CONNCAT CULINARY ARTS

O&M DOCUMENTS
Job 4397

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CN Series

Condensing Units

Installation, Operation, & Maintenance

⚠ WARNING

QUALIFIED INSTALLER

Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Startup and service must be performed by a Factory Trained Service Technician. A copy of this IOM should be kept with the unit.

⚠ WARNING

FOR YOUR SAFETY

Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

⚠ WARNING

If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

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V28960 · Rev. A · 150727

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Safety

Attention should be paid to the following statements:

NOTE - Notes are intended to clarify the unit installation, operation and maintenance.

CAUTION - Caution statements are given to prevent actions that may result in equipment damage, property damage, or personal injury.

WARNING - Warning statements are given to prevent actions that could result in equipment damage, property damage, personal injury or death.

DANGER - Danger statements are given to prevent actions that will result in equipment damage, property damage, severe personal injury or death.

WARNING

ELECTRIC SHOCK, FIRE OR EXPLOSION HAZARD

Failure to follow safety warnings exactly could result in dangerous operation, serious injury, death or property damage.

Improper servicing could result in dangerous operation, serious injury, death, or property damage.

- Before servicing, disconnect all electrical power to the furnace. More than one disconnect may be provided.
- When servicing controls, label all wires prior to disconnecting. Reconnect wires correctly.
- Verify proper operation after servicing. Secure all doors with key-lock or nut and bolt.

WARNING

QUALIFIED INSTALLER

Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Startup and service must be performed by a Factory Trained Service Technician. A copy of this IOM should be kept with the unit.

CAUTION

WHAT TO DO IF YOU SMELL GAS

- Do not try to turn on unit.
- Shut off main gas supply.
- Do not touch any electric switch.
- Do not use any phone in the building.
- Never test for gas leaks with an open flame.
- Use a gas detection soap solution and check all gas connections and shut off valves.

⚠ WARNING

FIRE, EXPLOSION OR CARBON MONOXIDE POISONING HAZARD

Failure to replace proper controls could result in fire, explosion or carbon monoxide poisoning. Failure to follow safety warnings exactly could result in serious injury, death or property damage. Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this appliance.

⚠ WARNING

Electric shock hazard. Before servicing, shut off all electrical power to the unit, including remote disconnects, to avoid shock hazard or injury from rotating parts. Follow proper Lockout-Tagout procedures.

⚠ WARNING

During installation, testing, servicing, and troubleshooting of the equipment it may be necessary to work with live electrical components. Only a qualified licensed electrician or individual properly trained in handling live electrical components shall perform these tasks.

Standard NFPA-70E, an OSHA regulation requiring an Arc Flash Boundary to be field established and marked for identification of where appropriate Personal Protective Equipment (PPE) be worn, should be followed.

⚠ WARNING

GROUNDING REQUIRED

All field installed wiring must be completed by qualified personnel. Field installed wiring must comply with NEC/CEC, local and state electrical code requirements. Failure to follow code requirements could result in serious injury or death. Provide proper unit ground in accordance with these code requirements.

⚠ WARNING

VARIABLE FREQUENCY DRIVES

Do not leave VFDs unattended in hand mode or manual bypass. Damage to personnel or equipment can occur if left unattended. When in hand mode or manual bypass mode VFDs will not respond to controls or alarms.

⚠ CAUTION

Electric motor over-current protection and overload protection may be a function of the Variable Frequency Drive to which the motors are wired. Never defeat the VFD motor overload feature. The overload ampere setting must not exceed 115% of the electric motors FLA rating as shown on the motor nameplate.

⚠ WARNING

UNIT HANDLING

To prevent injury or death lifting equipment capacity shall exceed unit weight by an adequate safety factor. Always test-lift unit not more than 24 inches high to verify proper center of gravity lift point to avoid unit damage, injury or death.

⚠ CAUTION

Door compartments containing hazardous voltage or rotating parts are equipped with door latches that allow locks. Door latches are shipped with a nut and bolt requiring tooled access. If the shipping hardware is not replaced with a pad lock, always re-install the nut and bolt after closing the door to maintain tooled access.

⚠ WARNING

Do not use oxygen, acetylene or air in place of refrigerant and dry nitrogen for leak testing. A violent explosion may result causing injury or death.

⚠ CAUTION

PVC (Polyvinyl Chloride) and CPVC (Chlorinated Polyvinyl Chloride) are vulnerable to attack by certain chemicals. Polyolester (POE) oils used with R-410A and other refrigerants, even in trace amounts, in a PVC or CPVC piping system will result in stress cracking of the piping and fittings and complete piping system failure.

⚠ CAUTION

Rotation must be checked on all MOTORS AND COMPRESSORS of 3 phase units at startup by a qualified service technician. Scroll compressors are directional and can be damaged if rotated in the wrong direction. Compressor rotation must be checked using suction and discharge gauges. Fan motor rotation should be checked for proper operation. Alterations should only be made at the unit power connection

⚠ CAUTION

To prevent damage to the unit, do not use acidic chemical coil cleaners. Do not use alkaline chemical coil cleaners with a pH value greater than 8.5, after mixing, without first using an aluminum corrosion inhibitor in the cleaning solution.

⚠ WARNING

Some chemical coil cleaning compounds are caustic or toxic. Use these substances only in accordance with the manufacturer's usage instructions. Failure to follow instructions may result in equipment damage, injury or death.

⚠ CAUTION

Do not clean DX refrigerant coils with hot water or steam. The use of hot water or steam on refrigerant coils will cause high pressure inside the coil tubing and damage to the coil.

⚠ CAUTION

Polyolester (POE) and Polyvinylether (PVE) oils are two types of lubricants used in hydrofluorocarbon (HFC) refrigeration systems. Refer to the compressor label for the proper compressor lubricant type.

⚠ WARNING

COMPRESSOR CYCLING

5 MINUTE MINIMUM OFF TIME
To prevent motor overheating compressors must cycle off for a minimum of 5 minutes.

5 MINUTE MINIMUM ON TIME
To maintain the proper oil level compressors must cycle on for a minimum of 5 minutes.

The cycle rate must not exceed 6 starts per hour.

1. Startup and service must be performed by a Factory Trained Service Technician

2. The unit is for outdoor use only. See General Information section for more information.

3. Every unit has a unique equipment nameplate with electrical, operational, and unit clearance specifications. Always refer to the unit nameplate for specific ratings unique to the model you have purchased.

4. READ THE ENTIRE INSTALLATION, OPERATION AND MAINTENANCE MANUAL. OTHER IMPORTANT SAFETY PRECAUTIONS ARE PROVIDED THROUGHOUT THIS MANUAL.

5. Keep this manual and all literature safeguarded near or on the unit.

CN Series Feature String Nomenclature

Model Options : Unit Feature Options

GEN	MJREV	SIZE	SERIES	MNREV	VLT	A1	A2	A3	A4	A5	1	2A	2B	3A	3B	4	5	6A	6B	6C	7	8A	8B	8C	8D	9	10	11	12	13	14	15	16	17	18	19	20	21	22
CN	A	- 055	- A	- 0	- 3	- C	A	0	0	E	: 0	- 00	- E0	- D	0	-	0	0	0	-	0	- DA	0	0	-	0	0	0	0	J	0	0	0	0	0	0	0	0	B

MODEL OPTIONS

Series and Generation
CN

Major Revision
A

Unit Size
055 = 55 ton Capacity
065 = 65 ton Capacity
075 = 75 ton Capacity
090 = 90 ton Capacity
105 = 105 ton Capacity
120 = 120 ton Capacity
130 = 130 ton Capacity
140 = 140 ton Capacity

Series
A = 55-75 ton units
B = 90-105 ton units
C = 120-140 ton units

Minor Revision
0

Voltage
2 = 230V/3Φ/60Hz
3 = 460V/3Φ/60Hz
4 = 575V/3Φ/60Hz
8 = 208V/3Φ/60Hz

A1: Compressor Style
C = R-410A VFD Compatible Scroll Compressor

A2: Condenser Style
A = Air-Cooled Microchannel Condenser

A3: Configuration
0 = Standard

A4: Coating
0 = Standard
E = Polymer E-coated Condenser Coil

A5: Staging
A = 1 Variable Capacity Comp + 1 On/Off Comp
B = 2 Variable Capacity Comp + 2 On/Off Comp
E = All Variable Capacity Compressors

UNIT FEATURE OPTIONS

1: Unit Orientation
A = Vertical Condenser Discharge with End Control Panel

2A: Refrigeration Control
0 = Standard
B = Fan Cycling
C = Adjustable Fan Cycling
D = Adjustable Compressor Lockout
K = Options B + D
M = Options C + D

2B: Blank
0 = Standard

3A: Refrigeration Options
0 = None
D = Hot Gas Bypass Non-Variable Compressors [HGBNV]
E = Modulating Hot Gas Reheat [MHGR]
L = Options D + E

3B: Blank
0 = Standard

CN Series Feature String Nomenclature

Model Options : Unit Feature Options

GEN	MJREV		SIZE		SERIES	MNREV	VLT	A1	A2	A3	A4	A5	1	2A	2B	3A	3B	**4**	**5**	**6A**	**6B**	**6C**	**7**	**8A**	**8B**	**8C**	**8D**	**9**	**10**	11	12	13	14	15
CN	A	-	055	-	A	-	0	-	3	-	C	A	0	0	E	:	0	-	0	0	-	E	0	-	**D0**	-	**0**	**0**	**0**	-	**0**	-	**DA**	**0**	**0**	-	**0**	**0**	0	0	J	0	0
																														0	0	0	0	0	0	B
																														16	17	18	19	20	21	22

4: Refrigeration Accessories
0 = None
A = Sight Glass
B = Compressor Isolation Valves
C = Options A + B
D = Flooded Condenser 0°F Low Ambient Controls - One Circuit
E = Options A + D
F = Options B + D
G = Options A + B + D
H = Flooded Condenser 0°F Low Ambient Controls - Two Circuit
J = Options A + H
K = Options B + H
L = Options A + B + H
M = Flooded Condenser 0°F Low Ambient Controls - Three Circuit
N = Options A + M
P = Options B + M
Q = Options A + B + M
R = Flooded Condenser 0°F Low Ambient Controls - Four Circuit
S = Options A + R
T = Options B + R
U = Options A + B + R

5: Blank
0 = Standard

6A: Unit Disconnect Type
0 = Standard Single Point Power Block
A = Single Point Power Non-Fused Disconnect

6B: Disconnect Size
J = 60 amps
N = 100 amps
R = 150 amps
U = 225 amps
Z = 400 amps
3 = 600 amps
5 = 800 amps
7 = 1200 amps

6C: Blank
0 = Standard

7: Accessories
0 = None
B = Phase & Brown Out Protection
D = Suction Pressure Transducer All Refrigeration Circuits
L = Options B + D

8A: Control Sequence
B = VAV Single Zone Unit Controller - VAV Cool + CAV Heat
C = VAV Single Zone Unit Controller - VAV Cool + VAV Heat
D = VAV Unit Controller - VAV Cool + VAV Heat
E = CAV Unit Controller - CAV Cool + CAV Heat
F = MUA Unit Controller - CAV Cool + CAV Heat
M = Field Installed DDC Controls by Others
N = Field Installed DDC Controls w/ Isolation Relays
P = Factory Installed DDC Controls Furnished by Others w/ Isolation Relays (SPA)

8B: Control Supplier
0 = AAON Refrigeration System Supervisory Controls
A = WattMaster Orion Control System
C = WattMaster Orion Control System (Main Controller in Air Handler)

8C: Control Supplier Options
0 = Standard

8D: BMS Connection & Diagnostics
0 = Standard

9: Blank
0 = Standard

10: Blank
0 = Standard

CN Series Feature String Nomenclature

Model Options : Unit Feature Options

GEN	MJREV	SIZE	SERIES	MNREV	VLT	A1	A2	A3	A4	A5	1	2A	2B	3A	3B	4	5	6A	6B	6C	7	8A	8B	8C	8D	9	10	11	12	13	14	15	16	17	18	19	20	21	22
CN	A	-	055	-	A	-	0	-	3	-	C	A	0	0	E	:	0	-	0	0	-	E	0	-	D	0	-	0	0	0	-	0	-	D	A	0	0	-	0	0	**0**	**0**	**J**	**0**	**0**	**0**	**0**	**0**	**0**	**B**

11: Maintenance Accessories
0 = None
A = 115VAC Convenience Outlet - Factory Wired
B = 115VAC Convenience Outlet - Field Wired
C = Service Access Lights
E = Remote Unit Start/Stop Terminals
F = Options A + C
H = Options A + E
J = Options B + C
L = Options B + E
N = Options C + E
R = Options A + C + E
U = Options B + C + E

12: Code Options
0 = Standard ETL US Listing
A = Chicago Code
B = ETL US + Canada Listing

13: Air-Cooled Condenser
H = Condenser Coil Guards + Three Phase Condenser Fan Motor
J = Condenser Coil Guards + Three Phase Condenser Fan Motor + VFD Controlled Condenser Fans (35˚F Low Ambient

14: Blank
0 = Standard

15: Blank
0 = Standard

16: Electrical Options
0 = Standard

17: Blank
0 = Standard

18: Blank
0 = Standard

19: Blank
0 = Standard

20: Cabinet Material
0 = Double Wall Galvanized Steel Cabinet + R-13 Foam Insulation

21: Warranty
0 = Standard Warranty
D = Extended Compressor Warranty Years 2-5

22: Paint and Special Pricing Authorization
B = Premium AAON Gray Paint Exterior
E = Premium AAON Gray Paint Exterior + Shrink Wrap
X = SPA + Option B
1 = SPA + Option E
4 = SPA + Special Exterior Paint Color
7 = SPA + Special Exterior Paint Color + Shrink Wrap

General Information

AAON CN Series condensing units are complete air-cooled condensing units ranging from 55 to 140 tons of cooling capacity. They are assembled, wired, and tested.

⚠ WARNING

Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Startup and service must be performed by a Factory Trained Service Technician.

Codes and Ordinances

CN Series units have been tested and certified, by ETL, in accordance with UL Safety Standard 1995/CSA C22.2 No. 236.

System should be sized in accordance with the American Society of Heating, Refrigeration and Air Conditioning Engineers Handbook.

Installation of CN Series units must conform to the ICC standards of the International Mechanical Code, the International Building Code, and local building, plumbing and waste water codes. All appliances must be electrically grounded in accordance with local codes, or in the absence of local codes, the current National Electric Code, ANSI/NFPA 70 or the current Canadian Electrical Code CSA C22.1.

⚠ WARNING

Coils and sheet metal surfaces present sharp edges and care must be taken when working with equipment.

⚠ WARNING

Failure to observe the following instructions will result in premature failure of your system and possible voiding of the warranty.

Receiving Unit

When received, the unit should be checked for damage that might have occurred in transit. If damage is found it should be noted on the carrier's Freight Bill. A request for inspection by carrier's agent should be made in writing at once. Nameplate should be checked to ensure the correct model sizes and voltages have been received to match the job requirements.

Storage

If installation will not occur immediately following delivery, store equipment in a dry protected area away from construction traffic and in the proper orientation as marked on the packaging with all internal packaging in place. Secure all loose-shipped items.

⚠ CAUTION

The Clean Air Act of 1990 bans the intentional venting of refrigerant as of July 1, 1992. Approved methods of recovery, recycling, or reclaiming must be followed.

⚠ WARNING

COMPRESSOR CYCLING

5 MINUTE MINIMUM OFF TIME
To prevent motor overheating compressors must cycle off for a minimum of 5 minutes.

5 MINUTE MINIMUM ON TIME
To maintain the proper oil level compressors must cycle on for a minimum of 5 minutes.

The cycle rate must not exceed 6 starts per hour.

