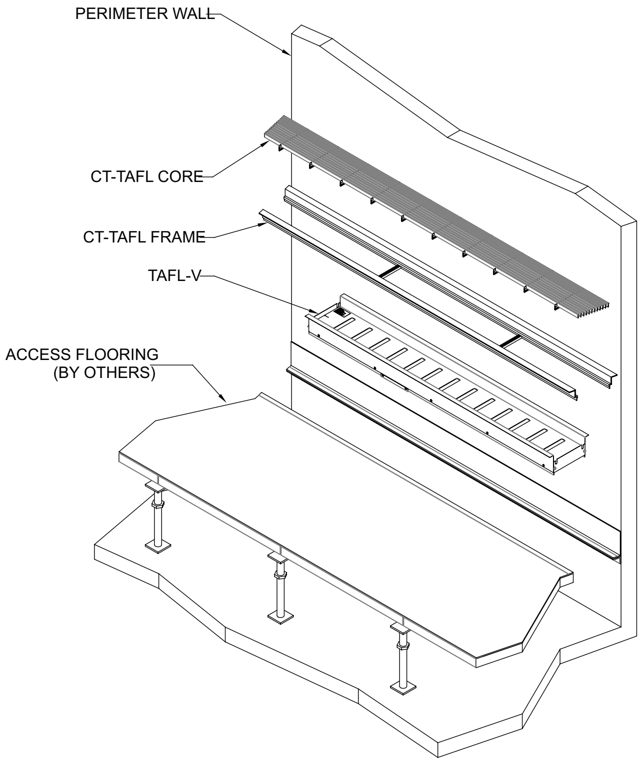
The TAF-L-V is a variable linear bar diffuser plenum for underfloor perimeter supply applications. The TAF-L-V cooling plenum has an engineered throw pattern that never breaks through the stratification layer created by the UFAD diffusers in the core. The dual aperture plate design allows the TAF-L-V/CT-TAF-L assembly to maintain this engineered throw pattern while modulating the airflow volume. This product saves energy and can contribute toward LEED certification.

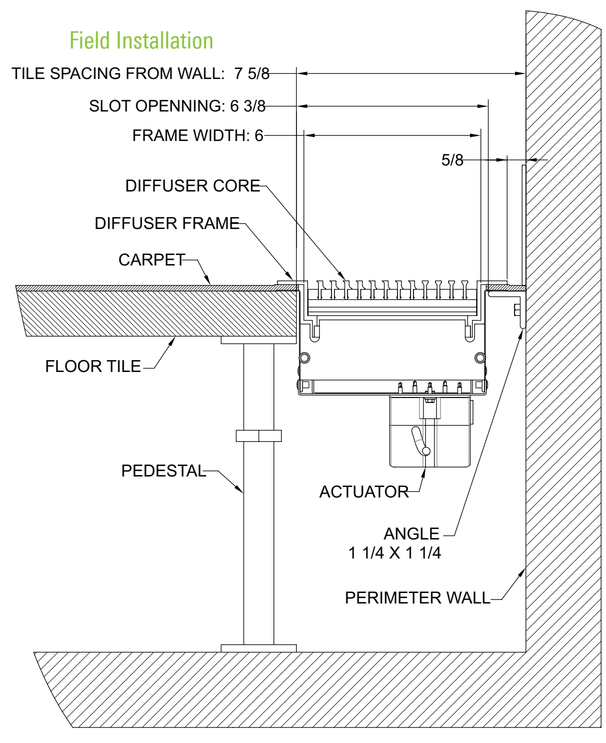


Cross section view of an installed TAF-L-V

TAF-L-V DIMENSIONS



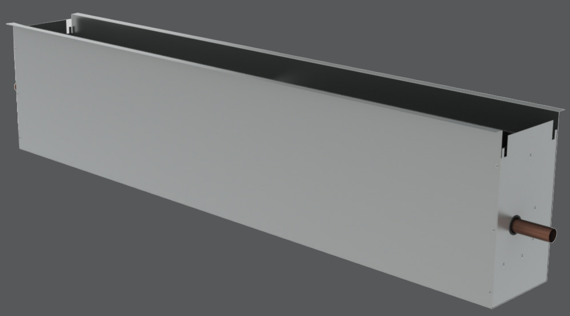




All dimensions are in inches

TAF–L–W

- Titus TAF-L-W is a fixed linear bar diffuser plenum for underfloor perimeter heating applications
- The TAF-L-W is designed to be integrated with the CT-TAF-L linear bar grille (see CT-TAF-L for more information)
- Installs into the CT-TAF-L from the top surface. Removal of the flooring is not required.
- The TAF-L-W return plenum drops into perimeter slot and sits on top of the raised floor tile (by others) and a perimeter angle
- The TAF-L-W has a fin tube heater assembly in the plenum
- The TAF-L-W has $2^1/_2$" of copper tubing extending beyond both sides of the plenum for system connections
- The TAF-L-W plenum is constructed of galvanized steel



TAF–L–W

energy solutions

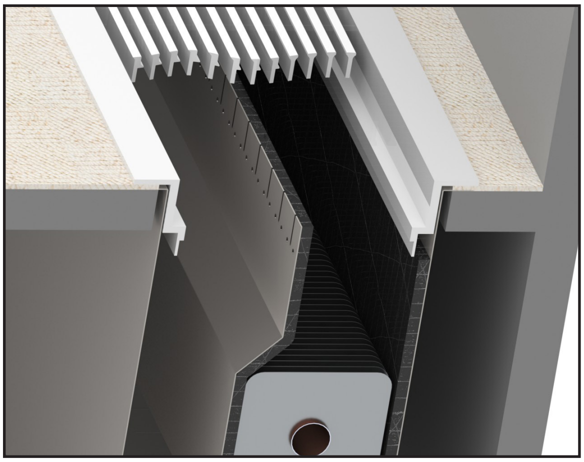
See website for Specifications

AVAILABLE MODEL:

TAF-L-W / Linear Diffuser Plenum with Fin-tube Heat

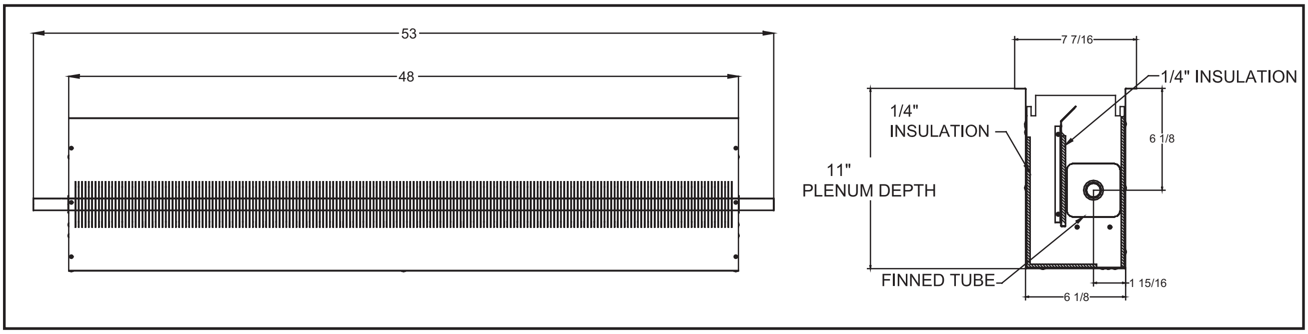
OVERVIEW

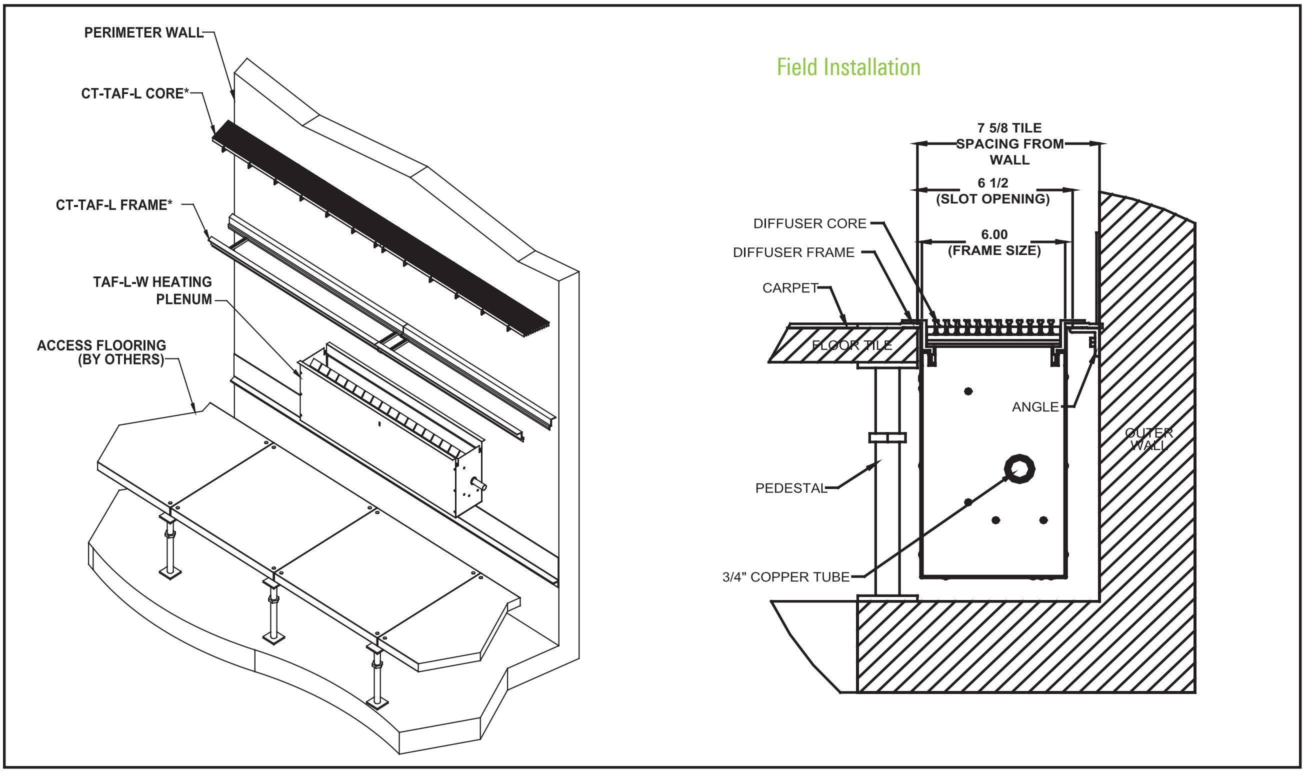
TAF-L-W is a fixed linear bar diffuser plenum for underfloor perimeter heating applications. The TAF-L-W's self-contained fin-tube heats the perimeter by utilizing the room air instead of the supply air. By allowing the denser cold air to flow into the TAF-L-W plenum while simultaneously inducing room air into the plenum, the TAF-L-W returns the warmer air to the window or exterior wall through natural convection. This product saves energy and can contribute toward LEED certification.



Cross section view of an installed TAF-L-W

TAF-L-W DIMENSIONS

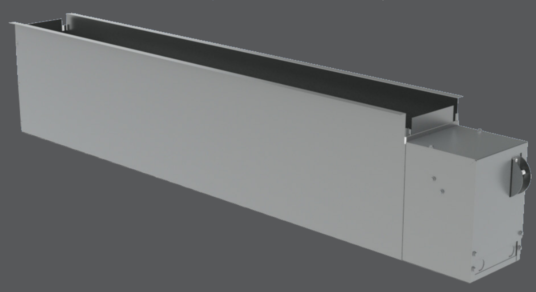




All dimensions are in inches

TAF-L-E

- Titus TAF-L-E is a fixed linear bar diffuser plenum for underfloor perimeter heating applications
- The TAF-L-E is designed to be integrated with the CT-TAF-L linear bar grille (see CT-TAF-L submittal for more information)
- Installs into the CT-TAF-L from the top surface. Removal of the flooring is not required.
- The TAF-L-E return plenum drops into perimeter slot and sits on top of the raised floor tile (by others) and a perimeter angle
- The TAF-L-E has an SCR electric heat fin tube assembly in the plenum
- The TAF-L-E plenum is constructed of galvanized steel
- ETL listed at 120V, 208V, 240V, 277V



TAF-L-E

energy solutions

See website for Specifications

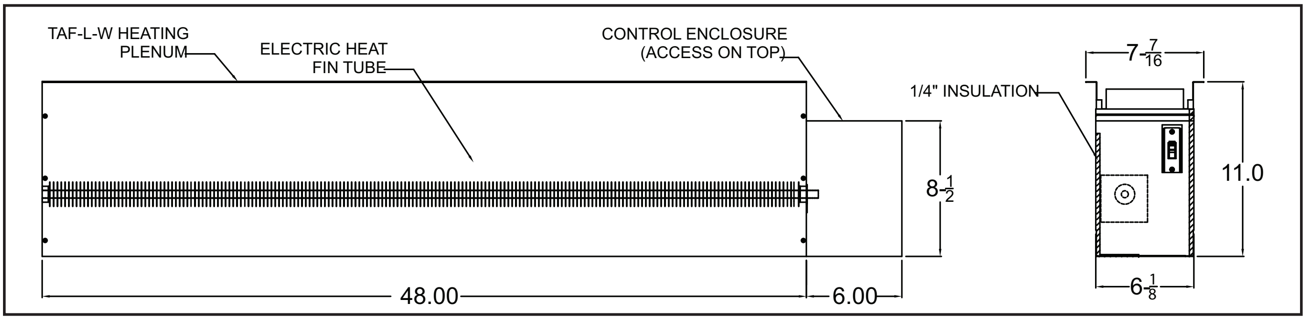
AVAILABLE MODEL:

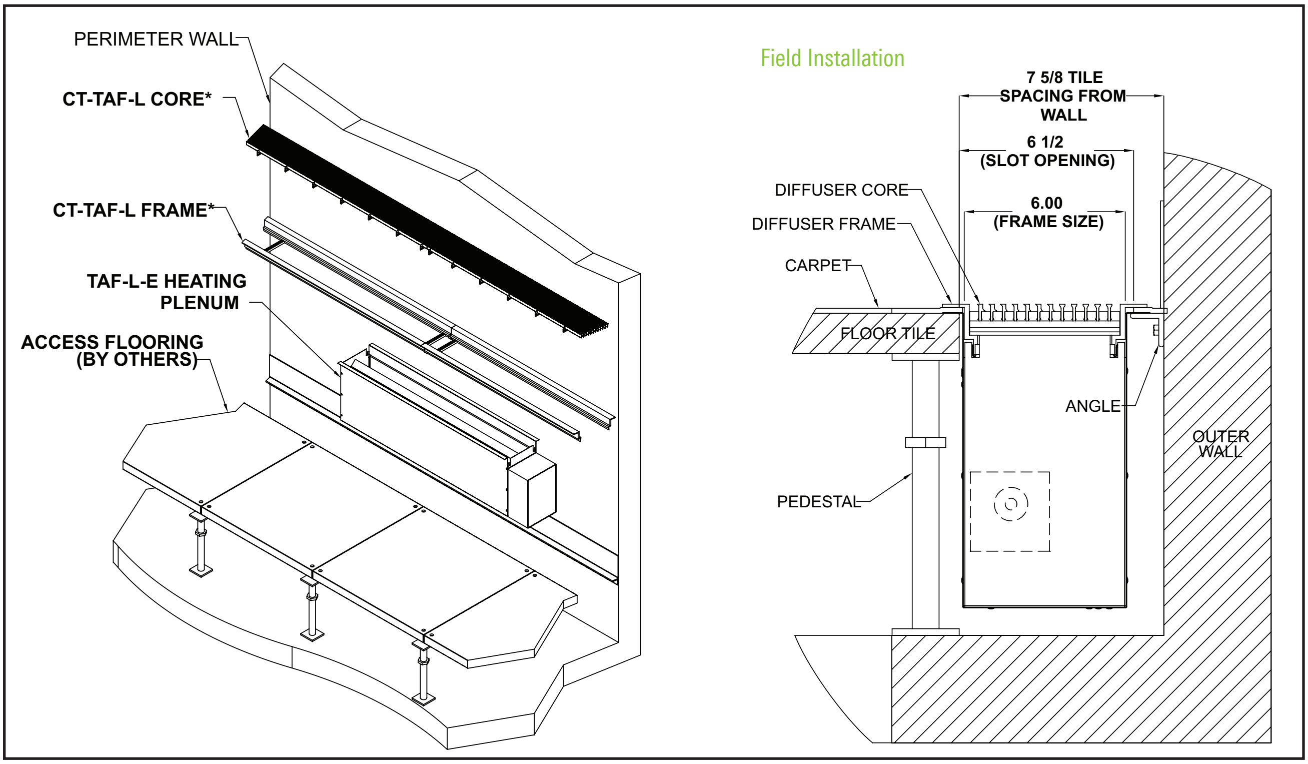
TAF-L-E / Linear Diffuser Heating Plenum with Fin-tube SCR Heat

OVERVIEW

The TAF-L-E is a fixed linear bar diffuser plenum constructed of galvanized steel for underfloor perimeter heating applications. The heating plenum drops into the perimeter slot and sits on top of the raised floor tile. The TAF-L-E has a SCR electric heat fin tube heating element. The unit is available at 120V, 208V, 240V, 277V, and has an ETL listing. This product saves energy and can contribute toward LEED certification.

