ENGINEERING GUIDE

TVL Parallel Fan-Powered, Low-Height, VAV Terminals

Johnson Controls

TABLE OF CONTENTS

NOTES:

- All data herein is subject to change without notice. Some drawings are not shown in this catalog.
- Drawings not for installation purposes.
- Construction drawings and performance data contained herein should not be used for submittal purposes.
- ETL Listing Number 3052384-001.

ARI PERFORMANCE CERTIFIED ™
ARI Standard 880 VAV Terminal
www.aridirectory.org

INTERTEK C ETL US LISTED

FEATURES AND BENEFITS

QUIET COMFORT

Model TVL fan terminals are specifically designed for quiet operation in shallow or congested ceiling spaces. They also offer improved space comfort and flexibility for a wide variety of HVAC systems. This is critical in today's buildings, where occupants are placing more emphasis on indoor acoustics.

OCCUPANT-SENSITIVE DESIGN

Due to heightened interest in Indoor Air Quality, many HVAC system designers are focusing on the effects of particulate contamination within a building's occupied space. Often, HVAC system noise is overlooked as a source of occupied space contamination. The TVL terminal is specifically designed to eliminate obtrusive fan noise from reaching the occupants.

Occupants will benefit from the TVL design that minimizes low frequency (125Hz-250Hz) sound levels that typically dominate the space sound level.

DESIGN FLEXIBILITY

Selection and Layout. The TVL provides flexibility in system design. Reduced noise at the fan terminal allows the system designer to place properly sized units directly above occupied spaces. It is not necessary to use the crowded space above a hall or corridor to locate the equipment. This will reduce lengthy and expensive discharge duct runs. The standard shallow casing height (10 5/8" or 12") minimizes conflict with other systems competing for ceiling space. The FlowStar™ sensor ensures accurate control, even when space constraints do not permit long straight inlet duct runs to the terminal.

Sizes. Model TVL terminals are available with primary air valves handling up to 3000 CFM. Three fan sizes provide a range of heating capacities between 100 and 1500 CFM. Units are available with multiple primary air valve and fan combinations to meet current industry needs.

CONVENIENT INSTALLATION

Quality. All TVL terminals are thoroughly inspected during each step of the manufacturing process, including a comprehensive "pre-ship" inspection, to assure the highest quality product available. Each unit is also "run tested" before leaving the factory to ensure trouble free field "start-up."

Quick Installation. A standard single point electrical main power connection is provided. Electronic controls and electrical components are located on the same side of the casing for quick access, adjustment, and troubleshooting. Installation time is minimized with the availability of factory calibrated controls.

Terminals can be ordered with left or right hand control configurations to facilitate clearance requirements from obstructions in a congested ceiling cavity. In spite of careful planning, clearance conflicts sometimes arise due to structural anomalies or multiple trades competing for the same ceiling space. With relatively little field labor, the TVL can be reconfigured to reverse the unit handing, thereby changing the clearance requirements to the opposite side. Except in cases where position

FEATURES AND BENEFITS

sensitive controls are required (e.g. mercury contactors), the internal fan deck is removed and reinstalled inverted, allowing the entire unit to be installed in an inverted fashion. This provides the contractor an option other than re-ordering a unit, or offsetting the duct spaces, possibly saving time, money, and degradation of overall system performance.

The terminal is constructed to allow installation with standard metal hanging straps. Optional hanger brackets for use with all-thread support rods or wire hangers are also available.

Air Balance. Finite fan speed adjustment is accomplished with an electronic SCR controller. The SCR fan speed controller is manufactured by Johnson Controls and is compatible with the fan motor. This minimizes electronic interference and harmonic distortion that occurs from non- compatible motor and SCR components. Increased motor life and efficiency result from the compatible design.

TVL terminals utilize three tap motors that accommodate a broad range of flow and static pressure field conditions while dramatically increasing efficiency.

The FlowStar™ sensor ensures accurate airflow measurement, minimizing commissioning and setup time. A calibration label and wiring diagram is located on the terminal for quick reference during start-up.

VALUE AND SECURITY

Quality. All metal components are fabricated from galvanized steel. Unlike most manufacturers' terminals, the steel used in the TVL is capable of withstanding a 125 hour salt spray test without showing any evidence of red rust.

Energy Efficiency. In addition to quiet and accurate temperature control, the building owner will benefit from lower operating costs. The highly amplified velocity pressure signal from the FlowStar™ inlet sensor allows precise airflow control at low air velocities.

The FlowStar™ sensor's airfoil shape provides minimal pressure drop across the terminal. This allows the central fan to run at a lower pressure and with less brake horsepower. Energy efficient three tap, three winding, permanent split capacitor fan motors are manufactured to ensure efficient, quiet, reliable, and low maintenance operation.

Three tap motors provide superior energy efficiency over single speed motors by delivering three separate horsepower outputs. For example, a nominal 1/2 HP motor delivers 1/3 HP on medium tap and 1/4 HP on low tap. This allows the motor to operate at a higher efficiency when at a reduced fan capacity.

Fan terminals that utilize a single speed motor must rely solely on an SCR controller to obtain the reduction in fan capacity. At minimum turndown, they suffer from excessive power consumption and high motor winding temperatures, significantly reducing the motor life.

Agency Certification. Model TVL terminals, including those with electric heat, are listed with ETL as an assembly, and bear the ETL label.

TVL terminals comply with applicable NEC requirements, are tested in accordance with ARI Standard 880, and are certified by ARI.

Maintenance and Service. TVL fan terminals require no periodic maintenance other than optional filter replacement. If component replacement becomes necessary, the unit is designed to minimize field labor. Both top and bottom casing panels can be removed to provide easy access to the fan assembly, and the motor electrical leads are easily unplugged.

CONTROLS

Model TVL terminals are available with analog electronic, consignment DDC, Pneumatic controls, and Johnson Controls DDC for BACnet, Lon or N2. Johnson Controls manufactures a complete line of analog electronic controls specifically designed for use with TVL terminals. These controls are designed to accommodate a multitude of control schemes.

From the most basic to the most sophisticated sequence of operation, the controls are designed by experts in VAV single duct terminal operation. Refer to the Electronic Controls Selection Guide, and the Pneumatic Controls Selection Guide for a complete description of the sequences and schematic drawings that are available.

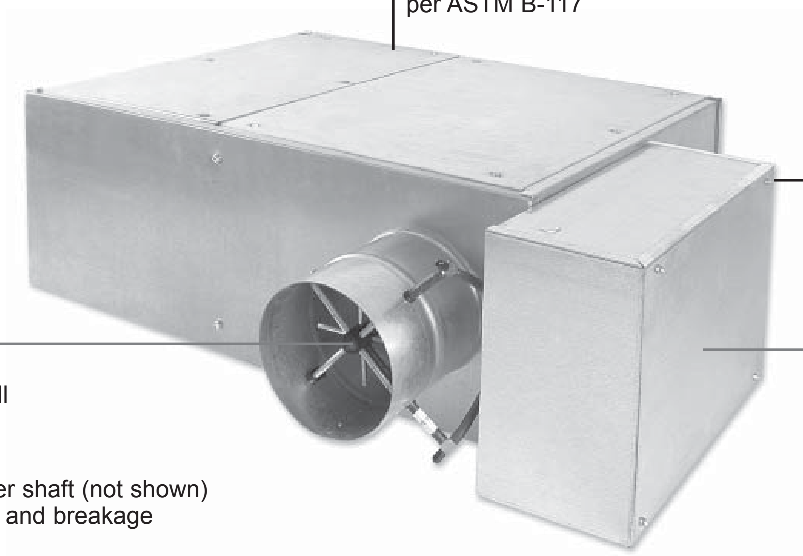
Available Control Types:
- Analog Electronic (shown)
- Pneumatic
- Factory mounted consignment DDC
- Johnson Controls DDC

Standard Features Include:
- Patented FlowStar™ Airflow Sensor
- ETL Listing
- NEMA 1 Enclosure
- 24 Volt Control Transformer
- Floating Modulating Actuator
- Balancing Tees and Plenum Rated Tubing

CONSTRUCTION FEATURES

MODEL TVL

The TVL terminal incorporates many standard features that are expensive options for other manufacturers.



OPTIONAL CONSTRUCTION FEATURES

- Mounting brackets to accept all-thread hanging rods or wire hangers
- Double wall construction
- Scrim reinforced foil faced insulation meeting ASTM C1136 for mold, mildew, and humidity resistance
- Elastomeric closed cell foam insulation
- Hot water (TVL-WC), steam, or electric heating (TVL-EH) coils
- Factory controls: analog electronic, DDC electronic and pneumatic
- Factory piping packages.

CONSTRUCTION FEATURES

ACCURATE AND ENERGY-SAVING AIRFLOW CONTROL WITH THE PATENTED FLOWSTAR™ SENSOR

Many VAV terminals waste energy due to an inferior airflow sensor design that requires the minimum CFM setpoint to be much higher than the IAQ calculation requirement. This is common with interior spaces that will be effected year round. These interior VAV terminals waste energy in several ways. First, the primary air fan (e.g. AHU) supplies more CFM than the building requires. The higher minimum CFM setpoint overcools the zone with VAV terminals without integral heat. To maintain thermal comfort a building engineer would need to change the minimum setpoint to zero CFM compromising indoor air quality. Interior VAV terminals with integral heat provide adequate comfort in the space but waste significant energy as energy is consumed to mechanically cool the primary air only to have more energy consumed to heat the cooled primary air. Significant energy savings is obtained with proper sizing and by making sure approved VAV terminals are capable of controlling at low CFM setpoints, providing the minimum ventilation requirement.

Currently, most DDC controllers have a minimum differential pressure limitation between 0.015" and 0.05" w.g. The major DDC manufacturers can control down to 0.015" w.g. An airflow sensor that does not amplify, e.g., a Pitot tube, requires about 490 FPM to develop 0.015" w.g. differential pressure. The FlowStar™ develops 0.015" w.g. pressure with only 290 FPM on a size 6 terminal and less than 325 FPM for a size 16. Consequently, VAV terminals utilizing a non-amplifying type sensor could have minimum CFM's that are well over 50% higher than a Johnson Controls terminal. Many airflow sensors provide some degree of amplification simply due to the decrease in free area of the inlet from large area of the sensor. These VAV terminals still require minimum CFM's up to 30% higher than a Johnson Controls terminal, have higher sound levels, and higher pressure drop requiring additional energy consumption at the primary air fan.

A VAV system designed with Johnson Controls terminals consumes significantly less energy than a comparable system with competitor's terminals. The FlowStar™ airflow sensor reduces energy consumption by allowing lower zone minimum CFM setpoints, greatly reducing or eliminating "reheat", and by imposing less resistance on the primary air fan.

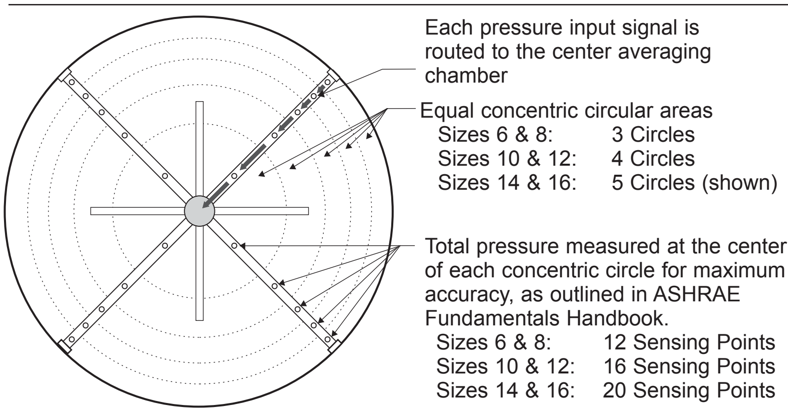
The Johnson Controls air valve features the FlowStar™ airflow sensor which has brought new meaning to airflow control accuracy. The multi-axis design utilizes between 12 and 20 sensing points that sample total pressure at center points within equal concentric cross-sectional areas, effectively traversing the air stream in two planes. Each distinct pressure reading is averaged within the center chamber before exiting the sensor to the controlling device.