Failure to observe the following instructions will result in premature failure of your system, and possible voiding of the warranty.

⚠ CAUTION

CRANKCASE HEATER OPERATION
Units may be equipped with compressor crankcase heaters, which should be energized at least 24 hours prior to cooling operation, to clear any liquid refrigerant from the compressors.

Never turn off the main power supply to the unit, except for complete shutdown. When power is cut off from the unit, any compressors using crankcase heaters cannot prevent refrigerant migration. This means the compressor will cool down, and liquid refrigerant may accumulate in the compressor. The compressor is designed to pump refrigerant gas and damage may occur when power is restored if liquid enters the compressor.

⚠ CAUTION

Rotation must be checked on all MOTORS AND COMPRESSORS of three phase units. All motors, to include and not be limited to pump motors and condenser fan motors, should all be checked by a qualified service technician at startup and any wiring alteration should only be made at the unit power connection.

Before unit operation, the main power switch must be turned on for at least 24 hours for units with compressor crankcase heaters. This will give the crankcase heater time to clear any liquid accumulation out of the compressor before it is required to run.

⚠ CAUTION

Scroll compressors are directional and will be damaged by operation in the wrong direction. Low pressure switches on compressors have been disconnected after factory testing. Rotation should be checked by a qualified service technician at startup using suction and discharge pressure gauges and any wiring alteration should only be made at the unit power connection.

Never cut off the main power supply to the unit, except for complete shutdown. Always control the system from the building management system, or control panel, never at the main power supply (except for emergency or for complete shutdown of the system).

Scroll compressors must be on a minimum of 5 minutes and off for a minimum of 5 minutes. The cycle rate must be no more than 6 starts per hour.

Compressor life will be seriously shortened by reduced lubrication, and the pumping of excessive amounts of liquid oil and liquid refrigerant.

Wiring Diagrams

A complete set of unit specific wiring diagrams in both ladder and point-to-point form are laminated in plastic and located inside the control compartment door.

General Maintenance

When the initial startup is made and on a periodic schedule during operation, it is necessary to perform routine service checks on the performance of the condensing unit. This includes reading and recording suction pressures and checking for normal sub-cooling and superheat. See the air-cooled condenser sections in this manual for specific details.

Installation

Unit Placement

The AAON CN Series is designed for outdoor applications and mounting at ground level or on a rooftop. It must be placed on a level and solid foundation that has been prepared to support its weight.

The placement relative to the building air intakes and other structures must be carefully selected. Be sure to observe the dimensions that are on the rating plate of the condensing unit for operational and service clearances.

Table 1 - Service Clearances

Location	Unit Size
	55-140 tons
Front - (Controls Side)	72”
Back	48”
Ends	96”
Top	Unobstructed

Condenser coils and fans must be free of any obstructions in order to start and operate properly with a correct amount of airflow. For proper unit operation, the immediate area around condenser must remain free of debris that may be drawn in and obstruct airflow in the condensing section.

Consideration must be given to obstruction caused by snow accumulation when placing the unit.

Curb and Steel Mount Installation

Make openings in the roof decking large enough to allow for water piping, electrical penetrations, and workspace only. Do not make openings larger than necessary. Set the curb to coincide with the openings. Make sure curb is level.

Unit specific curb drawing is included with job submittal. See SMACNA *Architectural Sheet Metal Manual* for curb installation details.

⚠ CAUTION

All roofing work should be performed by competent roofing contractors to avoid any possible leakage.

⚠ CAUTION

The base beneath the condenser section is open and must be considered when mounting on a curb.

Units require rail support along all four sides of the unit base.

When installed at ground level, a one-piece concrete slab should be used with footings that extend below the frost line. Care must also be taken to protect the coil and fins from damage due to vandalism or other causes.

If unit is elevated a field supplied catwalk is recommended to allow access to unit service doors.

This unit ships with a curb gasket that is 1¼” wide and 1½” tall. It is recommended that this or another similar gasket be used between the curb and the unit to reduce vibration from the unit to the building.

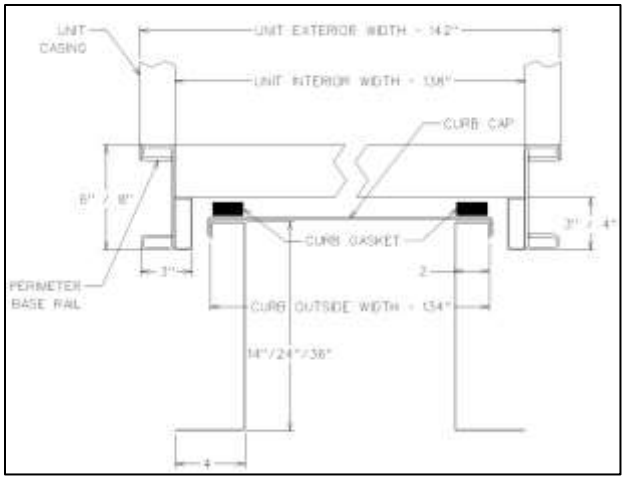

Figure 1 - Curb Mounting with Dimensions

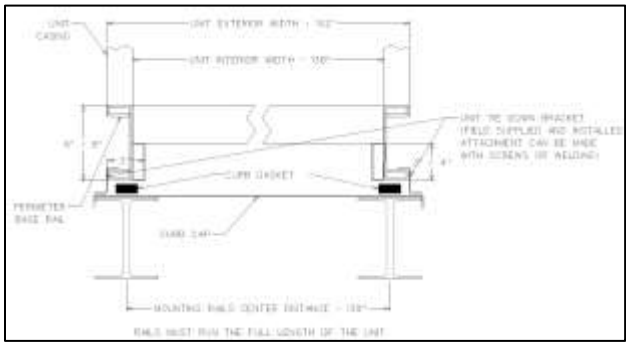

Figure 2 - Steel Mounting Rail with Dimensions

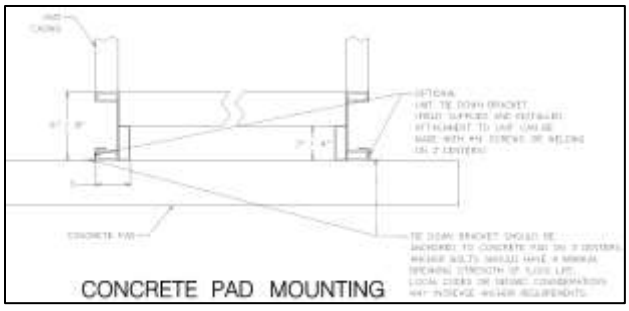

Figure 3 - Concrete Pad Mounting with Dimensions

Lifting and Handling

If cables or chains are used to hoist the unit they must be the same length and care should be taken to prevent damage to the cabinet. See Figure 6 for additional information.

Before lifting unit, be sure that all shipping material has been removed from unit. Secure hooks and cables at all lifting points/ lugs provided on the unit.

Hoist unit to a point directly above the curb or mounting rail. Be sure that the gasket material has been applied to the curb or mounting rail.

Carefully lower and align unit with utility and duct openings. Lower the unit until the unit skirt fits around the curb. Make sure the unit is properly seated on the curb and is level.

Do not push, pull or lift the unit from anything other than its base.

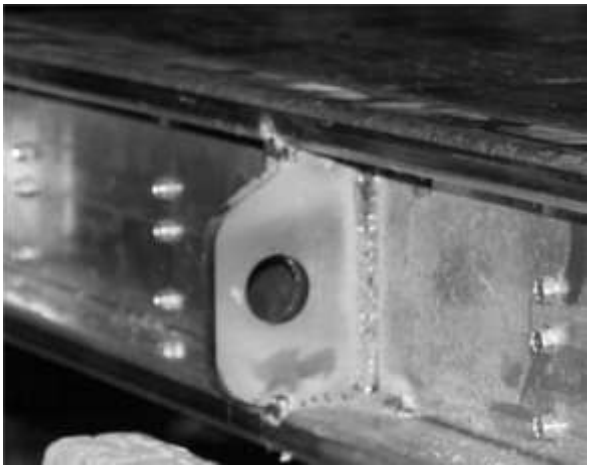

Figure 4 - Lifting Points

End Flashing Installation

AAON CN Series condensing units are 142" wide, and the cabinet width will overhang the shipping trailer on each side.

In order to secure and protect the unit during transit the sheet metal end flashings have been removed from the unit. The slot created at the base of each end of the unit allows the unit to set firmly on the trailer deck.

Sheet metal flashings are shipped loose with the unit and once the unit is set into place

the flashings must be installed on each end of the unit to complete the finished seal at the base. The flashings are unit specific and designed to cover the slot at each end of the unit to prevent water run-off into the curb.

Failure to attach and seal the end of unit with the flashings may result in water leakage into the curb.

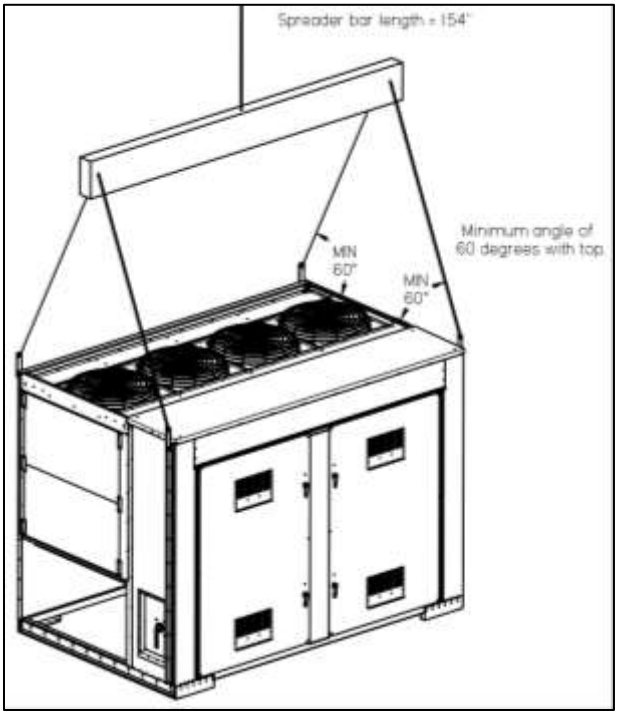

Figure 5 - CN Series A Cabinet Top Lifting Detail

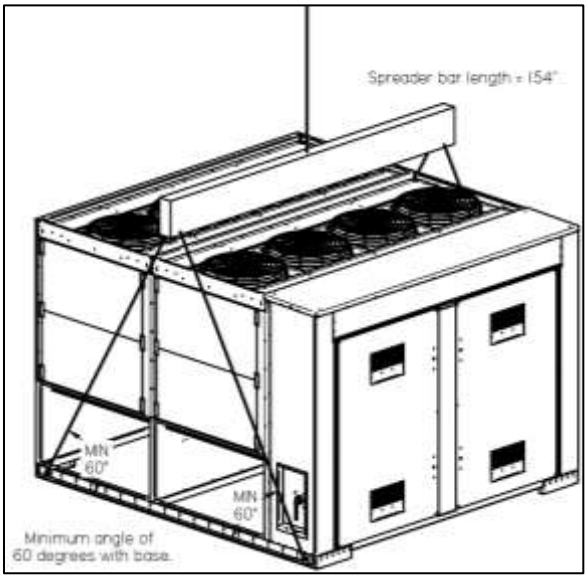

Figure 6 - CN Series B and C Cabinet Bottom Lifting Detail

Lifting slot locations are unit specific.
Unit must be rigged at all marked lifting points.

CAUTION

PVC (Polyvinyl Chloride) and CPVC (Chlorinated Polyvinyl Chloride) are vulnerable to attack by certain chemicals. Polyolester (POE) oils used with R-410A and other refrigerants, even in trace amounts, in a PVC or CPVC piping system will result in stress cracking of the piping and fittings and complete piping system failure.

Mounting Isolation

For roof mounted applications or anytime vibration transmission is a factor, full perimeter vibration isolators may be used.

Access Doors

Lockable access doors are provided to the compressor and control compartment.

Low Ambient Operation

The AAON low ambient (condenser flood-back) system is used to operate a refrigerant system below 35°F outside air temperature. As the ambient temperature drops, the condenser becomes more effective therefore lowering the head pressure. When the head pressure gets too low, there will be insufficient pressure to operate the expansion valve properly. During low ambient temperatures, it is difficult to start a system because the refrigerant will migrate to the cold part of the system (condenser) and make it difficult for refrigerant to flow.

The low ambient system maintains normal head pressure during periods of low ambient operation by restricting liquid flow from the condenser to the receiver, and at the same time bypassing hot gas around the condenser to the inlet of the receiver. This backs liquid refrigerant up into the condenser reducing its capacity that in turn increases the condensing pressure. At the same time the bypassed hot gas raises liquid pressure in the receiver, allowing the system to operate properly.

There are different types of low ambient control used. The following figure shows the type of system available on the CN Series.

Expansion Valve Operation

AAON recommends the use of electronic expansion valves in matching air handling units when using variable speed compressors in CN Series condensing units. Thermostatic expansion valves do not have enough turn down capacity and cannot properly manage suction superheat during low load conditions. Electronic expansion valves must be observed during startup through the entire operating range of the variable speed compressor to ensure that suction superheat never falls below 7°F. Insufficient suction superheat can introduce liquid refrigerant to the compressor and significantly reduce compressor life.

Determining Refrigerant Line Size

CAUTION

Line sizes must be selected to meet actual installation conditions, not simply based on the connection sizes at the condensing unit or air handling unit.

The piping between the condenser and low side must ensure:

1. Minimum pressure drop, **and**

2. Continuous oil return, **and**

3. Prevention of liquid refrigerant slugging, or carryover

Minimizing the refrigerant line size is favorable from an economic perspective,

reducing installation costs, and reducing the potential for leakage. However, as pipe diameters narrow, pressure-reducing frictional forces increase.

Excessive suction line pressure drop causes loss of compressor capacity and increased power usage resulting in reduced system efficiency. Excessive pressure drops in the liquid line can cause the liquid refrigerant to flash, resulting in faulty expansion valve operation and improper system performance. In order to operate efficiently and cost effectively, while avoiding malfunction, refrigeration systems must be designed to minimize both cost and pressure loss.

Equivalent Line Length

All line lengths discussed in this manual, unless specifically stated otherwise, are Equivalent Line Lengths. The frictional pressure drop through valves, fittings, and accessories is determined by establishing the equivalent length of straight pipe of the same diameter. **Always use equivalent line lengths when calculating pressure drop**. Special piping provisions must be taken when lines are run underground, up vertical risers, or in excessively long line runs.

Liquid Line

When sizing the liquid line, it is important to minimize the refrigerant charge to reduce installation costs and improve system reliability. This can be achieved by minimizing the liquid line diameter. However, reducing the pipe diameter will increase the velocity of the liquid refrigerant which increases the frictional pressure drop in the liquid line, and causes other undesirable effects such as noise.

Maintaining the pressure in the liquid line is critical to ensuring sufficient saturation temperature, avoiding flashing upstream of the expansion valve, and maintaining system efficiency. Pressure losses through the liquid line due to frictional contact, installed accessories, and vertical risers are inevitable. Maintaining adequate sub-cooling at the condenser to overcome these losses is the only method to ensure that liquid refrigerant reaches the expansion valve.

Liquid refrigerant traveling upwards in a riser loses head pressure. If the evaporator is below the condenser, and the liquid line does not include risers, the gravitational force will increase the pressure of the liquid refrigerant. This will allow the refrigerant to withstand greater frictional losses without the occurrence of flashing prior to the expansion vavle.

