ENGINEERING GUIDE

TSS Single-Duct VAV Terminals

Johnson Controls

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NOTES:

- All data is subject to change without notice. Drawings in this guide are not for installation purposes.
- Some drawings are not shown in this catalog. Construction drawings and performance data contained herein should not be used for submittal purposes.
- ETL Listing Number 492864.
- Visit www.johnsoncontrols.com for current literature and submittal drawings or contact your local sales representative for more information.

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

INTERTEK ETL LISTED C US

FEATURES AND BENEFITS

PRECISE ZONE CONTROL

Model TSS terminals provide variable air volume (VAV) control beyond the typical single duct box. They are specifically designed for precise air delivery throughout the entire operating range, regardless of the installed inlet conditions. They also offer improved space comfort and flexibility for a wide variety of HVAC applications.

TSS terminals take advantage of typical benefits provided by single duct units, while performing at extremely low sound levels. This is critical in today's buildings, where occupants are placing more emphasis on indoor acoustics.

The ability to provide comfort to the occupant is the measurement of quality for any VAV terminal. Comfort is achieved through quiet and precise control of airflow to the occupied space.

The TSS terminal provides the ultimate in airflow control with the patented FlowStar™ airflow sensor. No other sensor in the industry can match the FlowStar's ability to quietly and precisely measure airflow. Accurate airflow measurement is the basis for airflow control.

DESIGN FLEXIBILITY

Selection and Layout. The TSS provides flexibility in system design. The compact cabinet design and quiet operation give the system designer the versatility to place units directly above occupied spaces. It is not necessary to locate the unit in the crowded space above a hall or corridor. This will reduce lengthy and expensive discharge duct runs. The FlowStar™ sensor ensures accurate control, even when space constraints do not permit long straight inlet duct runs to the terminal.

Sizes. Model TSS terminals are available in ten unit sizes to handle airflow capacities between 45 and 8000 CFM.

A Windows® based Computer Selection Program is available on CD-ROM to facilitate the selection process. Contact your representative to obtain a copy of this powerful and time-saving program.

CONVENIENT INSTALLATION

Quality. All TSS terminals are thoroughly inspected during each step of the manufacturing process, including a comprehensive "pre-ship" inspection, to maintain the highest quality product available. All TSS terminals are packaged to minimize damage during shipment.

FEATURES AND BENEFITS

Quick Installation. A standard single point electrical main power connection is provided with all electronic controls and electrical components 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 and a low profile compact design.

The FlowStar™ sensor ensures accurate airflow measurement, regardless of the field installation conditions. A calibration label and wiring diagram is located on the terminal for quick reference during start-up.

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.

LASTING COMPONENTS AND LOW COST OPERATION

Quality. All metal components are fabricated from galvanized steel. Unlike most manufacturers' terminals, the TSS 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.

Agency Certification. Model TSS terminals with electronic controls and/or electric heat are listed with ETL as an assembly, and bear the ETL label.

TSS terminals and accessories are wired in compliance with all applicable NEC requirements and tested in accordance with ARI Standard 880.

Maintenance and Service. TSS terminals require no periodic maintenance and provide trouble-free operation. Controls are located on the outside of the unit casing for easy access by maintenance personnel.

A VARIETY OF CONTROLS

Model TSS terminals are available with analog electronic, consignment DDC, pneumatic controls and Johnson Controls DDC for BACnet, Lon or N2 specifically designed for use with TSS 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 above)
- Pneumatic
- Factory mounted consignment DDC
- Johnson Controls DDC for BACnet, Lon or N2

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

FEATURES AND BENEFITS

PATENTED FLOWSTAR™ SENSOR CONTROL

The 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.

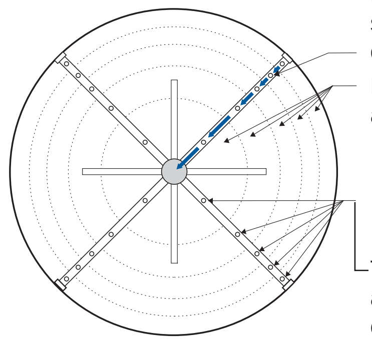
This sensor adds a new dimension to signal amplification. Most differential pressure sensors provide a signal equal to 1.5 times the equivalent velocity pressure signal. The FlowStar™ provides a differential pressure signal that is 2.5 to 3 times the equivalent velocity pressure signal. This amplified 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.

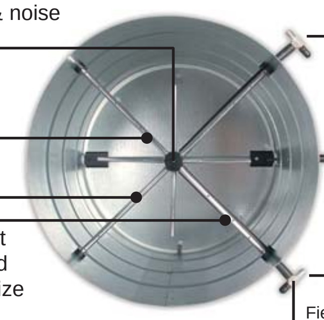
The VAV schedule should specify the minimum and maximum airflow setpoints, maximum sound power levels, and maximum air pressure loss for each terminal. The specification for the VAV terminal must detail the required performance of the airflow sensor. For maximum building occupant satisfaction, the VAV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

Using FlowStar™ sensing to amplify the airflow signal allows you to use lower minimum airflow setpoints. Many VAV controllers require a minimum differential pressure signal of 0.03 inch W.G. The airflow sensor should be able to generate this signal with only 400 to 450 FPM air velocity through the inlet collar.

Conventional airflow sensors without amplification capabilities require approximately 700 FPM to generate a 0.03 inch W.G. signal. If 700 FPM represents a 20% minimum condition, the inlet velocity would be 3500 FPM at the maximum airflow setpoint. This results in extremely noisy conditions. In addition, the airflow sensor should generate a differential pressure range of at least one inch W.G. over the operating range of the terminal unit.



FlowStar™ Airflow Sensor
Patent #5,481,925



FEATURES AND BENEFITS

UNIQUE ELECTRIC HEAT DESIGN

Model TSS-EH models are unique in that they correct common industry heating problems. Historically, heater elements placed downstream of a VAV damper have experienced two major problems:

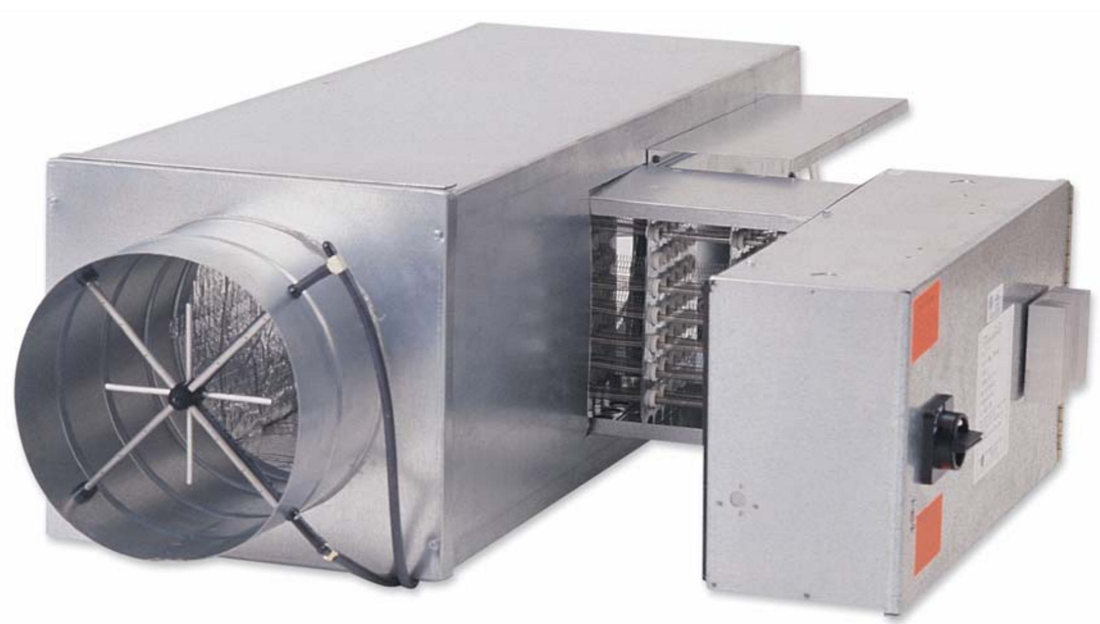
- Elements fail prematurely due to hot spots resulting from an uneven air velocity profile over the heater face
- Heaters suffer rapid nuisance cycling of the contactors and elements because the airflow switch probe is located on the low pressure (downstream side) of the VAV damper

Our unique electric heat VAV terminal, the TSS-EH, solves these problems. The heater elements are located midway between the air inlet and the damper. (See photo below.) This design provides uniform airflow over the face of the electric heater at all damper positions. Element life is extended, reducing repair cost and inconvenience.

With the heater elements located on the high pressure side of the VAV damper, the airflow pressure switch receives a reliable pressure signal even at minimum damper positions. This arrangement provides greater safety, as well as enhanced reliability.

The TSS-EH design permits tremendous flexibility when selecting KW, voltage, phase, balanced or unbalanced circuiting and method of control.

The TSS-EH breaks new ground in single duct VAV electric heater design. The patented FlowStar™ sensor permits modulation to lower airflow levels than all other sensors in the industry. This minimizes the energy expended for heat in many applications.



The FlowStar™ probe is visible in the inlet of the TSS-EH. The elements, partially removed for this photo, are midway between the inlet and the damper.

STANDARD CONSTRUCTION

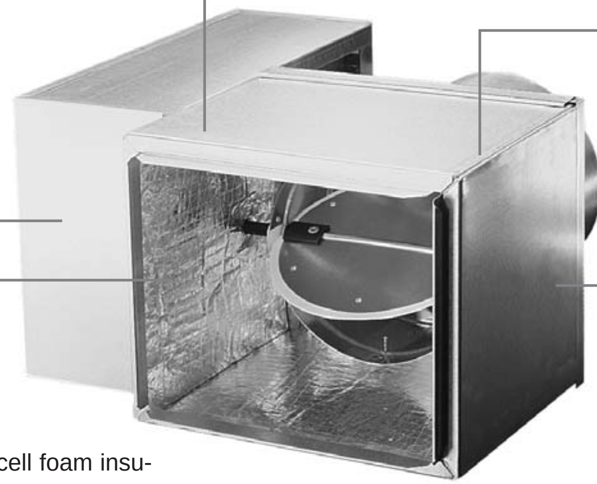
MODEL TSS

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

OPTIONAL CONSTRUCTION

MODEL TSS

The TSS single duct terminal is available with many optional features to meet any project requirement.



STANDARD AND OPTIONAL FEATURES

STANDARD FEATURES

Construction
- ARI 880 certified and labeled
- 22 gauge galvanized steel casing and valve
- 1/2" thick fiberglass insulation, mechanically fastened for added security

Primary Air Valve
- Embossed rigidity rings
- 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 Coil
- Designed and manufactured by Johnson Controls
- ARI 410 certified and labeled
- 1, 2, 3 or 4 rows
- Left or right hand connections
- Tested at a minimum of 450 PSIG under water and rated at 300 PSIG working pressure at 200°F

Electrical
- cETL listed for safety compliance with UL 1996
- NEMA 1 wiring enclosure

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

OPTIONAL FEATURES

Construction
- 20 gauge galvanized steel construction
- 3/4" and 1" insulation
- Foil faced scrim backed insulation
- 1/2" thick elastomeric closed cell foam insulation
- Double wall construction with 22 gauge liner

Hot Water Coil
- Coil access plate for cleaning coil

Electrical
- Toggle disconnect switch
- Primary and secondary transformer fusing

Electric Heat
- Proportional SSR heater control
- Mercury contactors
- Door interlocking disconnect switches

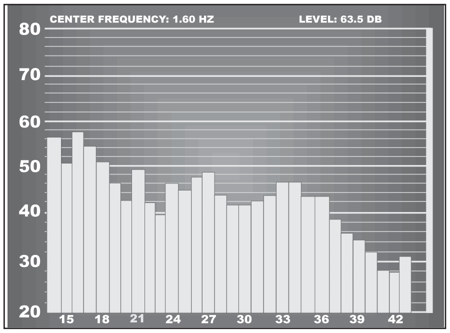
Controls
- Factory provided controls include:
  - Analog electronic
  - Pneumatic
- Factory mounted JCI DDC controls (factory mount and wire)

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

APPLICATION AND SELECTION

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. At the zone level, the terminal unit generates acoustical energy that can enter the zone along two primary paths. First, sound from the primary air valve 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).