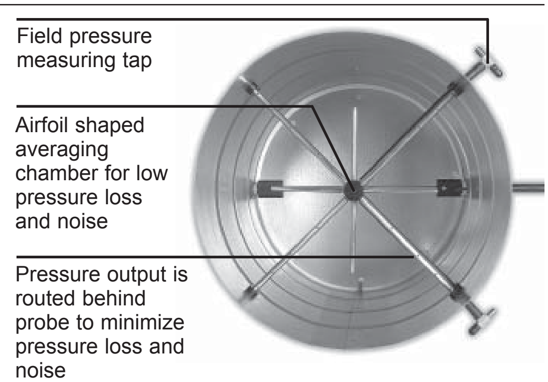
This sensor adds a new dimension to signal amplification. Most differential pressure sensors provide a signal between .5 and 2 times the equivalent velocity pressure signal. The FlowStar™ provides a differential pressure signal that is 2.5 to 3 times the equivalent velocity pressure signal. This amplified signal allows more accurate and stable airflow control at low airflow capacities. Low airflow control is critical for indoor air quality, reheat minimization, and preventing over cooling during light loads.

Unlike other sensors which use a large probe surface area to achieve signal amplification, the FlowStar™ utilizes an unprecedented streamline design which generates amplified signals unrivaled in the industry. The streamlined design also generates less pressure drop and noise.

The VAV schedule should specify the minimum and maximum airflow setpoints, maximum sound power levels, and maximum air pressure loss for each terminal. The specification for the VAV terminal must detail the required performance of the airflow sensor. For maximum building occupant satisfaction, the VAV system designer should specify the airflow sensor as suggested in the Guide Specifications of this catalog.

FlowStar™ Airflow Sensor Patent #5,481,925





STANDARD AND OPTIONAL FEATURES

STANDARD FEATURES

Construction
- ARI 880 certified and labeled
- 20 gauge galvanized steel casing
- 1/2" thick fiberglass insulation
- Large top and bottom access openings allowing removal of complete fan assembly for all heating coil options

Fan Assembly
- Forward curved, dynamically balanced, direct drive, galvanized blower wheel
- 115, 208/230 or 277 volt single phase, three tap PSC motor
- SCR fan speed controller
- Quick-select motor speed terminal
- Permanently lubricated motor bearings
- Thermally protected motor
- Vibration isolation motor mounts
- Single point wiring

Primary Air Valve
- Round inlets: 22 gauge galvanized steel with embossed rigidity rings
- Rectangular inlets: 18 gauge galvanized steel construction
- Low thermal conductance damper shaft
- Position indicator on end of damper shaft
- Mechanical stops for open and closed position
- FlowStar™ center averaging airflow sensor
- Balancing tees
- Plenum rated sensor tubing

Hot Water Coils
- Designed, manufactured, and tested by Johnson Controls
- ARI 410 certified and labeled
- 1, 2, 3, or 4 row coils
- Tested at a minimum of 450 PSIG under water and rated at 300 PSIG working pressure at 200°F
- Left or right hand connections

Electrical
- cETL listed for safety compliance
- NEMA 1 wiring enclosure

Electric Heat
- cETL listed as an assembly for safety compliance per UL 1995
- Integral electric heat assembly
- Automatic reset primary and back-up secondary thermal limits
- Single point power connection
- Hinged electrical enclosure door
- Fusing per NEC

OPTIONAL FEATURES

Construction
- Foil faced scrim backed insulation
- Elastomeric closed cell foam insulation
- Double wall construction with 22 gauge liner
- 1" filter rack with throwaway filter

Fan Assembly
- 220/240 volt 50 Hz motors

Electrical
- Full unit toggle disconnect
- Inline motor fusing
- Primary and secondary transformer fusing

Electric Heat
- Proportional (SSR) heater control
- Mercury contactors (unit may not be inverted)
- Door interlocking disconnect switches

Controls
- Factory provided controls include:
  - Analog electronic
  - Pneumatic
  - Johnson Controls DDC
- Consignment DDC controls (factory mount and wire controls provided by others)

Piping Packages
- Factory assembled – shipped loose for field installation
- 1/2" and 3/4", 2 way, normally closed, two position electric motorized valves
- Isolation ball valves with memory stop
- Fixed and adjustable flow control devices
- Unions and P/T ports
- Floating point modulating control valves
- High pressure close-off actuators (1/2" = 50 PSIG; 3/4" = 25 PSIG)

APPLICATION AND SELECTION

PURPOSE OF PARALLEL FLOW FAN TERMINALS

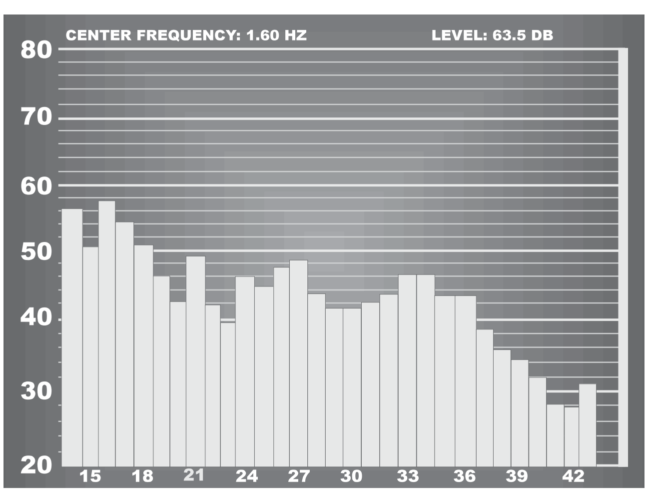
Parallel flow fan powered terminals offer improved space comfort and flexibility in a wide variety of applications. Substantial operating savings can be realized through the recovery of waste heat, and night setback operation.

Heat Recovery. The TVL recovers heat from lights and core areas to offset heating loads in perimeter zones. Additional heat is available at the terminal unit using electric, steam, or hot water heating coils. Controls are available to energize remote heating devices such as wall fin, fan coils, radiant panels, and roof load plenum unit heaters.

Typical Sequences of Operation. The TVL provides variable volume, constant temperature air in the cooling mode, and constant volume, variable temperature air in the heating mode.

At the design cooling condition, the primary air valve is handling the maximum scheduled airflow capacity while the unit fan is off. As the cooling load decreases, the primary air valve throttles toward the minimum scheduled airflow capacity. A further decrease in the cooling load causes the unit fan to start, inducing warm air from the ceiling plenum which increases the discharge air temperature to the zone. When the heating load increases, the optional hot water coil or electric heater is energized to maintain comfort conditions.

IAQ. The TVL enhances the indoor air quality of a building by providing higher air volumes in the heating mode than typically provided by straight VAV single duct terminals. The higher air capacity provides greater air motion in the space and lowers the heating discharge air temperature. This combination improves air circulation, preventing accumulation of CO^2 concentrations in stagnant areas. Increased air motion improves occupant comfort. The higher air capacity also improves the performance of diffusers and minimizes diffuser “dumping”.



ACOUSTICAL CONCEPTS

The focus on indoor air quality is also having an effect on proper selection of air terminal equipment with respect to acoustics.

Sound Paths. At the zone level, the terminal unit generates acoustical energy that can enter the zone along two primary paths. First, sound from the unit fan can propagate through the downstream duct and diffusers before entering the zone (referred to as Discharge or Airborne Sound). Acoustical energy is also radiated from the terminal casing and travels through the ceiling cavity and ceiling system before entering the zone (referred to as Radiated Sound).

Sound Power. To properly quantify the amount of acoustical energy emanating from a terminal unit at a specific operating condition (i.e. CFM and static pressure), manufacturers must measure and publish sound power levels.

The units of measurement, decibels, actually represent units of power (watts). The terminal equipment sound power ratings provide a consistent measure of the generated sound independent of the environment in which the unit is installed. This allows a straight forward comparison of sound performance between equipment manufacturers and unit models.

Noise Criteria (NC). The bottom line acoustical criteria for most projects is the NC (Noise Criteria) level. This NC level is derived from resulting sound pressure levels in the zone. These sound pressure levels are the effect of acoustical energy (sound power levels) entering the zone caused by the terminal unit and other sound generating sources (central fan system, office equipment, outdoor environment, etc.).

The units of measurement is once again decibels; however, in this case decibels represent units of pressure (Pascals), since the human ear and microphones react to pressure variations.

There is no direct relationship between sound power levels and sound pressure levels. Therefore, we must predict the resulting sound pressure levels (NC levels) in the zone based in part by the published sound power levels of the terminal equipment. The NC levels are totally dependent on the project specific design, archi-

APPLICATION AND SELECTION

tecturally and mechanically. For a constant operating condition (fixed sound power levels), the resulting NC level in the zone will vary from one project to another.

ARI 885. A useful tool to aid in predicting space sound pressure levels is an application standard referred to as ARI Standard 885. This standard provides information (tables, formulas, etc.) required to calculate the attenuation of the ductwork, ceiling cavity, ceiling system, and conditioned space below a terminal unit. These attenuation values are referred to as the “transfer function” since they are used to transfer from the manufacturer’s sound power levels to the estimated sound pressure levels resulting in the space below, and/or served by the terminal unit. The standard does not provide all of the necessary information to accommodate every conceivable design; however, it does provide enough information to approximate the transfer function for most applications. Furthermore, an Appendix is provided that contains typical attenuation values. Some manufacturers utilize different assumptions with respect to a "typical" project design; therefore, cataloged NC levels should not be used to compare acoustical performance. Only certified sound power levels should be used for this purpose.

GENERAL DESIGN RECOMMENDATIONS FOR A QUIET SYSTEM

The AHU. Sound levels in the zone are frequently impacted by central fan discharge noise that either breaks out (radiates) from the ductwork or travels through the distribution ductwork and enters the zone as airborne (discharge) sound. Achieving acceptable sound levels in the zone begins with a properly designed central fan system which delivers relatively quiet air to each zone.

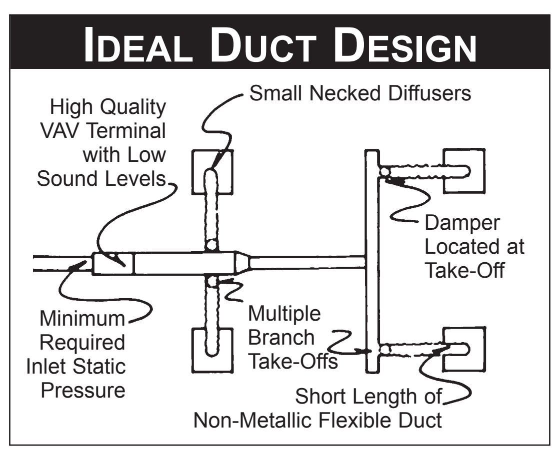
Supply Duct Pressure. One primary factor contributing to noisy systems is high static pressure in the primary air duct. This condition causes higher sound levels from the central fan and also higher sound levels from the terminal unit, as the primary air valve closes to reduce the pressure. This condition is compounded when flexible duct is utilized at the terminal inlet, which allows the central fan noise and air valve noise to break out into the ceiling cavity and then enter the zone located below the terminal. Ideally, the system static pressure should be reduced to the point where the terminal unit installed on the duct run associated with the highest pressure drop has the minimum required inlet pressure to deliver the design airflow to the zone. For systems that will have substantially higher pressure variances from one zone to another, special attention should be paid to the proper selection of air terminal equipment.

To date, the most common approach has been to select (size) all of the terminals based on the worst case (highest inlet static pressure) condition. Typically, this results in 80% (or higher) of the terminal units being oversized for their application. This in turn results in much higher equipment costs, but more importantly, drastically reduced operating efficiency of each unit. This consequently decreases the ability to provide comfort control in the zone. In addition, the oversized terminals cannot adequately control the minimum ventilation capacity required in the heating mode.

A more prudent approach is to utilize a pressure reducing device upstream of the terminal unit on those few zones closest to the central fan. This device could simply be a manual quadrant type damper if located well upstream of the terminal inlet. In tight quarters, perforated metal can be utilized as a quiet means of reducing system pressure. This approach allows all of the terminal units to experience a similar (lower) inlet pressure. They can be selected in a consistent manner at lower inlet pressure conditions that will allow more optimally sized units.

Inlet Duct Configuration. Inlet duct that is the same size as the inlet collar and as straight as possible will achieve the best acoustical performance. For critical applications, flexible duct should not be utilized at the terminal inlet.

Downstream Duct Design. On projects where internal lining of the downstream duct is not permitted, special considerations should be made to assure acceptable noise levels will be obtained. In these cases, a greater number of smaller zones will help in reducing sound levels. Where possible, the first diffuser takeoff should be located after an elbow or tee and a greater number of small necked diffusers should be utilized, rather than fewer large necked diffusers.



APPLICATION AND SELECTION

The downstream ductwork should be carefully designed and installed to avoid noise regeneration. Bull head tee arrangements should be located sufficiently downstream of the terminal discharge to provide an established flow pattern downstream of the fan. Place diffusers downstream of the terminal after the airflow has completely developed.