A moisture-indicating sight glass may be field installed in the liquid line to indicate the occurrence of premature flashing or moisture in the line. The sight glass should not be used to determine if the system is properly charged. **Use temperature and pressure measurements to determine liquid sub-cooling, not the sight glass.**

Liquid Line Routing

Care should be taken with vertical risers. When the system is shut down, gravity will pull liquid down the vertical column, and back to the condenser when it is below the evaporator. This could potentially result in compressor flooding. A check valve can be installed in the liquid line where the liquid column rises above the condenser to prevent this. The liquid line is typically pitched along with the suction line, or hot gas line, to minimize the complexity of the configuration.

Liquid Line Insulation

When the liquid line is routed through regions where temperature losses are expected, no insulation is required, as this

may provide additional sub-cooling to the refrigerant. When routing the liquid line through high temperature areas, insulation of the line is appropriate to avoid loss of sub-cooling through heat gain.

Liquid Line Guidelines

In order to ensure liquid at the expansion valve, frictional losses must not exceed available sub-cooling. A commonly used guideline to consider is a system design with pressure losses due to friction through the line not to exceed a corresponding 1-2°F change in saturation temperature.

If the velocity of refrigerant in the liquid line is too great, it could cause excessive noise or piping erosion. The recommended maximum velocities for liquid lines are 100 fpm from the condenser to a receiver tank to discourage fluid backup, and 300 fpm from receiver tank to the evaporator to minimize valve induced liquid hammer.

Liquid Line Accessories

Liquid line shut off valves and filter driers are factory provided. The total length equivalent of pressure losses through valves, elbows and fittings must be considered when adding additional components in the field. It is a good practice to utilize the fewest elbows that will allow the mating units to be successfully joined.

Suction Line

The suction line is more critical than the liquid line from a design and construction standpoint. More care must be taken to ensure that adequate velocity is achieved to return oil to the compressor at minimum loading conditions. However, reducing the piping diameter to increase the velocity at minimal load can result in excessive pressure losses, capacity reduction, and noise at full load.

⚠ CAUTION

Suction line must be sized in accordance to the minimum capacity of the variable speed compressor.

Suction Line Routing

Pitch the suction line in the direction of flow (about 1 foot per 120 feet of length) to maintain oil flow towards the compressor, and keep it from flooding back into the evaporator. Crankcase heaters may be provided to keep any condensed refrigerant that collects in the compressor from causing damage or wear. Make sure to provide support to maintain suction line positioning, and insulate completely between the evaporator and condensing unit.

It is important to consider part load operation when sizing suction lines. At minimum capacity, refrigerant velocity may not be adequate to return oil up the vertical riser. Decreasing the diameter of the vertical riser will increase the velocity, but also the frictional loss.

A double suction riser can be applied to the situation of part load operation with a suction riser. A double suction riser is designed to return oil at minimum load while not incurring excessive frictional losses at full load. A double suction riser consists of a small diameter riser in parallel with a larger diameter riser, and a trap at the base of the large riser. At minimum capacity, refrigerant velocity is not sufficient to carry oil up both risers, and it collects in the trap, effectively closing off the larger diameter riser, and diverting refrigerant up the small riser where velocity of the refrigerant is sufficient to maintain oil flow. At full load, the mass flow clears the trap of oil, and refrigerant is carried through both risers. The smaller diameter pipe should be

sized to return oil at minimum load, while the larger diameter pipe should be sized so that flow through both pipes provides acceptable pressure drop at full load.

Suction Line Insulation
The entire suction line should be insulated with a minimum 1 inch thick Armaflex insulation. This prevents condensation from forming on the line, and reduces any potential loss in capacity associated with heat gain placing additional load on the system.

Suction Line Guidelines
For proper performance, suction line velocities less than a 4,000 fpm maximum are recommended. The minimum velocity required to return oil is dependent on the pipe diameter, however, a general guideline of 1,000 fpm minimum may be applied.

In a fashion similar to the liquid line, a common guideline to consider is a system design with pressure losses due to friction through the line not to exceed a corresponding 1-2°F change in saturation temperature.

At points where small pipe size can be used to provide sufficient velocity to return oil in vertical risers at part loads, greater pressure losses are incurred at full loads. This can be compensated for by over sizing the horizontal runs and vertical drop sections. This will however require additional refrigerant charge.

Suction Line Accessories
If the job requirements specify suction accumulators, they must be separately purchased and field installed.

Hot Gas Bypass Line
Hot Gas Bypass is available for use with DX systems that may experience low suction pressure during the operating cycle. This may be due to varying load conditions associated with VAV applications or units supplying a large percentage of outside air. The system is designed to divert refrigerant from the compressor discharge to the low pressure side of the system in order to keep the evaporator from freezing and to maintain adequate refrigerant velocity for oil return at minimum load.

Hot discharge gas is redirected to the evaporator inlet via an auxiliary side connector (ASC) to false load the evaporator when reduced suction pressure is sensed. **Field piping between the condensing unit and the evaporator is required.**

Hot Gas Bypass Piping Considerations for Evaporator above Condensing Unit
Pitch the hot gas bypass (HGB) line downward in the direction of refrigerant flow, toward the evaporator.

When installing hot gas bypass risers, an oil drip line must be provided at the lowest point in the system. The oil drip line must be vertical, its diameter should be the same as the diameter of the riser, and it should be 1 foot long. Install a sight glass in the oil drip line for observation. Run an oil return line, using 1/8 inch capillary tube, 10 feet in length, from the oil drip line to the suction line. Connect the oil return line below the sight glass and 1 inch above the bottom of the oil drip line.

HGB valves are adjustable. Factory HGB valve settings will be sufficient for most applications, but may require slight adjustments for some applications, including some make up air applications.

Insulate the entire length of the HGB line with a minimum 1 inch thick Armaflex insulation.

Hot Gas Bypass Piping Considerations for Evaporator Below Condensing Unit
The line must slope downward from the HGB valve toward the evaporator.

Hot Gas Bypass Line Guidelines
Choose a small size line to ensure oil return, and minimize refrigerant charge.

Maintain velocities below a maximum of 4,000 fpm. A general minimum velocity guideline to use is approximately 1,000 fpm.

Hot Gas Reheat
The AAON modulating hot gas reheat system diverts hot discharge gas from the condenser to the air handling unit through the hot gas line. **Field piping between the condensing unit and the air handler is required.**

The line delivers the hot discharge gas to the reheat coil and/or the hot gas bypass valve, so it is sized as a discharge line.

Discharge lines should be sized to ensure adequate velocity of refrigerant to ensure oil return, avoid excessive noise associated with velocities that are too high, and to minimize efficiency losses associated with friction.

Pitch the hot gas line in the direction of flow for oil return.

When installing hot gas reheat risers, an oil drip line must be provided at the lowest point in the system. The oil drip line must be vertical, its diameter should be the same as the diameter of the riser, and it should be 1 foot long. Run a drip line, using 1/8 inch capillary tube, 10 feet in length, from the oil drip line to the suction line. Connect the oil return line below the sight glass and 1 inch above the bottom of the oil drip line.

Insulate the entire length of the hot gas line with a minimum 1 inch thick Armaflex insulation.

Hot Gas Reheat Guidelines
Maintain velocities below a maximum of 3,500 fpm. A general minimum velocity guideline is 2,000 fpm.

LAC Valve

The LAC valve is a non-adjustable three way valve that modulates to maintain receiver pressure. As the receiver pressure drops below the valve setting (295 psig for R-410A), the valve modulates to bypass discharge gas around the condenser. The discharge gas warms the liquid in the receiver and raises the pressure to the valve setting. The following schematic shows an example system using the LAC valve.

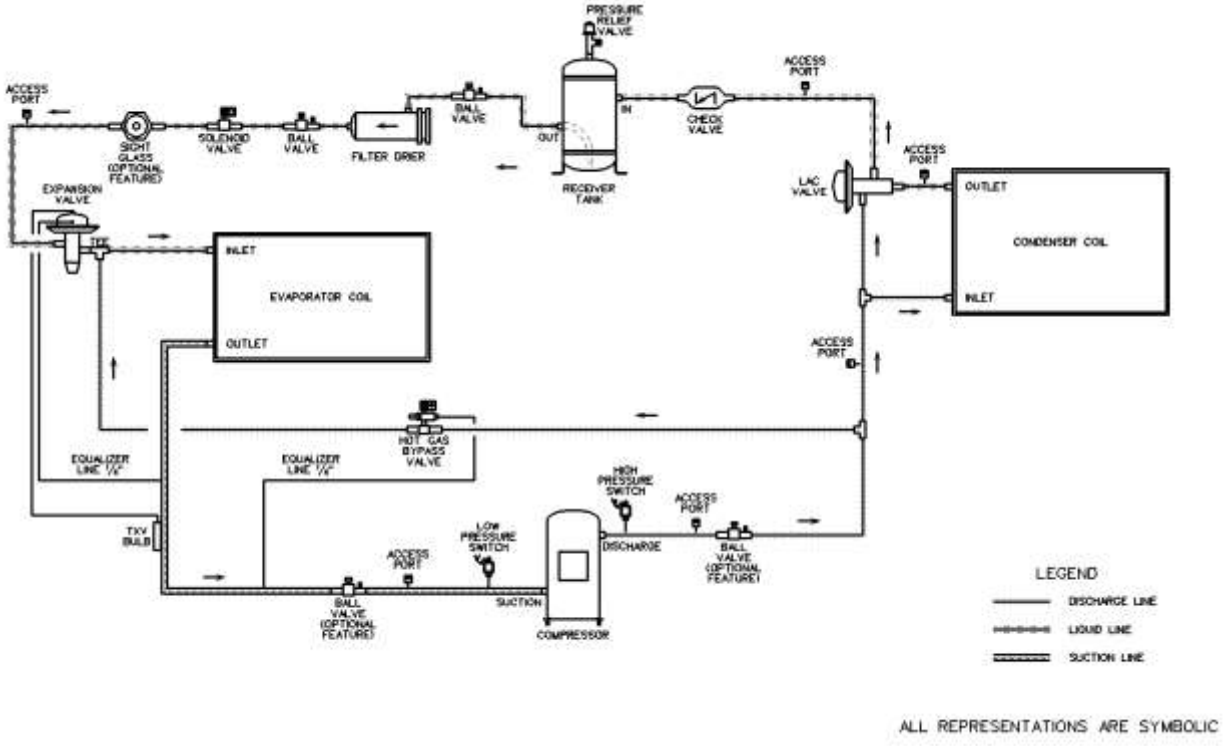

Figure 7 - Piping Schematic of Example System Using the LAC Valve.

Condenser Flooding

In order to maintain head pressure in the refrigeration system, liquid refrigerant is backed up in the condenser to reduce condenser surface. The following chart shows the percentage that a condenser must be flooded in order to function properly at the given ambient temperature.

Table 2 - Condenser Flooding

PERCENTAGE OF CONDENSER TO BE FLOODED								
Ambient Temperature (°F)	Evaporating Temperature (°F)							
	0°	**10°**	**20°**	**30°**	**35°**	**40°**	**45°**	**50°**
70°	40	24	0	0	0	0	0	0
60°	60	47	33	17	26	20	10	4
50°	70	60	50	38	45	40	33	28
40°	76	68	60	50	56	52	46	42
30°	80	73	66	59	64	60	55	51
20°	86	77	72	65	69	66	62	59
0°	87	83	78	73	76	73	70	68
-20°	91	87	82	77	80	79	76	73

During higher ambient temperatures the entire condenser is required to condense refrigerant. During these higher ambient temperatures, a receiver tank is used to contain the refrigerant that was required to flood the condenser during low ambient operation. The receiver must be sized to contain all of the flooded volume otherwise there will be high head pressures during higher ambient conditions.

Electrical

The single point electrical power connections are made in the electrical control compartment.

The microprocessor control furnished with the unit is supplied with its own power supply factory wired to the main power of the condensing unit.

Verify the unit nameplate voltage agrees with the power supply. Connect power and control field wiring as shown on the unit specific wiring diagram provided with the unit.

Size supply conductors based on the unit MCA rating. Supply conductors must be rated a minimum of 167°F (75°C).

Route power and control wiring, separately, through the utility entry. Do not run power and signal wires in the same conduit.

Protect the branch circuit in accordance with code requirements. The unit must be electrically grounded in accordance with local codes, or in the absence of local codes, the current National Electric Code, ANSI/NFPA 70 or the current Canadian Electrical Code CSA C22.1.

Power wiring is to the unit terminal block or main disconnect. All wiring beyond this point has been done by the manufacturer and cannot be modified without effecting the unit's agency/safety certification.

⚠ WARNING

Electric shock hazard. Before attempting to perform any installation, service, or maintenance, shut off all electrical power to the unit at the disconnect switches. Unit may have multiple power supplies. Failure to disconnect power could result in dangerous operation, serious injury, death, or property damage.

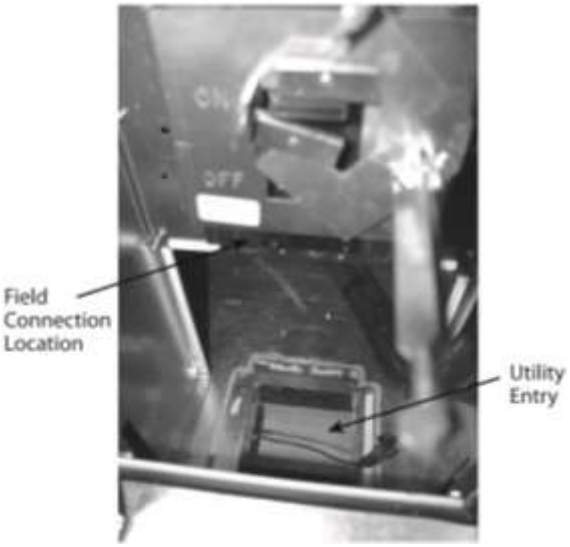

Figure 8 - Front View of Utility Entry and Power Switch from Control Compartment

Startup technician must check for proper motor rotation and check fan motor amperage listed on the motor nameplate is not exceeded. Motor overload protection may be a function of the variable frequency drive and must not be bypassed.

Note: All units are factory wired for 208/230V, 460V, or 575V.

Wire control signals to the unit's low voltage terminal block located in the controls compartment.

If any factory installed wiring must be replaced, use a minimum 221°F (105°C) type AWM insulated conductors.

⚠ CAUTION

Rotation must be checked on all MOTORS AND COMPRESSORS of three phase units. Condenser fan motors should all be checked by a qualified service technician at startup and any wiring alteration should only be made at the unit power connection. Variable frequency drives are programmed to automatically rotate the fan in the correct rotation. Do not rely on fans with variable frequency drives for compressor rotation.

⚠ CAUTION

Scroll compressors are directional and will be damaged by operation in the wrong direction. Low pressure switches on compressors have been disconnected after factory testing. Rotation should be checked by a qualified service technician at startup using suction and discharge pressure gauges and any wiring alteration should only be made at the unit power connection.

Startup

(See back of the manual for startup form)

⚠ WARNING

Electric shock hazard. Shut off all electrical power to the unit to avoid shock hazard or injury from rotating parts.

⚠ WARNING

Improper installation, adjustment, alteration, service, or maintenance can cause property damage, personal injury, or loss of life. Startup and service must be performed by a Factory Trained Service Technician

Before the startup of the condensing unit be sure that the following items have been checked.

1. Verify that electrical power is available to the unit.

2. Verify that any remote stop/start device is requesting the condensing unit to start.

⚠ CAUTION

Rotation must be checked on all MOTORS AND COMPRESSORS of three phase units. All motors, to include and not be limited to pump motors and condenser fan motors, should all be checked by a qualified service technician at startup and any wiring alteration should only be made at the unit power connection.

Cycle through all the compressors to confirm that all are operating within tolerance.

While performing the check, use the startup form to record observations of compressor amps and refrigerant pressures.

⚠ CAUTION

Before completing installation, a complete operating cycle should be observed to verify that all components are functioning properly.