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, 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, architecturally 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. Manufacturers use different assumptions with respect to a "typical" project design; therefore, it is impossible to compare product performance simply by looking at the published NC values.

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. The primary factor contributing to noisy systems (including single duct applications) 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. Many of today’s HVAC systems experience 0.5” w.g. pressure drop or less in the main

APPLICATION AND SELECTION

trunk. 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.

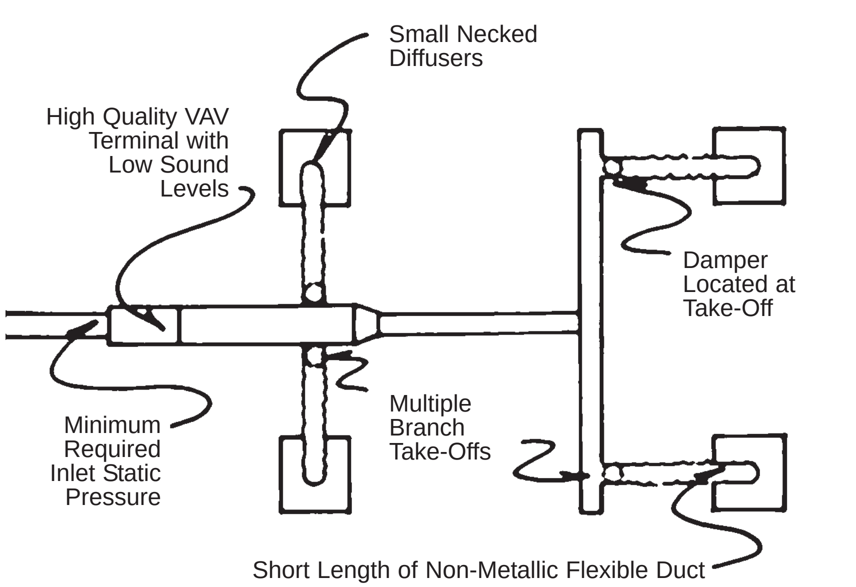
Inlet duct that is the same size as the inlet collar and as straight as possible will achieve the best acoustical performance. For critical applications, flexible duct should not be utilized at the terminal inlet.

Zoning. On projects where internal lining of the downstream duct is not permitted, special considerations should be made to obtain acceptable noise levels. 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.

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.

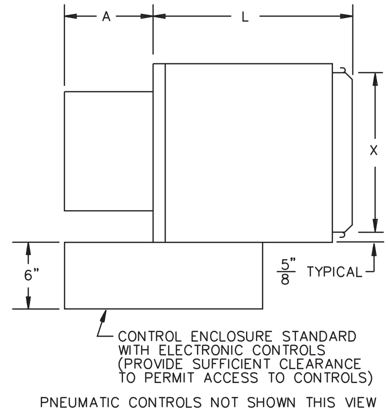
IDEAL DUCT DESIGN



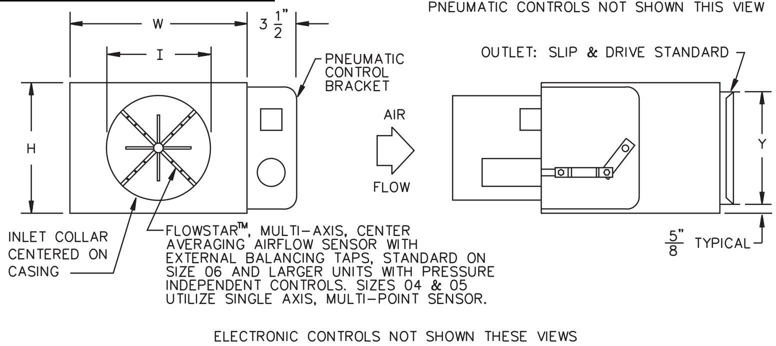
DIMENSIONAL DATA

MODEL TSS

UNIT SIZE	DIMENSIONS						
	W	H	L	A	I	X	Y
4	10 [254]	10 [254]	11 [279]	10 1/2 [267]	3 7/8 [98]	8 3/4 [222]	8 3/4 [222]
5	10 [254]	10 [254]	11 [279]	10 1/2 [267]	4 7/8 [124]	8 3/4 [222]	8 3/4 [222]
6	10 [254]	10 [254]	11 [279]	6 1/2 [165]	5 7/8 [149]	8 3/4 [222]	8 3/4 [222]
8	12 [305]	10 [254]	11 [279]	6 1/2 [165]	7 7/8 [200]	10 3/4 [273]	8 3/4 [222]
10	14 [356]	12 1/2 [318]	13 [330]	6 1/2 [165]	9 7/8 [251]	12 3/4 [324]	11 1/4 [286]
12	16 [406]	15 [381]	13 [330]	6 1/2 [165]	11 7/8 [302]	14 3/4 [375]	13 3/4 [349]
14	20 508]	17 1/2 [445]	17 1/2 [445]	6 1/2 [165]	13 7/8 [352]	18 3/4 [476]	16 1/4 [413]
16	24 [610]	17 1/2 [445]	17 1/2 [445]	6 1/2 [165]	15 7/8 [403]	22 3/4 [578]	16 1/4 [413]
19	30 [762]	17 1/2 [445]	11 [279]	8 [203]	28 1/4 [718] x 13 7/8 [352]	28 3/4 [730]	16 1/4 [413]
22	34 [864]	17 1/2 [445]	11 [279]	8 [203]	32 1/4 [819] x 15 7/8 [403]	32 3/4 [832]	16 1/4 [413]



NOTES:
1. All dimensions are in inches [mm] with a tolerance of ±1/8" [3mm].
2. Sizes 19 and 22 have rectangular inlet collar.



MODEL TSS - WC

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5	10 [254]	10 [254]	15 1/2 [394]	10 1/2 [267]	4 7/8 [124]
6	10 [254]	10 [254]	15 1/2 [394]	6 1/2 [165]	5 7/8 [149]
8	12 [305]	10 [254]	15 1/2 [394]	6 1/2 [165]	7 7/8 [200]
10	14 [356]	12 1/2 [318]	17 1/2 [445]	6 1/2 [165]	9 7/8 [251]
12	16 [406]	15 [381]	17 1/2 [445]	6 1/2 [165]	11 7/8 [302]
14	20 508]	17 1/2 [445]	21 1/2 [546]	6 1/2 [165]	13 7/8 [352]
16	24 [610]	17 1/2 [445]	21 1/2 [546]	6 1/2 [165]	15 7/8 [403]
19	30 [762]	17 1/2 [445]	15 1/2 [394]	8 [203]	28 1/4 [718] x 13 7/8 [352]
22	34 [864]	17 1/2 [445]	15 1/2 [394]	8 [203]	32 1/4 [819] x 15 7/8 [403]

NOTES:
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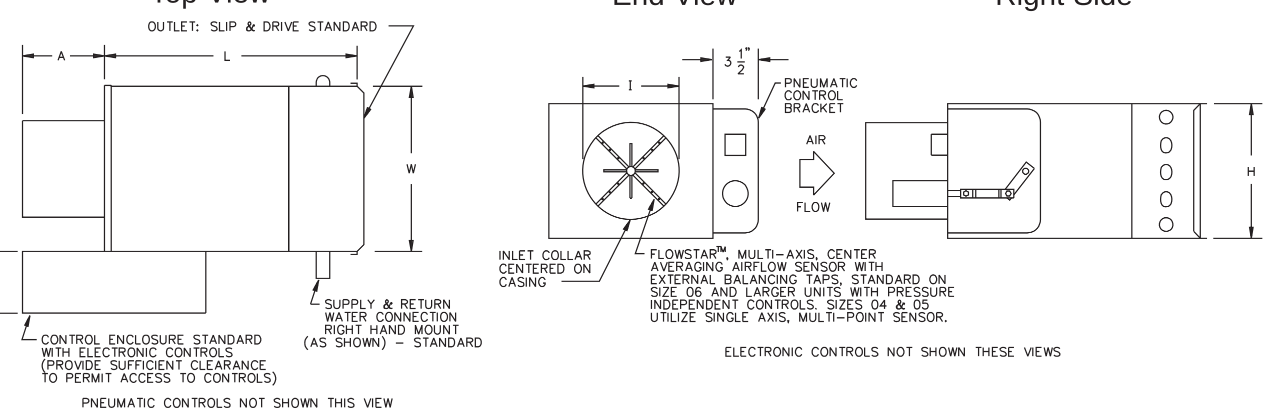
Top View

End View

Right Side



DIMENSIONAL DATA

MODEL TSS - EH

UNIT SIZE	DIMENSIONS						
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5	10 [254]	10 [254]	41 [1041]	4 7/8 [124]	8 3/4 [222]	8 3/4 [222]	10 1/2 [267]
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16	24 [610]	17 1/2 [445]	41 [1041]	15 7/8 [403]	22 3/4 [578]	16 1/4 [413]	6 1/2 [165]
19	30 [762]	17 1/2 [445]	44 1/2 [1130]	28 1/4 [718] x 13 7/8 [352]	28 3/4 [730]	16 1/4 [413]	1 1/2 [38]
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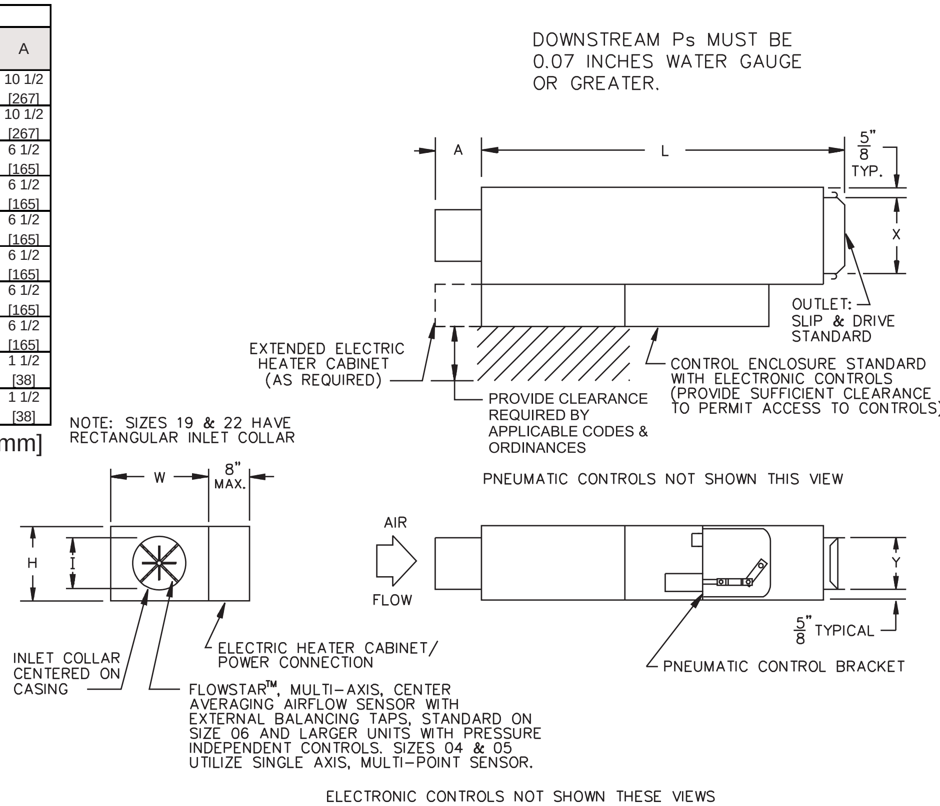