Downstream splitter dampers can cause noise problems if placed too close to the terminal, or when excessive air velocities exist. If tee arrangements are employed, volume dampers should be used in each branch of the tee, and balancing dampers should be provided at each diffuser tap. This arrangement provides maximum flexibility in quiet balancing of the system. Casing radiated sound usually dictates the overall room sound levels directly below the terminal. Because of this, special consideration should be given to the location of these terminals as well as to the size of the zone. Larger zones should have the terminal located over a corridor or open plan office space and not over a small confined private office. Fan powered terminals should never be installed over small occupied spaces where the wall partitions extend from slab-to-slab (i.e. fire walls or privacy walls).

Fan Terminal Isolation. Model TVL fan terminals are equipped with sufficient internal vibration dampening means to prevent the need for additional external isolation. Flexible duct connectors at the unit discharge typically do more harm than good. The sagging membrane causes higher air velocities and turbulence, which translates into noise. Furthermore, the discharge noise breaks out of this fitting more than with a hard sheet metal fitting.

SELECTION GUIDELINES

The TVL product line is designed to provide flexibility in matching primary air valve capacities (cooling loads) with unit fan capacities (heating loads). The TVL model code consists of two pairs of two digit numbers (e.g. 0805). The first two digits describe the primary air valve size (diameter in nominal inches), while the second pair refers to the unit fan capacity (hundreds of CFM) and overall physical size of the unit. Each unit fan size is available with two or more primary air valve sizes. This allows the heating airflow capacity (fan CFM) to be selected over a wide range of design airflow capacities (maximum primary CFM). This accommodates applications where the fan CFM needs to be only 15 to 20% of design capacity, and applications where the fan CFM must be 50 to 70% of design CFM.

The unit fan size should be selected first by cross plotting the specified fan capacity and external static pressure on the appropriate fan performance curves. Terminals utilizing hot water heating coils require the summation of the coil air pressure drop and the design E.S.P. to determine the total E.S.P. It is common to have more than one fan size which can meet the design requirements. Typically, the selection begins with the smallest fan that can meet the capacity. Occasionally, this selection may not meet the acoustical requirements and thus, the next larger fan size would be selected.

Fan selections can be made anywhere in the non-shaded areas. Each fan performance curve depicts the actual performance of the relative motor tap without any additional fan balance adjustment. Actual specified capacities which fall below a particular fan curve (low, medium, or high) are obtained by adjustment of the electronic (SCR) fan speed controller.

The primary air valve is selected next. Typically, the primary air valve sound is insignificant relative to the unit fan sound performance. The selection process involves choosing an air valve size that is as small as possible while yielding acceptable sound levels and pressure drop. For non-acoustically sensitive applications such as shopping malls and airports, the primary air valve can be sized at the maximum rated capacity.

SYSTEM PRESSURE CONSIDERATIONS

The central fan is required to produce sufficient inlet static pressure to force the air through the primary air valve, unit casing, downstream ductwork and fittings, and diffusers with the unit fan off. The TVL has been designed to reduce central fan power consumption by placing the optional hot water heating coil in the induction air stream, eliminating the coil from these central system pressure considerations.

The industry standard for testing and rating air terminal units (ARI 880) requires that published pressure drop performance be measured with hard, straight, unlined duct entering and leaving the terminal unit. On many projects, due to the limited available space, terminal units are not installed in this optimum manner. Frequently, flexible duct is used at the terminal inlet and a metal transition is utilized at the discharge. The entrance and exit losses in these instances exceed the actual terminal unit pressure loss. It is important to consider terminal unit pressure loss as well as those losses associated with the entire distribution ductwork (as outlined in applicable ASHRAE Handbooks) when sizing central system fan requirements.

GENERAL SELECTION DATA

PRIMARY AIR VALVE

UNIT SIZE	CFM	Min ∆Ps (IN. W.G.)	ROOM NOISE CRITERIA (NC) 0.5" W.G. ∆Ps Disch.	0.5" W.G. ∆Ps Rad.	1.0" W.G. ∆Ps Disch.	1.0" W.G. ∆Ps Rad.	3.0" W.G. ∆Ps Disch.	3.0" W.G. ∆Ps Rad.
0405	100	0.01	-	-	-	20	-	27
	150	0.02	-	22	-	26	20	31
	200	0.02	-	26	-	28	25	36
	250	0.03	-	30	22	32	30	38
0505	100	0.01	-	-	-	-	-	22
	200	0.01	-	-	-	22	-	30
	300	0.02	-	25	-	28	21	36
	350	0.02	-	27	-	32	22	38
0605	200	0.03	-	-	-	-	-	22
	250	0.04	-	-	-	20	-	27
	300	0.06	-	-	-	22	-	30
	350	0.09	-	22	-	26	-	31
	450	0.15	-	26	-	28	23	36
	550	0.22	-	30	22	32	27	38
0805	300	0.02	-	-	-	-	-	22
	400	0.03	-	-	-	20	-	27
	500	0.04	-	-	-	22	22	30
	600	0.05	-	22	-	26	25	31
	800	0.10	-	26	-	28	28	36
	1000	0.15	-	30	22	32	31	38
1009	600	0.03	-	-	-	21	26	32
	800	0.05	-	-	-	23	28	36
	1000	0.08	-	22	-	25	32	38
	1200	0.12	-	26	-	28	33	40
	1400	0.16	-	28	-	30	35	42
	1600	0.21	-	34	-	33	35	43
1209	800	0.03	-	-	-	21	22	30
	1100	0.06	-	-	-	23	28	36
	1400	0.09	-	22	-	25	32	38
	1700	0.13	-	26	-	28	33	40
	2000	0.19	-	28	-	30	35	42
	2300	0.27	-	34	-	33	35	43
1215	800	0.03	-	-	-	-	27	30
	1100	0.06	-	-	-	22	31	31
	1400	0.09	-	-	-	25	32	33
	1700	0.13	-	22	-	27	33	36
	2000	0.19	-	28	-	30	35	38
	2300	0.27	-	30	-	30	35	41
1415	1200	0.05	-	-	-	21	25	31
	1500	0.09	-	-	-	23	30	32
	1800	0.13	-	20	-	25	37	33
	2100	0.18	-	21	-	27	37	36
	2400	0.25	-	23	20	28	37	37
	2700	0.32	-	30	21	30	37	38
	3000	0.41	-	32	22	30	37	41

FAN

UNIT SIZE	FAN CFM	ROOM NOISE CRITERIA (NC) Discharge	Radiated
0405 0505 0605 0805	200	-	22
	300	-	27
	400	-	31
	500	-	33
1009 1209	300	-	24
	400	-	27
	500	-	29
	600	-	32
	700	-	35
	800	-	37
	900	21	38
1215 1415	600	-	31
	700	-	33
	800	-	35
	900	-	36
	1000	-	38
	1100	-	38
	1200	-	39
	1300	20	40
	1400	22	41

NOTES:

- Min. ∆Ps is the static pressure difference between the terminal inlet and discharge with the damper wide open. Data is applicable to units with or without optional heater.
- Performance data obtained from tests conducted in accordance with ARI Standard 880.
- Dash (-) indicates NC level less than 20.
- NC values calculated based upon the 2002 Addendum to ARI Standard 885 Appendix E Typical Sound Attenuation Values (shown below), using Ceiling Type 2 for calculating Radiated NC.
- NC (sound pressure) levels predicted by subtracting appropriate values below from published sound power levels (following pages).

DISCHARGE ATTENUATION VALUES	OCTAVE BAND 2	3	4	5	6	7
Small Box (< 300 CFM)	24	28	39	53	59	40
Medium Box (300-700 CFM)	27	29	40	51	53	39
Large Box (> 700 CFM)	29	30	41	51	52	39

RADIATED ATTENUATION VALUES	OCTAVE BAND 2	3	4	5	6	7
Type 2 - Mineral Fiber Ceiling	18	19	20	26	31	36

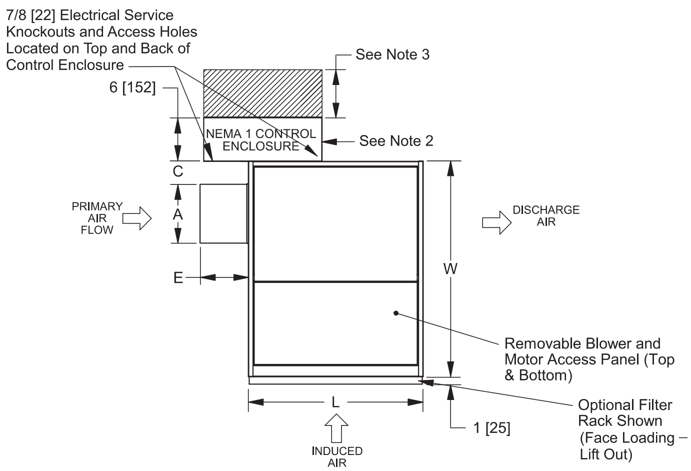
HORSEPOWER / AMPERAGE DATA

UNIT SIZE	FAN HORSEPOWER LOW	FAN HORSEPOWER MED	FAN HORSEPOWER HI	AMPERAGE 115V LOW	115V MED	115V HI	208V LOW	208V MED	208V HI	277V LOW	277V MED	277V HI
0405, 0505, 0605, 0805	1/50	1/20	1/8	0.8	1.3	1.7	0.3	0.6	0.9	0.32	0.5	0.68
1009, 1209	1/12	1/6	1/4	2.5	2.8	3.5	1.0	1.3	1.6	0.9	1.1	1.3
1215, 1415	1/4	1/3	1/2	3.1	3.7	5.8	1.4	1.7	2.7	1.1	1.5	2.2

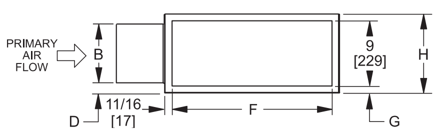
DIMENSIONAL DATA

MODEL TVL

Drawings are not to scale and not for submittal or installation purposes.

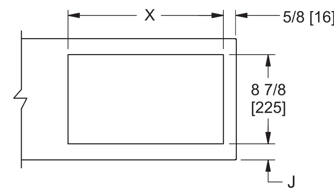


Top View



Side View

UNIT SIZE	A	B	C	D	E	F	G	J	X	W	L	H
0405	3 7/8ϕ [98]	3 7/8ϕ [98]	5 1/8 [130]	3 3/8 [86]	10 1/2 [267]	22 1/8 [562]	13/16 [21]	7/8 [22]	13 5/8 [346]	29 [737]	23 1/2 [597]	10 5/8 [270]
0505	4 7/8ϕ [124]	4 7/8ϕ [124]	4 5/8 [117]	2 7/8 [73]	10 1/2 [267]	22 1/8 [562]	13/16 [21]	7/8 [22]	13 5/8 [346]			
0605	5 7/8ϕ [149]	5 7/8ϕ [149]	4 1/8 [105]	2 3/8 [60]	6 1/2 [165]	22 1/8 [562]	13/16 [21]	7/8 [22]	13 5/8 [346]			
0805	7 7/8ϕ [200]	7 7/8ϕ [200]	3 1/8 [79]	1 3/8 [35]	6 1/2 [165]	22 1/8 [562]	13/16 [21]	7/8 [22]	13 5/8 [346]			
1009	10 [254]	8 [203]	2 1/2 [64]	1 5/16 [33]	6 1/2 [165]	34 5/8 [879]	13/16 [21]	7/8 [22]	16 [406]	36 [914]	36 [914]	
1209	14 [356]	8 [203]	2 1/2 [64]	1 5/16 [33]	6 1/2 [165]	34 5/8 [879]	13/16 [21]	7/8 [22]	16 [406]			
1215	14 [356]	8 [203]	2 1/2 [64]	2 [51]	6 1/2 [165]	38 5/8 [981]	1 1/2 [38]	1 9/16 [40]	20 [508]	40 [1016]	40 [1016]	12 [305]
1415	14 [356]	10 [254]	2 1/2 [64]	1 [25]	6 1/2 [165]	38 5/8 [981]	1 1/2 [38]	1 9/16 [40]	20 [508]			



Discharge Air Opening Detail

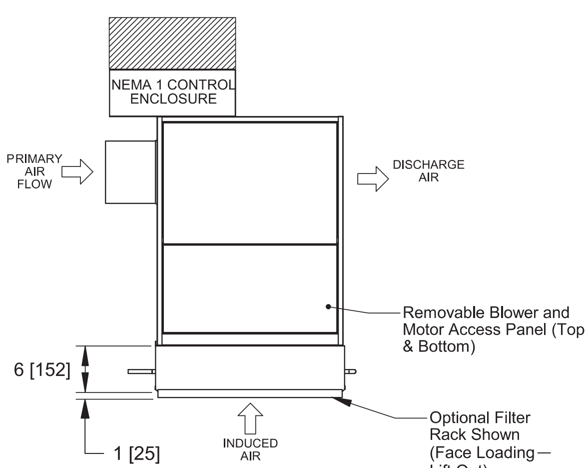
UNIT SIZE	UNIT WEIGHT			
	TVL		TVL-EH	
	Single Wall	Double Wall	Single Wall	Double Wall
0405, 0505, 0605, 0805	58 [26]	72 [33]	77 [35]	91 [41]
1009, 1209	86 [39]	109 [49]	107 [49]	130 [59]
1215, 1415	118 [54]	152 [69]	141 [64]	175 [79]

NOTE: Unit weights are in pounds [kg]. Refer to submittal drawings for hot water coil weights on Model TVL-WC.