Multi-Wing Z Series Aluminum Fan Blade Pitch Angle Setting Instructions

1. Maintain the balance of fan

Mark the hub castings across a joint, so the fan hub can be reassembled in the same orientation.

Mark the location of any balancing weight. Balancing weight will be on the outer bolt circle, in the form of washers, and/or longer bolts, or an additional balancing nut.

Number the blades and blade sockets, so that they are replaced into their original position.

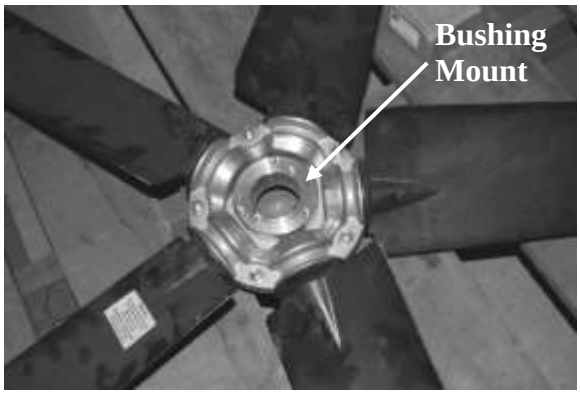

Figure 9 - Fan with the HUB on the top and RET on the bottom.

2. Determine the direction of rotation
Right, R, is clockwise when facing the discharge side of the fan and Left, L, is counterclockwise when facing the discharge side of the fan.

3. Determine the bushing mount location
The bushing mount is the center section of the hub through which the fan is mounted to the shaft, and typically contains either setscrews or a center-tapered hole where the bushing inserts.

Location A is with the bushing mount on air inlet side of the fan.
Location B is with the bushing mount on air discharge side of the fan.

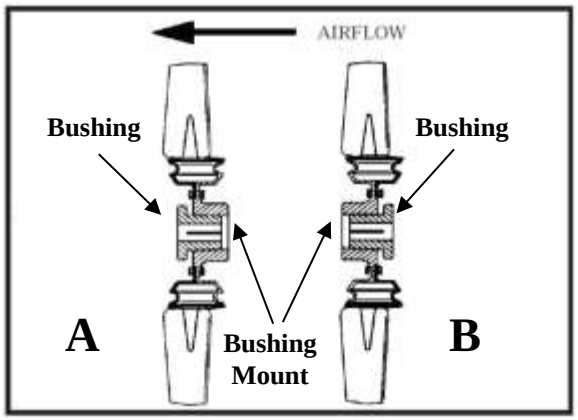

Figure 10 - Bushing Mount Location

4. Determine the pin location groove
Disassemble fan on a flat surface and note in which groove the pin is located.

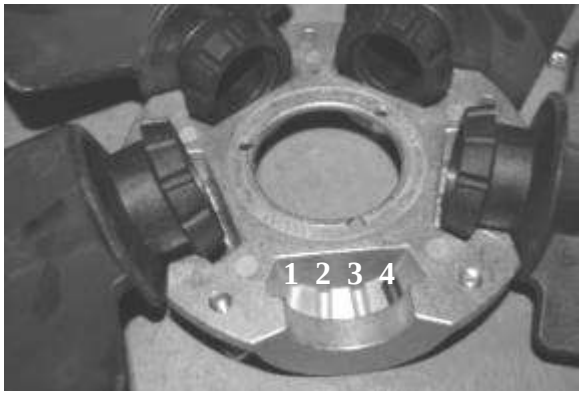

Figure 11 - RET with Pin in Groove 4

5. Determine whether the pin is in the HUB or RET

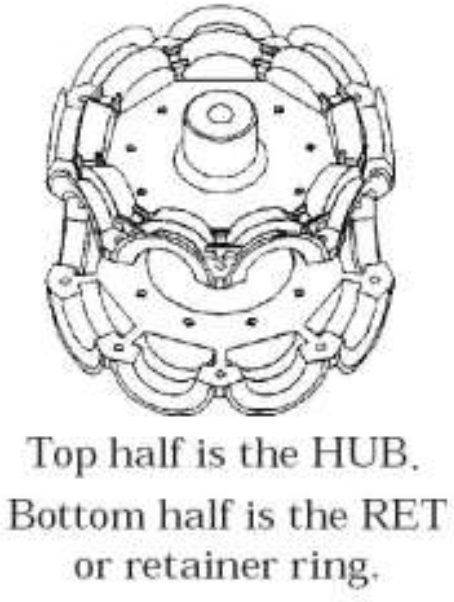

Figure 12 - Fan HUB and RET Castings

6. *Determine the current blade pitch and the pin location for the new blades*

Table 3 - Condenser Fan Pin Location

Type	Bushing Mount	Blade Pitch Angle									
		20°	25°	28°	30°	33°	35°	38°	40°	45°	50°
5Z	A	-	RET	-	RET	RET	RET	HUB	HUB	HUB	HUB
	B	-	HUB	-	HUB	HUB	HUB	RET	RET	RET	RET

Table 4 - Condenser Fan Pin Location

Type	Rot.	Blade Pitch Angle									
		20°	25°	28°	30°	33°	35°	38°	40°	45°	50°
5Z	R	-	4	-	3	2	1	4	3	2	1
	L	-	1	-	2	3	4	1	2	3	4

7. *Replace fan blades in the new pin location and reassemble the fan*

Replace the blades with the pin in the 1, 2, 3, or 4 groove position of either the HUB or RET. Assemble the fan making sure to place the blades in their previous blade sockets, to match up the previous orientation of HUB and RET and to replace any balancing weights in their previous locations. Tighten bolts in a cross pattern to 5-6 ft-lbs. of torque.

Multi-Wing W Series Black Glass Reinforced Polypropylene Fan Blade Pitch Angle Setting Instructions

Contact the AAON parts department to acquire the new pitch pins for the fan blades.

Note original position of retaining plates, center boss and all hardware including additional hardware used for balancing.

1. Remove all the bolts and nuts.

2. Determine blade rotation – on the concave side of the blade is a blade marking showing 6WR, 6WL, 7WL, 7WR, or 9WR. The “L” and “R” denote the rotation of the blade.

3. Replace the pitch insert in the blade root with an insert of the desired pitch.

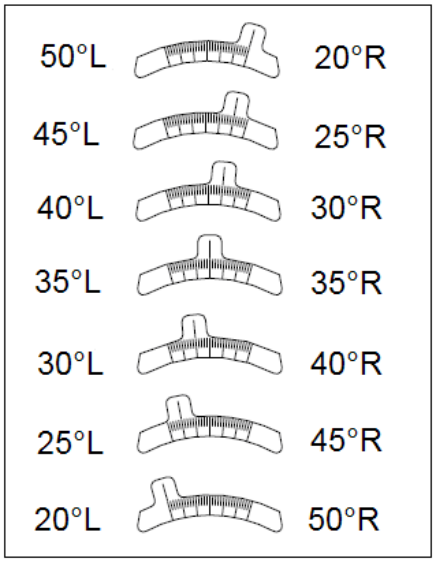

Figure 13 - Pitch Insert

4. Replace blades to their original location.

5. Replace all nuts, bolts, and washers on the fan hub.

6. Replace retaining plates and center boss to original location.

7. Tighten nuts and bolts to 14 ft-lbs of torque.

Fan Assembly Bushings

The fan assembly bushings should be tightened to the specifications listed in the following table.

Table 5 - Fan Assembly Bushing Torque Specifications

Bushing	**Tightening Torque (in-lbs.)**
H X 1.125"	95
H X 1.375"	95
SH X 1.125"	108
SH X 1.375"	108
SD X 1.125"	108
SD X 1.375"	108
SD X 1.625"	108
SD X 1.875"	108
SK X 2.125"	180

Maintenance

General
Qualified technicians must perform routine service checks and maintenance. This includes reading and recording the condensing and suction pressures and checking for normal sub-cooling and superheat.

Air-cooled condenser units require maintenance schedules/procedures. Unit specific instructions are included in this manual.

Compressors
The scroll compressors are fully hermetic and require no maintenance except keeping the shell clean.

Refrigerant Filter Driers
Each refrigerant circuit contains a filter drier. Replacement is recommended when there is excessive pressure drop across the assembly or moisture is indicated in a liquid line sight glass.

Table 6 - Filter Drier Maximum Pressure Drop

Circuit Loading	Max. Pressure Drop
100%	10 psig
50%	5 psig

Adjusting Refrigerant Charge
All AAON CN Series condensing units are shipped with a 15 lb refrigerant charge per refrigeration system and will not be the full system charge. Adjusting the charge of a system will be required.

Adjusting the charge of a system in the field must be based on determination of liquid sub-cooling and evaporator superheat. On a system with an expansion valve liquid sub-cooling is more representative of the charge than evaporator superheat but both measurements must be taken.

⚠ CAUTION

Polyolester (POE) and Polyvinylether (PVE) oils are two types of lubricants used in hydrofluorocarbon (HFC) refrigeration systems. Refer to the compressor label for the proper compressor lubricant type.

⚠ CAUTION

The Clean Air Act of 1990 bans the intentional venting of refrigerant (CFC's and HCFC's) as of July 1, 1992. Approved methods of recovery, recycling or reclaiming must be followed. Fines and/or incarceration may be levied for non-compliance.

Before Charging
Refer to the unit nameplate as a reference when determining the proper refrigerant charge.

Unit being charged must be at or near full load conditions before adjusting the charge.

Units equipped with hot gas bypass must have the hot gas bypass valve closed to get the proper charge.

After adding or removing charge the system must be allowed to stabilize, typically 10-15 minutes, before making any other adjustments.

The type of unit and options determine the ranges for liquid sub-cooling and evaporator superheat. Refer to Table 7 when determining the proper sub-cooling.

For units equipped with low ambient (0°F) option see the special charging instructions at the end of this section.

Checking Liquid Sub-cooling

Measure the temperature of the liquid line as it leaves the condenser coil.

Read the gauge pressure at the liquid line close to the point where the temperature was taken. You must use liquid line pressure as it will vary from discharge pressure due to condenser coil pressure drop.

Convert the pressure obtained to a saturated temperature using the appropriate refrigerant temperature-pressure chart.

Subtract the measured liquid line temperature from the saturated temperature to determine the liquid sub-cooling.

Compare calculated sub-cooling to the table below for the appropriate unit type and options.

Checking Evaporator Superheat

Measure the temperature of the suction line close to the compressor.

Read gauge pressure at the suction line close to the compressor.

Convert the pressure obtained to a saturated temperature using the appropriate refrigerant temperature-pressure chart.

Subtract the saturated temperature from the measured suction line temperature to determine the evaporator superheat.

For refrigeration systems with tandem scroll compressors, it is critical that the suction superheat setpoint on the expansion valve is set with one compressor running. The suction superheat should be 10-13°F with one compressor running. The suction superheat will increase with both compressors in a tandem running. Inadequate suction superheat can allow liquid refrigerant to return to the compressors which will wash the oil out of the compressor. Lack of oil lubrication will destroy a compressor. Liquid sub-cooling should be measured with both compressors in a refrigeration system running.

Compare calculated superheat to Table 7 for the appropriate unit type and options.

Table 7 - Acceptable Refrigeration Circuit Values

Air-Cooled Condenser	
Sub-Cooling	12-18°F
Sub-Cooling with Hot Gas Reheat	15-22°F
Superheat	8-15°F

⚠ CAUTION

Expansion valves must be adjusted to approximately 10-15°F of suction superheat. Failure to have sufficient superheat will damage the compressor and void the warranty.

Adjusting Sub-cooling and Superheat Temperatures

The system is overcharged if the sub-cooling temperature is too high and the evaporator is fully loaded (low loads on the evaporator result in increased sub-cooling) and the evaporator superheat is within the temperature range as shown in Table 7 (high superheat results in increased sub-cooling)

Correct an overcharged system by reducing the amount of refrigerant in the system to lower the sub-cooling.

⚠ CAUTION

DO NOT OVERCHARGE!

Refrigerant overcharging leads to excess refrigerant in the condenser coils resulting in elevated compressor discharge pressure.

The system is undercharged if the superheat is too high and the sub-cooling is too low.

Correct an undercharged system by adding refrigerant to the system to reduce superheat and raise sub-cooling.

If the sub-cooling is correct and the superheat is too high, the expansion valve may need adjustment to correct the superheat.

Special Low Ambient Option Charging Instructions

For units equipped with low ambient refrigerant flood back option being charged in the summer when the ambient temperature is warm:

Once enough charge has been added to get the evaporator superheat and sub-cooling values to the correct setting more charge must be added. Add approximately 80% of the receiver tank volume to the charge to help fill the receiver tank. The additional charge is required for the system when running in cold ambient conditions.

For units equipped with low ambient refrigerant flood back option being charged in the summer when the ambient temperature is cold:

Once enough charge has been added to get the evaporator superheat and sub-cooling values to the correct setting more charge may need to be added. If the ambient temperature is 0°F no more charge is required. If the ambient temperature is around 40°F add approximately 40% of the receiver tank volume.

The unit will have to be checked for proper operation once the ambient temperature is above 80°F.

⚠ CAUTION

DO NOT OVERCHARGE!

Refrigerant overcharging leads to excess refrigerant in the condenser coils resulting in elevated compressor discharge pressure.

Table 8 - R-410A Refrigerant Temperature-Pressure Chart

°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG
20	78.3	**47**	134.7	**74**	213.7	**101**	321.0	**128**	463.2
21	80.0	**48**	137.2	**75**	217.1	**102**	325.6	**129**	469.3
22	81.8	**49**	139.7	**76**	220.6	**103**	330.2	**130**	475.4
23	83.6	**50**	142.2	**77**	224.1	**104**	334.9	**131**	481.6
24	85.4	**51**	144.8	**78**	227.7	**105**	339.6	**132**	487.8
25	87.2	**52**	147.4	**79**	231.3	**106**	344.4	**133**	494.1
26	89.1	**53**	150.1	**80**	234.9	**107**	349.3	**134**	500.5
27	91.0	**54**	152.8	**81**	238.6	**108**	354.2	**135**	506.9
28	92.9	**55**	155.5	**82**	242.3	**109**	359.1	**136**	513.4
29	94.9	**56**	158.2	**83**	246.0	**110**	364.1	**137**	520.0
30	96.8	**57**	161.0	**84**	249.8	**111**	369.1	**138**	526.6
31	98.8	**58**	163.8	**85**	253.7	**112**	374.2	**139**	533.3
32	100.9	**59**	166.7	**86**	257.5	**113**	379.4	**140**	540.1
33	102.9	**60**	169.6	**87**	261.4	**114**	384.6	**141**	547.0
34	105.0	**61**	172.5	**88**	265.4	**115**	389.9	**142**	553.9
35	107.1	**62**	175.4	**89**	269.4	**116**	395.2	**143**	560.9
36	109.2	**63**	178.4	**90**	273.5	**117**	400.5	**144**	567.9
37	111.4	**64**	181.5	**91**	277.6	**118**	405.9	**145**	575.1
38	113.6	**65**	184.5	**92**	281.7	**119**	411.4	**146**	582.3
39	115.8	**66**	187.6	**93**	285.9	**120**	416.9	**147**	589.6
40	118.1	**67**	190.7	**94**	290.1	**121**	422.5	**148**	596.9
41	120.3	**68**	193.9	**95**	294.4	**122**	428.2	**149**	604.4
42	122.7	**69**	197.1	**96**	298.7	**123**	433.9	**150**	611.9
43	125.0	**70**	200.4	**97**	303.0	**124**	439.6		
44	127.4	**71**	203.6	**98**	307.5	**125**	445.4		
45	129.8	**72**	207.0	**99**	311.9	**126**	451.3		
46	132.2	**73**	210.3	**100**	316.4	**127**	457.3		

Lubrication
All original motors and bearings are furnished with an original factory charge of lubrication.