MODEL TSS - SA

UNIT SIZE	DIMENSIONS					
	W	H	A	I	X	Y
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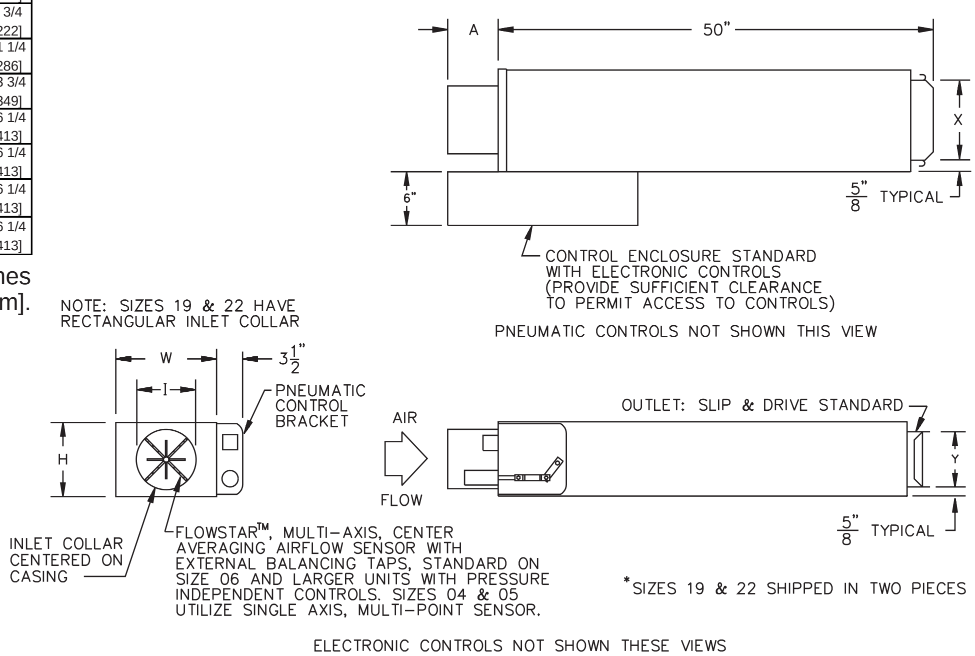
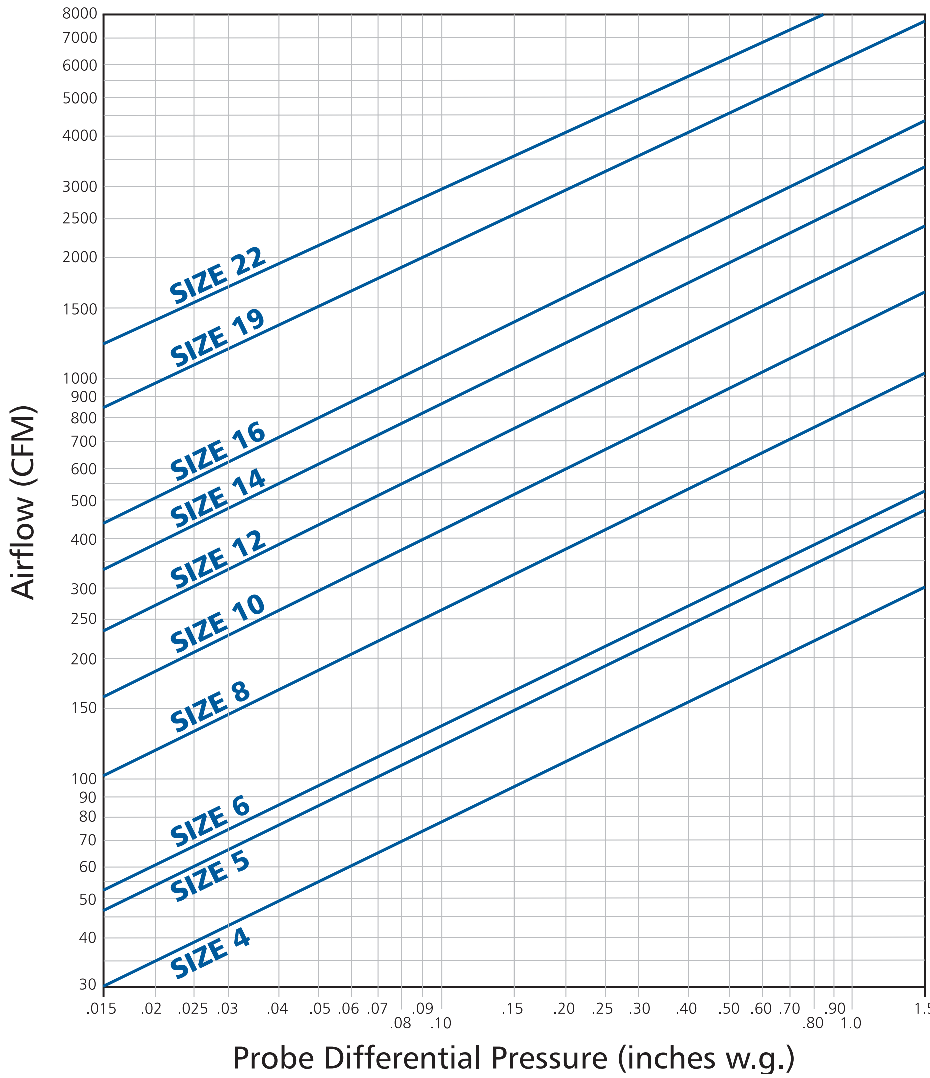


AIRFLOW CALIBRATION

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 for specific values. 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. Min. transducer differential pressure (in. w.g.)			MAX. Max. transducer differential pressure (in. w.g.)	
	MIN.	MAX.	MIN.	MAX.	0.015	0.03	0.05	1.0	≤1.5
4	43	250	35	250	30	43	55	250	250
5	68	350	50	350	48	65	88	350	350
6	75	490	60	550	53	75	97	435	530
8	145	960	115	1000	105	145	190	840	1000
10	235	1545	185	1600	165	235	305	1355	1600
12	340	2250	285	2300	240	340	440	1975	2300
14	475	3100	390	3100	335	475	615	2750	3100
16	625	4100	520	4100	440	625	805	3595	4100
19	1180	6500	1025	6500	845	1180	1510	6375	6500
22	1730	8000	1450	8000	1260	1730	2200	8000	8000

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.

SELECTION DATA

TERMINAL SIZE	CFM	MINIMUM ΔPs			DISCHARGE NOISE CRITERIA (NC)						RADIATED NOISE CRITERIA (NC)		
		Model TSS / TSS-SA	Model TSS-WC 1 Row	Model TSS-WC 2 Row	0.5" ΔPs		1.0" ΔPs		3.0" ΔPs		0.5" ΔPs	1.0" ΔPs	3.0" ΔPs
					Model TSS	Model TSS-SA	Model TSS	Model TSS-SA	Model TSS	Model TSS-SA	Model TSS & TSS-SA	Model TSS & TSS-SA	Model TSS & TSS-SA
4	100	0.01	0.02	0.03	--	--	--	--	--	--	--	--	--
	150	0.01	0.03	0.04	--	--	--	--	23	--	--	--	23
	200	0.01	0.04	0.07	--	--	20	--	28	22	--	20	28
	250	0.01	0.05	0.09	--	--	22	--	33	27	22	22	32
5	100	0.01	0.02	0.03	--	--	--	--	--	--	--	--	--
	200	0.01	0.04	0.07	--	--	--	--	21	--	--	--	21
	300	0.01	0.07	0.13	--	--	--	--	22	--	--	--	25
	350	0.01	0.09	0.16	--	--	--	--	25	--	--	21	27
6	200	0.02	0.05	0.08	--	--	--	--	--	--	--	--	20
	250	0.03	0.07	0.11	--	--	--	--	20	--	--	--	22
	300	0.04	0.10	0.16	--	--	--	--	20	--	--	--	25
	350	0.06	0.14	0.21	--	--	--	--	22	--	--	--	26
	450	0.10	0.22	0.33	--	--	--	--	26	20	--	21	30
	550	0.14	0.30	0.46	--	--	22	--	30	25	22	27	33
8	300	0.01	0.05	0.10	--	--	--	--	23	--	--	--	21
	400	0.01	0.08	0.15	--	--	--	--	23	--	--	--	26
	500	0.01	0.11	0.22	--	--	--	--	24	--	--	--	30
	600	0.01	0.15	0.30	--	--	--	--	24	--	--	--	31
	800	0.03	0.25	0.46	--	--	--	--	26	20	20	22	32
	1000	0.04	0.35	0.66	--	--	21	--	28	23	22	25	33
10	600	0.01	0.08	0.16	--	--	--	--	26	--	--	--	32
	800	0.01	0.13	0.26	--	--	--	--	26	--	--	--	32
	1000	0.02	0.20	0.39	--	--	--	--	27	20	--	20	32
	1200	0.02	0.25	0.47	--	--	--	--	30	23	--	22	33
	1400	0.03	0.32	0.61	--	--	21	--	31	25	--	23	33
	1600	0.04	0.40	0.76	--	--	23	20	32	27	23	26	34
12	800	0.01	0.08	0.15	--	--	--	--	23	--	--	21	33
	1100	0.01	0.13	0.26	--	--	--	--	25	--	--	22	34
	1400	0.02	0.21	0.40	--	--	--	--	27	21	--	24	35
	1700	0.02	0.26	0.50	--	--	--	--	30	25	--	25	36
	2000	0.03	0.34	0.65	--	--	20	--	32	27	20	26	37
	2300	0.04	0.43	0.82	--	--	21	--	33	28	22	27	38
14	1100	0.01	0.07	0.14	--	--	--	--	25	--	--	--	30
	1500	0.02	0.13	0.24	--	--	--	--	27	21	--	--	31
	1900	0.03	0.20	0.36	--	--	--	--	28	23	--	21	32
	2300	0.05	0.26	0.47	--	--	--	--	31	26	--	22	33
	2700	0.07	0.34	0.62	--	--	21	--	32	27	--	25	35
	3100	0.09	0.43	0.77	--	--	20	20	33	30	21	27	36
16	1600	0.01	0.10	0.19	--	--	--	--	24	--	--	--	32
	2100	0.02	0.17	0.31	--	--	--	--	27	21	--	20	35
	2600	0.03	0.24	0.45	--	--	--	--	32	27	--	21	35
	3100	0.04	0.29	0.55	--	--	21	--	33	28	--	23	36
	3600	0.05	0.37	0.70	--	--	23	20	36	32	21	26	37
	4100	0.06	0.46	0.86	--	--	25	21	38	35	24	28	38
19	2500	0.06	0.19	0.32	21	--	23	20	32	25	24	30	39
	3000	0.09	0.27	0.45	22	20	26	23	35	28	25	31	40
	3500	0.13	0.37	0.61	25	22	27	25	36	31	27	33	42
	4500	0.21	0.53	0.86	25	22	28	26	39	35	28	36	43
	5500	0.32	0.77	1.22	27	23	30	27	41	38	31	39	47
	6500	0.44	1.03	1.62	30	26	32	27	43	40	35	41	48
22	4000	0.06	0.30	0.55	25	22	27	25	37	31	24	31	42
	5000	0.09	0.46	0.83	26	22	30	27	39	35	25	34	45
	6000	0.14	0.56	0.99	27	25	32	30	41	37	26	37	45
	7000	0.18	0.72	1.27	28	26	35	31	42	39	28	37	46
	8000	0.24	0.91	1.59	30	27	36	32	43	40	31	38	46

NOTES:

- Min. ΔPs is the static pressure difference between the terminal inlet and discharge with the damper wide open.
- 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 at right) using Ceiling Type 2 for calculating Radiated NC.
- NC (sound pressure) levels predicted by subtracting appropriate values at right 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