Notes (applicable to TVL, TVL-WC, and TVL-EH):

1. Sizes 0405, 0505, 0605, and 0805 have round inlets. Sizes 1009, 1209, 1215, and 1415 have rectangular inlets.
2. Control enclosure is standard with factory mounted electronic controls.
3. Check all national and local codes for required clearances.
4. All dimensions are in inches [mm].
5. Arrangement #1 shown. See next page for other control and heater handing arrangements.

MODEL TVL-WC (HOT WATER COIL)

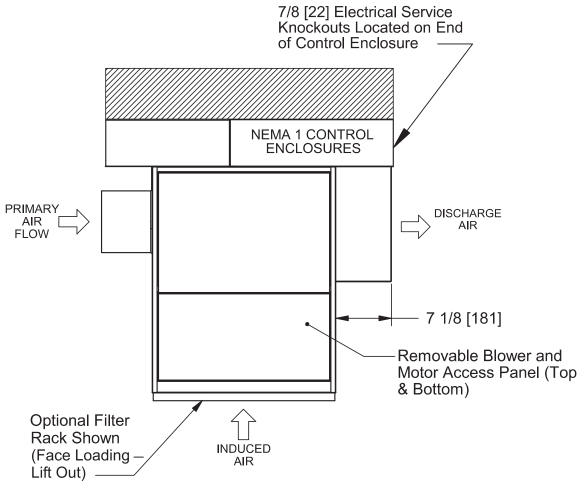


Top View

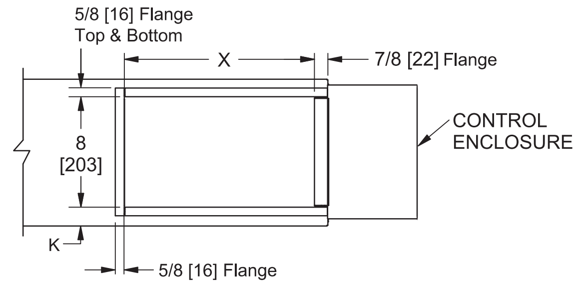
DIMENSIONAL DATA

MODEL TVL-EH (ELECTRIC HEAT)

Drawings are not to scale and not for submittal or installation purposes.



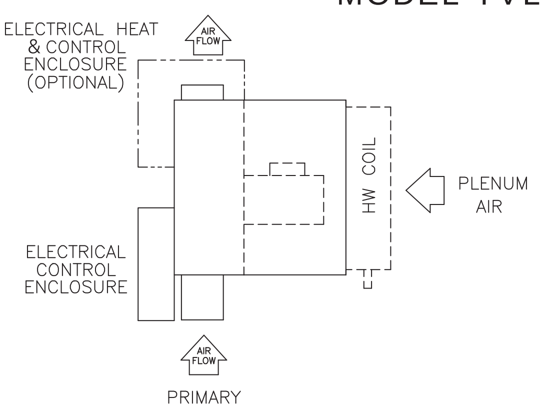
Top View



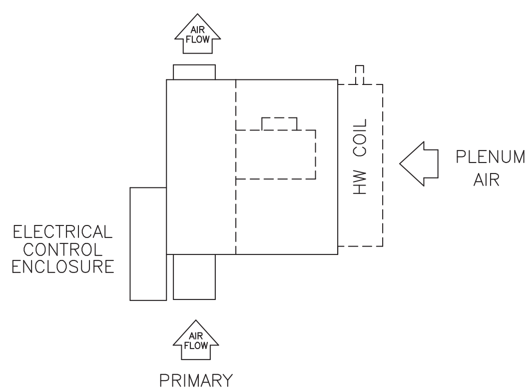
Discharge Air Opening Detail

UNIT SIZE	K
0405, 0505, 0605, 0805, 1009, 1209	1 5/16 [33]
1215, 1415	2 [51]

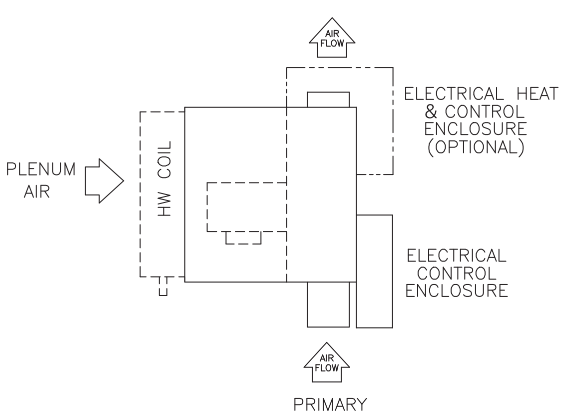
MODEL TVL ARRANGEMENTS



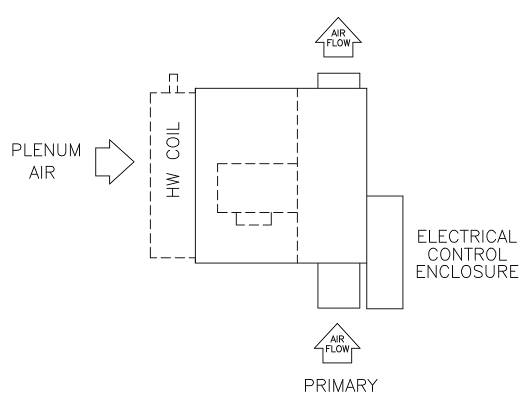
ARRANGEMENT 1
Left Hand Control Unit
With Left Hand Hot Water Coil
or Left Hand Electric Heat



ARRANGEMENT 2
Left Hand Control Unit
With Right Hand Hot Water Coil



ARRANGEMENT 3
Right Hand Control Unit
With Right Hand Hot Water Coil
or Right Hand Electric Heat



ARRANGEMENT 4
Right Hand Control Unit
With Left Hand Hot Water Coil

SOUND POWER DATA

PRIMARY AIR VALVE, DISCHARGE

UNIT SIZE	CFM	0.5" W.G. ∆Ps						1.0" W.G. ∆Ps						3.0" W.G. ∆Ps					
		OCTAVE BAND NUMBER						OCTAVE BAND NUMBER						OCTAVE BAND NUMBER					
		2	3	4	5	6	7	2	3	4	5	6	7	2	3	4	5	6	7
0405	100	49	50	42	36	32	29	50	52	47	41	36	32	52	53	50	46	46	43
	150	51	53	45	40	35	32	53	57	51	44	40	36	58	61	56	50	49	46
	200	54	57	48	43	38	35	57	60	53	47	43	39	63	65	59	52	41	48
	250	58	60	51	47	41	38	61	63	56	50	45	41	67	69	62	54	52	50
0505	100	44	44	42	36	33	30	45	45	46	42	38	34	50	47	48	47	48	45
	200	48	47	44	40	36	33	51	51	49	44	41	37	57	56	55	52	51	48
	300	55	54	49	45	40	36	56	56	53	48	44	40	63	62	59	54	52	49
	350	57	56	52	48	43	39	59	58	55	51	46	42	65	64	61	56	54	51
0605	200	48	45	42	36	33	30	50	49	47	42	38	34	55	54	53	50	48	45
	250	50	48	43	38	34	31	52	51	48	43	38	34	58	57	55	51	48	45
	300	51	50	45	40	34	31	55	53	50	44	39	35	60	59	56	51	49	46
	350	56	52	47	41	38	34	58	56	52	46	41	37	63	61	59	52	49	46
	450	61	57	52	46	42	38	63	59	56	49	45	40	67	65	62	54	51	48
	550	65	60	55	50	45	41	68	64	60	53	49	44	71	68	65	57	54	51
0805	300	51	48	46	43	38	34	55	53	52	49	42	39	61	58	58	56	51	49
	400	54	50	47	44	39	34	58	55	52	49	44	40	63	61	63	59	53	51
	500	57	53	49	45	42	36	61	57	54	50	47	42	66	64	64	59	55	52
	600	58	55	51	47	44	38	62	60	55	52	49	43	68	66	66	60	57	54
	800	63	59	55	51	48	42	66	62	59	54	53	47	72	70	67	63	61	56
	1000	65	61	59	55	51	46	69	65	62	57	55	50	75	72	70	64	63	58
1009	600	53	48	47	43	41	38	60	57	52	48	47	47	67	67	63	57	55	57
	800	54	50	48	44	42	39	62	58	53	49	48	48	69	70	65	58	56	59
	1000	55	52	49	45	43	40	64	59	54	50	49	49	71	73	67	59	57	61
	1200	55	55	55	47	44	41	64	59	55	50	49	50	75	74	67	60	58	63
	1400	56	56	61	50	46	43	64	61	57	51	50	51	77	75	67	60	59	64
	1600	59	57	66	54	50	48	64	62	65	53	52	52	78	75	67	61	59	64
1209	800	53	48	45	43	40	36	58	56	50	47	47	44	62	60	61	62	55	54
	1100	55	50	47	45	43	39	63	59	52	49	48	47	68	70	66	58	57	59
	1400	55	52	48	45	43	40	64	59	54	49	49	48	70	73	67	58	57	60
	1700	55	54	53	46	43	41	64	59	55	50	49	49	74	74	67	59	58	62
	2000	56	56	61	50	46	43	64	61	57	51	50	51	77	75	67	60	59	64
	2300	59	57	66	54	50	48	64	62	65	53	52	52	78	75	67	61	59	64
1215	800	55	50	47	44	42	39	63	59	51	48	48	47	67	69	66	59	57	58
	1100	55	50	48	45	43	40	64	59	52	49	49	48	69	72	67	58	57	60
	1400	55	52	49	45	43	40	64	59	54	50	49	49	71	73	67	59	57	61
	1700	55	57	55	47	44	41	64	59	55	50	49	50	75	74	67	60	58	63
	2000	56	57	61	50	46	43	64	61	57	51	50	51	77	75	67	60	59	64
	2300	59	57	66	54	50	48	64	62	65	53	52	52	78	75	67	61	59	64
1415	1200	57	53	48	46	44	41	65	61	52	49	48	47	65	67	65	59	58	59
	1500	57	53	49	46	43	42	65	62	54	50	49	49	68	71	67	59	58	60
	1800	58	54	52	46	44	42	66	62	55	50	50	49	72	77	69	60	59	61
	2100	60	56	53	47	45	44	67	62	57	51	50	50	77	77	69	61	59	62
	2400	61	60	56	48	46	45	68	63	58	52	50	51	78	77	69	61	59	62
	2700	61	61	59	51	47	45	68	64	60	53	51	51	78	77	69	62	60	63
	3000	62	62	60	55	49	47	69	65	63	55	52	52	79	77	69	62	60	63

NOTES:
- Data obtained from tests conducted in accordance with ARI Standard 880.
- Sound levels are expressed in decibels, dB re: 1 x 10^{12} Watts.
- ∆Ps is the difference in static pressure across the primary air valve.