Air-Cooled Condenser
The air-cooled condenser section rejects heat by passing outdoor air over the fin tube coils for cooling of the hot refrigerant gas from the compressors. The heated air will discharge from the top of the section through the axial flow fans.

The condenser coils should be inspected yearly to ensure unrestricted airflow. If the installation has a large amount of airborne dust or other material, the condenser coils should be cleaned according to the microchannel coil cleaning section.

E-Coated Coil Cleaning
Documented routine cleaning of e-coated coils is required to maintain coating warranty coverage.

⚠ WARNING

Electric shock hazard. Shut off all electrical power to the unit to avoid shock hazard or injury from rotating parts.

Surface loaded fibers or dirt should be removed prior to water rinse to prevent restriction of airflow. If unable to back wash the side of the coil opposite of the coils entering air side, then surface loaded fibers or dirt should be removed with a vacuum cleaner. If a vacuum cleaner is not available, a ***soft non-metallic*** bristle brush may be used. In either case, the tool should be applied in the direction of the fins. Coil surfaces can be easily damaged (fin edges bent over) if the tool is applied across the fins.

Use of a water stream, such as a garden hose, against a surface loaded coil will drive the fibers and dirt into the coil. This will make cleaning efforts more difficult. Surface loaded fibers must be completely removed prior to using low velocity clean water rinse.

A ***monthly*** clean water rinse is recommended for coils that are applied in coastal or industrial environments to help to remove chlorides, dirt, and debris. It is very important when rinsing, that water temperature is less than 130°F and pressure is than 900 psig to avoid damaging the fin edges. An elevated water temperature (not to exceed 130°F) will reduce surface tension, increasing the ability to remove chlorides and dirt.

⚠ CAUTION

High velocity water from a pressure washer or compressed air should only be used at a very low pressure to prevent fin and/or coil damages. The force of the water or air jet may bend the fin edges and increase airside pressure drop. Reduced unit performance or nuisance unit shutdowns may occur.

Quarterly cleaning is essential to extend the life of an e-coated coil and is required to maintain coating warranty coverage. Coil cleaning shall be part of the unit's regularly scheduled maintenance procedures. Failure to clean an e-coated coil will void the warranty and may result in reduced efficiency and durability.

For routine quarterly cleaning, first clean the coil with the below approved coil cleaner. After cleaning the coils with the approved cleaning agent, use the approved chloride remover to remove soluble salts and revitalize the unit.

⚠ CAUTION

Harsh chemicals, household bleach, or acid cleaners should not be used to clean outdoor or indoor e-coated coils. These cleaners can be very difficult to rinse out of the coil and can accelerate corrosion and attack the e-coating. If there is dirt below the surface of the coil, use the recommended coil cleaners.

Microchannel Coil Cleaning

Documented routine cleaning of microchannel coils with factory provided e-coating is required to maintain coating warranty coverage. See E-Coated Coil Cleaning section.

Air-cooled heat exchangers may include microchannel coils.

Cleaning microchannel coils is necessary in all locations. In some locations it may be necessary to clean the coils more or less often than recommended. In general, a condenser coil should be cleaned at a minimum of once a year. In locations where there is commonly debris or a condition that causes dirt/grease build up it may be necessary to clean the coils more often. Proper procedure should be followed at every cleaning interval. Using improper cleaning technique or incorrect chemicals will result in coil damage, system performance fall off, and potentially leaks requiring coil replacement.

Documented routine cleaning of microchannel coils with factory provided e-coating is required to maintain coating warranty coverage. Use the E-Coated Coil Cleaning section for details on cleaning e-coated coils.

Field applied coil coatings are not recommended with microchannel coils.

Allowed Chemical Cleaners and Procedures

AAON recommends certain chemicals that can be used to remove buildup of grime and debris on the surface of microchannel coils. These chemicals have been tested for performance and safety and are the only chemicals that AAON will warrant as correct for cleaning microchannel coils.

There are three procedures that are outlined below that will clean the coils effectively without damage to the coils. Use of any other procedure or chemical may void the warranty to the unit where the coil is installed. **With all procedures make sure the unit is off before starting.**

⚠ WARNING ⚠

Electric shock hazard. Shut off all electrical power to the unit to avoid shock hazard or injury from rotating parts.

The water pressure used to clean should not exceed 140 psi, from no closer than 3 inches from the coils, and with the water aimed perpendicular to the coils.

#1 Simple Green

Simple Green is available from AAON Parts and Supply (Part# T10701) and is biodegradable with a neutral 6.5 pH. Recommendation is to use it at a 4 to 1 mix. Use the following procedure.

1. Rinse the coil completely with water. Use a hard spray but be careful not to bend or damage the fins. A spray that is too hard will bend the fins. Spray from the fan side of the coil.
2. With a pump sprayer filled with a mix of 4 parts water to one part Simple Green spray the air inlet face of the coil.

Be sure to cover all areas of the face of the coil.
3. Allow the coil to soak for 10-15 minutes.
4. Rinse the coil with water as in step one.
5. Repeat as necessary.

#2 Vinegar

This is standard white vinegar available in gallons from most grocery stores. It has a pH of 2-3, so it is slightly acidic. Use the following procedure.

1. Rinse the coil completely with water. Use a hard spray but be careful not to bend or damage the fins. A spray that is too hard will bend the fins. Spray from the fan side of the coil.
2. Use a pump sprayer filled with vinegar (100%). Spray from the face of the coil in the same direction as the airflow. Be sure to cover all areas of the face of the coil.
3. Allow the coil to soak for 10-15 minutes.
4. Rinse the coil with water as in step one.
5. Repeat as necessary.

#3 Water Flush

This procedure can be used when the only material to cause the coil to need cleaning is debris from plant material that has impinged the coil face.

1. Rinse the coil completely with water. Use a hard spray but be careful not to bend or damage the fins. A spray that is too hard will bend the fins. Spray from the fan side of the coil.
2. Spray and rinse the coil from the face.

⚠ CAUTION

Use pressurized clean water, with pressure not to exceed 140 psi. Nozzle should be 6” and 80° to 90° from coil face. Failure to do so could result in coil damage.

Application Examples

The three procedures can be used to clean microchannel coils. They will fit with the application depending on the area. In some areas where the spring/summer has a large cottonwood bloom #3 might work fine if the unit is installed on an office building and no other environmental factors apply.

When a unit is installed where the sprinkler system has water being sprayed onto the condenser coil you might have better results using #2. Vinegar is slightly acidic and may help with the calcium build up from drying water. This also works well when grease is part of the inlet air to a condenser coil.

Generally the best and broadest based procedure is #1. The grease cutting effect of the Simple Green is good for restaurant applications.

Other Coil Cleaners

There are many cleaners on the market for condenser coils. Before using any cleaner that is not covered in this section you must get written approval from the AAON warranty and service department. Use of unapproved chemicals will void the warranty.

AAON testing has determined that unless a chemical has a neutral pH (6-8) it should not be used.

Beware of any product that claims to be a foaming cleaner. The foam that is generated is caused by a chemical reaction to the aluminum fin material on tube and fin coils and with the fin, tube, and coating material on microchannel coils.

Microchannel coils are robust in many ways, but like any component they must be treated correctly. This includes cleaning the coils correctly to give optimal performance over many years.

Service
If the unit will not operate correctly and a service company is required, only a company with a Factory Trained Service Technician qualified and experienced in air conditioning is permitted to service the systems to keep warranties in effect.

Replacement Parts
Parts for AAON equipment may be obtained from your local AAON sales representative. When ordering parts reference the unit serial number and part number.

AAON Warranty, Service and Parts Department
2424 S. Yukon Ave.
Tulsa, OK 74107
Ph: 918-583-2266
Fax: 918-382-6364
www.aaon.com

Note: Before calling, the Factory Trained Service Technician should have model and serial number of the unit available for the service department to help answer questions regarding the unit