TAF-L-E DIMENSIONS

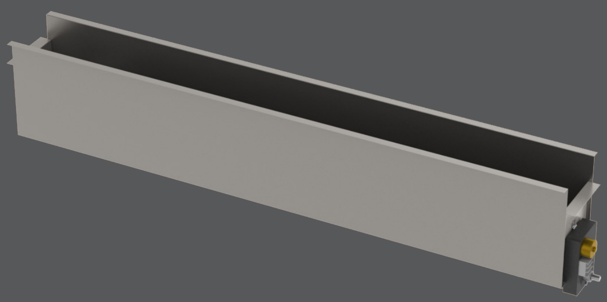




All dimensions are in inches

TAF-L-F

- Titus TAF-L-F is a fixed linear bar diffuser plenum for underfloor perimeter supply applications
- The TAF-L-F, when used with the CT-TAF-L is designed to provide a uniform throw pattern throughout its operating range, regardless of damper position
- Installs into the CT-TAF-L from the top surface. Removal of the flooring is not required.
- The TAF-L-F is designed to be integrated with the CT-TAF-L linear bar grille (see CT-TAF-L for more information)
- Damper design provides consistent air distribution across the full length of the TAF-L-F
- Optional 24VAC electric damper actuator may be supplied with the assembly
- The TAF-L-F plenum is constructed of galvanized steel



TAF-L-F

energy solutions

See website for Specifications

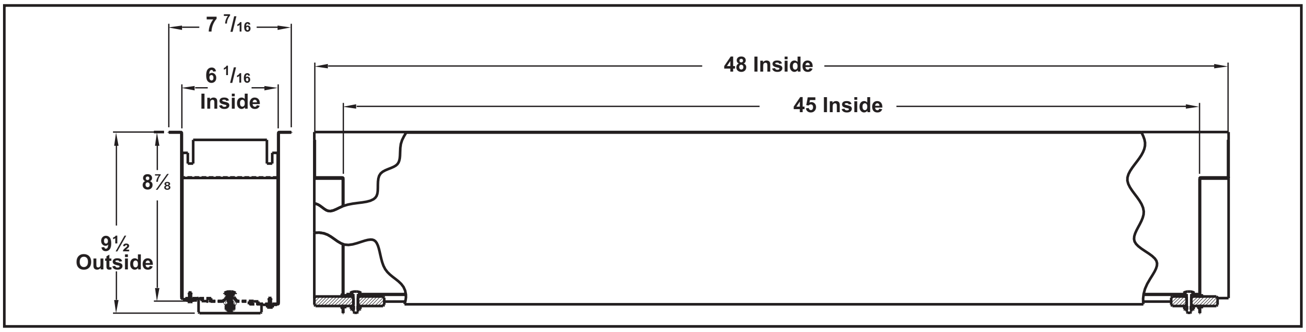
AVAILABLE MODEL:

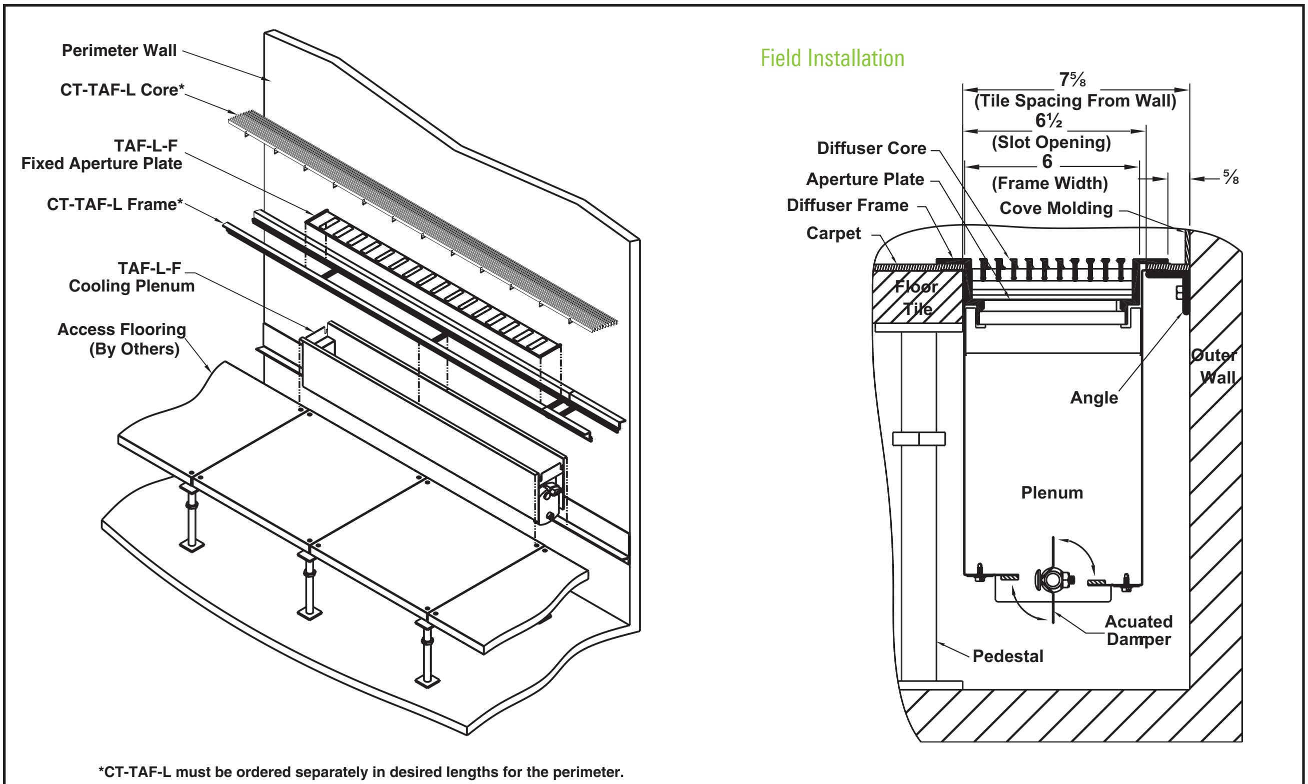
TAF-L-F / Linear Diffuser Plenum with Fixed Aperture Plate

OVERVIEW

The TAF-L-F is a fixed linear bar diffuser plenum constructed of galvanized steel for underfloor perimeter supply applications. The plenum drops into the perimeter slot and sits on top of the raised floor tile. This product saves energy and can contribute toward LEED certification.

TAF-L-F DIMENSIONS

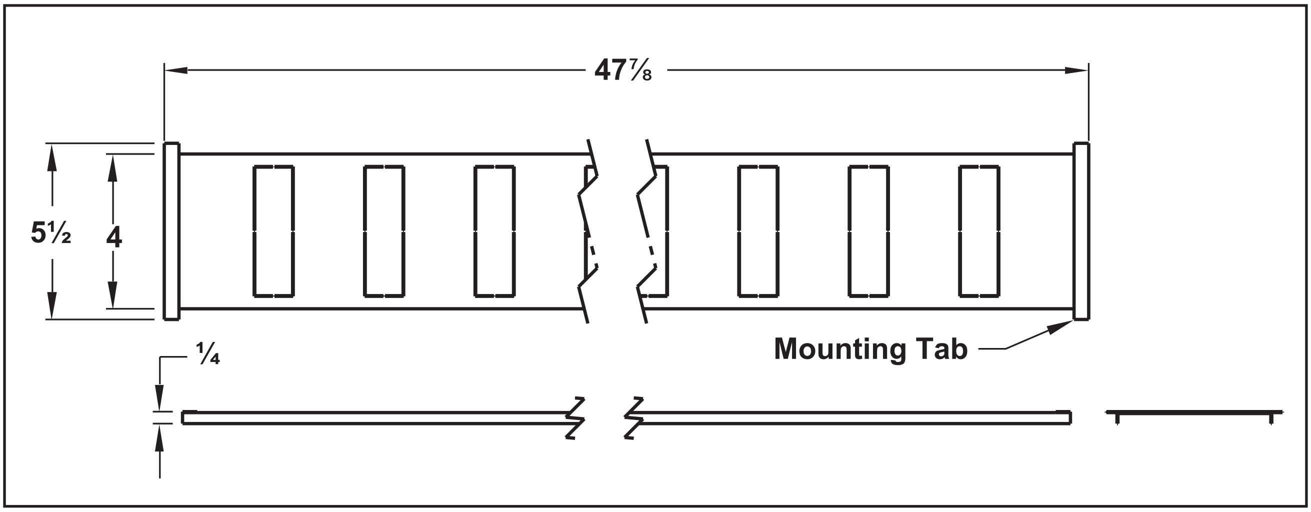




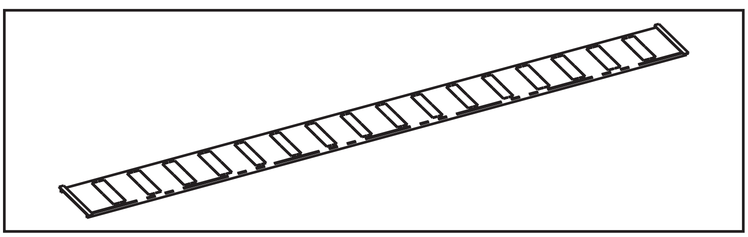
*CT-TAF-L must be ordered separately in desired lengths for the perimeter.

All dimensions are in inches

TAF-L-F DIMENSIONS

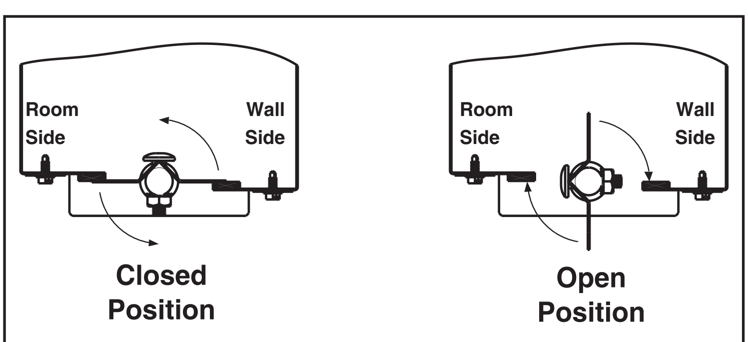


APERTURE PLATE



Flow Rate (cfm)	Total Open Apertures	Aperture Plate Pattern X = Closed, 0 = Open
115	8	X X X X 0 0 0 0 0 0 0 0 X X X X
120	8	X X X X 0 0 0 0 0 0 0 0 X X X X
130	10	X X X 0 0 0 0 0 0 0 0 0 0 X X X
160	12	X X 0 0 0 0 0 0 0 0 0 0 0 0 X X
180	12	X X 0 0 0 0 0 0 0 0 0 0 0 0 X X
185	14	X 0 0 0 0 0 0 0 0 0 0 0 0 0 0 X
190	14	X 0 0 0 0 0 0 0 0 0 0 0 0 0 0 X
215	16	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
225	16	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

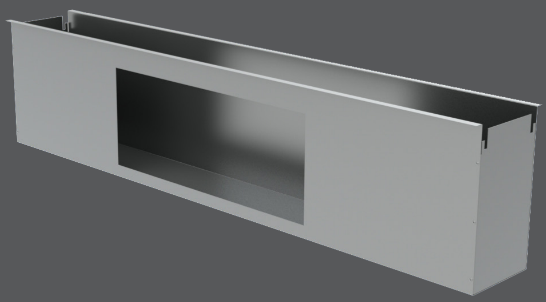
DAMPER POSITIONS



All dimensions are in inches

TAF-L-R

- Titus TAF-L-R is a fixed linear bar diffuser plenum for underfloor perimeter return applications
- The TAF-L-R is designed to be integrated with the CT-TAF-L linear bar grille (see CT-TAF-L for more information)
- Installs into the CT-TAF-L from the top surface. Removal of the flooring is not required.
- The TAF-L-R return plenum drops into perimeter slot and sits on top of the raised floor tile (by others) and a perimeter angle
- 20 x 8 inches inlet can be used for ducted or non-ducted applications
- The TAF-L-R plenum is constructed of galvanized steel



TAF-L-R

energy solutions

See website for Specifications

AVAILABLE MODEL:

TAF-L-R / Linear Diffuser Return Plenum

OVERVIEW

The TAF-L-R is a fixed linear bar diffuser plenum constructed of galvanized steel for underfloor perimeter return applications. The return plenum drops into the perimeter slot and sits on top of the raised floor tile. This product saves energy and can contribute toward LEED certification.