SOUND POWER DATA

PRIMARY AIR VALVE, RADIATED

UNIT SIZE	CFM	0.5" W.G. ∆Ps						1.0" W.G. ∆Ps						3.0" W.G. ∆Ps					
		OCTAVE BAND NUMBER						OCTAVE BAND NUMBER						OCTAVE BAND NUMBER					
		2	3	4	5	6	7	2	3	4	5	6	7	2	3	4	5	6	7
0405	100	55	45	40	34	31	31	58	47	43	36	32	31	64	56	52	44	39	35
	150	60	49	43	37	33	32	63	52	47	41	36	33	67	60	56	47	41	36
	200	63	53	49	39	34	32	65	56	52	43	38	33	71	64	59	49	45	37
	250	66	56	53	44	37	32	68	59	56	46	39	33	73	66	61	52	48	40
0505	100	52	40	38	34	31	30	56	45	41	35	31	31	60	50	48	40	36	33
	200	56	44	41	35	33	31	60	50	46	38	35	32	65	58	55	45	39	35
	300	62	52	46	38	34	31	65	56	52	42	38	33	71	64	59	49	45	37
	350	64	54	50	41	36	32	68	59	55	45	38	33	73	67	62	52	49	38
0605	200	52	40	38	34	31	30	56	45	41	35	31	31	60	50	48	40	36	33
	250	55	42	40	34	31	31	58	47	43	36	32	31	64	56	52	44	39	35
	300	56	44	41	35	33	31	60	50	46	38	35	32	65	58	55	45	39	35
	350	60	49	43	37	33	32	63	52	47	41	36	33	67	60	56	47	41	36
	450	63	53	49	39	34	32	65	56	52	42	38	33	71	64	59	49	45	37
	550	66	56	53	44	37	32	68	59	56	46	39	33	73	66	61	52	48	41
0805	300	52	40	40	34	31	30	56	45	41	35	31	31	60	50	48	40	36	33
	400	55	42	40	34	31	31	58	47	43	36	32	31	64	56	52	44	39	35
	500	56	44	40	35	33	31	60	50	46	38	35	33	65	58	55	45	39	35
	600	60	49	43	37	33	32	63	52	47	41	36	33	67	60	56	47	41	36
	800	63	53	49	39	34	32	65	56	52	42	38	33	71	64	59	49	45	37
	1000	66	56	53	44	37	32	68	59	56	46	39	33	73	66	61	52	48	41
1009	600	54	46	36	37	35	31	56	53	39	38	37	32	64	62	54	47	44	41
	800	56	49	42	37	35	32	59	55	44	39	37	33	67	65	55	47	43	41
	1000	57	52	48	38	35	33	62	56	49	40	37	34	71	67	57	48	43	41
	1200	59	54	52	41	37	34	65	57	52	43	39	35	74	68	57	49	44	42
	1400	62	55	54	46	39	35	66	59	54	45	40	36	76	69	59	50	45	43
	1600	66	60	59	50	42	36	67	60	58	49	43	37	77	69	60	52	47	43
1209	800	54	47	39	36	35	32	59	52	42	38	36	33	64	60	53	47	42	40
	1100	55	48	42	37	35	32	59	54	43	38	36	33	67	65	55	47	43	41
	1400	57	51	48	39	35	33	62	56	49	40	38	34	70	67	56	47	43	41
	1700	59	54	52	42	37	34	64	58	52	42	39	35	73	68	57	49	44	42
	2000	62	55	54	46	39	35	66	59	54	45	40	36	76	69	59	50	45	43
	2300	66	60	59	50	42	36	67	60	58	49	43	37	77	69	60	52	47	43
1215	800	52	47	42	36	36	37	56	51	44	38	37	38	60	58	55	49	45	44
	1100	55	49	43	37	37	38	58	54	46	40	39	39	63	61	56	50	47	46
	1400	56	50	45	38	37	38	61	56	48	41	40	40	66	63	58	51	48	47
	1700	58	52	48	40	38	38	64	57	50	43	41	40	69	65	60	53	49	48
	2000	59	55	54	43	40	39	66	59	53	45	43	41	72	67	61	54	50	49
	2300	61	56	55	45	43	41	66	60	55	47	45	42	74	70	62	55	51	49
1415	1200	54	48	43	38	37	37	57	53	45	40	39	39	62	61	56	50	46	46
	1500	56	49	44	37	37	38	59	55	46	40	39	39	65	62	57	51	47	46
	1800	57	50	46	38	37	38	62	56	49	41	40	40	67	63	58	52	48	47
	2100	58	52	47	39	38	38	64	57	50	43	40	40	69	65	59	52	49	48
	2400	58	53	49	40	39	39	65	58	51	44	41	41	70	66	60	53	49	48
	2700	59	55	55	43	40	39	66	59	53	45	43	41	72	67	61	54	50	49
	3000	62	57	57	46	43	41	66	60	55	47	45	42	74	70	62	55	51	49

NOTES:
- Data obtained from tests conducted in accordance with ARI Standard 880.
- Sound levels are expressed in decibels, dB re: 1 x 10^{12} Watts.
- ∆Ps is the difference in static pressure across the primary air valve.

SOUND POWER DATA, ARI RATINGS

UNIT FAN ONLY

UNIT SIZE	CFM	DISCHARGE SOUND POWER DATA – OCTAVE BAND NUMBER 2	3	4	5	6	7	RADIATED SOUND POWER DATA – OCTAVE BAND NUMBER 2	3	4	5	6	7
0405, 0505, 0605, 0805	200	51	48	46	42	39	33	58	52	48	42	33	32
	300	55	51	48	46	41	36	60	57	53	46	39	36
	400	56	54	49	50	42	38	63	60	56	49	42	41
	500	58	55	51	52	45	40	66	63	58	51	45	44
1009 1209	300	52	50	46	43	40	37	58	56	50	43	40	39
	400	54	51	47	45	41	37	60	58	51	45	40	39
	500	54	51	47	45	41	37	61	60	53	48	41	39
	600	57	56	50	50	45	40	63	62	55	50	46	42
	700	58	58	51	51	46	41	64	65	58	54	49	46
	800	59	61	52	52	48	43	67	66	60	56	52	49
	900	61	64	54	55	50	46	69	67	62	57	53	50
1215 1415	600	56	52	48	46	42	38	62	61	53	45	41	40
	700	57	53	49	47	42	40	64	63	55	47	44	42
	800	59	55	50	49	43	41	65	64	57	49	46	44
	900	61	57	52	51	45	43	67	66	59	51	48	46
	1000	63	59	54	53	47	46	68	67	60	53	50	48
	1100	64	60	55	54	48	47	69	67	62	54	51	50
	1200	65	61	56	55	49	48	70	68	63	55	53	52
	1300	66	63	58	57	51	50	71	69	64	57	54	53
	1400	68	65	60	59	53	53	72	70	65	58	56	55

NOTES:
- Data obtained from tests conducted in accordance with ARI Standard 880.
- Sound levels are expressed in decibels, dB re: 1 x 10^{12} Watts.
- Fan external static pressure is 0.25" w.g.

ARI RATINGS: FAN PERFORMANCE

UNIT SIZE	FAN CFM	POWER (WATTS)	SOUND POWER LEVEL, dB re: 10^{-12} WATTS – DISCHARGE – OCTAVE BAND NUMBER 2	3	4	5	6	7	RADIATED – OCTAVE BAND NUMBER 2	3	4	5	6	7
0405	450	202	58	54	50	51	43	38	65	62	57	51	44	43
0505	450	202	58	54	50	51	43	38	65	62	57	51	44	43
0605	450	202	58	54	50	51	43	38	65	62	57	51	44	43
0805	450	202	58	54	50	51	43	38	65	62	57	51	44	43
1009	850	268	61	63	54	54	49	46	68	67	61	56	52	50
1209	850	268	61	63	54	54	49	46	68	67	61	56	52	50
1215	1450	585	69	66	61	60	54	53	73	72	66	59	57	56
1415	1450	585	69	66	61	60	54	53	73	72	66	59	57	56

NOTE: Fan external static pressure is 0.25" w.g.

ARI PERFORMANCE CERTIFIED™
ARI Standard 880 VAV Terminal
www.aridirectory.org

ARI RATINGS: PRIMARY AIR VALVE PERFORMANCE

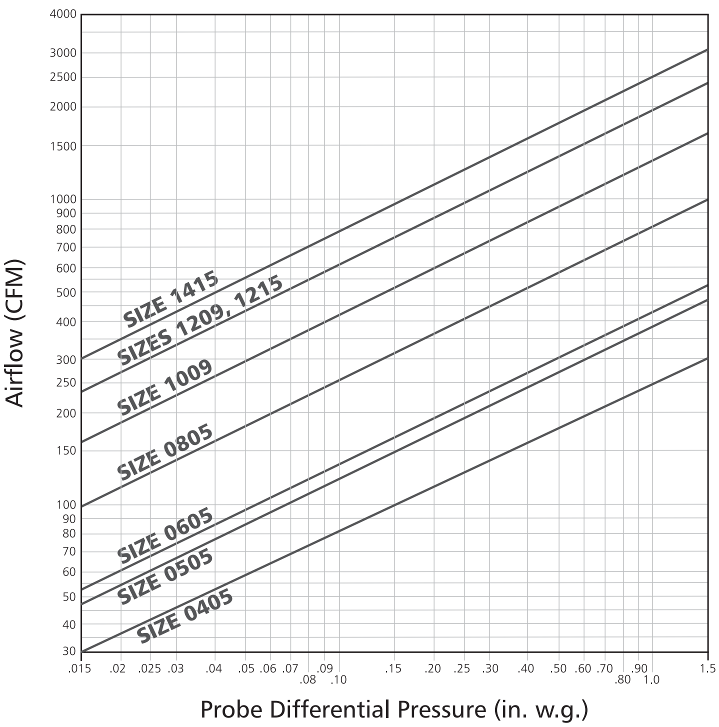
UNIT SIZE	PRIMARY CFM	MIN. OPER. PRESSURE (In. Water)	SOUND POWER LEVEL, dB re: 10^{-12} WATTS – DISCHARGE – OCTAVE BAND NUMBER 2	3	4	5	6	7	RADIATED – OCTAVE BAND NUMBER 2	3	4	5	6	7
0405	150	0.02	56	58	53	45	41	37	65	55	49	43	38	36
0505	250	0.02	56	56	53	48	44	40	66	57	52	42	39	35
0605	400	0.12	63	59	56	49	45	40	66	58	54	44	40	36
0805	700	0.08	67	64	60	56	54	48	64	54	49	41	37	33
1009	1100	0.11	65	60	54	50	49	48	62	55	46	40	39	39
1209	1550	0.12	68	64	59	53	53	55	67	60	52	43	39	37
1215	1550	0.12	66	63	57	52	52	54	62	56	47	43	40	40
1415	1925	0.16	67	66	60	55	54	56	65	58	50	43	41	40

NOTE: Inlet static pressure is 1.5" w.g.

PRIMARY AIRFLOW CALIBRATION

FLOWSTAR™ CALIBRATION CHART

(For dead-end differential pressure transducers)



NOTE: Maximum and minimum CFM limits are dependent on the type of controls that are utilized. Refer to the table below when factory provided pneumatic or analog electric controls are furnished by Johnson Controls. When DDC controls are furnished by others, the CFM limits are dependent on the specific control vendor that is employed. After obtaining the differential pressure range from the control vendor, the maximum and minimum CFM limits can be obtained from the chart above (many controllers are capable of controlling minimum setpoint down to .015" w.g.).