Refrigerant Piping Diagrams

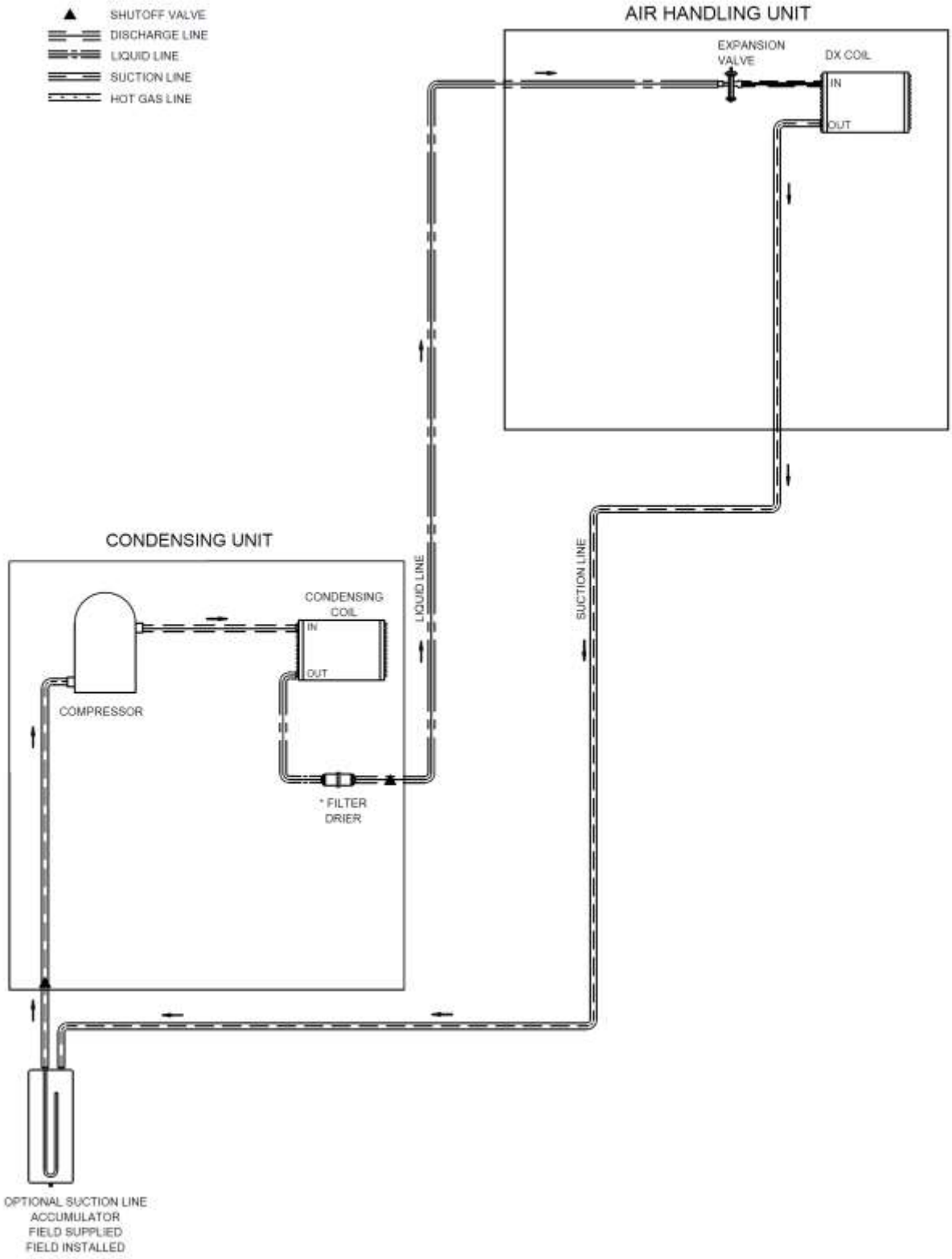

Figure 14 - A/C Only Piping, AHU Above CU

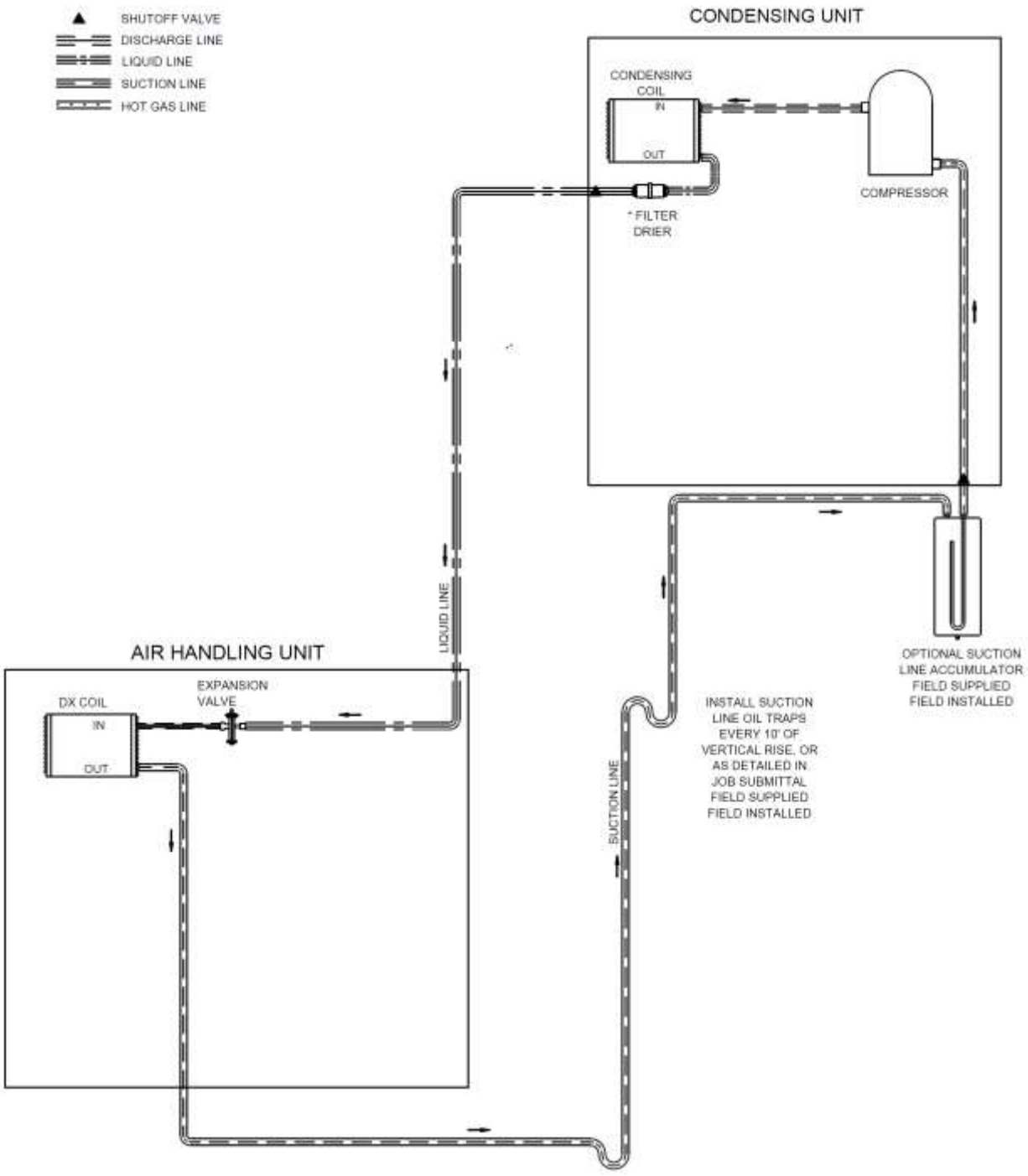

Figure 15 - A/C Only Piping, AHU Below CU

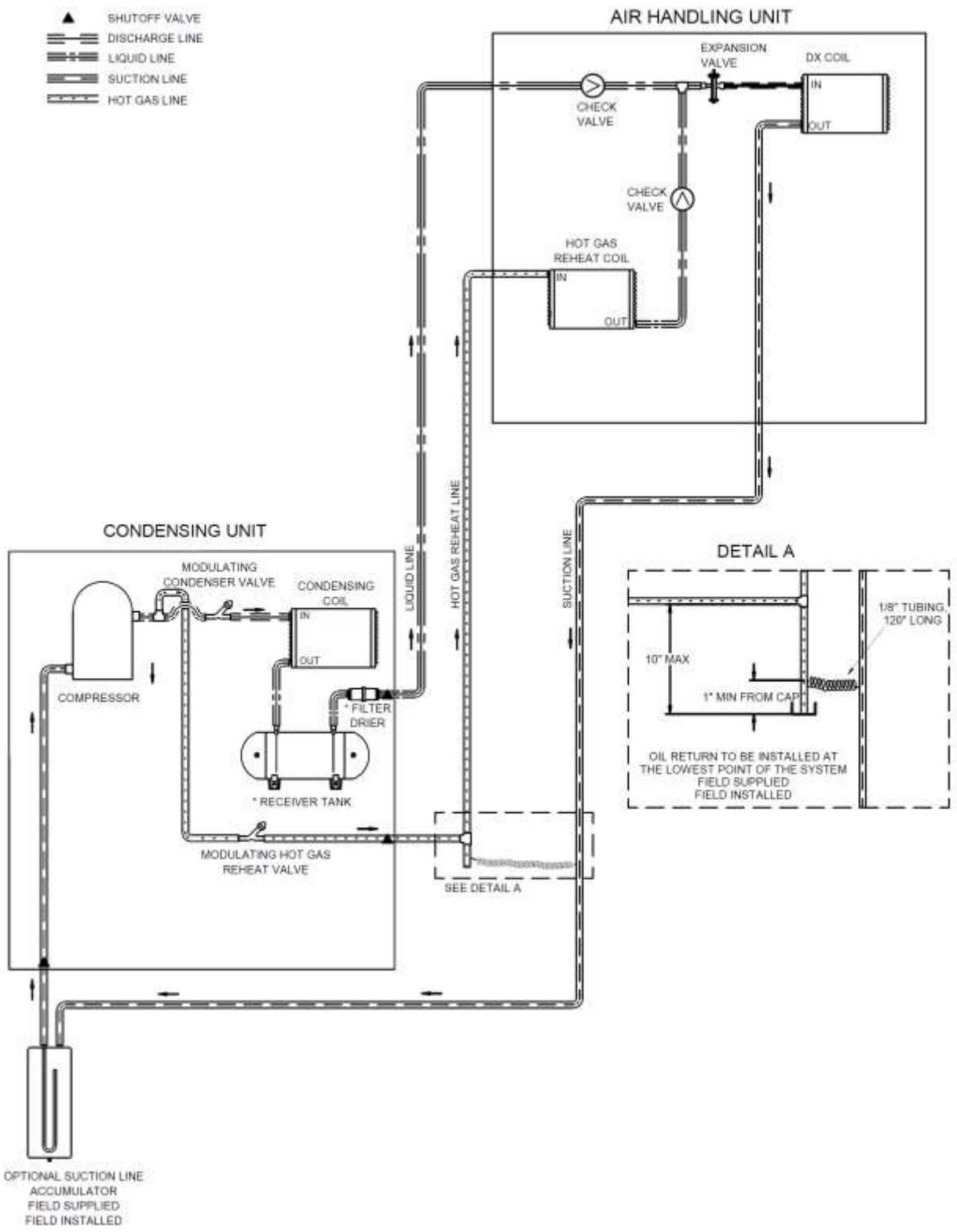

Figure 16 - Modulating Hot Gas Reheat Piping, AHU Above CU

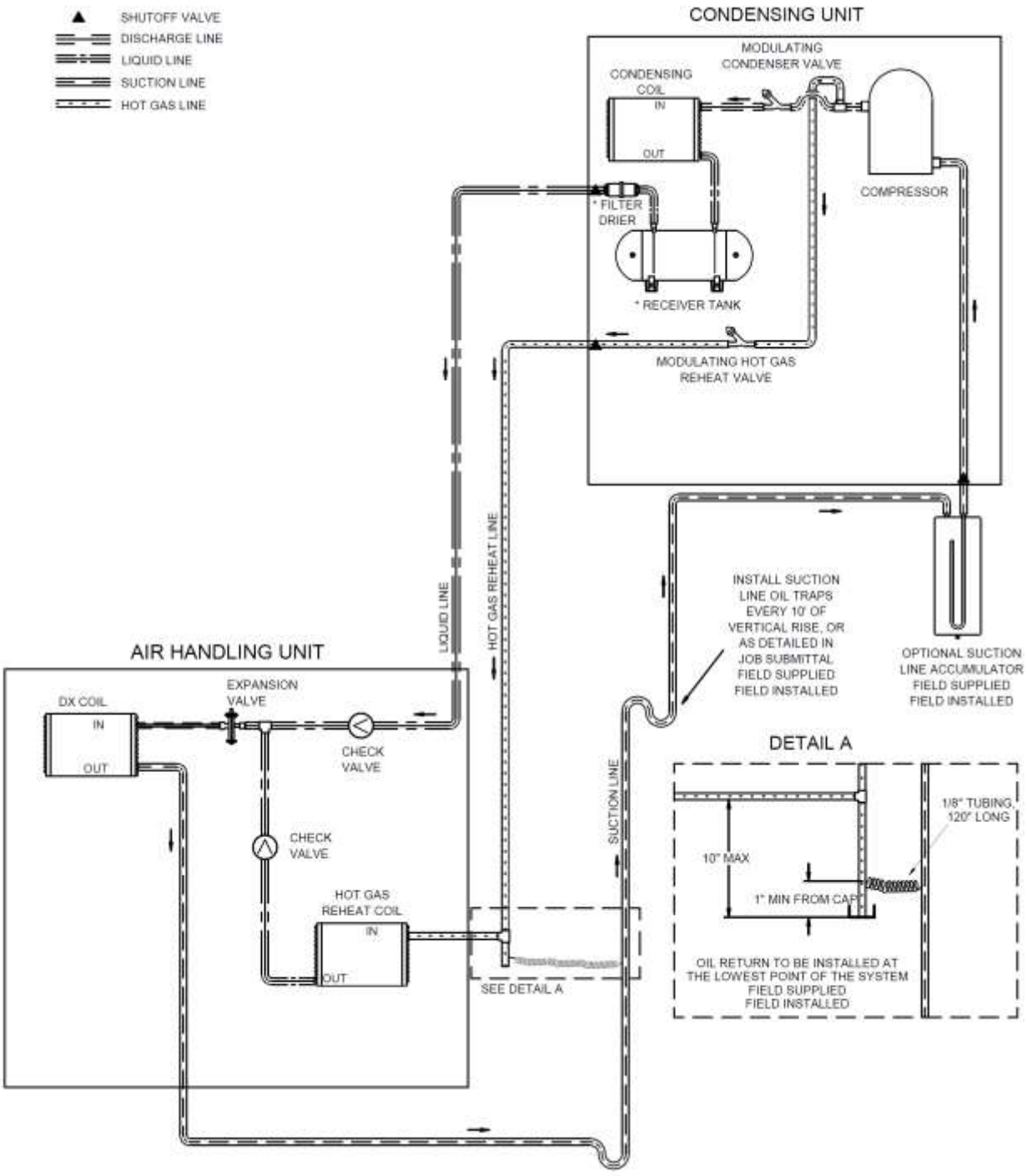

Figure 17 - Modulating Hot Gas Reheat Piping, AHU Below CU

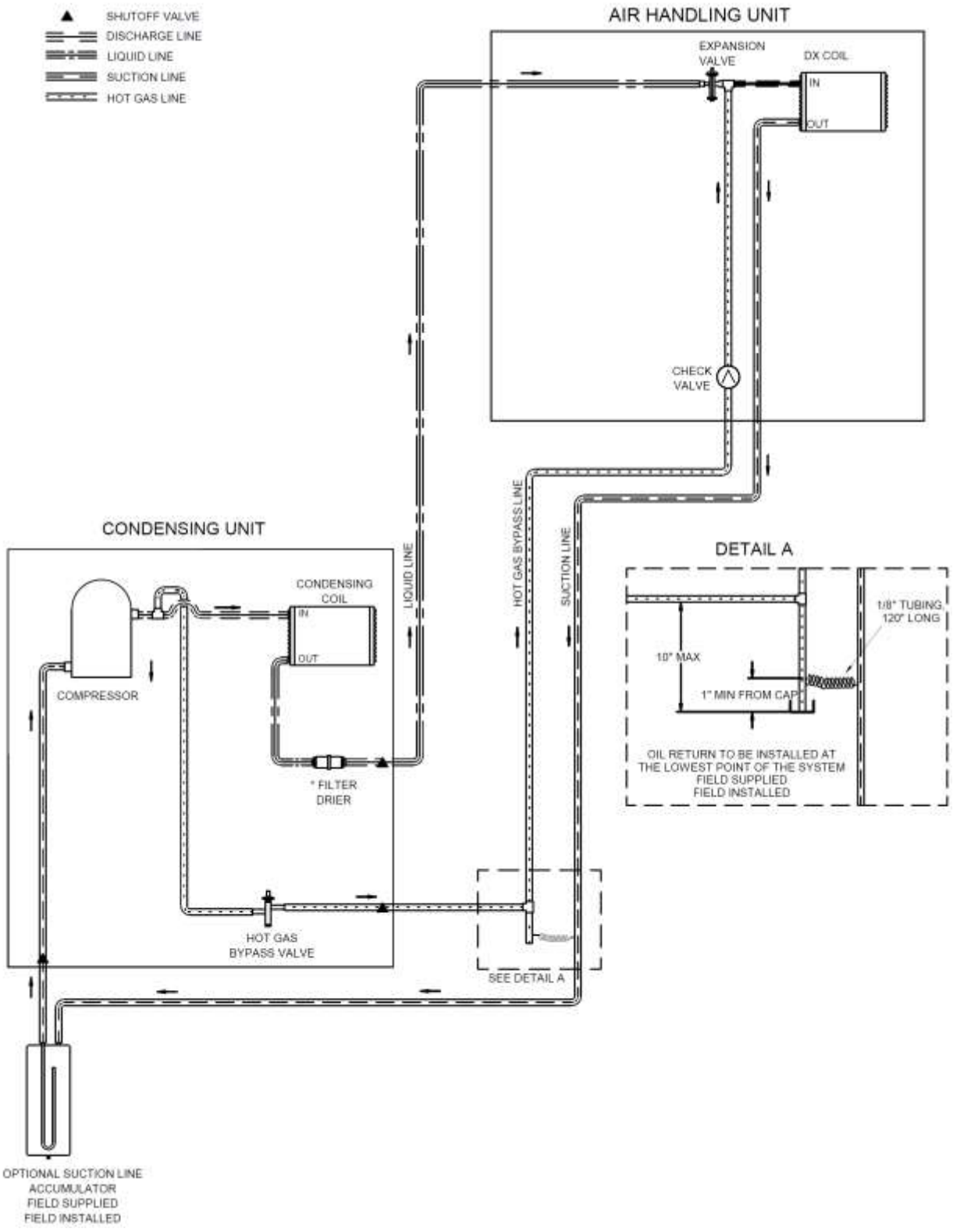

Figure 18 - Hot Gas Bypass Piping, AHU Above CU

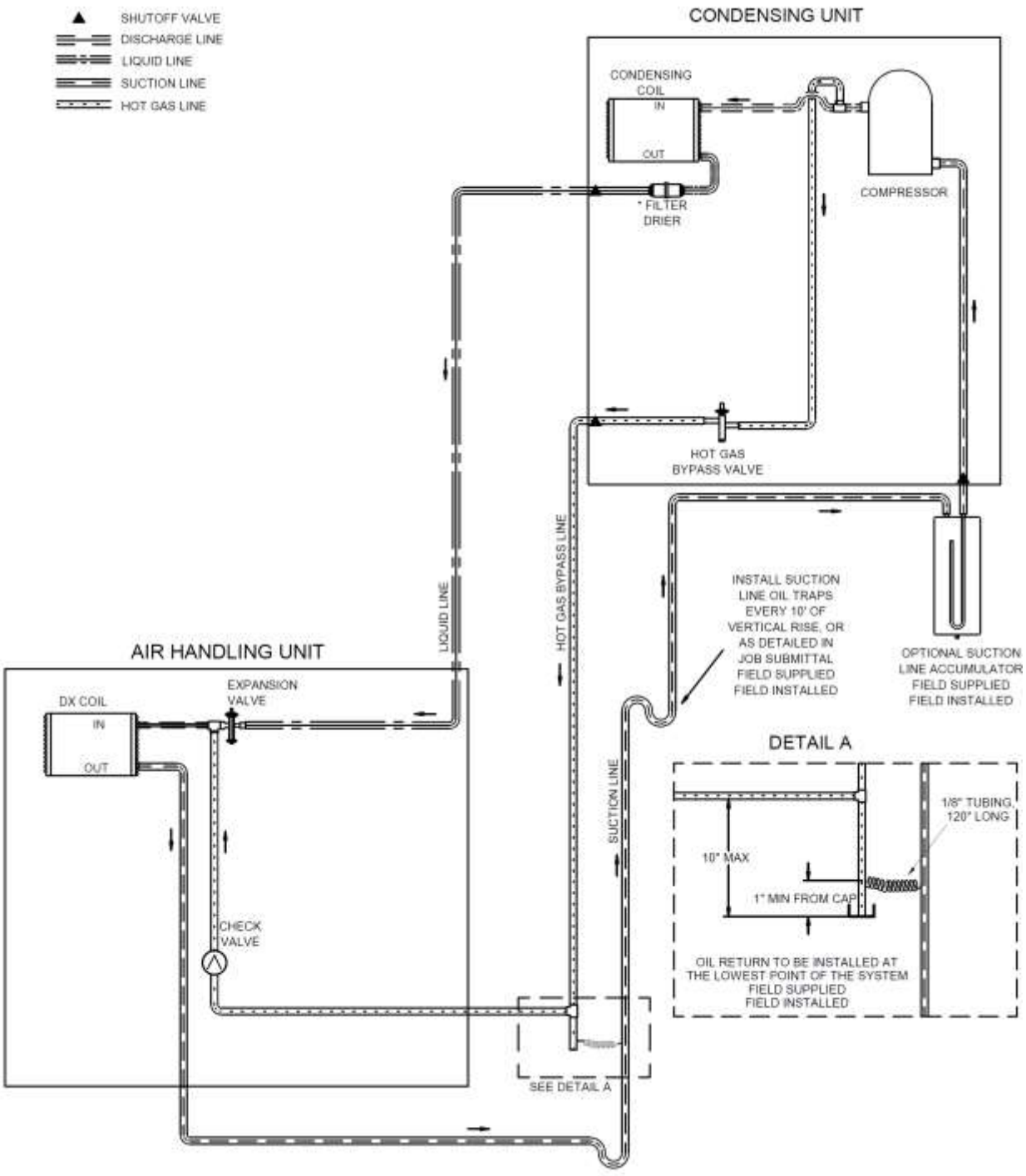

Figure 19 - Hot Gas Bypass Piping, AHU Below CU

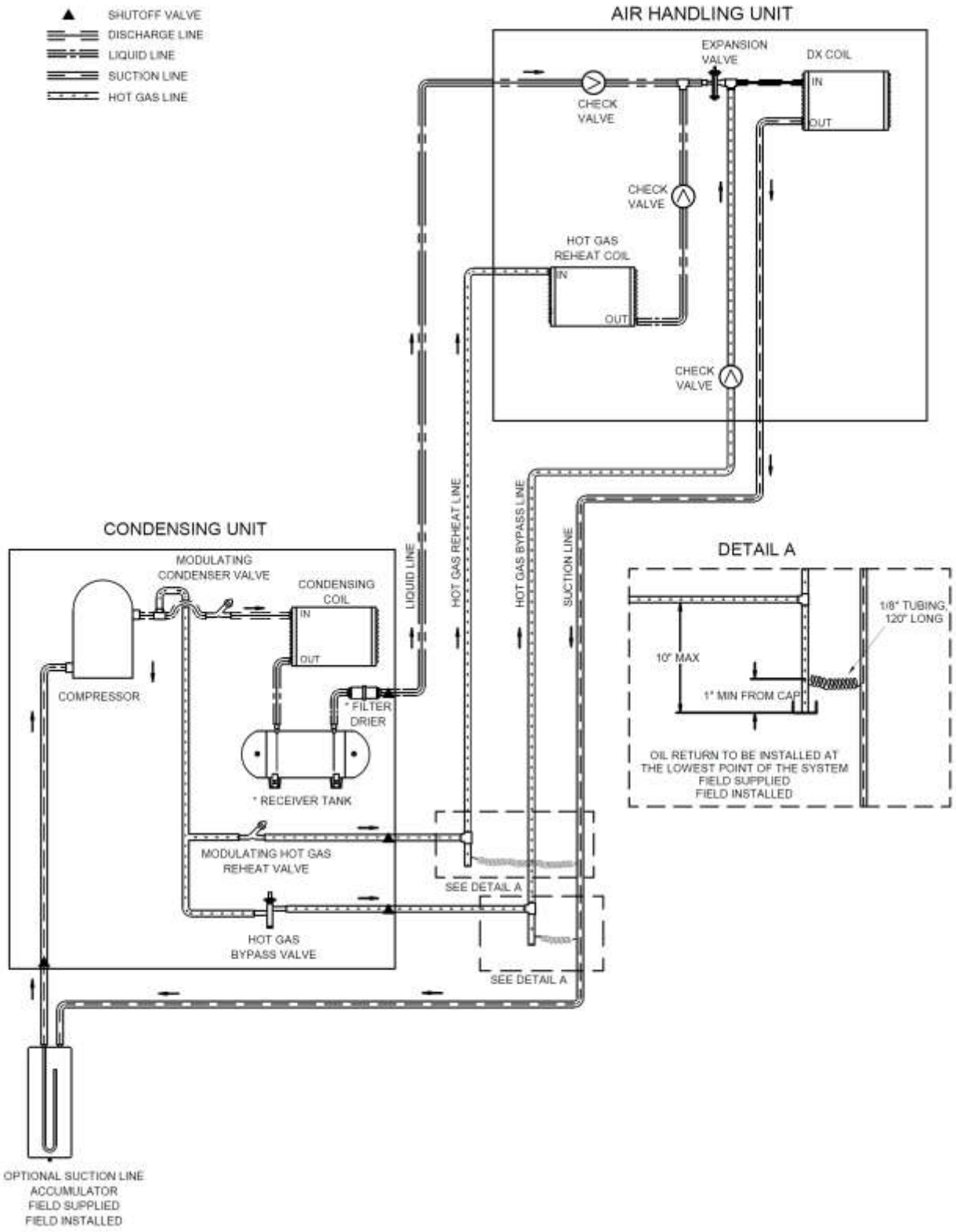

Figure 20 - Modulating Hot Gas Reheat with Hot Gas Bypass Piping, AHU Above CU

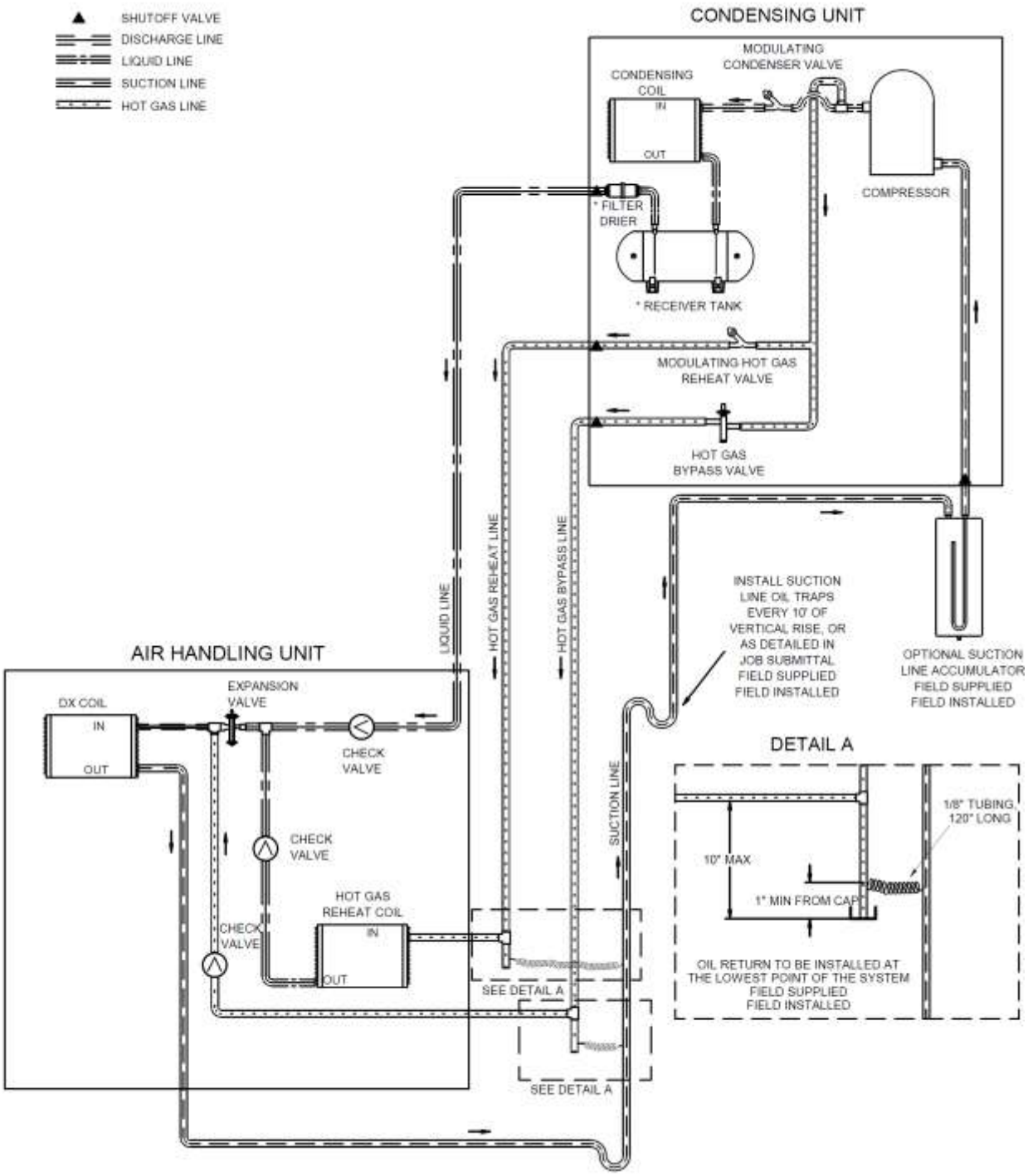

Figure 21 - Modulating Hot Gas Reheat with Hot Gas Bypass Piping, AHU Below CU

CN Series Startup Form

Job Name:_____ Date:_____

Address:_____

_____

Model Number:_____

Serial Number:_____ Tag:_____

Startup Contractor:_____

Address:_____

_____ Phone:_____

Pre Startup Checklist

Installing contractor should verify the following items.	
1. Is there any visible shipping damage?	☐Yes ☐No
2. Is the unit level?	☐Yes ☐No
3. Are the unit clearances adequate for service and operation?	☐Yes ☐No
4. Do all access doors open freely and are the handles operational?	☐Yes ☐No
5. Have all shipping braces been removed?	☐Yes ☐No
6. Have all electrical connections been tested for tightness?	☐Yes ☐No
7. Does the electrical service correspond to the unit nameplate?	☐Yes ☐No
8. On 208/230V units, has transformer tap been checked?	☐Yes ☐No
9. Has overcurrent protection been installed to match the unit nameplate requirement?	☐Yes ☐No
10. Have all set screws on the fans been tightened?	☐Yes ☐No
11. Do all fans rotate freely?	☐Yes ☐No

Ambient Temperature

Ambient Dry Bulb Temperature _____°F Ambient Wet Bulb Temperature _____°F

Compressors/DX Cooling

Check Rotation ☐							
Number	Model #	L1	L2	L3	Head Pressure PSIG	Suction Pressure PSIG	Crankcase Heater Amps
1							
2							
3							
4							

Refrigeration System 1 - Cooling Mode

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Refrigeration System 2 - Cooling Mode

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Refrigeration System 3 - Cooling Mode

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Refrigeration System 4 - Cooling Mode

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Condenser Fans

Alignment ☐		Check Rotation ☐		Nameplate Amps_____
Number	hp	L1	L2	L3
1				
2				
3				
4				
5				
6				
7				
8				

Maintenance Log

This log must be kept with the unit. It is the responsibility of the owner and/or maintenance/service contractor to document any service, repair or adjustments. AAON Service and Warranty Departments are available to advise and provide phone help for proper operation and replacement parts. The responsibility for proper start-up, maintenance and servicing of the equipment falls to the owner and qualified licensed technician.

Entry Date	Action Taken	Name/Tel.

Literature Change History

March 2014
Initial version.

July 2015
Updated *Microchannel Coil Cleaning* section. Added *Features and Options Information.*

AAON
2425 South Yukon Ave.
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www.aaon.com

CN Series
Installation, Operation, & Maintenance
V28960 · Rev. A · 150727

M2 Series

Modular Indoor Air Handling Units
& Self-Contained Units

Installation, Operation & Maintenance

⚠ WARNING

FIRE OR EXPLOSION HAZARD

Failure to follow safety warnings exactly could result in serious injury, death or property damage.

Be sure to read and understand the installation, operation and service instructions in this manual.

Improper installation, adjustment, alteration, service or maintenance can cause serious injury, death or property damage.

A copy of this IOM should be kept with the unit.

⚠ WARNING

Do not store gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Leave the building immediately.
- Immediately call you gas supplier from a phone remote from the building. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier call the fire department.

Startup and service must be performed by a Factory Trained Service Technician.

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(ACP 30752)

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Tables:

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Safety

Attention should be paid to the following statements:

NOTE - Notes are intended to clarify the unit installation, operation and maintenance.

⚠ **CAUTION** - Caution statements are given to prevent actions that may result in equipment damage, property damage, or personal injury.

⚠ **WARNING** - Warning statements are given to prevent actions that could result in equipment damage, property damage, personal injury or death.

⚠ **DANGER** - Danger statements are given to prevent actions that will result in equipment damage, property damage, severe personal injury or death.

⚠ WARNING

ELECTRIC SHOCK, FIRE OR EXPLOSION HAZARD

Failure to follow safety warnings exactly could result in dangerous operation, serious injury, death or property damage.

Improper servicing could result in dangerous operation, serious injury, death, or property damage.