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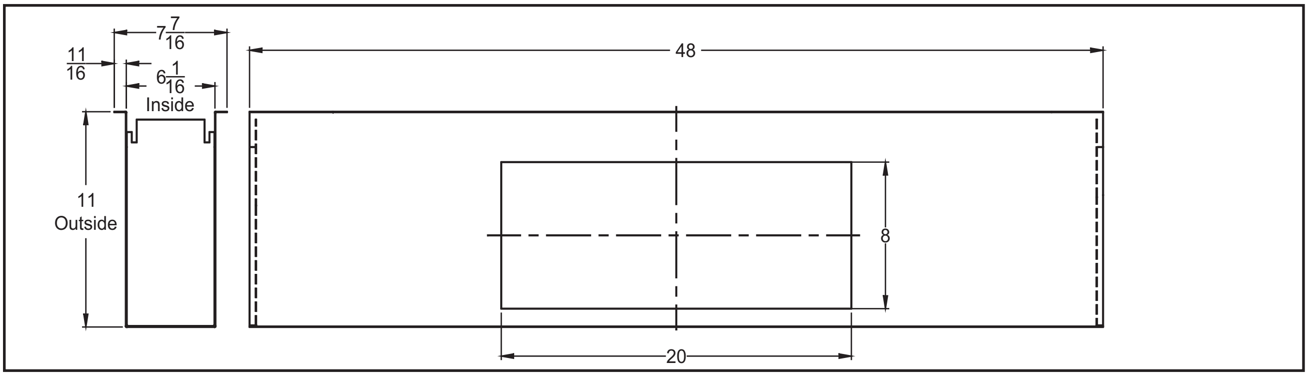
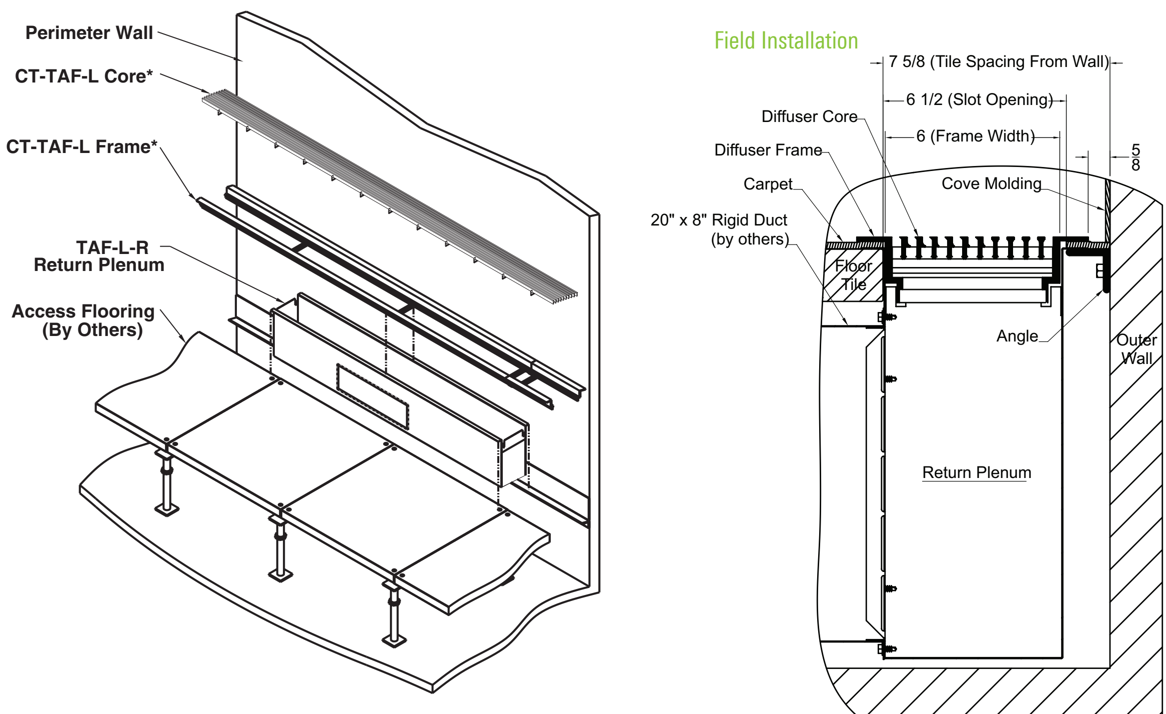
TAF-L-R DIMENSIONS



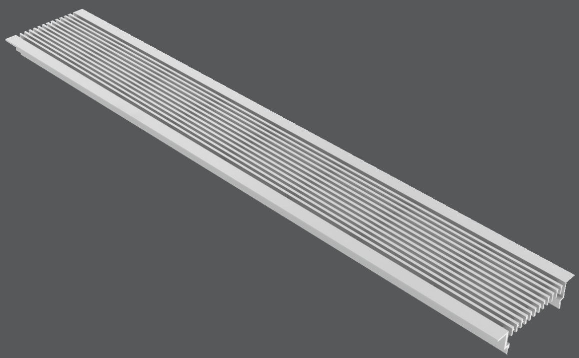


***CT-TAF-L must be ordered separately in desired lengths for the perimeter.**

All dimensions are in inches

CT-TAF-L

- Titus CT-TAF-L is a fixed linear bar diffuser for underfloor perimeter return applications
- The CT-TAF-L is designed to be integrated with the TAF-L-V, TAF-L-E, TAF-L-R, and TAF-L-W plenums (see TAF-L-V, TAF-L-E, and TAF-L-R, and TAF-L-W submittals for more information)
- CT frame drops into perimeter slot and sits on top of carpeting
- CT-TAF-L Core drops into frame
- Installs into the TAF-L plenums from the top surface. Removal of the flooring is not required.
- ½-inch may be cut from the end of the frame and core to fit perimeter (NEVER cut off the last core support or frame support)
- Sections can be joined end-to-end for continuous appearance, using alignment clips
- Standard lengths are 1, 2, 3, 4, 5 and 6 feet, furnished as complete, welded assemblies
- Lengths greater than 6 feet are furnished in multiple sections, the number and size determined by the factory



CT-TAF-L

- All deflection bars are fixed and are parallel to the long dimension
- Fixed Bars are extruded aluminum

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See website for Specifications

AVAILABLE MODEL:

CT-TAF-L / Perimeter Linear Bar Diffuser

FINISHES

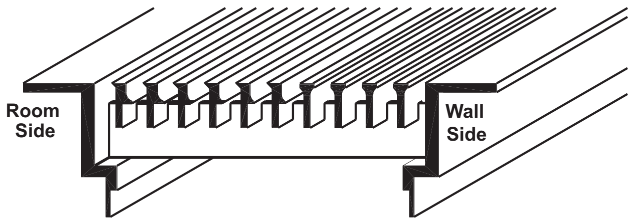
Standard Finish - #26 White
Optional Finish - Woodgrains (See Woodgrains Brochure for Finishes)

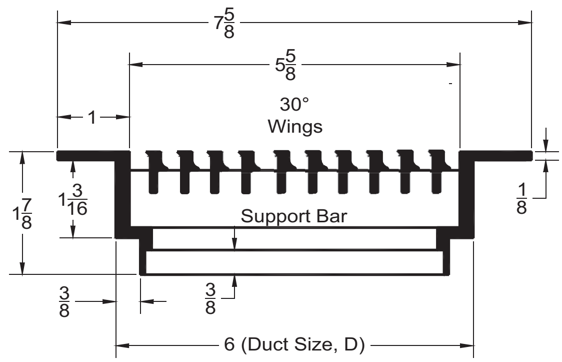
OVERVIEW

The Titus CT-TAF-L is a fixed linear bar diffuser for underfloor perimeter return applications. It is designed to be integrated with the TAF-L-V, TAF-L-E, TAF-L-R, and TAF-L-W plenums. The CT-TAF-L installs into the TAF-L plenums from the top surface. Removal of the flooring is not required. This product saves energy and can contribute toward LEED certification.

The CT-TAF-L is shown installed in a corporate office

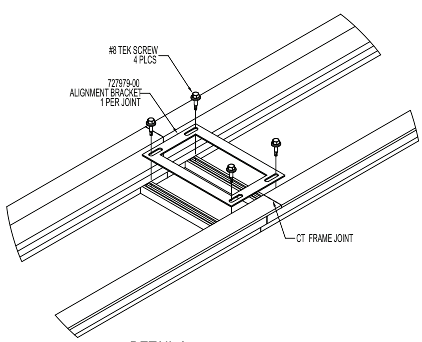
CT-TAF-L DIMENSIONS





CT-TAF-L is only available with Type 5 Heavy Duty CT Floor Frame. Diffuser core is a combination of CT-PP-0, CT-541, and CT-PP-3 Core (30° Deflection).

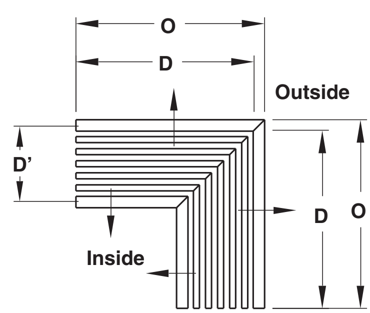
ALIGNMENT CLIP



DETAIL A

Alignment clip model AC-500 is sold separately in quantities of 500

MITER CORNER - MC-TAF-L



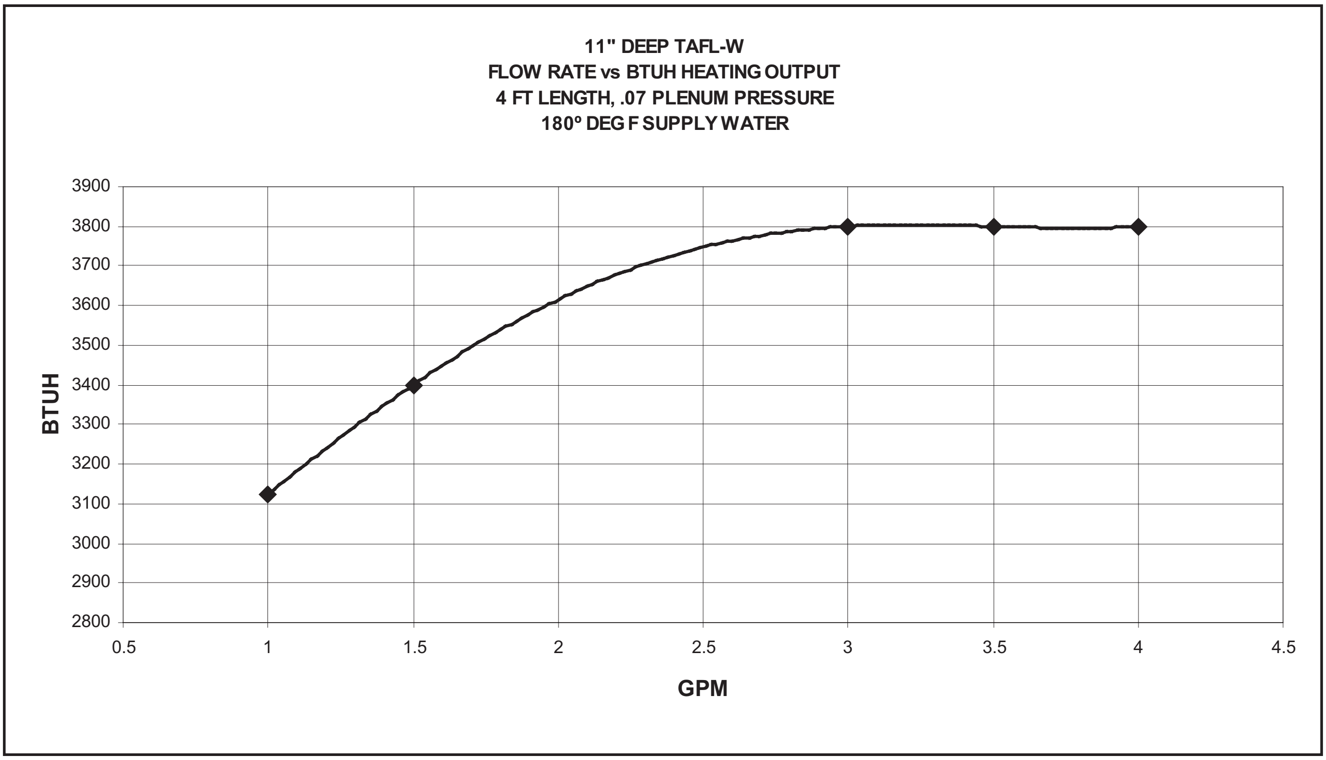
Duct Width D'	Duct Length D	O
6″	18	18 13/16

*Note: 0° deflection wings must be on wall side of frame when installed

For performance data, please refer to TAF-L-E, TAF-L-R, TAF-L-V, and TAF-L-W.

All dimensions are in inches

TAF-L-W



TAF-L-W

11" TAF-L-W 180 Degree Water Supply		
BTUH	Ps	GPM
2827	0.03	2
3499	0.05	2
3629	0.07	2
4083	0.09	2
2875	0.03	4
3383	0.05	4
3693	0.07	4
4183	0.09	4
2557	0.03	6
3218	0.05	6
3492	0.07	6
4018	0.09	6

11" TAF-L-W 160 Degree Water Supply		
BTUH	Ps	GPM
2252	0.03	2
2669	0.05	2
3023	0.07	2
3182	0.09	2
1994	0.03	4
2451	0.05	4
2912	0.07	4
3165	0.09	4
1645	0.03	6
1963	0.05	6
2623	0.07	6
2843	0.09	6

11" TAF-L-W 120 Degree Water Supply		
BTUH	Ps	GPM
896	0.03	2
1088	0.05	2
1264	0.07	2
1497	0.09	2
448	0.03	4
720	0.05	4
926	0.07	4
1268	0.09	4
30	0.03	6
259	0.05	6
532	0.07	6
765	0.09	6

TAF-L-R

Nominal Duct Size (in.)	Nominal Duct Area (ft²)	Core Area (ft²)	Core Velocity	300	400	500	600	700	800	900	1000
			Velocity Pressure	0.006	0.010	0.016	0.022	0.031	0.040	0.050	0.062
			Neg. Static Pressure	0.017	0.030	0.047	0.067	0.091	0.119	0.151	0.186
20 x 8	1.32	0.863	Air Flow, cfm	259	345	432	518	604	690	777	863
			NC	-	12	17	22	26	29	32	35

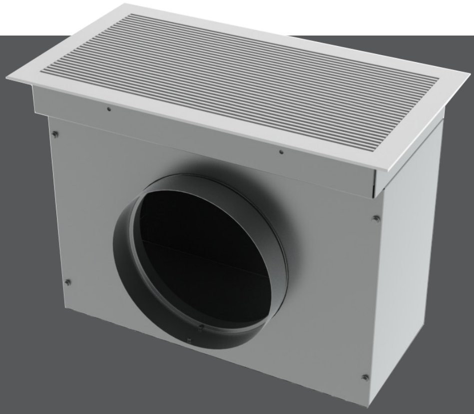
TAF-L-F

Number of Apertures Open		0.03	0.05	0.07	0.09	0.12	0.15
4	cfm	51	60	70	79	92	101
	NC	11	12	17	20	24	26
	Throw, ft 10° Delta	3-5-7	4-5-7	4-6-8	5-6-8	5-6-9	6-7-9
	Throw, ft 18° Delta	3-4-6	3-5-6	4-5-7	4-5-7	5-6-8	5-6-8
6	cfm	65	77	91	105	120	135
	NC	12	13	18	21	25	27
	Throw, ft 10° Delta	3-5-7	4-5-7	4-6-8	5-6-8	5-6-9	6-7-9
	Throw, ft 18° Delta	3-4-6	3-5-6	4-5-7	4-5-7	5-6-8	5-6-8
8	cfm	83	98	115	130	149	167
	NC	13	14	19	22	26	28
	Throw, ft 10° Delta	3-5-7	4-5-7	4-6-8	5-6-8	5-6-9	6-7-9
	Throw, ft 18° Delta	3-4-6	3-5-6	4-5-7	4-5-7	5-6-8	5-6-8
10	cfm	105	125	147	171	198	221
	NC	14	15	20	23	27	29
	Throw, ft 10° Delta	3-5-7	4-5-7	4-6-8	5-6-8	5-6-9	6-7-9
	Throw, ft 18° Delta	3-4-6	3-5-6	4-5-7	4-5-7	5-6-8	5-6-8
12	cfm	118	141	168	193	219	242
	NC	16	17	22	25	28	31
	Throw, ft 10° Delta	3-5-7	4-5-7	4-6-8	5-6-8	5-6-9	6-7-9
	Throw, ft 18° Delta	3-4-6	3-5-6	4-5-7	4-5-7	5-6-8	5-6-8
14	cfm	140	165	194	221	249	275
	NC	17	18	23	26	30	33
	Throw, ft 10° Delta	3-5-7	4-5-7	4-6-8	5-6-8	5-6-9	6-7-9
	Throw, ft 18° Delta	3-4-6	3-5-6	4-5-7	4-5-7	5-6-8	5-6-8
16	cfm	159	183	208	242	269	294
	NC	18	19	24	27	31	34
	Throw, ft 10° Delta	3-5-7	4-5-7	4-6-8	5-6-8	5-6-9	6-7-9
	Throw, ft 18° Delta	3-4-6	3-5-6	4-5-7	4-5-7	5-6-8	5-6-8

TAF-L-V

	UnderFloor Pressure, Inches WG	0.05	0.07	0.09
10°ΔT Aperture 25% Open	Airflow, cfm	128	140	157
	NC (Noise Criteria)	21	25	31
	Projection, ft, 150, 100, 50 fpm	2-3-4	3-4-6	4-5-7
10°ΔT Aperture 50%	Airflow, cfm	157	192	220
	NC (Noise Criteria)	25	30	33
	Projection, ft, 150, 100, 50 fpm	3-3-5	3-4-6	4-5-7
10°ΔT Aperture 75%	Airflow, cfm	200	237	271
	NC (Noise Criteria)	29	33	35
	Projection, ft, 150, 100, 50 fpm	3-4-6	3-5-7	4-5-8
10°ΔT Aperture 100%	Airflow, cfm	218	264	300
	NC (Noise Criteria)	30	34	36
	Projection, ft, 150, 100, 50 fpm	3-4-6	3-5-7	4-6-8