AIRFLOW RANGES (CFM)

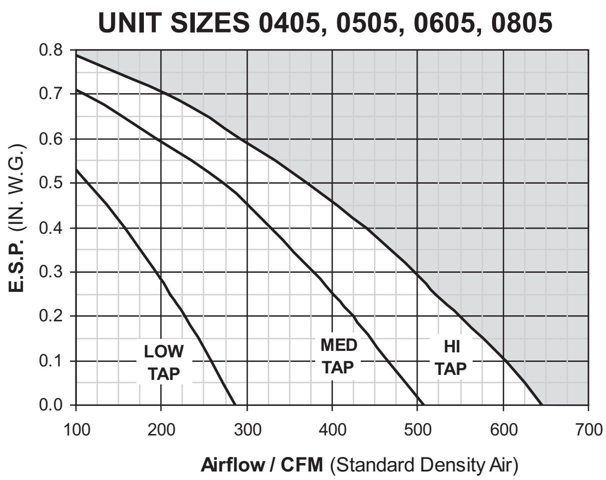
UNIT SIZE	400 SERIES (PNEUMATIC) STANDARD CONTROLLER		7000 SERIES ANALOG ELECTRONIC		DDC CONSIGNMENT CONTROLS (See Notes Below)				
					MIN.			MAX.	
	MIN.	MAX.	MIN.	MAX.	Min. transducer differential pressure (in.w.g.)			Max. transducer differential pressure (in.w.g.)	
					0.015	0.03	0.05	1.0	>=1.5
0405	43	250	35	250	30	43	55	250	250
0505	68	350	50	350	48	68	88	350	350
0605	75	490	60	550	53	75	97	435	530
0805	145	960	115	1000	105	145	190	840	1000
1009	235	1545	170	1600	170	235	305	1370	1600
1209, 1215	340	2250	240	2300	240	340	435	1955	2300
1415	430	2835	305	3045	305	430	555	2485	3000

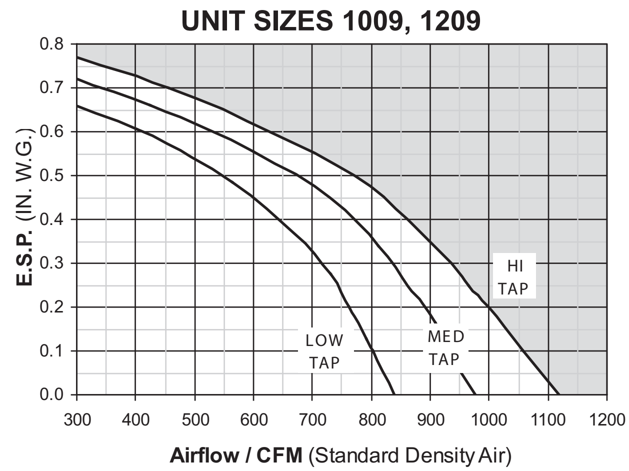
NOTES:
1. Minimum and maximum airflow limits are dependent on the specific DDC controller supplied. Contact the control vendor to obtain the minimum and maximum differential pressure limits (inches W.G.) of the transducer utilized with the DDC controller.
2. Maximum CFM is limited to value shown in General Selection Data.

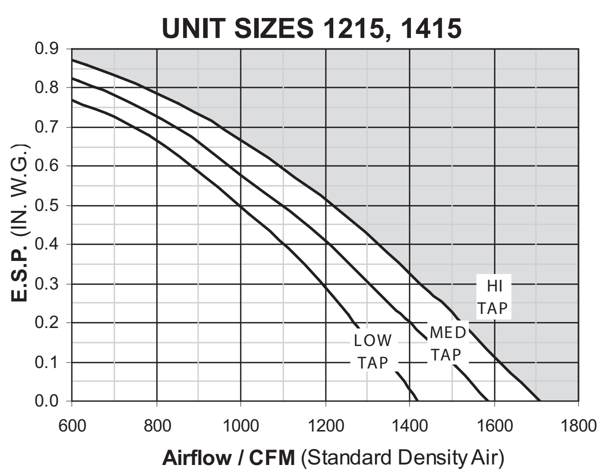
FAN PERFORMANCE DATA

GENERAL FAN NOTE

Each fan curve depicts the actual performance for the relative motor tap without any additional fan balance adjustment. Actual specified capacities which fall below a particular fan curve (LOW, MED or HI) can be obtained by adjustment of the electronic fan speed controller. Selections can be made anywhere in the non-shaded area.







Notes:

1. Terminals equipped with a hot water coil (Model TVL-WC) require the addition of the coil pressure drop and the specified E.S.P. prior to making a fan selection.
2. Terminals with electric heat (Model TVL-EH) require a minimum of 0.1" w.g. downstream pressure.

ELECTRIC HEAT

MODEL TVL-EH

STANDARD FEATURES
- cETL listed as an assembly for safety compliance per UL 1995
- Primary auto-reset high limit
- Secondary high limit
- Hinged control panel
- Ni-Chrome elements
- Primary/secondary power terminations
- Fusing per NEC
- Wiring diagram and ETL label
- Fan interlock device (relay or P.E. switch)
- Single point power connection
- Available kW increments are as follows:
  0.5 to 12.0 kW - .50 kW;
  12.0 to 18.0 kW - 1.0 kW

OPTIONAL FEATURES
- Disconnect (toggle or door interlocking)
- P.E. switches
- Mercury and magnetic contactors
- Manual reset secondary limit
- Proportional control (SSR)
- 24 volt control transformer
- Airflow switch

SELECTION PROCEDURE
With standard heater elements, the maximum capacity (kW) is obtained by dividing the heating (fan) SCFM by 70. In other words, the terminal must have at least 70 SCFM per kW. In addition, each size terminal has a maximum allowable kW based upon the specific heater element configuration (i.e. voltage, phase, number of steps, etc.). Contact your Johnson Controls representative for design assistance.

Heaters require a minimum of 0.1" w.g. downstream static pressure to ensure proper operation.

For optimum diffuser performance in overhead heating applications, the supply air temperature should be within 20°F of the desired space temperature. This typically requires a higher air capacity which provides higher air motion in the space increasing thermal comfort. The electric heater should be selected with this in mind, keeping the LAT as low as possible.

Selection Equations

$$kW = \frac{SCFM \times \Delta T \times 1.085^*}{3413}$$

$$CFM = \frac{kW \times 3413}{\Delta T \times 1.085^*}$$

$$T = \frac{kW \times 3413}{SCFM \times 1.085^*}$$

** Air density at sea level - reduce by 0.036 for each 1000 feet of altitude above sea level.*

Calculating Line Amperage

$$\text{Single Phase Amps} = \frac{kW \times 1000}{Volts}$$

$$\text{Three Phase Amps} = \frac{kW \times 1000}{Volts \times 1.73}$$

SINGLE POINT POWER		ELECTRIC HEAT KW LIMITS					
		Unit Size					
Heater Volts	Motor Volts	0405, 0505 0605, 0805		1009, 1209		1215, 1415	
		Min	Max	Min	Max	Min	Max
115 - 120 / 1ϕ	115 - 120 / 1ϕ	0.5	5.5	0.5	5.5	0.5	5.5
208 / 1ϕ	208 / 1ϕ	0.5	6	0.5	9.5	0.5	9.5
230 - 240 / 1ϕ	230 / 1ϕ	0.5	6	0.5	11	0.5	11
277 / 1ϕ	277 / 1ϕ	0.5	6	0.5	12	0.5	13
208 / 3ϕ, 3 wire	208 / 1ϕ	1	6	1	12	1	17
240 / 3ϕ, 3 wire	230 / 1ϕ	1	6	1	12	1	18
208 / 3ϕ, 4 wire	115 - 120 / 1ϕ	1	6	1	12	1	17
240 / 3ϕ, 4 wire	115 - 120 / 1ϕ	1	6	1	12	1	18
460 - 480 / 3ϕ, 4 wire	277 / 1ϕ	1	6	1	12	1	18

HOT WATER COIL DATA

MODEL TVL-WC

STANDARD FEATURES

- Designed, manufactured and tested by Johnson Controls
- Aluminum fin construction with die-formed spacer collars for uniform spacing
- Mechanically expanded copper tubes, leak tested to 450 PSIG air pressure and rated at 300 PSIG working pressure at 200°F
- 1, 2, 3 and 4 row configurations
- Male sweat type water connections

OPTIONAL FEATURES

- Multi-circuit coils for reduced water pressure drop
- Opposite hand water connections

DEFINITION OF TERMS

EAT Entering Air Temperature (°F)
LAT Leaving Air Temperature (°F)
EWT Entering Water Temperature (°F)
LWT Leaving Water Temperature (°F)
CFM Air Capacity (Cubic Feet per Minute)
GPM Water Capacity (Gallons per Minute)
MBH 1,000 BTUH
BTUH Coil Heating Capacity (British Thermal Units per Hour)
∆T EWT minus EAT

SELECTION PROCEDURE

Hot Water Coil Performance Tables are based upon a temperature difference of 115°F between entering water and entering air. If this ∆T is suitable, proceed directly to the performance tables for selection. All pertinent performance data is tabulated.

ENTERING WATER - AIR TEMPERATURE DIFFERENTIAL (∆T) CORRECTION FACTORS															
∆T	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**
FACTOR	0.15	0.19	0.23	0.27	0.31	0.35	0.39	0.43	0.47	0.51	0.55	0.59	0.63	0.67	0.71
∆T	**85**	**90**	**95**	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**
FACTOR	0.75	0.79	0.83	0.88	0.92	0.96	1.00	1.04	1.08	1.13	1.17	1.21	1.25	1.29	1.33

The table above gives correction factors for various entering ∆T's (difference between entering water and entering air temperatures). Multiply MBH values obtained from selection tables by the appropriate correction factor above to obtain the actual MBH value. Air and water pressure drop can be read directly from the selection table. The leaving air and leaving water temperatures can be calculated from the following fundamental formulas:

$$LAT = EAT + \frac{BTUH}{1.085 \times CFM} \qquad LWT = EWT - \frac{BTUH}{500 \times GPM}$$

HOT WATER COIL DATA

MODEL TVL-WC UNIT SIZES 0405, 0505, 0605, 0805

STANDARD CIRCUITING

AIRFLOW		WATER FLOW			LAT (°F)		LWT (°F)		CAPACITY (MBH)	
Rate (CFM)	Air PD (IN.W.G.)	Rate (GPM)	Water PD (FT.W.G.) 1 Row	Water PD (FT.W.G.) 2 Row	1 Row	2 Row	1 Row	2 Row	1 Row	2 Row
100	1 Row 0.01 2 Row 0.01	0.5	0.45	0.88	132.5	156.6	150.0	139.5	7.3	9.9
		1.0	1.39	2.67	139.9	164.5	163.3	157.9	8.1	10.8
		2.0	4.90	9.28	144.3	168.3	171.2	168.5	8.6	11.2
		4.0	17.38	-	146.8	-	175.4	-	8.9	-
200	1 Row 0.01 2 Row 0.02	0.5	0.45	0.88	112.5	133.0	137.9	120.0	10.3	14.7
		1.0	1.39	2.67	120.7	145.7	155.3	144.2	12.1	17.5
		2.0	4.90	9.28	125.9	152.8	166.5	160.5	13.2	19.0
		4.0	17.38	-	128.9	-	172.9	-	13.9	-
300	1 Row 0.02 2 Row 0.03	0.5	0.45	0.88	102.1	118.5	130.7	109.2	12.1	17.4
		1.0	1.39	2.67	110.1	132.5	150.0	135.2	14.7	21.9
		2.0	4.90	9.28	115.5	141.2	163.2	154.6	16.4	24.8
		4.0	17.38	-	118.7	-	171.0	-	17.5	-
400	1 Row 0.02 2 Row 0.05	0.5	0.45	0.88	95.7	109.1	125.8	102.4	13.3	19.1
		1.0	1.39	2.67	103.3	123.1	146.1	128.7	16.6	25.2
		2.0	4.90	9.28	108.6	132.6	160.6	150.0	18.9	29.3
		4.0	17.38	-	111.9	-	169.6	-	20.3	-
500	1 Row 0.03 2 Row 0.07	0.5	0.45	0.88	91.3	102.4	122.0	97.7	14.2	20.3
		1.0	1.39	2.67	98.4	116.0	143.0	123.7	18.1	27.6
		2.0	4.90	9.28	103.6	125.8	158.5	146.3	20.9	32.9
		4.0	17.38	-	106.9	-	168.3	-	22.7	-

MULTI-CIRCUITING

AIRFLOW		WATER FLOW			LAT (°F)		LWT (°F)		CAPACITY (MBH)	
Rate (CFM)	Air PD (IN.W.G.)	Rate (GPM)	Water PD (FT.W.G.) 1 Row	Water PD (FT.W.G.) 2 Row	1 Row	2 Row	1 Row	2 Row	1 Row	2 Row
100	1 Row 0.01 2 Row 0.01	0.5	0.09	0.15	129.3	153.8	151.5	140.7	7.0	9.6
		1.0	0.31	0.52	137.7	162.8	163.8	158.3	7.9	10.6
		2.0	1.05	1.68	142.9	167.4	171.3	168.6	8.4	11.1
		4.0	3.85	6.03	145.9	169.6	175.5	174.2	8.8	11.3
200	1 Row 0.01 2 Row 0.02	0.5	0.09	0.15	109.2	129.5	140.8	123.0	9.6	14.0
		1.0	0.31	0.52	118.1	143.0	156.4	145.4	11.5	16.9
		2.0	1.05	1.68	124.1	151.1	166.8	160.9	12.8	18.6
		4.0	3.85	6.03	127.8	155.5	173.0	169.9	13.6	19.6
300	1 Row 0.02 2 Row 0.03	0.5	0.09	0.15	99.1	115.2	134.7	113.6	11.1	16.3
		1.0	0.31	0.52	107.5	129.5	151.7	137.2	13.8	21.0
		2.0	1.05	1.68	113.6	139.2	163.8	155.3	15.8	24.1
		4.0	3.85	6.03	117.5	144.8	171.2	166.7	17.1	25.9
400	1 Row 0.02 2 Row 0.05	0.5	0.09	0.15	92.9	106.1	130.6	107.6	12.1	17.8
		1.0	0.31	0.52	100.8	120.1	148.3	131.3	15.5	23.9
		2.0	1.05	1.68	106.7	130.3	161.4	151.0	18.1	28.3
		4.0	3.85	6.03	110.7	136.6	169.8	164.1	19.8	31.0
500	1 Row 0.03 2 Row 0.07	0.5	0.09	0.15	88.8	99.8	127.5	103.5	12.9	18.8
		1.0	0.31	0.52	96.1	113.1	145.6	126.9	16.8	26.0
		2.0	1.05	1.68	101.8	123.5	159.6	147.6	19.9	31.7
		4.0	3.85	6.03	105.7	130.2	168.7	161.9	22.0	35.3

NOTES:
1. Data is based on 180°F entering water and 65°F entering air temperature at sea level. See selection procedure for other conditions.
2. For optimum diffuser performance in overhead heating applications, the supply air temperature should be within 20°F of the desired space temperature. This typically requires a higher air capacity which provides higher air motion in the space, increasing thermal comfort. The hot water coil should be selected with this in mind, keeping the LAT as low as possible.