SOUND DATA

DISCHARGE SOUND POWER DATA - MODEL TSS

TERMINAL SIZE	CFM	OCTAVE BAND NUMBER																	
		0.5" ΔPs						1.0" ΔPs						3.0" ΔPs					
		2	3	4	5	6	7	2	3	4	5	6	7	2	3	4	5	6	7
4	100	49	48	41	41	36	35	53	53	47	46	43	43	54	57	53	53	52	52
	150	51	52	44	44	39	38	58	58	50	49	46	45	60	64	59	57	56	56
	200	56	56	48	47	42	42	63	61	53	52	48	48	65	68	63	60	58	58
	250	60	59	51	53	46	45	65	63	56	55	51	49	69	72	66	62	60	59
5	100	46	44	40	40	35	33	48	47	44	42	42	43	51	54	50	49	50	51
	200	49	49	44	41	36	36	53	52	49	46	43	44	57	62	58	55	55	55
	300	55	53	48	45	39	39	60	57	53	50	46	46	62	64	62	59	58	56
	350	57	55	50	47	42	40	63	60	55	53	49	47	64	66	64	62	60	57
6	200	45	46	41	39	34	35	51	52	48	44	41	42	56	60	55	55	54	53
	250	51	49	43	41	37	37	55	54	49	46	42	43	57	61	58	56	54	55
	300	53	51	45	43	38	38	56	56	51	48	44	44	60	62	60	57	56	55
	350	54	53	48	46	40	40	57	59	54	51	46	46	61	64	62	59	58	57
	450	56	55	51	49	41	41	60	61	57	53	48	48	65	67	65	61	59	60
	550	59	58	54	53	44	45	62	64	60	56	50	50	68	70	68	62	60	63
8	300	47	46	43	40	38	35	50	52	51	47	47	45	56	62	64	60	60	59
	400	50	47	44	41	39	36	53	53	51	48	47	46	57	63	65	60	60	59
	500	52	51	47	44	40	38	56	55	53	50	48	46	59	64	66	61	61	60
	600	54	53	49	46	42	39	58	57	54	52	48	46	61	65	67	62	61	60
	800	58	56	53	49	44	41	61	61	58	55	51	49	66	68	67	63	62	61
	1000	62	60	56	54	48	45	64	64	61	58	55	51	70	70	69	64	63	62
10	600	51	49	46	44	40	36	57	56	55	50	48	46	63	67	67	63	58	57
	800	53	51	47	45	41	37	58	58	56	52	48	46	64	68	68	64	59	58
	1000	57	54	51	48	43	40	60	60	58	54	50	47	68	69	68	64	61	59
	1200	58	56	53	50	43	40	62	62	59	55	51	48	69	71	69	65	61	60
	1400	60	58	55	53	45	42	64	64	61	58	53	50	71	72	70	67	62	61
	1600	63	60	58	56	47	45	68	66	64	60	55	52	74	73	72	69	64	63
12	800	50	50	48	44	43	40	54	57	57	54	52	50	60	66	67	63	60	59
	1100	52	53	50	45	43	41	57	59	59	55	53	52	64	67	67	65	63	61
	1400	55	55	53	48	45	41	60	61	60	56	54	52	65	69	70	67	64	62
	1700	57	56	55	50	46	43	62	62	61	58	55	52	69	71	71	69	66	64
	2000	60	59	57	53	48	45	64	63	63	60	57	53	72	73	72	70	67	66
	2300	64	61	60	56	51	49	67	64	64	61	58	55	74	74	74	70	68	67
14	1100	51	49	47	46	43	40	59	57	54	53	52	52	65	67	67	64	62	62
	1500	55	51	50	46	44	41	60	58	56	54	53	52	67	69	68	65	63	63
	1900	57	54	53	48	45	41	63	61	58	55	54	53	70	70	69	66	64	63
	2300	59	57	56	51	47	43	64	62	60	56	55	54	71	72	69	68	66	64
	2700	61	58	59	53	49	46	66	64	62	58	56	55	73	73	71	69	67	65
	3100	63	60	61	55	51	47	66	64	64	60	57	56	75	74	72	70	68	67
16	1600	53	49	47	44	43	41	57	56	54	54	52	51	65	64	61	62	62	60
	2100	57	53	51	47	44	42	62	59	56	55	54	51	67	69	65	65	64	62
	2600	60	55	54	49	46	42	65	62	58	56	54	53	71	73	68	68	67	65
	3100	61	58	56	52	48	44	66	64	60	57	55	54	74	74	70	69	67	66
	3600	62	60	59	53	50	46	67	66	63	58	56	54	76	76	72	70	68	67
	4100	64	62	62	56	51	48	68	67	67	60	57	55	78	78	74	70	68	68
19	2500	66	64	58	57	57	51	69	66	64	63	63	59	73	73	73	73	72	68
	3000	67	65	60	59	58	52	70	68	67	65	64	60	75	75	74	74	73	69
	3500	68	67	61	61	60	55	71	69	69	66	66	61	76	76	75	75	74	70
	4500	69	67	63	63	62	58	72	70	72	69	68	64	79	79	79	79	78	74
	5500	70	69	66	65	65	61	73	71	73	71	70	67	81	81	82	83	79	76
	6500	72	71	71	68	67	63	75	72	73	72	71	69	84	83	84	85	80	78
22	4000	68	67	64	60	56	54	72	69	70	65	62	60	79	77	80	77	75	72
	5000	69	68	66	63	59	57	74	71	74	68	64	62	81	79	82	79	76	73
	6000	71	69	69	66	62	60	76	73	76	71	67	65	82	81	83	81	77	75
	7000	74	70	71	68	64	63	77	75	77	73	69	67	83	82	85	82	78	75
	8000	76	71	74	70	66	65	78	76	78	75	71	69	84	83	86	83	79	76

- Performance data obtained from tests conducted in accordance with ARI Standard 880.
- Sound levels are expressed in decibels, dB re: 1 x 10^{-12} watts.

SOUND DATA

RADIATED-SOUND DATA - MODEL TSS

TERMINAL SIZE	CFM	OCTAVE BAND NUMBER																	
		0.5" ΔPs						1.0" ΔPs						3.0" ΔPs					
		2	3	4	5	6	7	2	3	4	5	6	7	2	3	4	5	6	7
4	100	46	43	32	28	26	27	49	44	31	29	27	24	48	50	42	37	33	30
	150	49	47	35	30	26	28	52	48	38	34	29	28	53	55	46	42	36	32
	200	52	51	37	32	28	29	56	52	41	37	30	29	58	59	50	45	38	33
	250	54	54	40	35	28	29	58	54	43	38	31	29	61	62	52	48	40	34
5	100	42	35	27	24	22	20	45	40	32	27	24	22	47	47	39	36	32	30
	200	46	40	31	28	26	28	49	45	38	32	28	28	52	53	46	43	36	32
	300	49	45	35	30	27	28	53	51	42	35	29	29	56	56	51	47	38	32
	350	52	47	37	32	27	28	56	53	43	37	30	29	58	58	52	47	40	33
6	200	43	38	29	26	24	23	47	44	36	31	27	28	51	52	45	44	36	32
	250	46	41	32	27	24	23	48	46	38	33	29	29	53	54	47	45	36	32
	300	48	43	34	28	25	24	50	48	40	34	29	29	55	56	48	45	37	32
	350	50	46	36	31	27	26	53	50	42	36	30	29	57	57	50	46	38	33
	450	54	48	41	33	29	28	57	53	45	38	31	29	60	60	53	48	39	34
	550	60	53	46	39	32	30	64	58	51	44	36	31	63	63	55	50	40	35
8	300	46	37	32	27	25	24	49	46	40	34	30	29	53	53	47	41	37	34
	400	49	39	33	29	26	24	52	47	41	34	32	30	58	56	52	47	41	37
	500	50	41	35	30	27	25	53	48	42	36	34	31	57	57	55	49	43	40
	600	53	43	37	31	29	26	56	50	44	38	34	31	60	58	56	50	44	41
	800	58	47	41	34	31	28	60	53	47	41	36	32	64	61	57	50	45	42
	1000	60	52	47	40	33	30	62	56	50	44	38	33	67	63	58	52	46	43
10	600	49	40	35	30	27	28	53	47	43	37	31	29	58	58	57	49	42	36
	800	51	42	37	31	27	29	55	49	44	38	31	30	60	59	57	50	43	36
	1000	53	44	39	33	28	29	56	51	46	39	32	30	62	60	57	50	43	37
	1200	55	46	41	35	30	29	57	53	48	40	33	30	64	61	58	52	44	38
	1400	57	48	43	37	30	29	59	54	49	42	34	31	65	62	58	52	45	38
	1600	61	51	46	39	31	29	63	56	51	43	35	31	67	63	59	53	45	39
12	800	47	41	39	33	30	29	51	49	47	40	37	33	54	60	58	52	47	43
	1100	49	44	41	34	31	29	54	51	48	42	38	33	57	61	59	53	48	45
	1400	51	46	42	35	32	29	56	52	50	43	39	34	59	62	60	54	49	46
	1700	53	48	44	37	33	29	56	53	51	44	39	34	61	63	61	55	49	46
	2000	54	49	46	39	33	29	57	54	52	45	40	34	63	64	62	56	50	46
	2300	55	50	48	40	34	30	58	55	53	46	41	35	65	65	63	57	51	47
14	1100	47	42	36	34	34	30	53	49	42	39	40	36	60	60	54	50	47	45
	1500	49	44	38	36	34	30	54	51	45	40	41	36	62	61	55	52	48	47
	1900	51	46	41	37	34	30	56	53	47	43	43	37	63	62	56	53	51	48
	2300	53	48	42	38	34	30	57	54	48	43	43	37	65	63	58	54	53	50
	2700	54	50	44	39	34	30	59	56	49	44	43	37	66	64	59	55	54	50
	3100	56	53	46	40	34	30	60	58	51	45	43	37	67	65	60	57	55	50
16	1600	48	43	36	35	29	30	53	49	43	40	36	33	60	62	56	50	46	40
	2100	49	44	39	36	30	30	54	52	46	41	39	33	61	64	56	52	46	40
	2600	52	47	41	36	31	30	57	53	47	43	40	33	63	64	58	53	47	41
	3100	54	49	44	37	32	30	59	55	48	43	41	33	65	65	59	53	48	42
	3600	56	51	47	39	34	30	60	57	51	44	42	33	67	66	61	54	49	42
	4100	58	53	50	41	35	31	61	59	53	45	42	34	69	67	62	55	50	43
19	2500	59	54	50	40	34	30	65	60	54	46	40	34	70	67	64	57	49	47
	3000	59	55	51	42	36	31	65	61	55	46	42	35	70	68	65	57	50	47
	3500	60	58	53	45	36	31	66	62	58	47	42	36	71	68	67	57	51	48
	4500	60	58	54	45	37	32	66	62	61	50	44	38	72	70	68	59	53	49
	5500	62	61	56	47	39	33	67	62	64	53	47	41	73	70	71	61	55	51
	6500	66	63	60	50	41	34	67	63	66	54	48	42	75	71	72	62	57	52
22	4000	58	53	50	43	34	31	65	61	55	47	40	37	70	68	67	58	51	51
	5000	59	54	51	44	34	31	65	61	59	49	42	38	72	68	69	59	51	51
	6000	62	56	52	46	36	32	65	62	62	51	44	40	72	69	69	60	54	51
	7000	64	59	53	47	38	33	66	62	62	53	45	41	73	69	70	61	55	52
	8000	66	61	55	48	39	34	67	62	63	54	46	42	74	69	70	62	56	52

- Performance data obtained from tests conducted in accordance with ARI Standard 880.
- Sound levels are expressed in decibels, dB re: 1 x 10^{-12} watts.