TAF-D



- Heavy gauge diffuser plenum designed for floor applications
- Heavy gauge steel plenum
- Installs into access flooring from top surface

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See website for Specifications

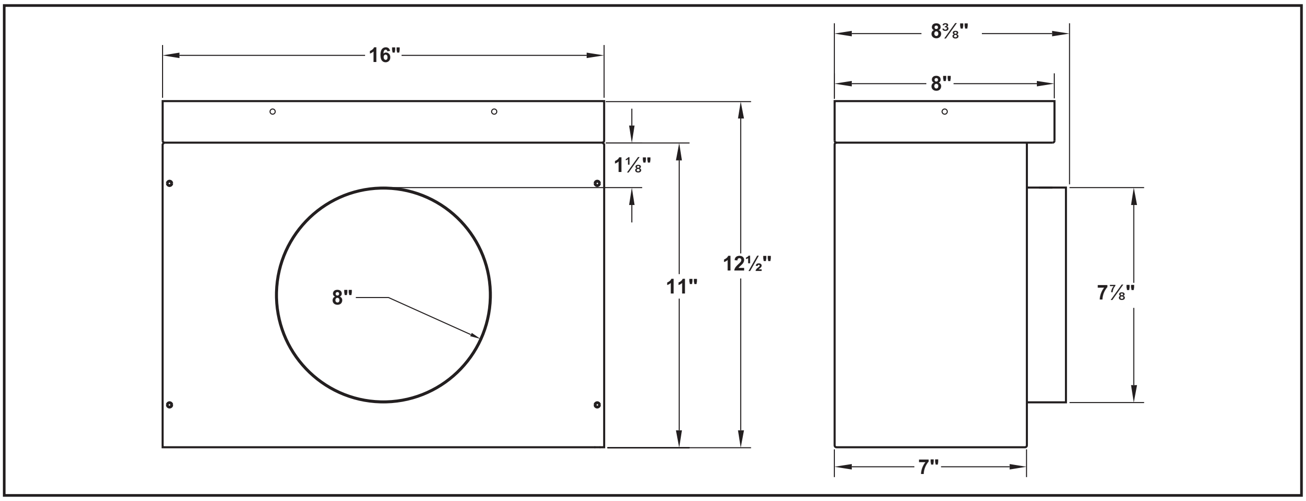
AVAILABLE MODEL:

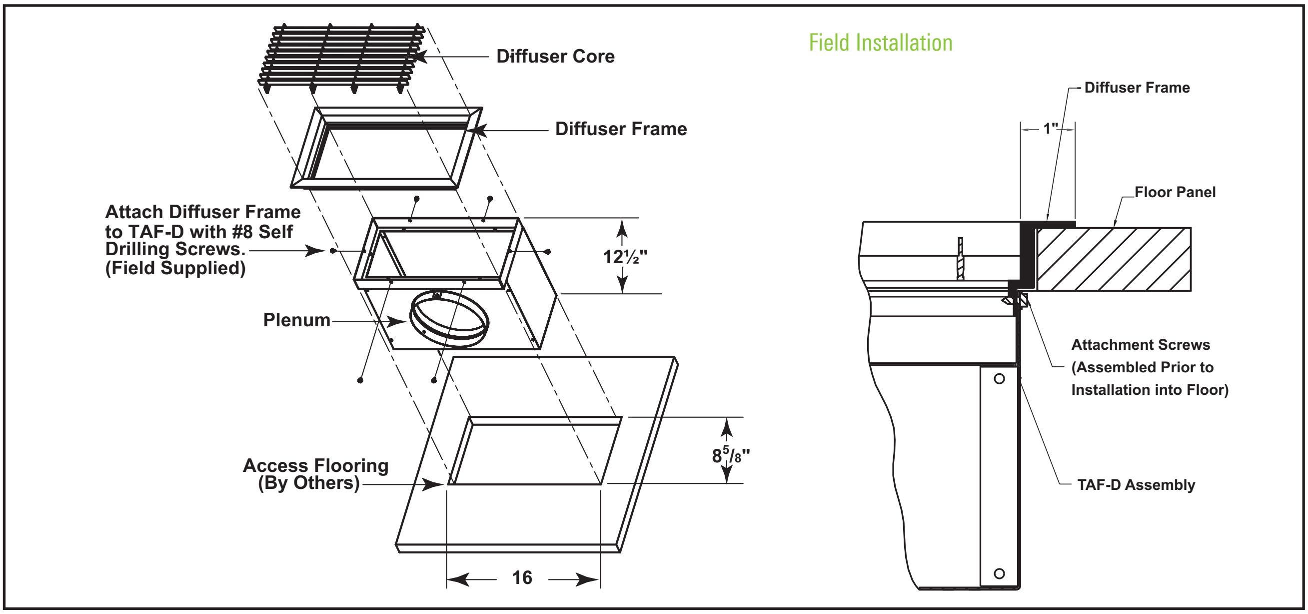
TAF-D / Diffuser Plenum with Inlet

OVERVIEW

The TAF-D ducted plenum is constructed of a heavy gauge steel and is designed for application in underfloor air distribution systems. It is used as a ducted supply or return unit. This product saves energy and can contribute toward LEED certification.

TAF-D DIMENSIONS



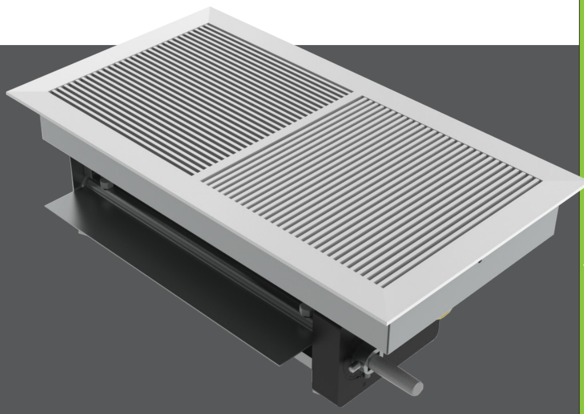


Note: CT-TAF diffuser and TAF-D are sold as separate units. The CT-TAF is available as a CT-TAF-480, CT-TAF-481, CT-TAF-PP0 and CT-TAF-PP3 in single or multiple core deflection patterns. See CT-TAF section for diffuser information.

All dimensions are in inches

TAF–V

- Designed for areas with frequent changes in heating loads. Provides variable air volume cooling only control for non-ducted applications.
- Tight close-off damper with optional 24 VAC electric actuator
- Heavy gauge diffuser plenum designed for floor applications
- Available with single or multiple diffuser cores
- Installs into access flooring from top surface



TAF–V

energy solutions

See website for Specifications

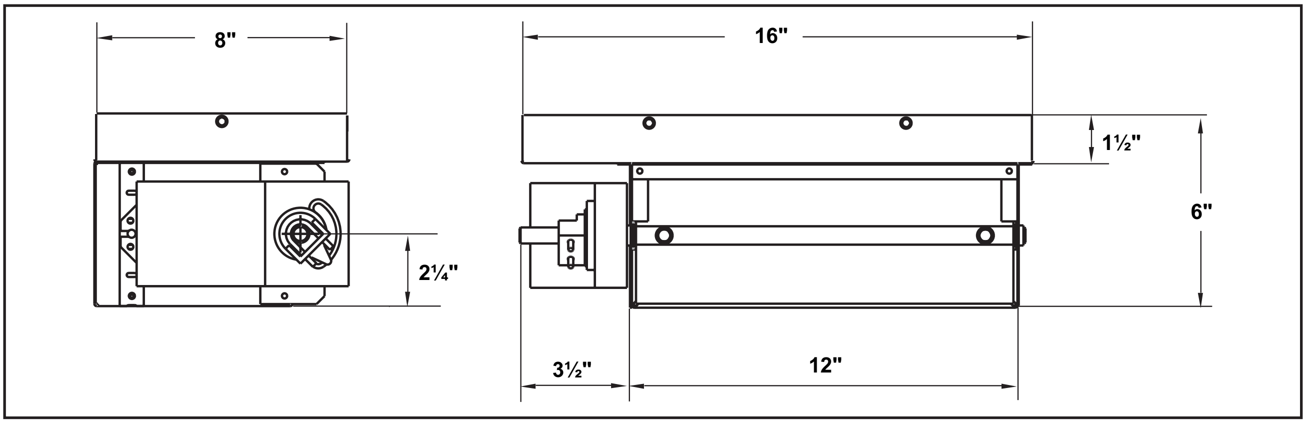
AVAILABLE MODEL:

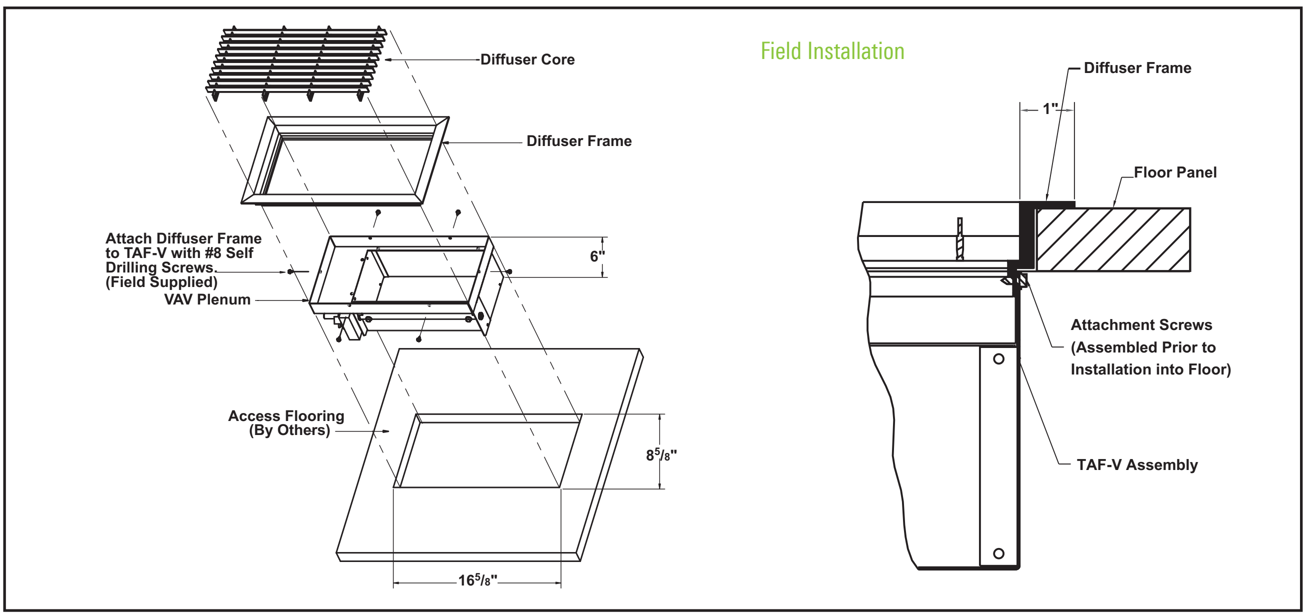
TAF-V / Variable Volume Diffuser Plenum

OVERVIEW

The TAF-V is a heavy gauge varible volume diffuser plenum designed for floor application in underfloor air distribution systems where frequent changes in heating loads occur. This product saves energy and can contribute toward LEED certification.

TAF-V DIMENSIONS

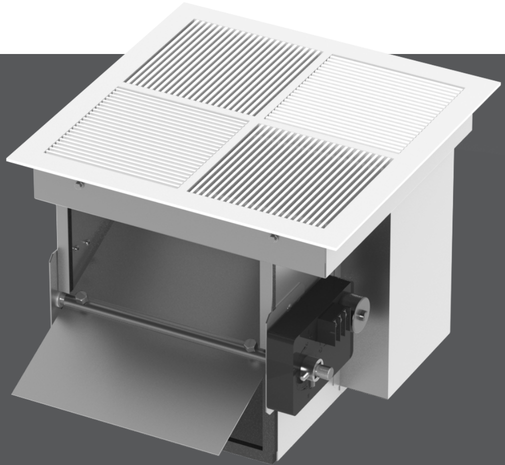




Note: CT-TAF diffuser and TAF-V are sold as separate units. The CT-TAF is available as a CT-TAF-480, CT-TAF-481, CT-TAF-PP0 and CT-TAF-PP3 in single or multiple core deflection patterns. See CT-TAF section for diffuser information.

TAF-V MULTI-4 PIECE

- Designed for areas with frequent changes in heating loads. Provides variable air volume cooling only control for non-ducted applications.
- Tight close-off damper with optional 24 VAC electric actuator
- Heavy gauge diffuser plenum designed for floor applications
- Available with single or multiple diffuser cores
- Installs into access flooring from top surface
- Diffuser cores are field adjustable
- Tight close off damper with optional 24VAC electric actuator



TAF-V MULTI-4 PIECE

energy solutions

See website for Specifications

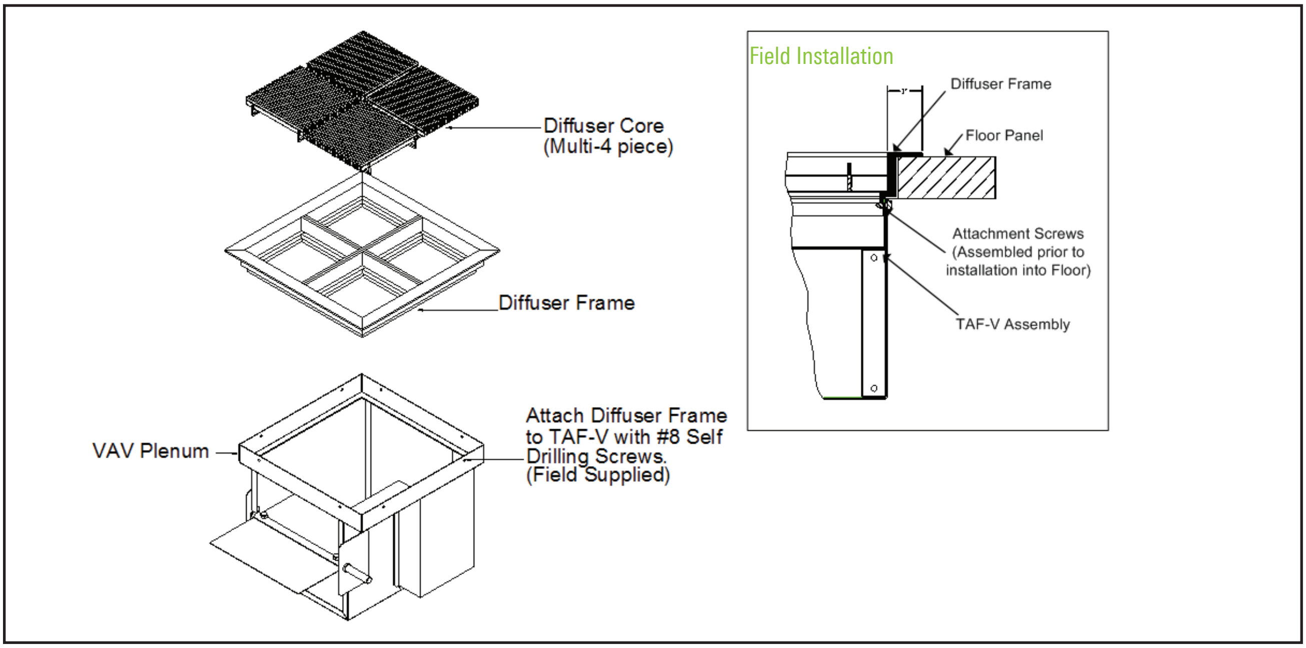
AVAILABLE MODEL:

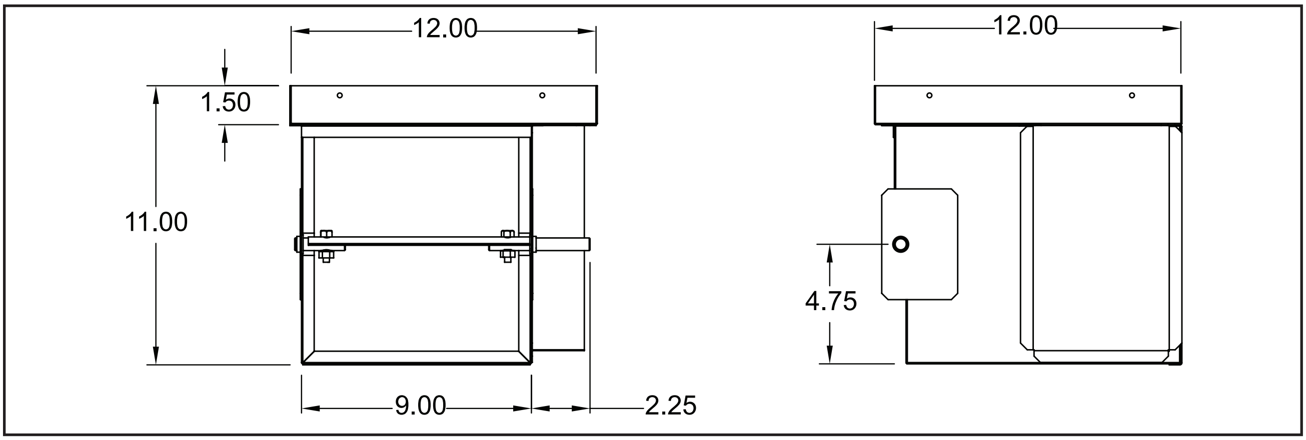
TAF-V Multi-4 Piece / Variable Volume Diffuser Plenum

OVERVIEW

The TAF-V is a heavy gauge varible volume diffuser plenum designed for floor application in underfloor air distribution systems where frequent changes in heating loads occur. This product saves energy and can contribute toward LEED certification.