HOT WATER COIL DATA

MODEL TVL-WC UNIT SIZES 1009, 1209

STANDARD CIRCUITING

AIRFLOW		WATER FLOW			LAT (°F)		LWT (°F)		CAPACITY (MBH)	
Rate (CFM)	Air PD (IN.W.G.)	Rate (GPM)	Water PD (FT.W.G.) 1 Row	Water PD (FT.W.G.) 2 Row	1 Row	2 Row	1 Row	2 Row	1 Row	2 Row
300	1 Row 0.01 2 Row 0.02	0.5	0.55	1.09	108.1	124.5	122.9	101.5	14.0	19.3
		1.0	1.68	3.27	118.0	140.8	144.8	129.7	17.2	24.6
		2.0	5.84	11.23	124.6	150.6	160.1	151.5	19.4	27.8
		4.0	20.57	-	128.6	-	169.4	-	20.7	-
400	1 Row 0.01 2 Row 0.02	0.5	0.55	1.09	100.8	113.9	116.9	93.9	15.5	21.2
		1.0	1.68	3.27	110.3	130.8	139.8	121.9	19.6	28.5
		2.0	5.84	11.23	117.1	142.0	156.9	145.9	22.6	33.4
		4.0	20.57	-	121.2	-	167.5	-	24.3	-
500	1 Row 0.02 2 Row 0.03	0.5	0.55	1.09	95.7	106.5	112.4	88.9	16.6	22.5
		1.0	1.68	3.27	104.8	123.1	136.0	115.9	21.6	31.5
		2.0	5.84	11.23	111.5	135.0	154.2	141.3	25.2	37.9
		4.0	20.57	-	115.7	-	165.9	-	27.4	-
600	1 Row 0.02 2 Row 0.05	0.5	0.55	1.09	91.9	100.9	108.9	85.4	17.5	23.4
		1.0	1.68	3.27	100.6	117.0	132.8	111.3	23.1	33.8
		2.0	5.84	11.23	107.1	129.2	151.9	137.4	27.4	41.7
		4.0	20.57	-	111.3	-	164.5	-	30.1	-
700	1 Row 0.03 2 Row 0.06	0.5	0.55	1.09	89.0	96.7	106.2	82.7	18.2	24.0
		1.0	1.68	3.27	97.3	112.0	130.1	107.5	24.5	35.7
		2.0	5.84	11.23	103.7	124.3	150.0	134.1	29.3	45.0
		4.0	20.57	-	107.8	-	163.3	-	32.5	-
800	1 Row 0.04 2 Row 0.07	0.5	0.55	1.09	86.6	80.6	103.8	93.3	18.7	24.5
		1.0	1.68	3.27	94.5	107.9	127.8	104.4	25.6	37.2
		2.0	5.84	11.23	100.8	120.2	148.3	131.2	31.0	47.8
		4.0	20.57	-	104.9	-	162.2	-	34.6	-
900	1 Row 0.04 2 Row 0.09	0.5	0.55	1.09	84.7	90.6	101.9	79.0	19.2	24.9
		1.0	1.68	3.27	92.3	104.5	125.8	101.8	26.6	38.5
		2.0	5.84	11.23	98.4	116.6	146.7	128.6	32.5	50.3
		4.0	20.57	-	102.5	100.7	161.3	157.2	36.5	-

MULTI-CIRCUITING

AIRFLOW		WATER FLOW			LAT (°F)		LWT (°F)		CAPACITY (MBH)	
Rate (CFM)	Air PD (IN.W.G.)	Rate (GPM)	Water PD (FT.W.G.) 1 Row	Water PD (FT.W.G.) 2 Row	1 Row	2 Row	1 Row	2 Row	1 Row	2 Row
300	1 Row 0.01 2 Row 0.02	0.5	0.10	0.19	105.4	121.8	126.4	105.0	13.1	18.5
		1.0	0.36	0.62	115.7	138.4	146.3	131.3	16.5	23.9
		2.0	1.19	1.97	122.9	148.9	160.7	152.1	18.8	27.3
		4.0	4.31	6.97	127.5	154.7	169.6	165.0	20.3	29.2
400	1 Row 0.01 2 Row 0.02	0.5	0.11	0.19	98.3	111.6	121.2	98.1	14.4	20.2
		1.0	0.36	0.62	108.0	128.3	141.9	124.1	18.7	27.4
		2.0	1.19	1.97	115.3	140.1	157.6	146.7	21.8	32.5
		4.0	4.32	6.98	120.0	147.0	167.8	161.8	23.8	35.5
500	1 Row 0.02 2 Row 0.03	0.5	0.11	0.19	93.4	104.4	117.4	93.4	15.4	21.3
		1.0	0.36	0.63	102.6	120.6	138.4	118.6	20.4	30.1
		2.0	1.19	1.98	109.7	133.0	155.2	142.4	24.2	36.8
		4.0	4.32	7.00	114.5	140.6	166.2	159.0	26.8	40.9
600	1 Row 0.02 2 Row 0.05	0.5	0.11	0.19	89.8	99.1	114.4	90.1	16.1	22.2
		1.0	0.36	0.63	98.5	114.6	135.6	114.4	21.7	32.2
		2.0	1.19	1.99	105.4	127.1	153.1	138.7	26.3	40.4
		4.0	4.32	7.01	110.1	135.2	164.9	156.6	29.3	45.6
700	1 Row 0.03 2 Row 0.06	0.5	0.11	0.19	87.0	95.1	112.0	87.6	16.7	22.8
		1.0	0.36	0.63	95.2	109.7	133.2	111.0	22.9	33.9
		2.0	1.20	1.99	102.0	122.3	151.3	135.7	28.0	43.4
		4.0	4.33	7.02	106.6	130.6	163.8	154.5	31.6	49.8
800	1 Row 0.04 2 Row 0.07	0.5	0.11	0.19	84.8	91.9	110.0	85.6	17.2	23.3
		1.0	0.36	0.63	92.6	105.8	131.2	108.1	23.9	35.3
		2.0	1.20	1.99	99.1	118.1	149.7	133.0	29.6	46.0
		4.0	4.33	7.03	103.7	126.7	162.8	152.6	33.6	53.4
900	1 Row 0.04 2 Row 0.09	0.5	0.11	0.19	83.1	89.3	108.4	84.0	17.6	23.7
		1.0	0.36	0.63	90.4	102.5	129.5	105.8	24.8	36.5
		2.0	1.20	2.00	96.7	114.6	148.3	130.7	31.0	48.4
		4.0	4.33	7.03	101.3	123.2	161.8	150.9	35.4	56.8

See Notes on following page.

HOT WATER COIL DATA

MODEL TVL-WC UNIT SIZES 1215 AND 1415

STANDARD CIRCUITING

AIRFLOW		WATER FLOW			LAT (°F)		LWT (°F)		CAPACITY (MBH)	
Rate (CFM)	Air PD (IN.W.G.)	Rate (GPM)	Water PD (FT.W.G.) 1 Row	Water PD (FT.W.G.) 2 Row	1 Row	2 Row	1 Row	2 Row	1 Row	2 Row
600	1 Row 0.02 2 Row 0.04	0.5	0.58	0.20	92.8	100.0	106.6	87.8	18.1	22.7
		1.0	1.78	0.66	102.0	116.2	130.9	112.3	24.1	33.3
		2.0	6.17	2.07	109.0	129.3	150.7	137.3	28.6	41.8
		4.0	21.66	7.30	113.5	137.7	163.8	155.8	31.5	47.2
800	1 Row 0.03 2 Row 0.06	0.5	0.58	0.20	87.4	92.5	101.3	83.4	19.4	23.8
		1.0	1.78	0.66	95.8	107.1	125.6	105.8	26.7	36.5
		2.0	6.17	2.07	102.4	120.1	146.8	131.2	32.4	47.8
		4.0	21.66	7.30	106.9	129.1	161.4	151.6	36.3	55.5
1000	1 Row 0.04 2 Row 0.09	0.5	0.58	0.20	83.7	87.7	97.6	80.5	20.3	24.6
		1.0	1.78	0.66	91.4	100.8	121.7	101.2	28.6	38.8
		2.0	6.17	2.07	97.8	113.4	143.7	126.6	35.5	52.4
		4.0	21.66	7.30	102.1	122.5	159.4	148.1	40.2	62.3
1200	1 Row 0.06 2 Row 0.12	0.5	0.58	0.20	81.1	84.3	94.8	78.6	21.0	25.0
		1.0	1.78	0.66	88.2	96.1	118.5	97.8	30.2	40.5
		2.0	6.17	2.07	94.3	108.1	141.1	122.9	38.1	56.0
		4.0	21.66	7.30	98.5	117.3	157.7	145.3	43.6	67.9
1400	1 Row 0.08 2 Row 0.15	0.5	0.58	0.20	79.2	81.8	92.6	77.1	21.5	25.4
		1.0	1.78	0.66	85.8	92.6	115.9	95.2	31.5	41.8
		2.0	6.17	2.07	91.5	103.9	138.9	119.8	40.3	59.1
		4.0	21.66	7.30	95.7	113.0	156.2	142.8	46.5	72.8

MULTI-CIRCUITING

AIRFLOW		WATER FLOW			LAT (°F)		LWT (°F)		CAPACITY (MBH)	
Rate (CFM)	Air PD (IN.W.G.)	Rate (GPM)	Water PD (FT.W.G.) 1 Row	Water PD (FT.W.G.) 2 Row	1 Row	2 Row	1 Row	2 Row	1 Row	2 Row
600	1 Row 0.02 2 Row 0.04	0.5	0.11	0.05	90.8	97.3	111.8	94.8	16.8	21.0
		1.0	0.38	0.19	100.0	112.7	133.6	116.9	22.7	31.0
		2.0	1.24	0.67	107.3	126.2	151.8	139.4	27.5	39.8
		4.0	4.47	2.38	112.3	135.4	164.2	156.5	30.7	45.8
800	1 Row 0.03 2 Row 0.06	0.5	0.11	0.05	85.6	90.4	107.3	90.8	17.9	22.0
		1.0	0.38	0.19	93.8	104.0	129.0	111.3	25.0	33.8
		2.0	1.24	0.67	100.8	117.0	148.2	134.0	31.0	45.1
		4.0	4.47	2.38	105.7	126.7	161.9	152.6	35.3	53.5
1000	1 Row 0.04 2 Row 0.09	0.5	0.11	0.05	82.3	85.9	104.1	88.1	18.7	22.7
		1.0	0.38	0.19	89.7	98.0	125.5	107.4	26.7	35.7
		2.0	1.24	0.67	96.2	110.3	145.4	129.9	33.8	49.1
		4.0	4.47	2.38	101.0	120.1	160.0	149.5	39.0	59.6
1200	1 Row 0.06 2 Row 0.12	0.5	0.11	0.05	79.8	82.8	101.6	86.2	19.3	23.1
		1.0	0.38	0.19	86.6	93.6	122.8	104.4	28.1	37.2
		2.0	1.24	0.67	92.8	105.2	143.1	126.7	36.1	52.3
		4.0	4.47	2.38	97.4	114.8	158.4	146.9	42.1	64.8
1400	1 Row 0.08 2 Row 0.15	0.5	0.11	0.05	78.0	80.5	99.7	84.8	19.8	23.5
		1.0	0.38	0.19	84.2	90.3	120.5	102.2	29.2	38.3
		2.0	1.24	0.67	90.1	101.2	141.1	124.1	38.1	54.9
		4.0	4.47	2.38	94.6	110.6	157.0	144.6	44.8	69.1

NOTES:

1. Data is based on 180°F entering water and 65°F entering air temperature at sea level. See selection procedure for other conditions.
2. For optimum diffuser performance in overhead heating applications, the supply air temperature should be within 20°F of the desired space temperature. This typically requires a higher air capacity which provides higher air motion in the space, increasing thermal comfort. The hot water coil should be selected with this in mind, keeping the LAT as low as possible.