SOUND DATA

DISCHARGE-SOUND DATA - MODEL TSS-SA

TERMINAL SIZE	CFM	OCTAVE BAND NUMBER 0.5" ∆ Ps						1.0" ∆ Ps						3.0" ∆ Ps					
		2	3	4	5	6	7	2	3	4	5	6	7	2	3	4	5	6	7
4	100	44	43	34	29	21	22	47	47	41	34	24	24	47	50	47	41	30	28
	150	47	48	38	32	23	22	53	53	44	37	27	23	55	58	53	45	35	32
	200	52	52	42	35	24	25	58	57	47	40	29	26	60	63	57	48	37	34
	250	56	55	45	41	28	26	62	59	50	43	32	27	65	67	61	50	39	34
5	100	41	39	34	29	20	20	42	40	38	30	23	24	45	47	44	37	28	27
	200	45	45	38	30	20	21	48	47	43	35	24	23	52	56	53	44	34	31
	300	52	49	42	34	21	22	57	53	47	39	26	24	58	59	57	48	37	32
	350	54	51	44	36	24	21	60	56	49	42	29	25	60	61	59	51	39	32
6	200	41	41	34	28	19	22	46	46	42	32	22	23	51	54	50	43	32	29
	250	48	45	37	30	22	23	51	50	45	35	23	23	53	55	52	45	33	31
	300	51	48	40	32	22	23	53	53	47	37	25	23	56	58	56	46	35	31
	350	51	50	43	35	23	24	54	56	50	40	27	24	57	60	58	48	37	33
	450	52	51	45	37	23	24	57	57	53	42	28	24	61	62	60	50	38	36
	550	56	55	49	42	26	26	59	61	56	46	32	29	65	66	64	52	39	38
8	300	44	42	38	29	22	22	45	47	46	36	28	27	51	53	56	47	38	36
	400	47	43	39	30	23	23	49	48	45	37	28	28	52	54	57	47	38	36
	500	49	47	42	34	24	24	53	51	48	39	30	28	55	57	59	50	41	38
	600	50	49	44	36	26	24	55	53	48	42	30	28	57	59	61	52	41	38
	800	54	52	48	39	29	26	58	57	52	45	34	30	63	63	61	53	43	39
	1000	58	57	52	44	33	29	61	61	56	49	40	32	67	66	64	55	44	40
10	600	48	46	41	34	23	23	52	51	50	40	30	29	58	56	56	49	37	37
	800	50	48	42	35	25	24	55	54	51	42	31	30	60	60	59	53	40	39
	1000	53	51	46	38	28	26	57	56	53	44	34	32	64	63	61	55	43	40
	1200	54	54	48	40	29	27	59	58	55	45	37	33	66	66	63	56	44	42
	1400	56	56	50	43	32	29	61	60	57	48	40	35	68	67	65	58	46	44
	1600	59	58	55	47	35	32	65	63	61	51	43	37	71	69	67	61	48	46
12	800	47	47	43	35	28	26	50	53	53	45	36	33	56	57	57	51	42	40
	1100	49	50	46	37	29	28	54	56	55	46	38	38	60	60	60	55	47	43
	1400	51	52	49	40	32	28	57	58	56	47	40	38	61	64	65	58	49	45
	1700	53	53	51	42	34	31	59	59	57	49	42	38	65	67	66	60	52	48
	2000	56	57	53	45	37	33	61	60	59	51	45	40	69	69	68	61	53	51
	2300	60	59	56	48	40	37	64	61	60	52	47	42	71	70	69	61	55	52
14	1100	49	46	42	38	32	26	56	54	50	44	39	35	61	61	59	53	48	45
	1500	53	49	45	39	34	28	58	56	52	45	41	38	63	64	62	57	51	48
	1900	53	51	48	42	35	29	61	59	54	46	43	41	66	66	65	58	53	49
	2300	56	55	51	45	38	32	62	60	56	47	45	43	68	68	65	60	56	51
	2700	58	56	54	47	40	36	64	62	58	49	47	45	71	69	67	61	57	53
	3100	60	58	56	49	42	37	63	63	60	51	48	46	73	71	68	61	58	56
16	1600	51	47	43	36	32	27	55	53	50	47	39	34	61	58	53	51	48	43
	2100	55	51	47	40	34	29	60	57	52	48	42	37	63	64	59	57	52	47
	2600	56	52	50	43	36	30	63	60	54	49	43	41	67	69	63	62	56	51
	3100	58	56	52	46	39	33	64	62	57	49	45	43	71	70	66	61	57	53
	3600	59	58	56	47	41	36	65	63	60	50	47	44	74	73	68	62	58	55
	4100	61	60	59	50	42	38	65	64	63	52	49	45	76	75	70	62	59	57
19	2500	63	62	54	50	47	38	67	63	60	56	50	42	69	67	65	62	58	51
	3000	64	63	56	53	49	41	68	66	63	58	52	46	71	70	68	66	61	54
	3500	65	65	57	54	50	46	69	67	65	59	55	49	72	72	70	69	63	56
	4500	66	65	59	56	52	49	70	68	68	61	58	53	76	75	75	71	68	61
	5500	67	66	62	58	56	51	71	69	69	63	61	57	79	78	78	75	69	64
	6500	69	68	67	60	58	53	72	69	69	64	63	59	82	80	80	77	71	67
22	4000	65	65	60	53	46	41	70	67	66	58	50	46	75	72	74	69	63	57
	5000	65	65	62	57	49	45	72	69	70	61	53	50	77	75	77	73	65	59
	6000	68	67	65	60	53	49	74	71	73	63	57	54	79	77	79	73	67	62
	7000	71	68	68	62	55	53	75	72	74	65	60	57	81	79	81	74	68	63
	8000	73	69	71	64	57	55	75	73	74	67	63	59	82	80	82	75	70	65

- Performance data obtained from tests conducted in accordance with ARI Standard 880.
- Sound levels are expressed in decibels, dB re: 1 x 10^{-12} watts.

SOUND DATA

RADIATED-SOUND DATA - MODEL TSS-SA

TERMINAL SIZE	CFM	OCTAVE BAND NUMBER																	
		0.5" ∆ Ps						1.0" ∆ Ps						3.0" ∆ Ps					
		2	3	4	5	6	7	2	3	4	5	6	7	2	3	4	5	6	7
4	100	46	43	32	28	26	27	49	44	31	29	27	24	48	50	42	37	33	30
	150	49	47	35	30	26	28	52	48	38	34	29	28	53	55	46	42	36	32
	200	52	51	37	32	28	29	56	52	41	37	30	29	58	59	50	45	38	33
	250	54	54	40	35	28	29	58	54	43	38	31	29	61	62	52	48	40	34
5	100	42	35	27	24	22	20	45	40	32	27	24	22	47	47	39	36	32	30
	200	46	40	31	28	26	28	49	45	38	32	28	28	52	53	46	43	36	32
	300	49	45	35	30	27	28	53	51	42	35	29	29	56	56	51	47	38	32
	350	52	47	37	32	27	28	56	53	43	37	30	29	58	58	52	47	40	33
6	200	43	38	29	26	24	23	47	44	36	31	27	28	51	52	45	44	36	32
	250	46	41	32	27	24	23	48	46	38	33	29	29	53	54	47	45	36	32
	300	48	43	34	28	25	24	50	48	40	34	29	29	55	56	48	45	37	32
	350	50	46	36	31	27	26	53	50	42	36	30	29	57	57	50	46	38	33
	450	54	48	41	33	29	28	57	53	45	38	31	29	60	60	53	48	39	34
	550	60	53	46	39	32	30	64	58	51	44	36	31	63	63	55	50	40	35
8	300	46	37	32	27	25	24	49	46	40	34	30	29	53	53	47	41	37	34
	400	49	39	33	29	26	24	52	47	41	34	32	30	58	56	52	47	41	37
	500	50	41	35	30	27	25	53	48	42	36	34	31	57	57	55	49	43	40
	600	53	43	37	31	29	26	56	50	44	38	34	31	60	58	56	50	44	41
	800	58	47	41	34	31	28	60	53	47	41	36	32	64	61	57	50	45	42
	1000	60	52	47	40	33	30	62	56	50	44	38	33	67	63	58	52	46	43
10	600	49	40	35	30	27	28	53	47	43	37	31	29	58	58	57	49	42	36
	800	51	42	37	31	27	29	55	49	44	38	31	30	60	59	57	50	43	36
	1000	53	44	39	33	28	29	56	51	46	39	32	30	62	60	57	50	43	37
	1200	55	46	41	35	30	29	57	53	48	40	33	30	64	61	58	52	44	38
	1400	57	48	43	37	30	29	59	54	49	42	34	31	65	62	58	52	45	38
	1600	61	51	46	39	31	29	63	56	51	43	35	31	67	63	59	53	45	39
12	800	47	41	39	33	30	29	51	49	47	40	37	33	54	60	58	52	47	43
	1100	49	44	41	34	31	29	54	51	48	42	38	33	57	61	59	53	48	45
	1400	51	46	42	35	32	29	56	52	50	43	39	34	59	62	60	54	49	46
	1700	53	48	44	37	33	29	56	53	51	44	39	34	61	63	61	55	49	46
	2000	54	49	46	39	33	29	57	54	52	45	40	34	63	64	62	56	50	46
	2300	55	50	48	40	34	30	58	55	53	46	41	35	65	65	63	57	51	47
14	1100	47	42	36	34	34	30	53	49	42	39	40	36	60	60	54	50	47	45
	1500	49	44	38	36	34	30	54	51	45	40	41	36	62	61	55	52	48	47
	1900	51	46	41	37	34	30	56	53	47	43	43	37	63	62	56	53	51	48
	2300	53	48	42	38	34	30	57	54	48	43	43	37	65	63	58	54	53	50
	2700	54	50	44	39	34	30	59	56	49	44	43	37	66	64	59	55	54	50
	3100	56	53	46	40	34	30	60	58	51	45	43	37	67	65	60	57	55	50
16	1600	48	43	36	35	29	30	53	49	43	40	36	33	60	62	56	50	46	40
	2100	49	44	39	36	30	30	54	52	46	41	39	33	61	64	56	52	46	40
	2600	52	47	41	36	31	30	57	53	47	43	40	33	63	64	58	53	47	41
	3100	54	49	44	37	32	30	59	55	48	43	41	33	65	65	59	53	48	42
	3600	56	51	47	39	34	30	60	57	51	44	42	33	67	66	61	54	49	42
	4100	58	53	50	41	35	31	61	59	53	45	42	34	69	67	62	55	50	43
19	2500	59	54	50	40	34	30	65	60	54	46	40	34	70	67	64	57	49	47
	3000	59	55	51	42	36	31	65	61	55	46	42	35	70	68	65	57	50	47
	3500	60	58	53	45	36	31	66	62	58	47	42	36	71	68	67	57	51	48
	4500	60	58	54	45	37	32	66	62	61	50	44	38	72	70	68	59	53	49
	5500	62	61	56	47	39	33	67	62	64	53	47	41	73	70	71	61	55	51
	6500	66	63	60	50	41	34	67	63	66	54	48	42	75	71	72	62	57	52
22	4000	58	53	50	43	34	31	65	61	55	47	40	37	70	68	67	58	51	51
	5000	59	54	51	44	34	31	65	61	59	49	42	38	72	68	69	59	51	51
	6000	62	56	52	46	36	32	65	62	62	51	44	40	72	69	69	60	54	51
	7000	64	59	53	47	38	33	66	62	62	53	45	41	73	69	70	61	55	52
	8000	66	61	55	48	39	34	67	62	63	54	46	42	74	69	70	62	56	52

- Performance data obtained from tests conducted in accordance with ARI Standard 880.
- Sound levels are expressed in decibels, dB re: 1 x 10^{-12} watts.

ARI RATINGS

ARI STANDARD RATINGS

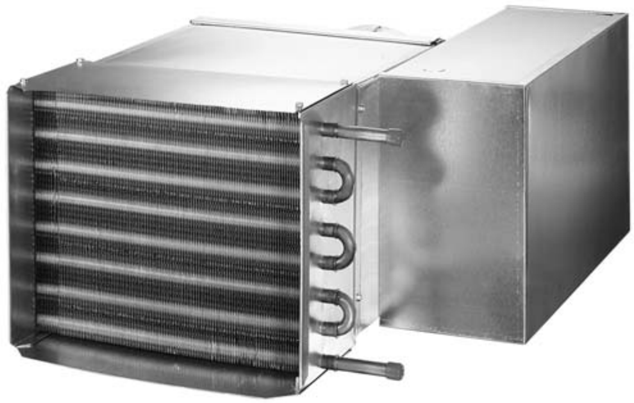
SIZE	RATED AIRFLOW CFM	MINIMUM OPERATING PRESSURE (IN. W.G.)	STANDARD RATINGS – SOUND POWER LEVEL, dB RE: 1 x 10^{-12} WATTS											
			1.5" WATER STATIC PRESSURE											
			RADIATED						DISCHARGE					
			Hz Octave Band Center Frequency						Hz Octave Band Center Frequency					
			125	250	500	1000	2000	4000	125	250	500	1000	2000	4000
4	150	0.01	53	53	43	37	31	30	59	63	56	55	53	52
5	250	0.01	53	51	44	37	31	30	58	59	56	54	51	51
6	400	0.08	54	54	47	41	33	31	60	63	58	56	52	53
8	700	0.02	58	56	51	43	39	35	61	64	61	59	57	55
10	1100	0.02	59	55	53	44	36	32	64	65	64	61	57	54
12	1600	0.02	57	56	58	48	43	40	64	66	67	62	60	59
14	2100	0.04	60	58	51	46	46	41	66	66	64	61	60	59
16	2800	0.03	60	59	52	46	42	37	70	68	65	61	59	59
19	5400	0.30	68	66	69	58	51	45	74	77	77	75	73	71
22	7100	0.19	67	66	68	58	49	45	79	79	82	76	72	70

Rated in accordance with ARI Standard 880.