TAF-V MULTI-4 PIECE DIMENSIONS



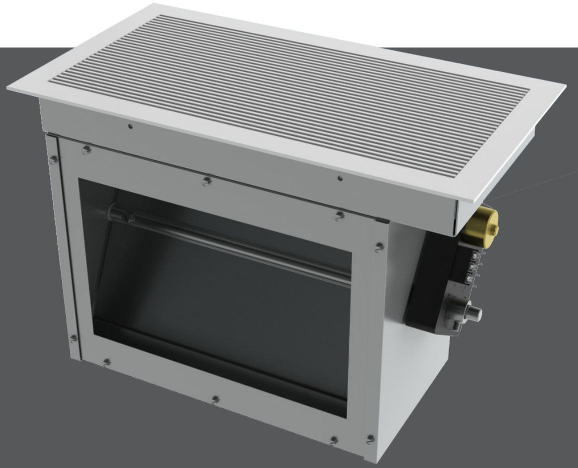


Note: CT-TAF diffuser and TAF-V are sold as separate units. The CT-TAF is available as a CT-TAF-480, CT-TAF-481, CT-TAF-PP0 and CT-TAF-PP3 in single or multiple core deflection patterns. See CT-TAF section for diffuser information.

All dimensions are in inches

TAF-HC

- The Titus model TAF-HC ducted plenum is designed for application in access floor air distribution systems for use as a ducted supply or return
- The TAF-HC delivers constant volume heating & VAV cooling within the same unit. It can be ducted for heating & provides variable air volume cooling control (from pressurized floor plenum).
- The TAF-HC plenum is constructed of a heavy gauge steel housing
- Diffuser core available in single or multi-piece configuration
- Installs into access flooring from top surface. Removal of flooring is not required.
- Optional 24 VAC actuator available


TAF-HC

See website for Specifications

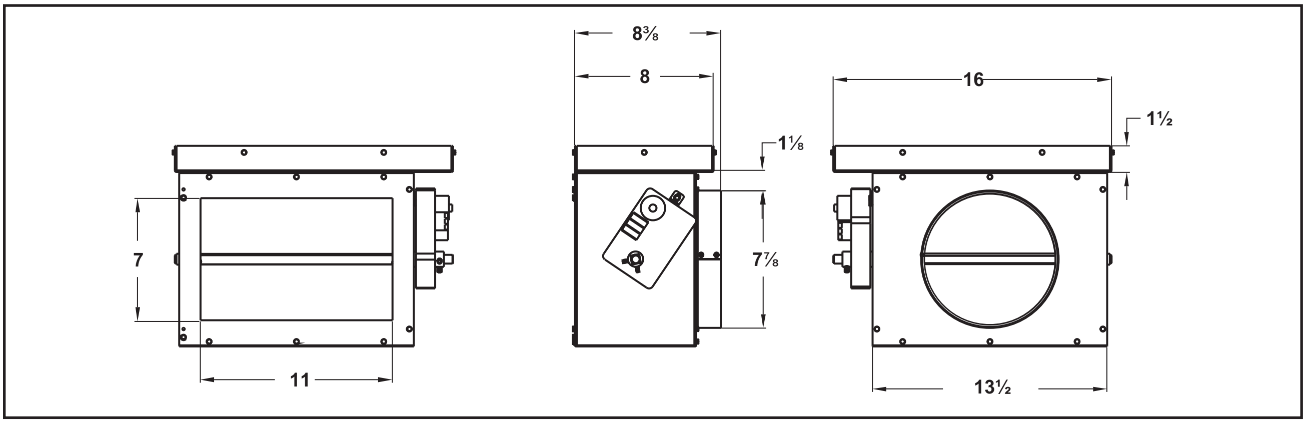
AVAILABLE MODEL:

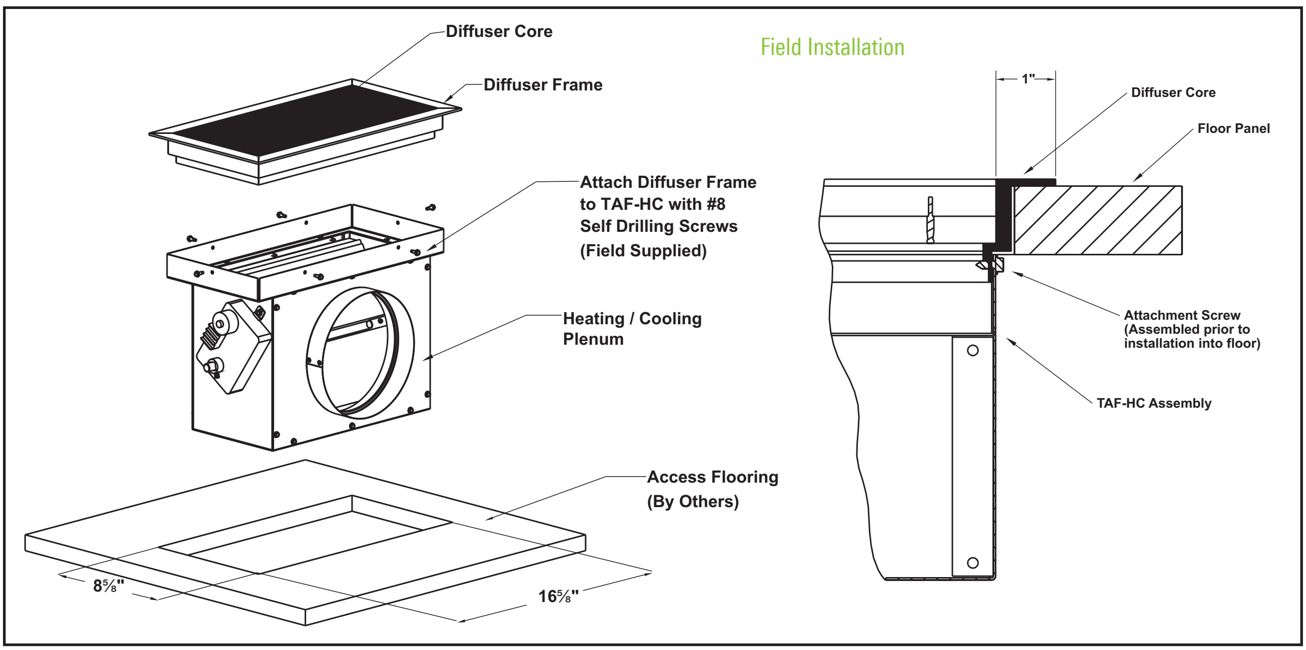
TAF-HC / Diffuser Heating & Cooling Plenum, Dual Inlet with Damper

OVERVIEW

The TAF-HC ducted plenum is constructed of a heavy gauge steel and is designed for application in underfloor air distribution systems. It is used as a ducted supply or return unit. This product saves energy and can contribute toward LEED certification.

TAF-HC DIMENSIONS





Note: CT-TAF diffuser and TAF-HC are sold as separate units. The CT-TAF is available as a CT-TAF-480, CT-TAF-481, CT-TAF-PP0 and CT-TAF-PP3 in single or multiple core deflection patterns. See CT-TAF section for diffuser information.

All dimensions are in inches

TAF-D 8" x 16"	Total Pressure	0.01	0.02	0.03	0.05	0.07	0.1	0.13	0.17	0.21
	cfm	97	123	151	188	214	259	296	338	373
	NC (Noise Criteria)	-	-	14	20	24	29	33	37	40
	Throw	9-11-16	10-12-18	11-14-19	13-15-22	13-16-23	15-18-25	16-19-27	17-20-29	18-22-30
TAF-V 8" x 16"	Total Pressure	0.01	0.02	0.03	0.05	0.07	0.1	0.13	0.17	0.21
	cfm	36	80	87	123	147	178	204	236	264
	NC (Noise Criteria)	-	-	-	-	13	18	23	27	30
	Throw	3-5-9	7-10-14	8-10-15	10-12-18	11-13-19	12-15-21	13-16-21	14-17-24	15-18-26
TAF-HC 8" x 16"	Total Pressure	0.01	0.02	0.03	0.05	0.07	0.1	0.13	0.17	0.21
	cfm	97	123	151	188	214	259	296	338	373
	NC (Noise Criteria)	-	-	14	20	24	29	33	37	40
	Throw	9-11-16	10-12-18	11-14-19	13-15-22	13-16-23	15-18-25	16-19-27	17-20-29	18-22-30

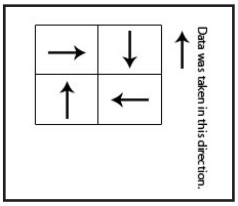
Data is based on CT-480

PERFORMANCE NOTES

- The throw values are for vertical jet, blowing upwards from the floor for terminal velocities of 50, 100, & 150 FPM
- The throw values are for 10°F ΔT cooling between the suppy and average occupied room temperature
- All data is with the damper in the full open position
- NC values are based on a room absorption of 10bB
- Data obtained per ASHRAE Standard 70-2006 and ANSI 51.51 procedures
- Dash (-) in space denotes NC level less than 10

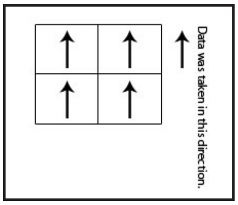
TAF-V: 4-WAY

Core Direction	Total Pressure	0.02	0.035	0.06
Inward	Velocity, fpm	214	321	427
	Airflow CFM	100	150	200
	Vertical Throw Up, ft.	2-4-6	4-5-8	5-6-9



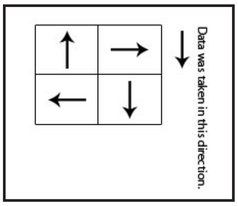
Inlet size

Core Direction	Total Pressure	0.02	0.035	0.06
One-way	Velocity, fpm	214	321	427
	Airflow CFM	100	150	200
	Vertical Throw Up, ft.	2-4-6	4-5-7	5-6-8



Inlet size

Core Direction	Total Pressure	0.02	0.035	0.06
Outward	Velocity, fpm	214	321	427
	Airflow CFM	100	150	200
	Vertical Throw Up, ft.	1-3-5	3-4-6	4-5-7

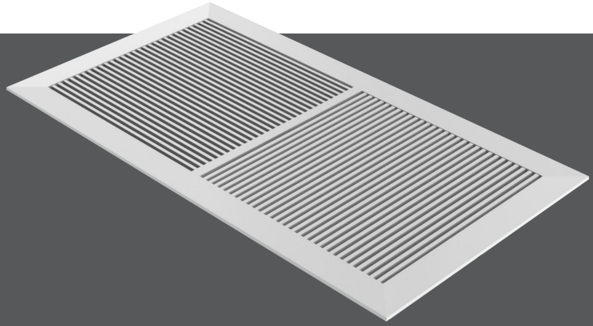


Inlet size

Data is based on CT-480-PP3

CT-TAF

- Titus CT-TAF diffusers are fixed linear bar diffuser for underfloor applications
- The CT-TAF is designed to be integrated with the TAF-HC, TAF-V and TAF-D plenums (see TAF-HC, TAF-V and TAF-D for more information)
- CT-TAF frame drops into plenum opening and sits on top of carpeting
- All deflection bars are fixed and are parallel to the long dimension
- Fixed Bars are extruded aluminum
- CT-TAF diffuser cores are available in single, dual & quad core configurations



CT-TAF

woodgrains energy solutions

See website for Specifications

AVAILABLE MODELS:

CT-TAF-480 / ¼" Spacing / 1/8" Bars / 0° Deflection
CT-TAF-481 / ¼" Spacing / 1/8" Bars / 15° Deflection
CT-TAF-PP0 / 7/16" Spacing / 7/32" Bars / 0° Deflection
CT-TAF-PP3 / 7/16" Spacing / 7/32" Bars / 30° Deflection

FINISHES

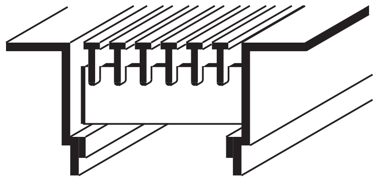
Standard Finish - #26 White
Optional Finish - Woodgrains (See Woodgrains Brochure for Finishes)

OVERVIEW

Titus CT-TAF diffusers are fixed linear bar diffuser for underfloor applications. The CT-TAF is designed to be integrated with the TAF-HC, TAF-V, and TAF-D plenums.

Titus
Redefine your comfort zone.™

CT-TAF DIMENSIONS

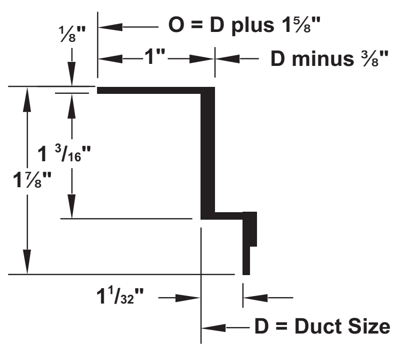


Type 5 heavy duty mounting frame is shown

CT-TAF diffusers are designed to fit the dimensions of the TAF-HC, TAF-V and TAF-D plenums. See TAF-HC, TAF-V and TAF-D submittals for information on required hole size for access floor tile.