- Before servicing, disconnect all electrical power to the furnace. More than one disconnect may be provided.
- When servicing controls, label all wires prior to disconnecting. Reconnect wires correctly.
- Verify proper operation after servicing. Secure all doors with key-lock or nut and bolt.

⚠ WARNING

QUALIFIED INSTALLER

Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Startup and service must be performed by a Factory Trained Service Technician. A copy of this IOM should be kept with the unit.

⚠ CAUTION

WHAT TO DO IF YOU SMELL GAS

- Do not try to turn on unit.
- Shut off main gas supply.
- Do not touch any electric switch.
- Do not use any phone in the building.
- Never test for gas leaks with an open flame.
- Use a gas detection soap solution and check all gas connections and shut off valves.

⚠ WARNING

Electric shock hazard. Before servicing, shut off all electrical power to the unit, including remote disconnects, to avoid shock hazard or injury from rotating parts. Follow proper Lockout-Tagout procedures.

⚠ WARNING

FIRE, EXPLOSION OR CARBON MONOXIDE POISONING HAZARD

Failure to replace proper controls could result in fire, explosion or carbon monoxide poisoning. Failure to follow safety warnings exactly could result in serious injury, death or property damage. Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this appliance.

⚠ WARNING

During installation, testing, servicing, and troubleshooting of the equipment it may be necessary to work with live electrical components. Only a qualified licensed electrician or individual properly trained in handling live electrical components shall perform these tasks.

Standard NFPA-70E, an OSHA regulation requiring an Arc Flash Boundary to be field established and marked for identification of where appropriate Personal Protective Equipment (PPE) be worn, should be followed.

⚠ WARNING

ROTATING COMPONENTS

Unit contains fans with moving parts that can cause serious injury. Do not open door containing fans until the power to the unit has been disconnected and fan wheel has stopped rotating.

⚠ WARNING

GROUNDING REQUIRED

All field installed wiring must be completed by qualified personnel. Field installed wiring must comply with NEC/CEC, local and state electrical code requirements. Failure to follow code requirements could result in serious injury or death. Provide proper unit ground in accordance with these code requirements.

⚠ WARNING

VARIABLE FREQUENCY DRIVES

Do not leave VFDs unattended in hand mode or manual bypass. Damage to personnel or equipment can occur if left unattended. When in hand mode or manual bypass mode VFDs will not respond to controls or alarms.

⚠ CAUTION

Electric motor over-current protection and overload protection may be a function of the Variable Frequency Drive to which the motors are wired. Never defeat the VFD motor overload feature. The overload ampere setting must not exceed 115% of the electric motors FLA rating as shown on the motor nameplate.

⚠ WARNING

UNIT HANDLING

To prevent injury or death lifting equipment capacity shall exceed unit weight by an adequate safety factor. Always test-lift unit not more than 24 inches high to verify proper center of gravity lift point to avoid unit damage, injury or death.

⚠ CAUTION

Rotation must be checked on all MOTORS AND COMPRESSORS of 3 phase units at startup by a qualified service technician. Scroll compressors are directional and can be damaged if rotated in the wrong direction. Compressor rotation must be checked using suction and discharge gauges. Fan motor rotation should be checked for proper operation. Alterations should only be made at the unit power connection

⚠ CAUTION

Failure to properly drain and vent coils when not in use during freezing temperature may result in coil and equipment damage.

⚠ WARNING

Do not use oxygen, acetylene or air in place of refrigerant and dry nitrogen for leak testing. A violent explosion may result causing injury or death.

⚠ WARNING

WATER PRESSURE

Prior to connection of condensing water supply, verify water pressure is less than maximum pressure shown on unit nameplate. To prevent injury or death due to instantaneous release of high pressure water, relief valves should be field supplied on system water piping.

⚠ WARNING

Always use a pressure regulator, valves and gauges to control incoming pressures when pressure testing a system. Excessive pressure may cause line ruptures, equipment damage or an explosion which may result in injury or death.

CAUTION

To prevent damage to the unit, do not use acidic chemical coil cleaners. Do not use alkaline chemical coil cleaners with a pH value greater than 8.5, after mixing, without first using an aluminum corrosion inhibitor in the cleaning solution.

WARNING

Some chemical coil cleaning compounds are caustic or toxic. Use these substances only in accordance with the manufacturer's usage instructions. Failure to follow instructions may result in equipment damage, injury or death.

CAUTION

Door compartments containing hazardous voltage or rotating parts are equipped with door latches to allow locks. Door latch are shipped with nut and bolts requiring tooled access. If you do not replace the shipping hardware with a pad lock always re-install the nut & bolt after closing the door.