GUIDE SPECIFICATIONS

GENERAL

Furnish and install Johnson Controls Model TVL, or equal, Low Height Parallel Flow Variable Volume Fan Powered Terminals of the sizes and capacities scheduled. Units shall be ETL listed. Terminals with electric heat shall be listed as an assembly. Separate listings for the terminal and electric heater are not acceptable. Terminals shall include a single point electrical connection. Terminal units shall be ARI certified and bear the ARI 880 seal.

The entire unit shall be designed and built as a single unit. Field-assembled components or built-up terminals employing components from multiple manufacturers are not acceptable.

CONSTRUCTION

Terminals shall be constructed of not less than 20 gauge galvanized steel, able to withstand a 125 hour salt spray test per ASTM B-117. The terminal casing shall be mechanically assembled (spot-welded casings are not acceptable).

Casing shall be internally lined with 1/2" thick fiberglass insulation, rated for a maximum air velocity of 5000 f.p.m. Maximum thermal conductivity shall be .24 (BTU • in) / (hr • ft2 • °F). Insulation must meet all requirements of ASTM C1071 (including C665), UL 181 for erosion, and carry a 25/50 rating for flame spread/ smoke developed per ASTM E-84, UL 723 and NFPA 90A. Raw insulation edges on the discharge of the unit must be covered with metal liner to eliminate flaking of insulation during field duct connections. Simple "buttering" of raw edges with an approved sealant is not acceptable.

Casing shall have bottom access to gain access to the primary air valve and fan assembly. The opening shall be sufficiently large to allow complete removal of the fan if necessary. The casing shall be constructed in a manner to provide a single rectangular discharge collar. Multiple discharge openings are not acceptable. All appurtenances including control assemblies, control enclosures, hot water heating coils, and electric heating coils shall not extend beyond the top or bottom of the unit casing.

At an air velocity of 2000 f.p.m. through the primary inlet, the static pressure drop across the basic terminal or basic terminal with electric heat shall not exceed 0.20" W.G. for all unit sizes.

SOUND

The terminal manufacturer shall provide ARI certified sound power data for radiated and discharge sound. The sound levels shall not exceed the octave band sound power levels indicated on the schedule. If the sound data does not meet scheduled criteria, the contractor shall be responsible for the provision and installation of any additional equipment or material necessary to achieve the scheduled sound performance.

PRIMARY AIR VALVE

Rectangular shaped primary air valves shall consist of minimum 18 gauge galvanized steel. Cylindrically shaped primary air valves shall consist of minimum 22 gauge galvanized steel and include embossment rings for rigidity. The damper blade shall be connected to a solid shaft by means of an integral molded sleeve which does not require screw or bolt fasteners. The shaft shall be manufactured of a low thermal conducting composite material, and include a molded damper position indicator visible from the exterior of the unit. The damper shall pivot in self lubricating bearings. The damper actuator shall be mounted on the exterior of the terminal for ease of service. The valve assembly shall include internal mechanical stops for both full open and closed positions. The damper blade seal shall be secured without use of adhesives. The air valve leakage shall not exceed 1% of maximum inlet rated airflow at 3" W.G. inlet pressure for cylindrical valves. Rectangular valve leakage shall not exceed 2% of maximum inlet rated airflow at 3" W.G. inlet pressure.

PRIMARY AIRFLOW SENSOR

Differential pressure airflow sensor shall traverse the duct along two perpendicular diameters. Single axis sensor shall not be acceptable for duct diameters 6" or larger. A minimum of 12 total pressure sensing points shall be utilized. The total pressure inputs shall be averaged using a pressure chamber located at the center of the sensor. A sensor that delivers the differential pressure signal from one end of the sensor is not acceptable. The sensor shall output an amplified differential pressure signal that is at least 2.3 times the equivalent velocity pressure signal obtained from a conventional pitot tube. The sensor shall develop a differential pressure of 0.015" w.g. at an air velocity of < 325 FPM. Documentation shall be submitted which substantiates this requirement. Balancing taps and airflow calibration charts shall be provided for field airflow measurements.

GUIDE SPECIFICATIONS

FAN ASSEMBLY

The unit fan shall utilize a forward curved, dynamically balanced, galvanized wheel with a direct drive motor. The motor shall be permanent split capacitor type with three separate horsepower taps. Single speed motors with electronic speed controllers are not acceptable.

The fan motor shall be unpluggable from the electrical leads at the motor case for simplified removal (open frame motors only). The motor shall utilize permanently lubricated sleeve type bearings, include thermal overload protection and be suitable for use with electronic fan speed controllers.

The terminal shall utilize an electronic (SCR) fan speed controller for aid in balancing the fan capacity. The speed controller shall have a turn down stop to prevent possibility of harming motor bearings.

HOT WATER COIL

Terminal shall include an integral hot water coil where indicated on the plans. The coil shall be manufactured by the terminal unit manufacturer and shall have a minimum 22 gauge galvanized sheet metal casing. Coil to be constructed of pure aluminum fins with full fin collars to assure accurate fin spacing and maximum tube contact. Fins shall be spaced with a minimum of 10 per inch and mechanically fixed to seamless copper tubes for maximum heat transfer.

Each coil shall be hydrostatically tested at a minimum of 450 PSIG under water, and rated for a maximum 300 PSIG working pressure at 200°F.

ELECTRIC HEATERS

Terminal shall include an integral electric heater where indicated on the plans. The heater cabinet shall be constructed of not less than 20 gauge galvanized steel. Heater shall have a hinged access panel for entry to the controls.

A power disconnect shall be furnished to render the heater non-operational. Heater shall be furnished with all controls necessary for safe operation and full compliance with UL 1995 and National Electric Code requirements.

Heater shall have a single point electrical connection. It shall include a primary disc-type automatic reset high temperature limit, secondary high limit(s), Ni-Chrome elements, and fusing per UL and NEC. Heater shall have complete wiring diagram with label indicating power requirement and KW output. Heater shall be interlocked with fan terminal so as to preclude operation of the heater when the fan is not running.

OPTIONS

Foil Faced Insulation
Insulation shall be covered with scrim backed foil facing. All insulation edges shall be covered with foil or metal nosing. In addition to the basic requirements, insulation shall meet ASTM C1136 for insulation facings, and ASTM C1338 for mold, mildew and humidity resistance.

Elastomeric Closed Cell Foam Insulation
Provide Elastomeric Closed Cell Foam Insulation in lieu of standard. Insulation shall conform to UL 181 for erosion and NFPA 90A for fire, smoke and melting, and comply with a 25/50 Flame Spread and Smoke Developed Index per ASTM E-84 or UL 723. Additionally, insulation shall comply with Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21. Polyethylene insulation is not acceptable.

Double Wall Construction
The terminal casing shall be double wall construction using a 22 gauge galvanized metal liner covering all insulation.

Filters
Terminals shall include a filter rack and 1" thick disposable fiberglass filter, allowing removal without horizontal sliding.

PIPING PACKAGES

Provide a standard factory assembled non-insulated valve piping package to consist of a 2 way, on/off, motorized electric control valve and two ball isolation valves. Control valves are piped normally closed to the coil. Maximum entering water temperature on the control valve shall be 200°F. The maximum close-off pressure is 40 PSIG (1/2") or 20 PSIG (3/4"). Maximum operating pressure shall be 300 PSIG.

Option: Provide 3-wire floating point modulating control valve (fail-in-place) in lieu of standard 2-position control valve with factory assembled valve piping package.

Option: Provide high pressure close-off actuators for 2-way, on/off control valves. Maximum close-off pressure is 50 PSIG (1/2") or 25 PSIG (3/4)".

Option: Provide either a fixed or adjustable flow control device for each piping package.

GUIDE SPECIFICATIONS

Option: Provide unions and/or pressure-temperature ports for each piping package.

Piping package shall be completely factory assembled, including interconnecting pipe, and shipped separate from the unit for field installation on the coil, so as to minimize the risk of freight damage.

CONTROLS

Analog Electronic Controls

Furnish and install Series 7000 Pressure Independent Analog Electronic Control System where indicated on the plans and in the specifications. The complete system shall be fully operational and include the following:

- Single duct, dual duct, and/or fan powered terminal units
- Pressure independent Series 7000 analog electronic zone controllers with integral differential pressure transducer
- Analog electronic wall thermostat
- Electronic air valve actuator
- 24 VAC control transformers
- Air pressure switches as required
- Electronic duct temperature sensors as required

Pneumatic Controls

Units shall be controlled by a pneumatic differential pressure reset volume controller. Controller shall be capable of pressure independent operation down to 0.03 inches W.G. differential pressure and shall be factory set to the specified airflow (CFM). Controller shall not exceed 11.5 scim (Standard Cubic Inches per Minute) air consumption @ 20 PSIG.

Unit primary air valve shall modulate in response to the room mounted thermostat and shall maintain airflow in relation to thermostat pressure regardless of system static pressure changes. An airflow (CFM) curve shall be affixed to the terminal unit expressing differential pressure vs. CFM. Pressure taps shall be provided for field use and ease of balancing.

Terminal unit manufacturer shall supply and manufacture a 5 to 10 PSIG pneumatic actuator capable of a minimum of 45 in. lbs. of torque.

Actual sequence of operation is shown on the contract drawings. Terminal unit manufacturer shall coordinate, where necessary, with the Temperature Control Contractor.

JOHNSON CONTROLS DDC CONTROL

N2

Each VAV terminal unit shall be bundled with a digital controller. The controller shall be compatible with a Johnson Controls N2 system network. A unique Johnson Controls N2 network address shall be assigned to each controller, and referenced to the tagging system used on the drawings and in the schedules provided by the Project Engineer. All controllers shall be factory mounted and wired, with the controller's hardware address set, and all of the individual terminal's data pre-loaded into the controller. The terminal's data shall include, but not be limited to the Max CFM, Min CFM, Heating CFM, and terminal K factor. Heating system operating data shall also be factory installed for all terminals with heat. Communication with the digital controller shall be accomplished through the Johnson Controls N2 network. The digital controller shall have hardware input and output connections to facilitate the specified sequence of operation in either the network mode, or on a stand-alone basis. The terminal unit manufacturer shall coordinate, where necessary, with the Temperature Control Contractor.

MS/TP

Each VAV terminal unit shall be bundled with a digital controller. The controller shall be compatible with a MS/TP BACnet system network. A unique network address and a BACnet site address shall be assigned to each controller, and referenced to the tagging system used on the drawings and in the schedules provided by the Project Engineer. All controllers shall be factory mounted and wired, with the controller's hardware address set, and all of the individual terminal's data pre-loaded into the controller. The terminal's data shall include, but not be limited to Max CFM, Min CFM, Heating CFM, and terminal K factor. Heating system operating data shall also be factory installed for all terminals with heat. Communications with the digital controller shall be accomplished through the MS/TP BACnet network or through a Bluetooth connector. The digital controller shall have hardware input and output connections to facilitate the specified sequence of operation in either the network mode, or on a stand-alone basis. The terminal unit manufacturer shall coordinate, where necessary, with the Temperature Control Contractor.

LON

Each VAV terminal unit shall be bundled with a digital controller. The controller shall be compatible with a LON system network. A unique network address shall be assigned to each controller and referenced to the tagging system used on the drawings and in the schedules

GUIDE SPECIFICATIONS

provided by the Project Engineer. All controllers shall be factory mounted and wired, and all of the individual terminal's data pre-loaded into the LNS database for the project. The terminal's data shall include, but not be limited to Max CFM, Min CFM, Heating CFM, and terminal K factor. Heating system operating data shall also be factory installed for all terminals with heat. Communication with the digital controller shall be accomplished through the LON network. The digital controller shall have hardware input and output connections to facilitate the specified sequence of operation in either the network mode, or on a stand-alone basis. The terminal unit manufacturer shall coordinate, where necessary, with the Temperature Control Contractor.

NOTES

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