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

HOT WATER COIL DATA

MODEL TSS-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
- Male sweat type water connections
- 1, 2, 3, and 4 row configurations

OPTIONAL FEATURES

- Low pressure steam coils
- Multi-circuit coils for reduced water pressure drop
- Opposite hand water connections
- Bottom and top access plates for cleaning

SELECTION PROCEDURE

TSS-WC Hot Water Coil Performance Tables are based upon a temperature difference of 125°F between the entering water and the entering air. If this ΔT is suitable, proceed directly to the tables for selection. All pertinent performance data is tabulated. **For Variable Air Volume Applications, the static pressure drop must be based on the maximum air volume.**

ENTERING WATER - AIR TEMPERATURE DIFFERENTIAL (ΔT) CORRECTION FACTORS															
ΔT	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
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
ΔT	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165
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 ΔT's (difference between EWT and EAT). 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 tables. The LAT and LWT can be calculated from the following fundamental formulas:

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

DEFINITION OF TERMS

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

HOT WATER COIL DATA

MODEL TSS-WC • SIZES 4, 5, 6

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
50		0.5	0.3	0.1	123.7	149.3	164.7	159.1	3.7	5.1
	1 Row 0.01	1.0	1.0	0.3	128.4	155.8	171.8	168.8	4.0	5.5
	2 Row 0.01	2.0	3.4	0.9	131.2	159.3	175.8	174.2	4.1	5.7
		4.0	12.2	3.4	132.7	161.2	177.8	177.0	4.2	5.8
100		0.5	0.3	0.1	105.7	127.4	157.5	147.9	5.5	7.8
	1 Row 0.01	1.0	1.0	0.3	111.2	137.0	167.5	161.8	6.1	8.9
	2 Row 0.02	2.0	3.4	1.0	114.6	142.8	173.4	170.2	6.5	9.5
		4.0	12.2	3.4	116.5	146.2	176.6	174.9	6.7	9.9
150		0.5	0.3	0.1	96.0	114.0	152.7	140.8	6.7	9.6
	1 Row 0.02	1.0	1.0	0.3	101.7	124.7	164.4	156.8	7.6	11.3
	2 Row 0.03	2.0	3.4	1.0	105.3	131.7	171.6	167.2	8.2	12.5
		4.0	12.2	3.4	107.5	135.8	175.6	173.3	8.5	13.1
200		0.5	0.3	0.1	89.8	104.9	149.1	135.8	7.5	10.8
	1 Row 0.03	1.0	1.0	0.3	95.4	115.9	162.0	153.0	8.8	13.2
	2 Row 0.06	2.0	3.4	1.0	99.1	123.5	170.2	164.8	9.6	14.8
		4.0	12.2	3.4	101.4	128.1	174.8	171.9	10.0	15.8
250		0.5	0.3	0.1	85.4	98.4	146.3	132.0	8.2	11.8
	1 Row 0.04	1.0	1.0	0.3	90.9	109.3	160.1	149.9	9.7	14.7
	2 Row 0.08	2.0	3.4	1.0	94.6	117.1	169.0	162.7	10.7	16.8
		4.0	12.2	3.4	96.9	122.1	174.2	170.7	11.3	18.2
300		0.5	0.3	0.1	82.1	93.4	144.0	129.0	8.8	12.5
	1 Row 0.06	1.0	1.0	0.3	87.4	104.1	158.4	147.3	10.5	16.0
	2 Row 0.12	2.0	3.4	1.0	91.1	112.0	167.9	161.0	11.7	18.5
		4.0	12.2	3.4	93.4	117.2	173.6	169.6	12.5	20.2
350		0.5	0.3	0.1	79.5	89.5	142.1	126.6	9.3	13.1
	1 Row 0.08	1.0	1.0	0.3	84.6	99.9	157.0	145.2	11.2	17.0
	2 Row 0.15	2.0	3.4	1.0	88.3	107.8	167.0	159.5	12.6	20.0
		4.0	12.2	3.4	90.6	113.1	173.1	168.7	13.5	22.0
400		0.5	0.3	0.1	77.4	86.4	140.4	124.6	9.7	13.6
	1 Row 0.10	1.0	1.0	0.3	82.4	96.4	155.7	143.3	11.9	17.9
	2 Row 0.19	2.0	3.4	1.0	86.0	104.3	166.2	158.1	13.4	21.4
		4.0	12.2	3.4	88.3	109.6	172.6	167.8	14.4	23.7

MODEL TSS-WC • SIZE 8

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
175		0.5	0.3	0.1	95.7	113.1	148.4	135.0	7.7	11.0
	1 Row 0.02	1.0	1.0	0.3	101.7	124.5	161.8	153.0	8.9	13.2
	2 Row 0.03	2.0	3.5	1.0	105.6	131.9	170.1	165.0	9.6	14.6
		4.0	12.7	3.5	107.9	136.2	174.8	172.1	10.0	15.4
250		0.5	0.3	0.1	88.0	101.9	143.4	128.2	8.9	12.7
	1 Row 0.03	1.0	1.0	0.3	94.0	113.5	158.4	147.6	10.6	15.8
	2 Row 0.06	2.0	3.6	1.0	97.9	121.6	168.1	161.5	11.6	18.0
		4.0	12.7	3.5	100.4	126.6	173.7	170.0	12.3	19.4
325		0.5	0.3	0.1	83.0	94.4	139.7	123.5	9.9	13.9
	1 Row 0.05	1.0	1.0	0.3	88.7	105.7	155.7	143.5	11.9	17.9
	2 Row 0.10	2.0	3.6	1.0	92.7	114.1	166.4	158.7	13.3	20.8
		4.0	12.7	3.6	95.2	119.5	172.7	168.3	14.1	22.7
400		0.5	0.3	0.1	79.4	89.0	136.8	119.9	10.6	14.7
	1 Row 0.07	1.0	1.0	0.3	84.9	99.9	153.4	140.2	13.0	19.5
	2 Row 0.14	2.0	3.6	1.0	88.8	108.3	165.0	156.3	14.7	23.1
		4.0	12.7	3.6	91.3	113.9	171.9	166.9	15.7	25.5
475		0.5	0.3	0.1	76.7	85.0	134.4	117.1	11.2	15.4
	1 Row 0.09	1.0	1.0	0.3	82.0	95.4	151.6	137.6	13.9	20.8
	2 Row 0.19	2.0	3.6	1.0	85.8	103.7	163.7	154.3	15.9	25.1
		4.0	12.7	3.6	88.3	109.4	171.2	165.6	17.1	28.0
550		0.5	0.3	0.1	74.6	81.9	132.4	114.9	11.7	16.0
	1 Row 0.12	1.0	1.0	0.3	79.6	91.7	149.9	135.3	14.7	21.9
	2 Row 0.25	2.0	3.6	1.0	83.4	100.0	162.6	152.6	16.9	26.8
		4.0	12.7	3.6	85.8	105.7	170.6	164.5	18.4	30.2
625		0.5	0.3	0.1	72.9	79.3	130.6	113.0	12.1	16.5
	1 Row 0.15	1.0	1.0	0.3	77.7	88.7	148.5	133.4	15.4	22.8
	2 Row 0.31	2.0	3.6	1.0	81.4	96.8	161.7	151.0	17.9	28.3
		4.0	12.7	3.6	83.8	102.5	170.0	163.5	19.5	32.2
700		0.5	0.3	0.1	71.4	77.2	129.1	111.4	12.5	16.9
	1 Row 0.19	1.0	1.0	0.3	76.1	86.2	147.3	131.7	16.0	23.7
	2 Row 0.38	2.0	3.6	1.0	79.7	94.1	160.8	149.7	18.7	29.6
		4.0	12.7	3.6	82.1	99.8	169.5	162.6	20.5	34.0

Data is based on 180°F entering water and 55°F entering air at sea level. See selection procedure for other conditions.

HOT WATER COIL DATA

MODEL TSS-WC • SIZE 10

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	2 Row	1 Row	2 Row	1 Row	2 Row	1 Row	2 Row
300		0.5	0.3	0.1	89.6	103.0	134.1	116.4	11.2	15.6
	1 Row 0.02	1.0	1.2	0.3	96.5	116.2	152.4	139.4	13.5	19.9
	2 Row 0.04	2.0	4.2	1.2	101.1	125.3	164.6	156.6	15.0	22.9
		4.0	14.9	4.2	103.9	130.9	171.8	167.3	15.9	24.7
400		0.5	0.3	0.1	83.8	94.5	129.1	110.4	12.5	17.1
	1 Row 0.04	1.0	1.2	0.3	90.4	107.3	148.6	133.7	15.4	22.7
	2 Row 0.07	2.0	4.2	1.2	95.1	116.9	162.2	152.5	17.4	26.8
		4.0	14.9	4.2	98.0	123.0	170.4	164.9	18.6	29.5
500		0.5	0.3	0.1	79.8	88.6	125.2	106.0	13.4	18.2
	1 Row 0.05	1.0	1.2	0.3	86.1	100.8	145.5	129.4	16.9	24.8
	2 Row 0.11	2.0	4.2	1.2	90.7	110.5	160.2	149.3	19.3	30.0
		4.0	14.9	4.2	93.6	116.9	169.3	162.8	20.9	33.5
600		0.5	0.3	0.1	76.8	84.2	122.2	102.8	14.2	19.0
	1 Row 0.07	1.0	1.2	0.3	82.9	95.8	143.0	125.9	18.1	26.5
	2 Row 0.15	2.0	4.2	1.2	87.4	105.4	158.4	146.5	21.0	32.7
		4.0	14.9	4.2	90.3	111.9	168.2	161.0	22.9	37.0
700		0.5	0.3	0.1	74.5	80.9	119.7	100.2	14.8	19.6
	1 Row 0.10	1.0	1.2	0.3	80.3	91.8	140.8	123.1	19.2	27.9
	2 Row 0.19	2.0	4.2	1.2	84.7	101.2	156.9	144.1	22.5	35.1
		4.0	15.0	4.2	87.6	107.9	167.3	159.4	24.7	40.1
800		0.5	0.3	0.1	72.7	78.3	117.6	98.1	15.3	20.2
	1 Row 0.12	1.0	1.2	0.3	78.2	88.6	138.9	120.7	20.1	29.1
	2 Row 0.25	2.0	4.2	1.2	82.5	97.8	155.6	142.1	23.8	37.1
		4.0	15.0	4.2	85.3	104.4	166.5	158.0	26.3	42.8
900		0.5	0.3	0.1	71.2	76.1	115.7	96.4	15.8	20.6
	1 Row 0.15	1.0	1.2	0.3	76.5	85.9	137.3	118.6	20.9	30.1
	2 Row 0.30	2.0	4.2	1.2	80.6	94.9	154.4	140.3	25.0	38.9
		4.0	15.0	4.2	83.4	101.5	165.8	156.8	27.7	45.3
1000		0.5	0.3	0.1	69.9	74.4	114.2	94.9	16.2	21.0
	1 Row 0.18	1.0	1.2	0.3	75.0	83.6	135.8	116.8	21.6	31.0
	2 Row 0.37	2.0	4.2	1.2	79.1	92.4	153.3	138.7	26.1	40.5
		4.0	15.0	4.2	81.8	98.9	165.1	155.6	29.1	47.6