Dim 1 Length	Dim 2 Length
15 ¾"	7 ¾"

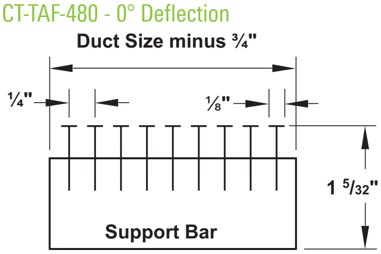
Removable core is furnished with frame



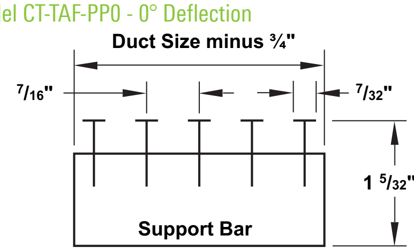
CORE SELECTIONS

¼" Spacing	7/16" Spacing
1/8" Bars	7/32" Bars

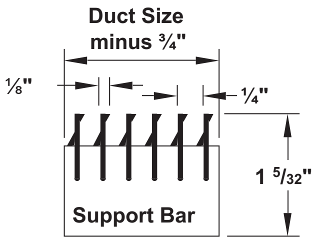
Model CT-TAF-480 - 0° Deflection



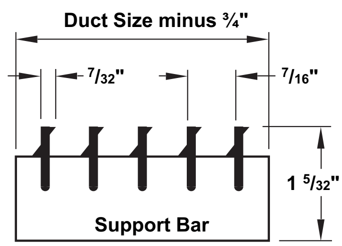
Model CT-TAF-PP0 - 0° Deflection



Model CT-TAF-481 - 15° Deflection



Model CT-TAF-PP3 - 30° Deflection

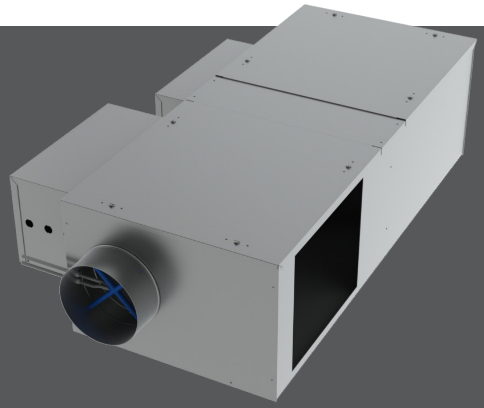


For Performance Data, please refer to TAF-D, TAF-V, TAF-HC.

All dimensions are in inches

LHK

- Designed to be installed in the underfloor plenum of an access floor grid system
- Heavy steel casing, with leak resistant construction
- Dual density insulation, coated to prevent erosion, meets requirements of NFPA 90A and UL 181
- Top access panels can be removed for service of damper, blower or filter sections
- Energy efficient fan motor, permanent split capacitor type, mounted in vibration isolators
- Ultra-high efficiency ECM motor available
- Adjustable SCR fan speed control, with minimum voltage stop
- Pressure independent primary airflow control
- Single point electrical connections
- Rectangular discharge opening is designed for flanged duct connections
- Optional ultra-high efficiency ECM motor available



LHK

- AeroCross™ multi-point velocity sensor with center averaging

energy solutions

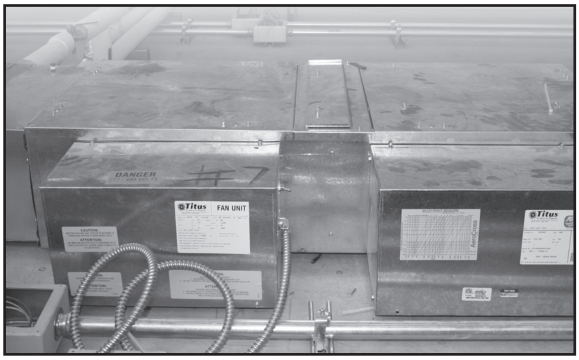
See website for Specifications

AVAILABLE MODELS:

ALHK / Analog Control
DLHK / Digital Control

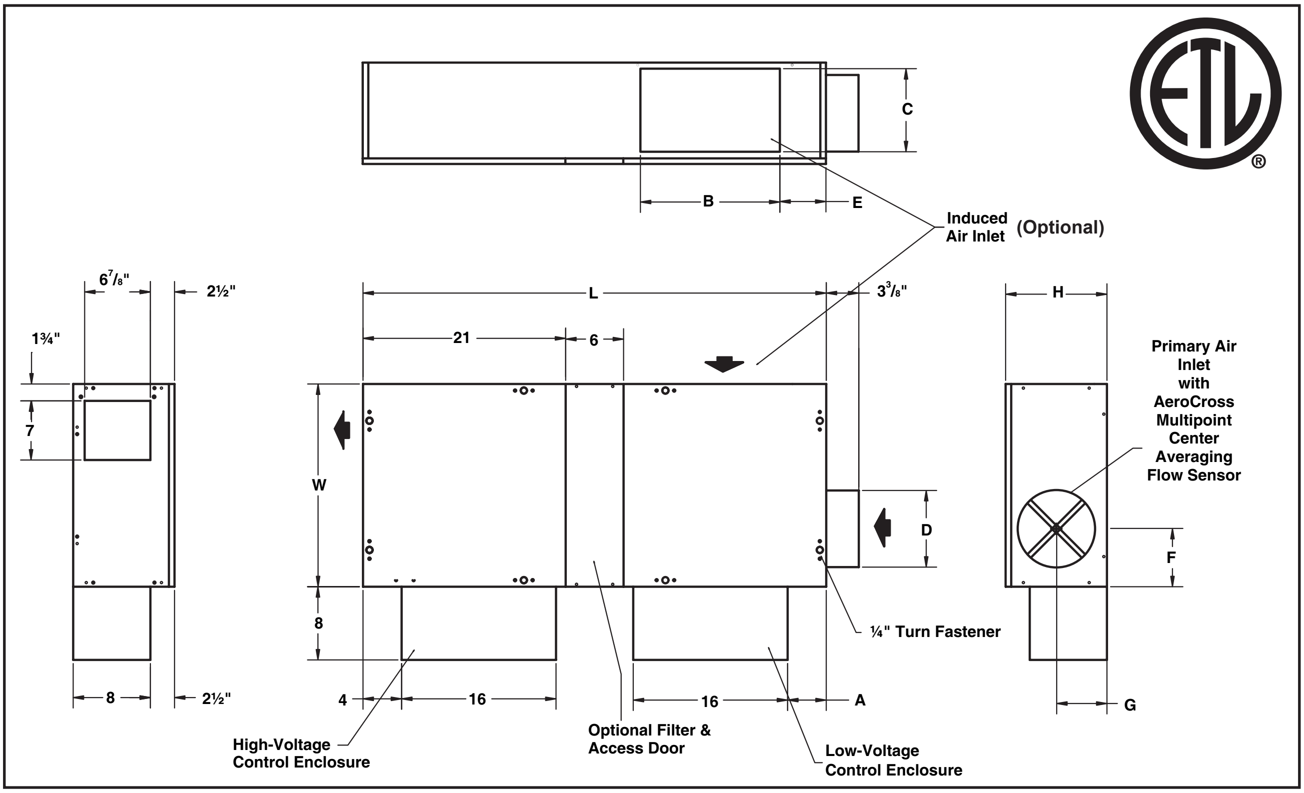
OVERVIEW

The LHK UnderFloor Fan Powered Terminal Unit is designed to be installed in the underfloor plenum of an access floor grid system. Constructed of a heavy steel casing that is leak resistant, the LHK contains an energy efficient fan motor. Like the PFC, the LHK fits within the modular pedestal systems of the raised floor and is available in various heights to fit under 12" through 18" raised floors. This product saves energy and can contribute toward LEED certification.



LHK terminal unit installed in an underfloor application

LHK DIMENSIONS



Unit Size	Inlet Size	A	B	C	D	E	F	G	H	L	T	W	Filter Size
3	9" Diameter	5	14	8	8	3½	5	7	10½	48	10	21	18 x 10
4	9" Diameter	5	14	12	8	3	5	7	14	48	13½	21	18 x 14
	10" Diameter				9		6						

All dimensions are in inches

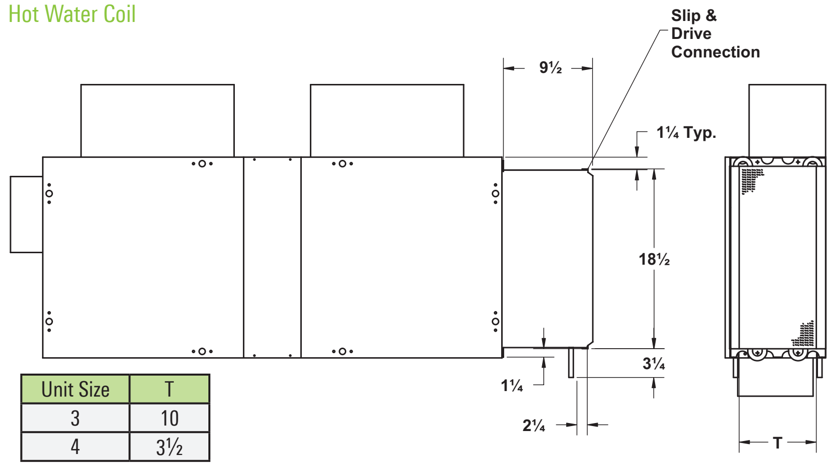
HOT WATER COIL SECTION

STANDARD FEATURES

- ½-inch copper tubes
- Aluminum ripple fins
- Connections: Male solder
  ⅝-inch for 1-row and ⅞"-2row
  Left or right hand connections
- Galvanized steel casing
- Slip & drive
- Coil is installed at discharge of unit

COIL ROWS

1-Row
2-Row



Unit Size	T
3	10
4	3½

ELECTRIC COIL SECTION

STANDARD FEATURES

- Auto reset thermal cutouts (one per element)
- 80/20 Nickel chrome heating elements
- Airflow safety switch
- Line terminal block (277/1ø, 208/240/3ø, or 480/3ø 4 wire)
- Flanged connection
- Control transformer for DDC or Analog electronic controls
- Fan relay for DDC fan terminals
- Magnetic contactor per step on terminals with DDC or analog electronic controls

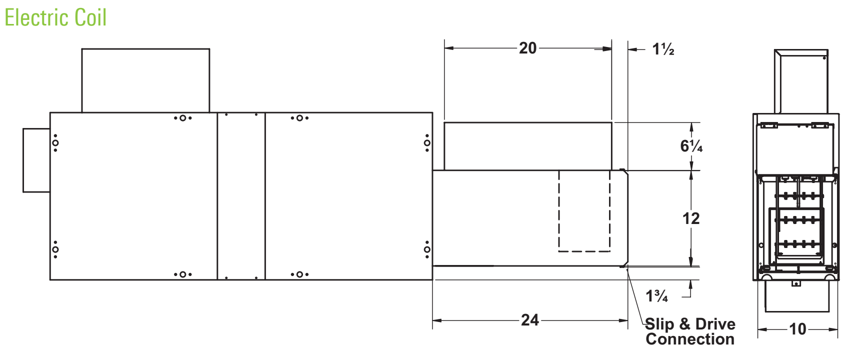
OPTIONS

- Mercury contactor
- Fuse block
- Disconnect switch, door interlock type
- Manual reset cutout
- Dust tight construction
- Optional Lynergy Comfort Controlled SSR Electric Heat

SUPPLY VOLTAGE

- 208 V, 1 ph, 60 Hz
- 240 V, 1 ph, 60 Hz
- 277 V, 1 ph, 60 Hz
- 208 V, 3 ph, 60 Hz
- 480 V, 3 ph, 60 Hz (4 wire wye only)

See Electric Heating Coils in Section O for more information



ADDITIONAL ACCESSORIES

(OPTIONAL)

- Induced air filter, 1-inch thick, disposable construction type
- Fan disconnect switch (not available on units with optional electric coils)
- Fan unit fusing
- Foil face Liner (½")
- Fibre-free Liner (½")
- EcoShield (½")

Electrical Data

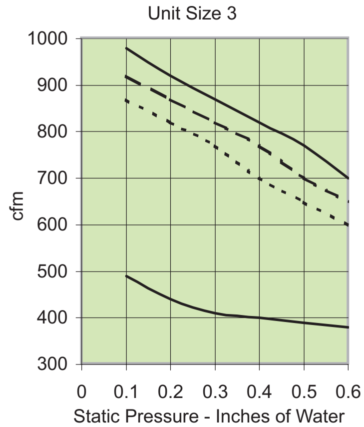
Unit Size	Motor HP	Motor Amperage Ratings		
		120/1/60 FLA	208/240/1/60 FLA	277/1/60 FLA
3	¼	5.8	2.5	1.8
4	⅓	6.4	3.0	2.5

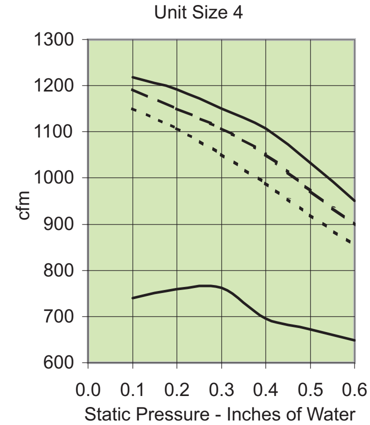
ECM Electrical Data

Unit Size	Motor HP	120V	208V	240V	277V
3	⅓	5.0	3.3	2.8	2.6
4	⅓	5.0	3.3	2.8	2.6

All dimensions are in inches

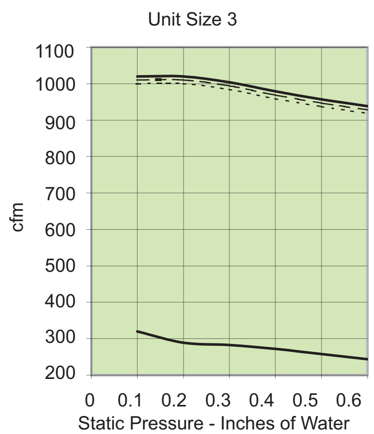
LHK FAN CURVES

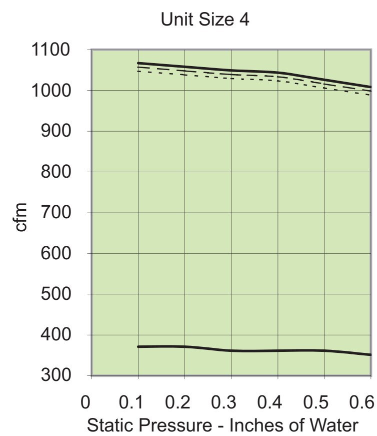




No Coil or with Electric Coil
1-Row Water Coil
2-Row Water Coil

LHK ECM FAN CURVES





WATER COIL HEATING CAPACITY (MBH)

Unit Size	Rows	gpm	Head Loss	Airflow, cfm						
				380	450	520	660	730	800	870
3	One-Row	0.5	0.22	11.0	11.7	12.2	13.1	13.4	13.7	14.0
		1.0	0.83	13.3	14.3	15.2	16.6	17.1	17.7	18.2
		2.0	3.16	14.9	16.2	17.2	19.1	19.9	20.7	21.3
		4.0	12.05	15.9	17.3	18.6	20.7	61.7	22.6	23.4
		Airside ΔPs		0.03	0.04	0.05	0.08	0.10	0.11	0.13
	Two-Row	1.0	0.22	19.6	21.2	22.5	24.5	25.4	26.2	26.9
		2.0	0.83	23.1	25.3	27.2	30.5	31.9	33.2	34.3
		3.0	1.81	24.6	27.1	29.3	33.2	34.8	36.4	37.8
		4.0	3.15	25.4	28.1	30.5	34.7	36.6	38.3	39.8
		Airside ΔPs		0.07	0.09	0.12	0.18	0.21	0.25	0.28

Unit Size	Rows	gpm	Head Loss	Airflow, cfm						
				650	730	800	870	950	1010	1100
4	One-Row	0.5	0.22	13.1	13.4	13.7	14.0	14.3	14.5	14.8
		1.0	0.83	16.6	17.1	17.7	18.2	18.7	19.0	19.5
		2.0	3.16	19.1	19.9	20.7	21.3	22.1	22.6	23.3
		4.0	12.05	20.7	61.7	22.6	23.4	24.3	24.9	25.8
		Airside ΔPs		0.08	0.10	0.11	0.13	0.15	0.17	0.20
	Two-Row	1.0	0.22	24.5	25.4	26.2	26.9	27.6	28.1	28.8
		2.0	0.83	30.5	31.9	33.2	34.3	35.6	36.4	37.6
		3.0	1.81	33.2	34.8	36.4	37.8	39.3	40.4	41.9
		4.0	3.15	34.7	36.6	38.3	39.8	41.5	42.7	44.4
		Airside ΔPs		0.18	0.21	0.25	0.28	0.33	0.36	0.42

- Hot Water capacities are in MBH
- Data based on 180°F entering water and 65°F entering air
- Head loss is in feet of water
- Air temperature rise = 927 x MBH / cfm
- Water temperature drop = 2.04 x MBH / gpm
- Connection: All coils are ½-inch O.D. male solder

ALHK, DLHK / SOUND APPLICATION DATA / NC VALUES

Unit Size	Inlet Size	cfm	Min. ΔPs	Noise Criteria (NC)							
				Radiated				Discharge			
				Fan Only	ΔPs			Fan Only	ΔPs		
					0.5″	1.0″	3.0″		0.5″	1.0″	3.0″
3	9	500	0.09	-	-	-	21	-	-	-	-
		700	0.18	-	-	21	25	24	24	24	26
		800	0.23	-	21	23	27	27	29	29	29
		900	0.29	-	22	25	29	30	32	32	32
4	10	700	0.09	-	22	26	33	-	25	27	29
		900	0.14	-	26	30	37	27	31	32	35
		1000	0.18	20	27	31	38	30	34	35	37
		1100	0.22	22	28	32	39	33	36	37	40
		1200	0.26	24	30	34	40	35	38	39	42

Radiated Sound	Octave Bands						
	2	3	4	5	6	7	
Environmental Effect	2	1	0	0	0	0	Per AHRI 885-98
Ceiling/Space Effect	29	33	33	35	35	36	Assumed effect for Double Gypsum Board roughly equal to access floor tile
Total dB reduction	31	34	33	35	35	36	

Discharge Sound	Octave Bands						
	2	3	4	5	6	7	
Environmental Effect	2	1	0	0	0	0	Per AHRI 885-98
Duct Lining	2	6	12	25	29	18	Flex Duct - Vinyl Core Flex
End Reflection	9	5	2	0	0	0	End Reflection - 8-inch Termination to Diffuser
Flex Duct	6	10	18	20	21	12	Fiberglass Flex Duct - 5-foot length, 1-inch duct work
Space Effect	5	6	7	8	9	10	Room Size - 2400 Cubic foot Room, 5 feet from sound source
Total dB reduction	24	28	39	53	59	40	

The following dB adjustments are used, per AHRI 885-98 for the calculation of NC above 300 cfm

	Octave Bands					
	2	3	4	5	6	7
300-700 cfm	2	1	1	-2	-5	-1
Over 700 cfm	4	3	2	-2	-7	-1

ALHK, DLHK / RADIATED SOUND POWER DATA

CFM	Discharge Ps	Min ΔPs	Octave Band Sound Power, Lw																											
			Fan Only							0.5" ΔPs							1.0" ΔPs							1.5″ ΔPs						
			2	3	4	5	6	7	NC	2	3	4	5	6	7	NC	2	3	4	5	6	7	NC	2	3	4	5	6	7	NC
500	0.25	0.09	68	51	50	47	38	26	**15**	68	54	50	47	41	31	**15**	70	58	54	50	43	38	**18**	70	61	55	51	46	42	**18**
600		0.13	69	54	53	49	41	30	**17**	69	57	53	49	43	34	**17**	71	60	56	52	45	40	**19**	72	64	57	53	47	43	**20**
700		0.18	70	57	55	52	43	33	**18**	70	60	55	52	43	36	**18**	73	63	58	54	47	40	**22**	74	66	60	55	49	44	**23**
800		0.23	70	59	56	53	46	36	**18**	72	62	56	53	46	36	**20**	74	65	60	56	49	41	**23**	75	68	61	57	51	45	**24**
850		0.26	71	60	57	54	47	37	**19**	73	63	57	54	47	37	**22**	75	66	61	56	50	42	**24**	76	69	62	57	52	46	**25**
800	0.25	0.08	65	57	56	52	46	38	**17**	73	66	61	56	50	43	**22**	75	69	65	59	54	48	**26**	77	72	67	62	56	51	**28**
875		0.10	66	58	58	54	48	41	**19**	74	67	62	57	52	45	**23**	76	70	66	60	55	49	**27**	78	73	68	63	58	52	**29**
950		0.12	67	60	59	56	50	42	**20**	75	68	63	59	53	46	**24**	77	71	67	61	55	50	**28**	79	74	69	63	58	52	**30**
1025		0.13	68	61	60	57	51	44	**21**	75	69	64	60	54	47	**25**	78	72	67	62	56	50	**28**	80	74	70	64	59	54	**31**
1100		0.15	69	62	61	59	53	46	**22**	76	69	65	61	55	48	**26**	79	73	68	63	57	51	**29**	80	75	71	64	59	54	**32**

- Radiated sound is the noise transmitted through the unit casing and emitted from the induction port
- Min ΔPs is the difference between atmospheric pressure and the inlet static pressure with the primary damper full open and the unit fan set to match the primary flow
- Sound power levels are in dB, ref 10^{-12} watts
- All performance based on tests conducted in accordance with ASHRAE 130-2008 and AHRI 880-2008
- All NC levels determined using the ceiling space effect of a double layer of 5/8 in gypsum (Ceiling Type 10 from Table D14, AHRI Standard 885-2008) to approximate the access floor panels
- Dash (-) in space denotes NC value less than NC10
- Only highlighted data points are AHRI certified. See page S58 for AHRI Certified Performance Listings.

ALHK, DLHK / DISCHARGE SOUND POWER DATA

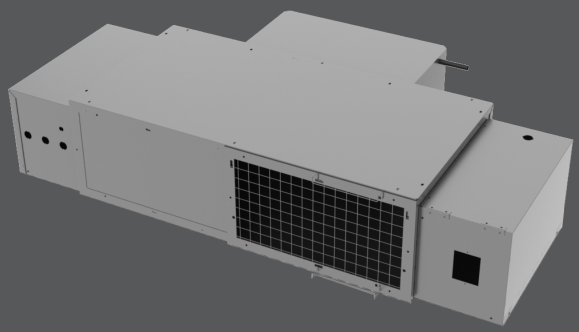
Size	CFM	Discharge Ps	Min ΔPs	Octave Band Sound Power, Lw																											
				Fan Only							0.5" ΔPs							1.0" ΔPs							1.5" ΔPs						
				2	3	4	5	6	7	NC	2	3	4	5	6	7	NC	2	3	4	5	6	7	NC	2	3	4	5	6	7	NC
309	500	0.25	0.09	69	58	59	55	56	52	**22**	69	60	61	58	58	52	**22**	69	60	61	58	58	52	**22**	71	60	61	58	58	52	**25**
	600		0.13	71	61	62	59	59	56	**25**	71	61	64	62	59	56	**25**	73	61	64	62	59	56	**28**	73	61	64	62	59	56	**28**
	700		0.18	73	64	64	62	62	60	**28**	73	66	64	65	62	60	**28**	75	66	64	65	62	60	**30**	75	66	64	65	62	60	**30**
	800		0.23	75	66	66	64	65	63	**28**	77	66	66	67	65	63	**30**	77	66	66	67	65	63	**30**	77	66	66	67	65	63	**30**
	850		0.26	75	67	67	65	66	65	**29**	75	67	67	68	66	67	**30**	77	67	67	68	66	67	**30**	77	67	67	68	66	67	**30**
410	800	0.25	0.08	78	72	71	71	70	68	**31**	81	74	71	71	70	68	**35**	81	75	73	71	70	68	**35**	81	75	73	71	70	68	**35**
	875		0.10	78	73	72	72	71	69	**32**	81	75	72	72	71	69	**35**	81	76	74	72	71	69	**36**	81	76	75	72	71	69	**36**
	950		0.12	79	74	73	73	72	71	**34**	82	76	75	73	72	71	**36**	82	77	76	73	72	71	**37**	82	78	76	73	72	71	**38**
	1025		0.13	79	75	74	74	73	72	**35**	82	78	76	74	73	72	**38**	82	78	77	74	73	72	**38**	82	79	77	74	75	72	**39**
	1100		0.15	79	76	75	75	74	73	**36**	82	79	77	75	74	73	**39**	82	79	78	75	76	73	**39**	82	80	78	75	76	75	**40**

- Discharge sound is the noise emitted from the unit discharge into the downstream ductwork
- Min ΔPs is the difference between atmospheric pressure and the inlet static pressure with the primary damper full open and the unit fan set to match the primary flow
- Sound power levels are in dB, ref 10^{-12} watts
- All performance based on tests conducted in accordance with ASHRAE 130-2008 and AHRI 880-2008
- All NC levels determined using AHRI 885-2008 Appendix E. See Terminal Unit Engineering Guidelines.
- Dash (-) in space denotes NC value less than NC10
- Only highlighted data points are AHRI Certified. See page S63 for AHRI Certified Performance Listings.

UnderFloor Fan Booster Terminals

PFC

- Designed to be installed in the underfloor plenum of an access floor grid system
- Heavy steel casing with leak resistant construction
- Energy efficient fan motor, permanent split capacitor type, mounted on vibration isolators
- Adjustable SCR fan speed control with minimum voltage stop
- Ultra-high efficiency ECM motor available
- Steel inlet screen covers the inlet side of the unit to protect the fan from debris
- Top access to unit high and low voltage controls for easy access from room above
- Single point electrical connections
- Rectangular discharge opening is designed for flanged duct connections
- Optional fan inlet sensor for cfm monitoring


PFC

energy solutions

See website for Specifications

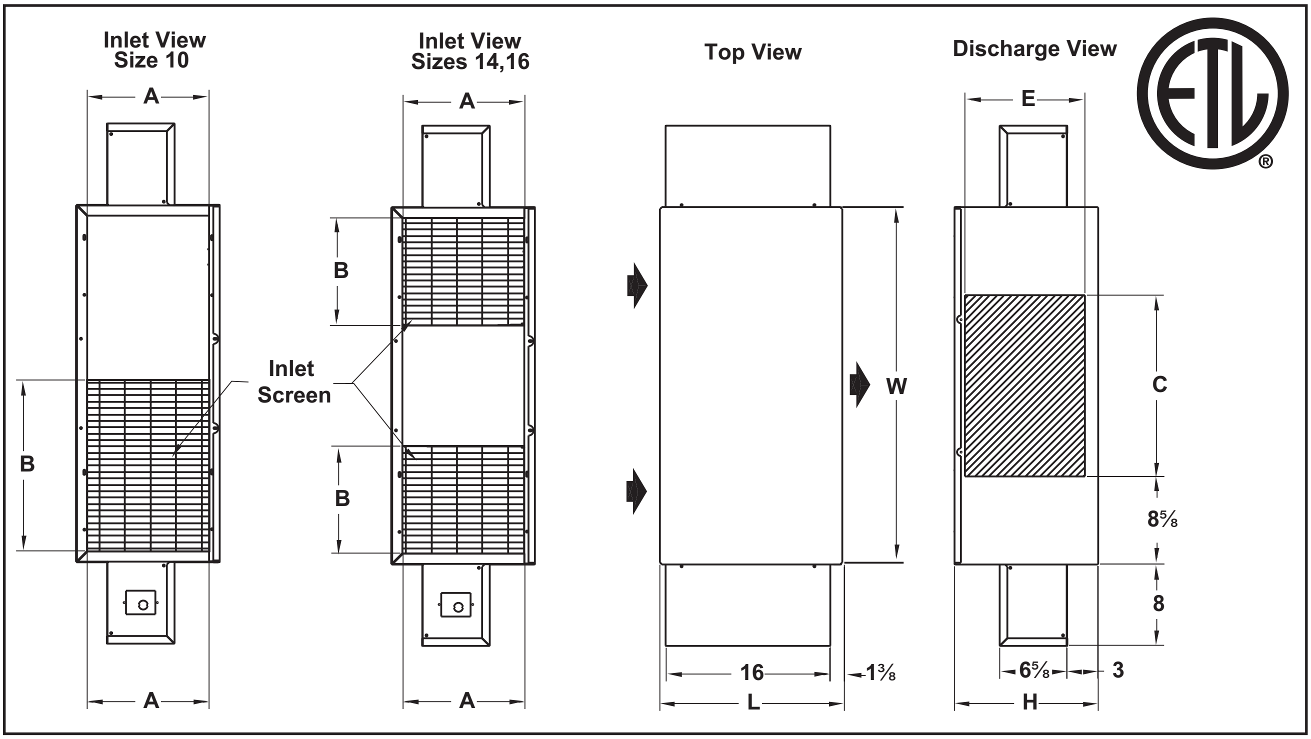
AVAILABLE MODEL:

DPFC / Digital Control

OVERVIEW

The PFC was designed to be used as a booster unit for perimeter applications. The PFC fan powered terminal unit is designed to be installed between the pedestals in an underfloor system and installed in a floor 12" to 18" in height. This product saves energy and can contribute toward LEED certification.

PFC DIMENSIONS



Unit Size	A	B	C	E	H	L	W	Filter Size	Filter Per Unit
10	8½	16 3/8	15¼	7¾	10½	18	34 7/8	10 x 18	1
14	12	10½	17¾	11¾	14	18	34 7/8	16 x 14	2
16	14	9 7/8	17¾	13¾	16	19	34 7/8	14 x 16	

All dimensions are in inches

HOT WATER COIL SECTION

STANDARD FEATURES

- ½-inch copper tubes
- Aluminum ripple fins
- Connections: Male solder
  5/8-inch for both 1-row and 2-row
  Left or right hand connections
- Galvanized steel casing
- Flanged duct connection
- Coil is installed at discharge of unit

COIL ROWS

1-Row
2-Row

ELECTRIC COIL SECTION

STANDARD FEATURES

- Auto reset thermal cutouts (one per element)
- 80/20 Nickel chrome heating elements
- Airflow safety switch
- Line terminal block (277/1ø, 208/240/3ø, or 480/3ø 4 wire)
- Flanged connection
- Control transformer for DDC or Analog electronic controls
- Fan relay for DDC fan terminals
- Magnetic contactor per step

OPTIONS

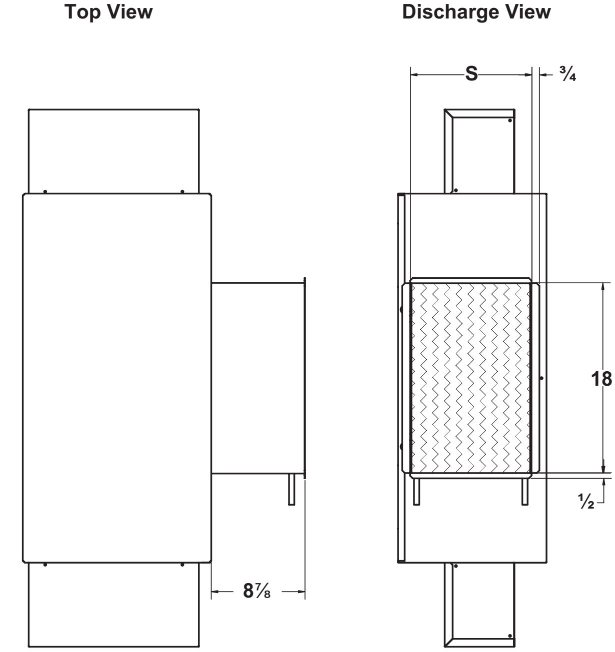
- Mercury contactor
- Fuse block
- Disconnect switch, door interlock type
- Manual reset cutout
- Dust tight construction
- Optional Lynergy Comfort Controlled SSR Electric Heat

SUPPLY VOLTAGE

- 208 V, 1 ph, 60 Hz
- 240 V, 1 ph, 60 Hz
- 277 V, 1 ph, 60 Hz
- 208 V, 3 ph, 60 Hz
- 480 V, 3 ph, 60 Hz (4 wire wye only)