MODEL TSS-WC • SIZE 12

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	2 Row	1 Row	2 Row	1 Row	2 Row	1 Row	2 Row
400		0.5	0.4	0.1	87.5	98.9	122.5	102.7	14.1	19.0
	1 Row 0.02	1.0	1.4	0.4	95.3	113.5	144.3	128.3	17.4	25.3
	2 Row 0.04	2.0	4.9	1.4	100.6	124.0	159.7	149.4	19.8	29.9
		4.0	17.4	4.9	103.9	130.5	169.1	163.2	21.2	32.7
550		0.5	0.4	0.1	81.3	89.8	116.2	95.8	15.7	20.7
	1 Row 0.04	1.0	1.4	0.4	88.6	103.5	139.1	121.1	20.0	28.9
	2 Row 0.07	2.0	4.9	1.4	93.9	114.5	156.2	143.8	23.2	35.4
		4.0	17.4	4.9	97.3	121.6	167.1	159.7	25.2	39.7
700		0.5	0.4	0.1	77.1	83.8	111.7	91.3	16.8	21.9
	1 Row 0.05	1.0	1.4	0.4	84.0	96.6	135.1	115.8	22.0	31.5
	2 Row 0.11	2.0	5.0	1.4	89.2	107.4	153.4	139.4	25.9	39.7
		4.0	17.4	4.9	92.6	114.9	165.4	156.7	28.5	45.4
850		0.5	0.4	0.1	74.2	79.6	108.2	88.1	17.7	22.7
	1 Row 0.08	1.0	1.4	0.4	80.6	91.4	131.8	111.8	23.6	33.5
	2 Row 0.16	2.0	5.0	1.4	85.7	102.0	151.1	135.8	28.3	43.3
		4.0	17.5	5.0	89.0	109.6	163.9	154.3	31.3	50.3
1000		0.5	0.4	0.1	71.9	76.5	105.4	85.6	18.4	23.3
	1 Row 0.10	1.0	1.4	0.4	78.0	87.4	129.1	108.6	24.9	35.1
	2 Row 0.21	2.0	5.0	1.4	82.9	97.7	149.0	132.8	30.2	46.2
		4.0	17.5	5.0	86.2	105.3	162.6	152.1	33.8	54.5
1150		0.5	0.4	0.1	70.2	74.1	103.1	83.7	18.9	23.8
	1 Row 0.13	1.0	1.4	0.4	75.9	84.3	126.8	105.9	26.1	36.4
	2 Row 0.27	2.0	5.0	1.4	80.7	94.2	147.3	130.2	32.0	48.8
		4.0	17.5	5.0	83.9	101.7	161.5	150.2	36.1	58.2
1300		0.5	0.4	0.1	68.8	72.2	101.1	82.1	19.4	24.2
	1 Row 0.17	1.0	1.4	0.4	74.2	81.7	124.8	103.7	27.1	37.5
	2 Row 0.33	2.0	5.0	1.4	78.8	91.2	145.7	128.0	33.5	51.0
		4.0	17.5	5.0	82.0	98.7	160.5	148.5	38.1	61.5
1450		0.5	0.4	0.1	67.6	70.6	99.5	80.8	19.8	24.5
	1 Row 0.20	1.0	1.4	0.4	72.8	79.5	123.1	101.8	27.9	38.5
	2 Row 0.40	2.0	5.0	1.4	77.2	88.7	144.3	126.1	34.9	52.9
		4.0	17.5	5.0	80.4	96.1	159.6	147.0	39.9	64.5

Data is based on 180°F entering water and 55°F entering air at sea level. See selection procedure for other conditions.

HOT WATER COIL DATA

MODEL TSS-WC • SIZE 14

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	2 Row	1 Row	2 Row	1 Row	2 Row	1 Row	2 Row
700		0.5	0.5	0.1	80.2	87.0	102.4	81.8	19.1	24.2
	1 Row 0.03	1.0	1.7	0.5	88.6	102.1	128.1	107.4	25.5	35.7
	2 Row 0.06	2.0	6.0	1.7	94.9	114.8	149.0	133.7	30.3	45.4
		4.0	21.0	6.0	99.1	123.3	162.9	153.5	33.4	51.8
900		0.5	0.5	0.1	75.9	81.0	97.3	77.5	20.4	25.3
	1 Row 0.04	1.0	1.7	0.5	83.7	94.7	123.1	101.4	27.9	38.7
	2 Row 0.09	2.0	6.0	1.7	89.9	107.2	145.2	128.1	34.0	50.9
		4.0	21.1	6.0	94.0	116.1	160.5	149.5	38.0	59.6
1100		0.5	0.5	0.1	72.9	76.9	93.5	74.6	21.3	26.0
	1 Row 0.06	1.0	1.7	0.5	80.1	89.3	119.1	97.0	29.9	40.9
	2 Row 0.13	2.0	6.1	1.7	86.1	101.4	142.1	123.6	37.0	55.3
		4.0	21.1	6.0	90.2	110.5	158.5	146.2	41.9	66.1
1300		0.5	0.5	0.1	70.6	73.9	90.6	72.5	22.0	26.6
	1 Row 0.08	1.0	1.8	0.5	77.4	85.3	115.8	93.6	31.5	42.6
	2 Row 0.17	2.0	6.1	1.7	83.1	96.9	139.5	120.0	39.6	58.9
		4.0	21.1	6.0	87.2	105.9	156.8	143.4	45.3	71.7
1500		0.5	0.5	0.1	68.9	71.6	88.3	70.9	22.6	27.0
	1 Row 0.11	1.0	1.8	0.5	75.2	82.1	113.1	90.8	32.9	44.0
	2 Row 0.22	2.0	6.1	1.8	80.8	93.2	137.2	116.9	41.9	62.0
		4.0	21.2	6.1	84.7	102.1	155.2	140.9	48.3	76.5
1700		0.5	0.5	0.1	67.5	69.8	86.3	69.6	23.1	27.3
	1 Row 0.14	1.0	1.8	0.5	73.5	79.5	110.8	88.6	34.0	45.1
	2 Row 0.27	2.0	6.1	1.8	78.8	90.1	135.2	114.3	43.9	64.6
		4.0	21.2	6.1	82.7	98.9	153.9	138.7	51.0	80.8
1900		0.5	0.5	0.1	66.4	68.4	84.7	68.6	23.5	27.5
	1 Row 0.17	1.0	1.8	0.5	72.0	77.4	108.8	86.7	35.0	46.0
	2 Row 0.33	2.0	6.1	1.8	77.2	87.5	133.4	112.0	45.6	66.9
		4.0	21.2	6.1	81.0	96.1	152.6	136.8	53.5	84.7
2100		0.5	0.5	0.1	65.5	67.2	83.3	67.8	23.9	27.8
	1 Row 0.20	1.0	1.8	0.5	70.8	75.6	107.0	85.1	35.9	46.8
	2 Row 0.40	2.0	6.1	1.8	75.8	85.3	131.8	110.0	47.2	68.8
		4.0	21.2	6.1	79.5	93.7	151.5	135.0	55.7	88.1

MODEL TSS-WC • SIZE 16

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	2 Row	1 Row	2 Row	1 Row	2 Row	1 Row	2 Row
1600		0.5	0.6	0.1	68.9	71.2	82.5	66.6	24.1	28.1
	1 Row 0.09	1.0	1.9	0.6	75.6	82.1	107.4	85.0	35.7	46.9
	2 Row 0.18	2.0	6.6	1.9	81.7	94.0	132.8	111.3	46.3	67.5
		4.0	22.9	6.6	86.1	103.7	152.4	136.9	53.9	84.4
1800		0.5	0.6	0.1	67.6	69.5	80.7	65.5	24.5	28.3
	1 Row 0.11	1.0	1.9	0.6	73.9	79.6	105.1	82.9	36.9	47.9
	2 Row 0.22	2.0	6.6	1.9	79.8	91.0	130.7	108.7	48.3	70.1
		4.0	22.9	6.6	84.1	100.6	150.9	134.6	56.8	88.9
2000		0.5	0.6	0.1	66.5	68.2	79.2	64.7	24.9	28.5
	1 Row 0.13	1.0	1.9	0.6	72.5	77.5	103.1	81.2	37.9	48.8
	2 Row 0.26	2.0	6.6	1.9	78.1	88.4	128.8	106.4	50.1	72.4
		4.0	23.0	6.6	82.4	97.9	149.6	132.6	59.4	92.9
2200		0.5	0.6	0.1	65.6	67.0	78.0	64.0	25.2	28.7
	1 Row 0.16	1.0	1.9	0.6	71.3	75.8	101.3	79.7	38.7	49.5
	2 Row 0.31	2.0	6.6	1.9	76.7	86.2	127.2	104.4	51.8	74.4
		4.0	23.0	6.6	80.9	95.5	148.4	130.7	61.8	96.6
2400		0.5	0.6	0.1	64.8	66.1	76.8	63.4	25.5	28.8
	1 Row 0.18	1.0	1.9	0.6	70.2	74.3	99.7	78.4	39.5	50.2
	2 Row 0.37	2.0	6.6	1.9	75.5	84.3	125.6	102.6	53.3	76.2
		4.0	23.0	6.6	79.6	93.4	147.3	129.1	64.0	99.9
2600		0.5	0.6	0.1	64.1	65.3	75.9	62.9	25.7	29.0
	1 Row 0.21	1.0	1.9	0.6	69.3	73.0	98.3	77.3	40.2	50.7
	2 Row 0.42	2.0	6.6	1.9	74.4	82.6	124.2	101.0	54.7	77.8
		4.0	23.0	6.6	78.4	91.5	146.2	127.5	66.0	102.9
2800		0.5	0.6	0.1	63.6	64.6	75.0	62.5	25.9	29.1
	1 Row 0.24	1.0	1.9	0.6	68.5	71.9	97.0	76.3	40.9	51.2
	2 Row 0.48	2.0	6.7	1.9	73.5	81.1	123.0	99.6	56.0	79.2
		4.0	23.0	6.6	77.4	89.9	145.2	126.1	67.9	105.7
3000		0.5	0.6	0.1	63.0	64.0	74.2	62.1	26.1	29.2
	1 Row 0.27	1.0	1.9	0.6	67.8	70.9	95.9	75.4	41.4	51.7
	2 Row 0.55	2.0	6.7	1.9	72.6	79.8	121.8	98.3	57.1	80.5
		4.0	23.1	6.6	76.5	88.3	144.3	124.8	69.7	108.3

Data is based on 180°F entering water and 55°F entering air at sea level. See selection procedure for other conditions.