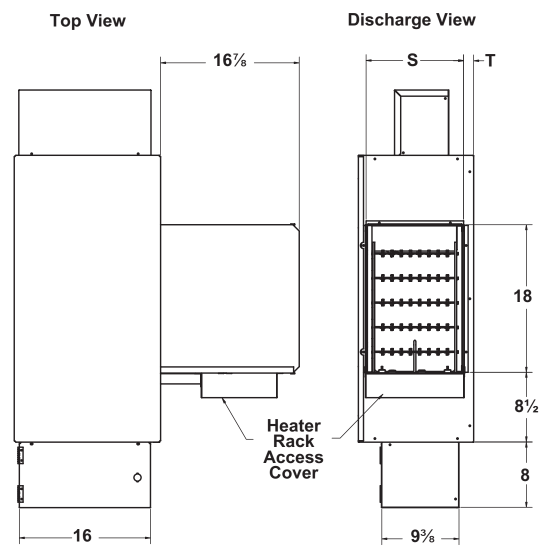
See Electric Heating Coils in Section O for more information

Hot Water Coil



Unit Size	S
10	10
14	11½
16	13 7/8

Electric Coil



Unit Size	S	T
10	9½	1
14	12	1¼
16	13½	1 5/8

ADDITIONAL ACCESSORIES

(OPTIONAL)

- Induced air filter, 1-inch thick, disposable construction type
- Fan disconnect switch (not available on units with optional electric coils)
- Fan unit fusing

Electrical Data

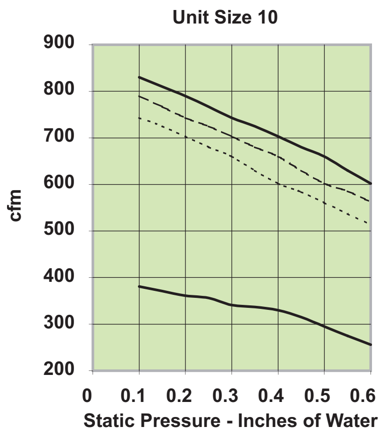
Unit Size	Motor hp	Motor Amperage Ratings		
		120/1/60 FLA	208/240/1/60 FLA	277/1/60 FLA
10	1/4	3.4	1.7	1.7
14	1/3	7.0	3.1	3.2
16	3/4	11.4	5.2	5.1

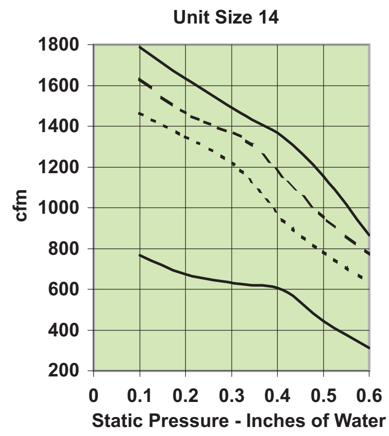
ECM Electrical Data

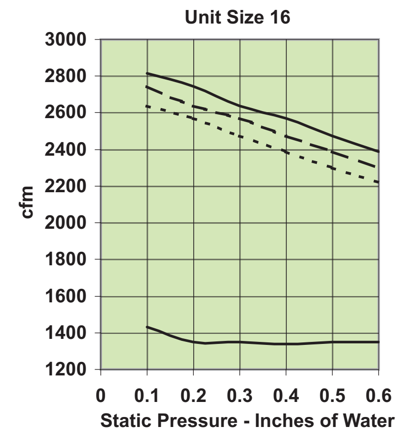
Unit Size	Motor HP	120V	208V	240V	277V
10	1/3	5.0	3.3	2.8	2.6
14	½	7.7	5.0	4.3	4.1
16	1	12.8	10.5	9.1	6.9

All dimensions are in inches

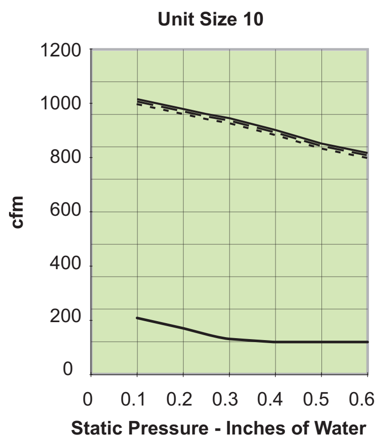
DPFC FAN CURVES

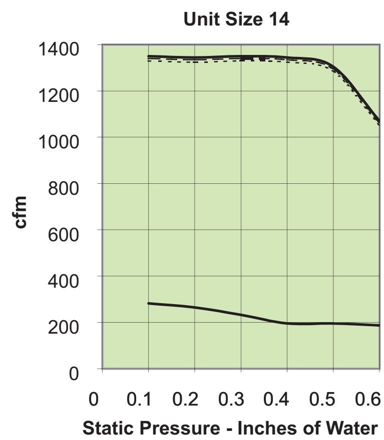


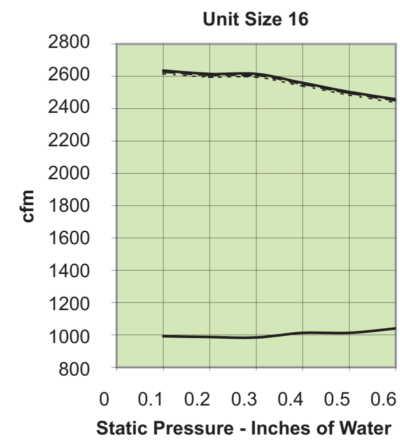




DPFC ECM FAN CURVES







No Coil or with Electric Coil ———
1-Row Water Coil – – – –
2-Row Water Coil - - - - - - - -

WATER COIL HEATING CAPACITY (MBH)

Unit Size	Rows	gpm	Head Loss	Airflow, cfm								
				400	450	500	550	600	650	700	750	800
10	One Row	0.5	0.22	11.2	11.7	12.1	12.4	12.7	13.0	13.3	13.5	13.7
		1.0	0.83	13.6	14.3	14.9	15.5	16.0	16.5	16.9	17.3	17.7
		2.0	3.16	15.3	16.2	17.0	17.7	18.4	19.0	19.6	20.1	20.7
		4.0	12.05	16.3	17.3	18.2	19.1	19.9	20.6	21.3	22.0	22.6
		Airside ∆Ps		0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11
	Two Row	0.5	0.06	15.3	15.9	16.4	16.8	17.2	17.5	17.8	18.1	18.3
		1.0	0.22	20.1	21.2	22.1	22.9	23.7	24.4	25.1	25.6	26.2
		2.0	0.83	23.8	25.3	26.7	28.0	29.2	30.3	31.3	32.3	33.2
		4.0	3.15	26.2	28.1	29.8	31.5	33.0	34.4	35.8	37.1	38.3
		Airside ∆Ps		0.08	0.09	0.11	0.13	0.15	0.17	0.20	0.22	0.25

Unit Size	Rows	gpm	Head Loss	Airflow, cfm								
				320	480	600	750	900	1000	1130	1280	1450
14	One Row	0.5	0.03	9.8	11.2	11.9	12.5	13.0	13.3	13.6	13.9	14.2
		1.0	0.11	12.1	14.2	15.4	16.6	17.5	18.0	18.7	19.3	19.9
		2.0	0.43	13.7	16.5	18.2	19.9	21.2	22.1	23.0	24.0	24.9
		4.0	1.63	14.7	18.1	20.1	22.1	23.9	24.9	26.2	27.4	28.7
		Airside ∆Ps		0.02	0.04	0.06	0.09	0.12	0.14	0.18	0.22	0.27
	Two Row	0.5	0.06	14.5	16.6	17.7	18.6	19.3	19.7	20.1	20.5	20.9
		1.0	0.24	18.6	22.4	24.5	26.5	28.1	29.0	30.0	31.0	31.9
		2.0	0.91	21.6	27.0	30.2	33.4	36.1	37.6	39.4	41.2	43.0
		4.0	3.48	23.4	30.1	34.1	38.4	42.0	44.2	46.7	49.3	51.9
		Airside ∆Ps		0.05	0.09	0.13	0.19	0.26	0.31	0.38	0.47	0.58

Unit Size	Rows	gpm	Head Loss	Airflow, cfm								
				1400	1550	1700	1850	2000	2150	2300	2450	2600
16	One Row	0.5	0.04	15.6	15.9	16.1	16.3	16.5	16.6	16.8	16.9	17.1
		1.0	0.14	21.9	22.5	22.9	23.4	23.8	24.2	24.5	24.8	25.1
		2.0	0.54	27.5	28.4	29.3	30.0	30.7	31.3	31.9	32.4	33.0
		4.0	2.04	31.7	32.9	34.0	35.1	36.0	36.9	37.7	38.5	39.2
		Airside ∆Ps		0.18	0.22	0.25	0.30	0.34	0.38	0.43	0.48	0.53
	Two Row	0.5	0.08	22.1	22.4	22.6	22.9	23.1	23.2	23.3	23.5	23.6
		1.0	0.30	34.1	34.9	35.7	36.3	36.9	37.4	37.8	38.2	38.6
		2.0	1.14	46.2	47.9	49.3	50.6	51.8	52.9	53.9	54.8	55.7
		4.0	4.31	56.0	58.4	60.7	62.7	64.6	66.4	68.0	69.5	71.0
		Airside ∆Ps		0.39	0.46	0.54	0.62	0.71	0.80	0.89	0.99	1.10

- Hot water capacities are in MBH.
- Data based on 180°F entering water and 65°F entering air.
- Head loss is in feet of water.
- Air temperature rise = 927 x MBH / cfm.
- Water temperature drop = 2.04 x MBH / gpm.
- Connection: All coils are ½-inch O.D. male solder.

DPFC / SOUND APPLICATION DATA / NC VALUES

Unit Size	cfm	NC Levels 0.25" Discharge ΔPs Radiated	NC Levels 0.25" Discharge ΔPs Discharge
10	350	17	22
	400	18	22
	500	21	24
	600	23	28
	750	29	30
14	800	21	21
	900	24	24
	1000	26	26
	1100	28	28
	1300	31	31
	1500	34	34
16	1500	31	25
	1700	34	28
	2000	37	31
	2100	38	33
	2300	40	35
	2500	42	38

Radiated Sound	Octave Bands 2	3	4	5	6	7	
Environmental Effect	2	1	0	0	0	0	Per AHRI Standard 885-98
Ceiling/Space Effect	29	33	33	35	35	36	Assumed effect for Double Gypsum Board roughly equal to access floor tile
Total dB reduction	31	34	33	35	35	36	

Discharge Sound	Octave Bands 2	3	4	5	6	7	
Environmental Effect	2	1	0	0	0	0	Per AHRI 885-98
Duct Lining	2	6	12	25	29	18	Flex Duct - Vinyl Core Flex
End Reflection	9	5	2	0	0	0	End Reflection - 8-inch Termination to Diffuser
Flex Duct	6	10	18	20	21	12	Fiberglass Flex Duct - 5-foot length, 1-inch duct work
Space Effect	5	6	7	8	9	10	Room Size - 2400 Cubic foot Room, 5 feet from sound source
Total dB reduction	24	28	39	53	59	40	

The following dB adjustments are used, per AHRI 885-98 for the calculation of NC above 300 cfm.

	Octave Bands 2	3	4	5	6	7
300-700 cfm	2	1	1	-2	-5	-1
Over 700 cfm	4	3	2	-2	-7	-1

DPFC / SOUND PERFORMANCE DATA

Size	CFM	Discharge Ps	Octave Band Sound Power, Lw — Radiated 2	3	4	5	6	7	NC	Discharge 2	3	4	5	6	7	NC
10	400	0.25	64	56	58	55	56	52	**16**	64	58	60	58	58	52	**15**
	500		66	59	61	59	59	56	**20**	66	59	63	62	59	56	**18**
	600		68	62	63	62	62	60	**24**	68	64	63	65	62	60	**22**
	675		70	64	65	64	65	63	**26**	72	64	65	67	65	63	**24**
	750		70	65	66	65	66	65	**28**	70	65	66	68	66	67	**25**
14	800	0.25	73	70	70	71	70	68	**31**	76	72	70	71	70	68	**30**
	1000		73	71	71	72	71	69	**32**	76	73	71	72	71	69	**31**
	1200		74	72	72	73	72	71	**34**	77	74	74	73	72	71	**33**
	1350		74	73	73	74	73	72	**35**	77	76	75	74	73	72	**35**
	1500		74	74	74	75	74	73	**36**	77	77	76	75	74	73	**36**
16	1400	0.25	69	66	64	64	63	60	**27**	102	22	47	29	68	57	**61**
	1700		73	70	68	68	67	64	**31**	106	27	51	34	72	62	**66**
	2000		76	73	70	71	71	68	**35**	109	31	55	38	76	66	**70**
	2300		78	76	73	74	74	72	**38**	112	35	58	42	80	69	**74**
	2600		80	79	75	77	77	75	**41**	115	38	60	45	82	72	**78**

- N/A in a space denotes a minimum inlet static pressure greater than 0.5-inch at rated airflow
- Outlet ΔPs, the difference in static pressure from the terminal discharge to the room, is 0.25-inch
- Radiated sound power is the noise transmitted through the casing walls
- Sound power levels are in decibel, re 10^{-12} watts
- Ratings in accordance with AHRI Standard 880-98 and certified to AHRI

AHRI Directory of Certified Performance

Titus is a charter member company and current participant in the AHRI Directory of Certified Performance. This voluntary certification program was developed by participating manufacturers in conjunction with the former Air-Conditioning and Refrigeration Institute (ARI) in the 1990's. It is currently administrated by the Air-Conditioning, Heating, and Refrigeration Institute (AHRI). The purpose of this program is to provide for the independent verification of manufacturers' published performance data. Only participating products are authorized to bear the AHRI VAV Certification Mark. Certified data may be viewed and downloaded at www.ahrinet.org.

In order to participate in this program, member companies pay annual dues based on sales volume, submit published performance data for all applicable model types, and agree to provide a number of randomly selected product samples for annual rounds of independent testing at the manufacturers' expense. All verification testing is conducted in accordance with ASHRAE Standard 130 'Methods of Testing Air Terminal Units'. These tests are conducted to verify that a manufacturer's published certified ratings are within the test tolerances outlined in AHRI Standard 880 'Performance Rating of Air Terminals'. Any failure to demonstrate the certified performance is punished by additional testing requirements, mandatory performance re-rating, monetary penalties and possible expulsion from the Certified Directory.

Product samples provided for certification testing are standard production units with standard ½ in dual density fiberglass lining (unless otherwise specified) and no optional appurtenances such as add-on attenuators or heating/cooling coils. The certified ratings are measured at the standard operating points under the following test conditions:

- Rated airflow (cfm) – Based on lesser of an inlet velocity of 2000 fpm or the maximum fan flow with 0.25 in wg of downstream pressure
- Rated fan power (watts) – Based on fan operating at the rated airflow with 0.25 in wg of downstream pressure
- Rated Min ∆Ps (in wg) – Min ∆Ps is the difference between atmospheric pressure and the inlet static pressure at rated airflow with the primary damper full open and the unit fan set to match the primary flow
- Rated ∆Ps (in wg) – A static pressure of 1.5 in wg applied to the inlet duct
- Rated sound power by octave band (dB, re 10^{-12} watts) – Radiated and discharge sound performance conducted in a reverberation room that meets both the broadband and pure tone qualifications of AHRI Standard 220

Unit Size	Rated CFM	Fan Watts	Min ∆Ps	Discharge		Fan Only Radiated Sound Power						Fan Plus 100% Primary Radiated Sound Power						Fan Only Discharge Sound Power					
				H	W	2	3	4	5	6	7	2	3	4	5	6	7	2	3	4	5	6	7
309	850	510	0.26	10	18.5	71	60	57	54	47	37	76	69	62	57	52	46	75	67	67	65	66	65
410	1100	510	0.15	10	18.5	69	62	61	59	53	46	80	75	71	64	59	54	79	76	75	75	74	73