HOT WATER COIL DATA

MODEL TSS-WC • SIZE 19

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	2 Row	1 Row	2 Row	1 Row	2 Row	1 Row	2 Row
2300		0.5	0.6	0.1	65.7	66.9	72.3	60.5	26.6	29.6
	1 Row 0.11	1.0	2.2	0.6	71.9	76.1	94.6	73.8	42.1	52.5
	2 Row 0.23	2.0	7.4	2.2	78.1	87.5	121.5	97.9	57.4	80.9
		4.0	25.6	7.4	82.8	97.9	144.5	125.5	69.4	106.9
2600		0.5	0.6	0.1	64.6	65.6	70.8	59.9	27.0	29.7
	1 Row 0.14	1.0	2.2	0.6	70.3	73.9	92.4	72.2	43.2	53.3
	2 Row 0.28	2.0	7.4	2.2	76.2	84.6	119.1	95.3	59.8	83.5
		4.0	25.7	7.4	80.9	94.8	142.7	122.9	72.9	112.0
2900		0.5	0.6	0.1	63.7	64.5	69.7	59.4	27.3	29.8
	1 Row 0.17	1.0	2.2	0.6	69.1	72.2	90.4	70.8	44.2	54.0
	2 Row 0.34	2.0	7.5	2.2	74.7	82.3	117.0	93.0	61.8	85.7
		4.0	25.7	7.4	79.2	92.1	141.1	120.6	76.1	116.6
3200		0.5	0.6	0.1	62.9	63.6	68.7	59.0	27.5	29.9
	1 Row 0.21	1.0	2.2	0.6	68.0	70.7	88.7	69.7	45.0	54.6
	2 Row 0.41	2.0	7.5	2.2	73.4	80.3	115.2	91.1	63.7	87.6
		4.0	25.8	7.4	77.8	89.8	139.6	118.5	79.0	120.7
3500		0.5	0.6	0.1	62.3	62.9	67.8	58.7	27.7	30.0
	1 Row 0.24	1.0	2.2	0.6	67.1	69.5	87.3	68.7	45.7	55.0
	2 Row 0.48	2.0	7.5	2.2	72.2	78.6	113.5	89.5	65.3	89.3
		4.0	25.8	7.5	76.6	87.8	138.3	116.7	81.7	124.4
3800		0.5	0.6	0.1	61.8	62.3	67.1	58.4	27.9	30.1
	1 Row 0.28	1.0	2.2	0.6	66.3	68.5	86.0	67.9	46.4	55.4
	2 Row 0.56	2.0	7.5	2.2	71.2	77.1	112.0	88.0	66.8	90.8
		4.0	25.8	7.5	75.4	86.0	137.0	115.0	84.2	127.7
4100		0.5	0.6	0.1	61.3	61.8	66.5	58.2	28.1	30.2
	1 Row 0.32	1.0	2.2	0.6	65.6	67.6	84.8	67.2	47.0	55.8
	2 Row 0.64	2.0	7.5	2.2	70.4	75.7	110.6	86.7	68.2	92.1
		4.0	25.8	7.5	74.5	84.4	135.8	113.5	86.5	130.7
4400		0.5	0.6	0.1	60.9	61.3	65.9	58.0	28.2	30.2
	1 Row 0.36	1.0	2.2	0.6	65.0	66.8	83.7	66.6	47.5	56.1
	2 Row 0.73	2.0	7.5	2.2	69.6	74.6	109.4	85.5	69.5	93.3
		4.0	25.9	7.5	73.6	83.0	134.8	112.1	88.6	133.5

MODEL TSS-WC • SIZE 22

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	2 Row	1 Row	2 Row	1 Row	2 Row	1 Row	2 Row
3100		0.5	0.7	0.1	63.4	64.0	66.6	58.0	28.0	30.2
	1 Row 0.16	1.0	2.3	0.7	68.8	71.6	86.0	67.6	46.4	55.6
	2 Row 0.31	2.0	8.0	2.3	74.7	81.9	112.8	88.6	66.1	90.2
		4.0	27.5	8.0	79.5	92.2	137.9	116.4	82.4	124.9
3500		0.5	0.7	0.1	62.5	63.0	65.5	57.6	28.3	30.3
	1 Row 0.19	1.0	2.3	0.7	67.5	69.8	84.0	66.4	47.4	56.2
	2 Row 0.39	2.0	8.0	2.3	73.1	79.4	110.4	86.3	68.4	92.5
		4.0	27.6	8.0	77.8	89.3	135.9	113.8	86.3	130.1
3900		0.5	0.7	0.1	61.8	62.2	64.7	57.4	28.5	30.4
	1 Row 0.23	1.0	2.3	0.7	66.4	68.4	82.3	65.4	48.2	56.7
	2 Row 0.47	2.0	8.0	2.3	71.7	77.4	108.3	84.3	70.5	94.5
		4.0	27.6	8.0	76.2	86.9	134.2	111.5	89.7	134.7
4300		0.5	0.7	0.1	61.2	61.5	63.9	57.1	28.7	30.4
	1 Row 0.28	1.0	2.3	0.7	65.5	67.3	80.8	64.5	49.0	57.1
	2 Row 0.56	2.0	8.0	2.3	70.5	75.6	106.5	82.6	72.3	96.1
		4.0	27.7	8.0	74.9	84.8	132.6	109.4	92.9	138.8
4700		0.5	0.7	0.1	60.7	61.0	63.3	56.9	28.9	30.5
	1 Row 0.33	1.0	2.3	0.7	64.7	66.3	79.6	63.9	49.6	57.5
	2 Row 0.66	2.0	8.1	2.3	69.5	74.2	104.8	81.2	74.0	97.6
		4.0	27.7	8.0	73.8	83.0	131.2	107.6	95.7	142.4
5100		0.5	0.7	0.1	60.2	60.5	62.8	56.8	29.0	30.5
	1 Row 0.38	1.0	2.3	0.7	64.1	65.5	78.4	63.3	50.2	57.8
	2 Row 0.76	2.0	8.1	2.3	68.7	72.9	103.4	79.9	75.4	98.8
		4.0	27.7	8.0	72.8	81.4	129.8	106.0	98.4	145.7
5500		0.5	0.7	0.1	59.9	60.1	62.3	56.7	29.1	30.5
	1 Row 0.43	1.0	2.3	0.7	63.5	64.7	77.5	62.8	50.7	58.0
	2 Row 0.87	2.0	8.1	2.3	67.9	71.8	102.0	78.8	76.8	100.0
		4.0	27.7	8.1	71.9	80.0	128.6	104.5	100.8	148.7
5900		0.5	0.7	0.1	59.6	59.8	62.0	56.6	29.2	30.6
	1 Row 0.49	1.0	2.3	0.7	63.0	64.1	76.6	62.3	51.1	58.2
	2 Row 0.99	2.0	8.1	2.3	67.2	70.8	100.8	77.8	78.0	101.0
		4.0	27.8	8.1	71.1	78.7	127.5	103.1	103.0	151.4

Data is based on 180°F entering water and 55°F entering air at sea level. See selection procedure for other conditions.

ELECTRIC HEAT

MODEL TSS-EH

STANDARD FEATURES

- cETL listed as an assembly
- Single point power connection
- Primary auto-reset high limit
- Secondary high limit
- Airflow switch
- Hinged control panel
- Ni-Chrome elements
- Primary/secondary power terminations
- Fusing per NEC
- Wiring diagram and ETL label
- Available kW increments are as follows:
  0.5 to 8.0 kW - .50 kW; 8.0 to 16.0 kW - 1.0 kW
  Above 16 kW - 2.0 kW

OPTIONAL FEATURES

- Disconnect (toggle or door interlocking)
- PE switches
- Mercury and magnetic contactors
- Manual reset secondary limit
- Proportional control (SSR)
- 24 V control transformer

SELECTION PROCEDURE

With standard heater elements, the maximum capacity (kW) is obtained by dividing the heating (minimum) 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 or refer to the VAV computer selection program for design assistance.

Heaters require a minimum of 0.07" w.g. downstream static pressure to ensure proper operation.

Selection Equations

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

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

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

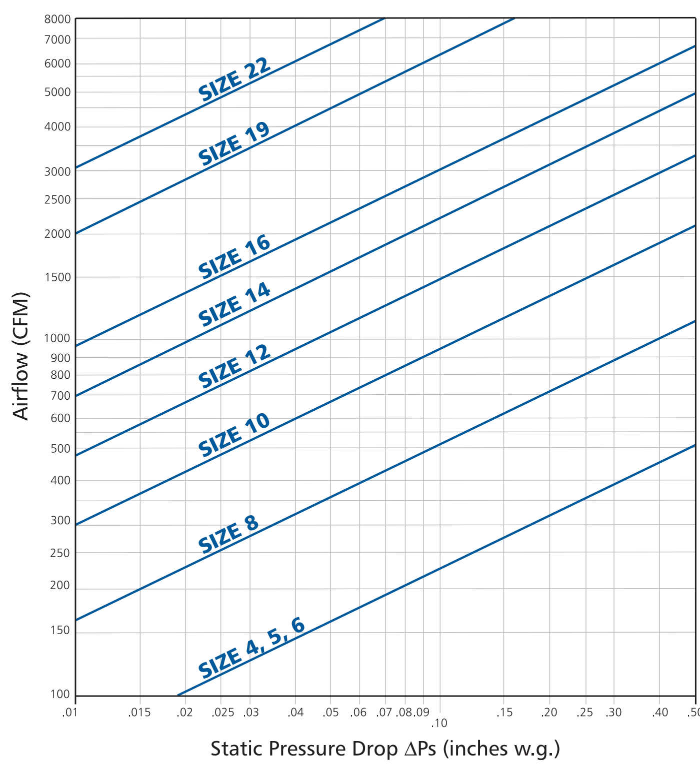
** Air density at sea level - reduce by 0.036 for each 1000 feet of altitude above sea level.*

Calculating Line Amperage

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

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

Electric Heater Pressure Drop



GUIDE SPECIFICATIONS

GENERAL

Furnish and install Johnson Controls Model TSS Single Duct Variable Air Volume Terminal Units of the sizes and capacities as scheduled. Terminals shall be certified by ARI and bear the ARI 880 seal.

CONSTRUCTION

Terminals shall be constructed of not less than 22 gauge galvanized steel, able to withstand a 125 hour salt spray test per ASTM B-117. Stainless steel casings, or galvannealed steel casings with a baked enamel paint finish, may be used as an alternative. 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. All appurtenances including control assemblies, control enclosures, hot water heating coils, and electric heating coils shall not extend beyond the top and bottom of the unit casing. At an inlet velocity of 2000 f.p.m., the static pressure drop across the basic terminal or basic terminal with a sound attenuator shall not exceed .08" W.G. for all unit sizes.

PRIMARY AIR VALVE

The primary air valve shall consist of a minimum 22 gauge cylindrical body that includes 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.

PRIMARY AIRFLOW SENSOR

For inlet diameters 6" or greater, the differential pressure airflow sensor shall traverse the duct along two perpendicular diameters. Cylindrically shaped inlets shall utilize the equal cross sectional area or log-linear traverse method. 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 2.5 times the equivalent velocity pressure signal obtained from a conventional pitot tube. The sensor shall develop a differential pressure of 0.03" w.g. at an air velocity of < 450 FPM. Documentation shall be submitted which substantiates this requirement. Balancing taps and airflow calibration charts shall be provided for field airflow measurements.

HOT WATER COIL

Single duct 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. Stainless steel casings, or galvannealed steel casings with a baked enamel paint finish, may be used as an alternative. Coil to be constructed of pure aluminum fins with full fin collars maintaining 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. Heater shall be cETL listed. The heater cabinet shall be constructed of not less than 20 gauge galvanized steel. Stainless steel cabinets, or galvannealed steel casings with a baked enamel paint finish, may be used as an alternative. Heater shall have a hinged access panel for entry to the controls.

Electric heaters shall be factory mounted to the terminal with the heating elements located upstream of the airflow control damper to ensure uniform velocity profile over elements. Elements located downstream of the damper are not acceptable.

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 1996 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), airflow switch, Ni-Chrome elements, and fusing per UL and NEC.

GUIDE SPECIFICATIONS

Heater shall have complete wiring diagram with label indicating power requirement and kW output.

SOUND ATTENUATOR

Sound attenuator shall be provided where scheduled to meet acoustical performance requirements. The attenuator and terminal unit shall be single piece construction at least 50” long. Attenuator casing shall be constructed as specified for the base terminal.

MULTIPLE-OUTLET PLENUM

Multiple-outlet plenum (MOP) shall be provided where scheduled. The MOP shall have trim balancing dampers in each outlet. Damper shall have a locking quadrant to ensure that the damper position is maintained. Multiple-outlet casing shall be constructed as specified for the base terminal.

OPTIONS

Foil Faced Insulation
Insulation shall be covered with scrim backed foil facing. All insulation edges shall be covered with foil or metal nosing. Insulation shall meet ASTM C1136 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.

Low Temperature Construction
Terminals shall be designed for use with primary airflow temperatures as low as 46°F and maximum ceiling plenum conditions of 78°F and 60% R.H. In addition to other design criteria, the primary air valve shall be thermally isolated from the terminal casing. The damper shaft shall be made from non-conducting thermoplastic composite material. Metal shafts will not be acceptable.

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.

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 BACnet

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 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.

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