CAUTION

Do not clean DX refrigerant coils with hot water or steam. The use of hot water or steam on refrigerant coils will cause high pressure inside the coil tubing and damage to the coil.

CAUTION

Cleaning the cooling tower or the condenser water loop with harsh chemicals, such as hydrochloric acid (muriatic acid) or chlorine, can damage the water-cooled condenser. Care should be taken to avoid allowing chemicals to enter the water-cooled condenser. See Appendix A - Heat Exchanger Corrosion Resistance for more information.

WARNING

OPEN LOOP APPLICATIONS

Failure of the condenser as a result of chemical corrosion is excluded from coverage under AAON Inc. warranties and the heat exchanger manufacturer's warranties.

WARNING

WATER FREEZING

Failure of the condenser due to freezing will allow water to enter the refrigerant circuit and will cause extensive damage to the refrigerant circuit components. Any damage to the equipment as a result of water freezing in the condenser is excluded from coverage under AAON warranties and the heat exchanger manufacturer warranties.

⚠ WARNING

HOT PARTS

Disconnect all power, close all isolation valves and allow equipment to cool before servicing equipment to prevent serious injury. Equipment may have multiple power supplies. Electric resistance heating elements and hot water or steam heating coils may have automatic starts. Hot water will circulate even after power is off.

⚠ CAUTION

PVC (Polyvinyl Chloride) and CPVC (Chlorinated Polyvinyl Chloride) are vulnerable to attack by certain chemicals. Polyolester (POE) oils used with R-410A and other refrigerants, even in trace amounts, in a PVC or CPVC piping system will result in stress cracking of the piping and fittings and complete piping system failure.

⚠ WARNING

Do not weld or cut foam panel with plasma cutters or a cutting torch – When burnt the foam produces dangerous fumes.

⚠ WARNING

Do not work in a closed area where refrigerant or nitrogen gases may be leaking. A sufficient quantity of vapors may be present and cause injury or death.

⚠ WARNING

Never attempt to open an access door or remove a panel while the unit is running. Pressure in the unit can cause excessive force against the panel.

⚠ WARNING

Ensure that sufficient dampers will be open to provide air path before fan is allowed to run.

1. Startup and service must be performed by a Factory Trained Service Technician.

2. Use only with type of the gas approved for the furnace. Refer to the furnace rating plate.

3. Provide adequate combustion ventilation air to the furnace. If a vent duct extension is used, a class III approved vent is required. See the Locating Units and Gas Heating sections of the Installation section of the manual.

4. Always install and operate furnace within the intended temperature rise range and duct system external static pressure (ESP) as specified on the unit nameplate.

5. The supply and return air ducts must be derived from the same space. It is recommended ducts be provided with access panels to allow inspection for duct tightness. When a down flow duct is used with electric heat, the exhaust duct should be an L shaped duct.

6. Clean furnace, duct and components upon completion of the construction setup. Verify furnace operating conditions including input rate, temperature rise and ESP.

7. Every unit has a unique equipment nameplate with electrical, operational, and unit clearance specifications. Always refer to the unit nameplate for specific ratings unique to the model you have purchased.

8. READ THE ENTIRE INSTALLATION, OPERATION AND MAINTENANCE MANUAL. OTHER IMPORTANT SAFETY PRECAUTIONS ARE PROVIDED THROUGHOUT THIS MANUAL.

9. Keep this manual and all literature safeguarded near or on the unit.

Feature String Nomenclature

Base Feature String
Identifies the main unit features and options.

Individual Module Feature String
Identifies module configurations, features and options.

M2-H-026-L-2-A-A-0-C-0 :

BBD-101-0-00-00000-00000-0-0
FTH-102-P-C0-20000-CE000-C-X
HRA-103-A-00-00000-00000-0-0
MBH-104-A-00-00000-0000-0-0
CLC-105-E-00-00000-610I0-S-0
SDB-106-M-EI-C0000-00000-0-0
PHG-107-H-00-00000-C0M0A-0-0
EDB-201-L-GI-C0000-00000-0-0
MBD-203-A-A0-00000-B0000-0-0

Complete Feature String

A complete unit feature string consists of a base model feature string followed by a series of individual module feature strings. In the individual module model number, the three numbers after the three letter Module ID indicate the position of the module in unit assembly, increasing in value from the return/outside air section to the discharge air section and from the bottom to the top. In the below example, the cooling coil module in Figure 1, CLC-**105**-E-00-00000-610I0-0-0, is the fifth module on the first level of the unit. The exhaust fan, EDB-**201**-L-GI-C000-00000-0-0, is the first module on the second level.

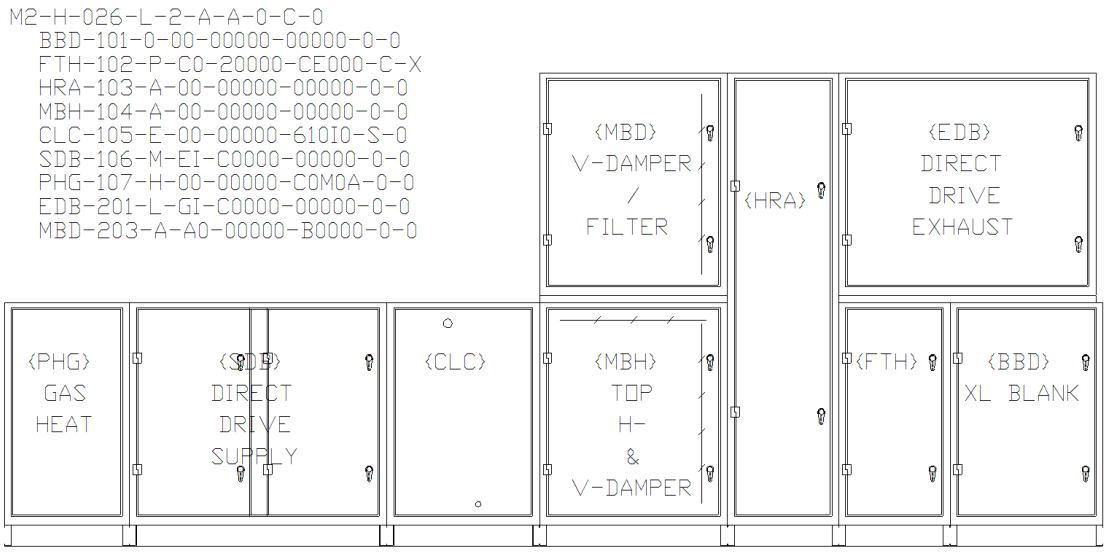

Figure 1 - Typical M2 Series Selection

M2 Series Base Feature String Nomenclature

Model Options

GEN	TYPE	UNIT SIZE	SUPPLY AIRFLOW	VOLTAGE	ASSEMBLY	WIRING	PAINT	BASE RAIL	SPECIAL
M2	- H	- 011	- R	- 2	- A	- A	- 0	- C	- 0

BASE MODEL DESCRIPTION

Series and Generation
M2

Type
H = Horizontal

Unit Size
005 = 5 ft^2 Coil
008 = 8 ft^2 Coil
011 = 11 ft^2 Coil
014 = 14 ft^2 Coil
018 = 18 ft^2 Coil
022 = 22 ft^2 Coil
026 = 26 ft^2 Coil
032 = 32 ft^2 Coil
036 = 36 ft^2 Coil

Supply Airflow
L = Left Hand
R = Right Hand

Voltage
1 = 230V/1Φ/60Hz
2 = 230V/3Φ/60Hz
3 = 460V/3Φ/60Hz
4 = 575V/3Φ/60Hz
8 = 208V/3Φ/60Hz
9 = 208V/1Φ/60Hz

Assembly
A = Factory Assembled
B = Loose Boxes

Wiring
A = Control Wiring in Fan Box
B = Control Wiring in Control Box

Paint
0 = Standard
A = Indoor Unit with Exterior Corrosion Protection
B = Indoor Unit with Interior and Exterior Corrosion Protection
E = Shipping Shrink Wrap
F = Indoor Unit with Exterior Corrosion Protection + Shipping Shrink Wrap
G = Indoor Unit with Interior and Exterior Corrosion Protection + Shipping Shrink Wrap

Base Rail
B = 8” High
C = 6” High
D = 10” High

Special
0 = None
X = Special Pricing Authorization

Fan Module Feature String Nomenclature

www.aaon.com

MDULE ID	POSITION	MOTOR SIZE	BLOWER	ISOLATION	MOTOR TYPE	BLANK	PULLEYS	SAFETY CONTROL	BLANK	BLANK	TYPE
SFA	- 103	- E	- B	I	- A	00	0C	- 0	0000	- 0	- 0

FAN MODULE DESCRIPTION

Module ID
SFA = Belt Driven Supply, Control Panel
SFC = Belt Drive Supply, Control Panel, Top Discharge
SFD = Belt Driven Supply, No Control Panel
SDB = Direct Drive Supply
SDD = Direct Drive Supply, Top Discharge
SDM = Dual Fan Direct Drive Supply
SDN = Dual Fan Direct Drive Supply, Top Discharge
PEA = Belt Driven Power Exhaust
PEC = Belt Driven Power Exhaust, Top Discharge
EDB = Direct Drive Power Exhaust
EDD = Direct Drive Power Exhaust, Top Discharge
RFA = Belt Driven Power Return
RDB = Direct Drive Power Return
RDM = Dual Fan Direct Drive Power Return

Position
= Level and Position of Module in Air Handling Unit

Motor Size
E = 1 hp
F = 2 hp
G = 3 hp
H = 5 hp
J = 7.5 hp
K = 10 hp
L = 15 hp
M = 20 hp
N = 25 hp
Q = 1.0 kW (1.3 hp)
S = 1.7 kW (2.3 hp)
T = 3.0 kW (4.0 hp)
U = 5.4 kW (8.0 hp)

Blower
A = 15” Backward Curved Plenum
B = 18” Backward Curved Plenum
C = 22” Backward Curved Plenum
D = 27” Backward Curved Plenum
E = 30” Backward Curved Plenum
F = 33” Backward Curved Plenum
G = 37” Backward Curved Plenum
H = 24” Backward Curved Plenum
J = 15” BC Plenum - 50% Width
K = 18” BC Plenum - 30% Width
L = 2 x 18” Backward Curved Plenum
M = 2 x 22” Backward Curved Plenum
N = 2 x 24” Backward Curved Plenum
P = 2 x 27” Backward Curved Plenum
Q = 14” ECM Backward Curved Plenum
R = 16” ECM Backward Curved Plenum
S = 18” ECM Backward Curved Plenum
T = 18” ECM Backward Curved Plenum

Isolation
0 = Standard
I = Fan Isolation

Motor Type
A = Standard Efficiency 1760 rpm
B = Premium Efficiency 1760 rpm
C = Premium Eff. 1760 rpm with VFD
D = Premium Eff. 1760 rpm with VFD and Bypass
E = Premium Efficiency 1170 rpm
F = Premium Eff. 1170 rpm with VFD
G = EC Motor

Blank
00 = Standard

Pulleys
= Pulley Combination

Safety Control
0 = None
A = Phase & Brownout Protection

Blank
0000 = Standard

Blank
0 = Standard

Type
0 = None
X = Special Pricing Authorization

Filter Module Feature String Nomenclature

MDULE ID	POSITION	FILTER TYPE	FILTERS	SAFETY CONTROL	BLANK	2ND FILTER TYPE	2ND FILTER	BLANK	FILTER OPTIONS	TYPE
FTA	- 102 -	P	- A0 -	0	0000 -	0	00	00 -	0	- 0

FILTER MODULE DESCRIPTION

Module ID
FTA = Small Flat Filter
FTC = Cartridge Filter
FTE = Medium Flat Filter
FTF = Large Flat Filter
FTH = Cartridge Filter with Flat Pre-Filter
FTK = Extra Large Flat Filter

Position
= Level and Position of Module in Air Handling Unit

Filter Type
P = Pleated
C = Cartridge

Filters
A0 = 2" Pleated, 30% Eff.
B0 = 4" Pleated, 30% Eff.
C0 = 4" Pleated, 65% Eff. or 12" Cartridge, 65% Eff.
D0 = 4" Pleated, 85% Eff. or 12" Cartridge, 85% Eff.
E0 = 4" Pleated, 95% Eff. or 12" Cartridge, 95% Eff.

Safety Control
0 = Standard
2 = Firestat

Blank
0000 = Standard

Second Filter Type
0 = Standard - None
C = Cartridge

Second Filter
00 = Standard - None
C0 = 12" Cartridge, 65% Eff.
D0 = 12" Cartridge, 85% Eff.
E0 = 12" Cartridge, 95% Eff.

Blank
00 = Standard

Filter Options
0 = Standard - None
A = Magnehelic Gauge
B = Clogged Filter Switch
C = Magnehelic Gauge & Clogged Filter Switch

Type
0 = None
X = Special Pricing Authorization

Mixing Module Feature String Nomenclature

MDULE ID	POSITION	ACTUATOR TYPE	FILTERS	SAFETY CONTROL	BLANK	BYPASS OPENING	BLANK	FILTER OPTIONS	TYPE
MBH	- 101	- A	- 00	- 0	0000	- 0	0000	- 0	- 0

MIXING MODULE DESCRIPTION

Module ID
MBA = Vertical Damper
MBB = Horizontal Top Damper
MBC = Vertical & Horizontal Bottom Damper
MBD = Vertical Damper with Filter
MBE = Horizontal Top Damper with Filter
MBF = Horizontal Bottom Damper
MBH = Vertical & Horizontal Top Damper
MBI = Horizontal Bottom Damper with Filter
MBJ = Vertical & Horizontal Top Damper with Filter
MBK = Vertical & Horizontal Bottom Damper with Filter

Position
= Level and Position of Module in Air Handling Unit

Actuator Type
0 = Standard - None
A = Two Position Actuator
B = DDC Actuator

Filters
00 = Standard - None
A0 = 2" Pleated, 30% Eff.
B0 = 4" Pleated, 30% Eff.
C0 = 4" Pleated, 65% Eff.
D0 = 4" Pleated, 85% Eff.
E0 = 4" Pleated, 95% Eff.

Safety Control
0 = Standard
2 = Firestat

Blank
0000 = Standard

Bypass Opening
0 = Standard - None
A = Top Open
B = Bottom Open

Blank
0000 = Standard

Filter Options
0 = Standard - None
A = Magnehelic Gauge
B = Clogged Filter Switch
C = Options A + B

Type
0 = Standard - None
X = Special Pricing Authorization

Heat Module Feature String Nomenclature

MDULE ID	POSITION	FUNCTION	FILTERS	ROWS	FPI	CIRCUITING	COATING	HEAT CAPACITY	STAGES	FUEL GAS	COMB INTAKE	FILTER OPTIONS	TYPE
PHA	**101**	**H**	**00**	**0**	**00**	**0**	**0**	**E**	02	0	0	0	0

HEAT MODULE DESCRIPTION

Module ID
PHA = Electric Heat
PHB = Hot Water Coil
PHC = Hot Water Coil with Filter
PHD = Electric Heat with Filter
PHG = Gas Heat

Position
= Level and Position of Module in Air Handling Unit

Function
H = Heating

Filters
00 = None
A0 = 2” Pleated, 30% Eff.
B0 = 4” Pleated, 30% Eff.
C0 = 4” Pleated, 65% Eff.
D0 = 4” Pleated, 85% Eff.
E0 = 4” Pleated, 95% Eff.

HEATING COIL

Rows
0 = No Hot Water Heating
1 = 1 Row
2 = 2 Rows

FPI
00 = No Hot Water Heating
08 = 8 Fins Per Inch
10 = 10 Fins Per Inch
12 = 12 Fins Per Inch

Circuiting
0 = No Hot Water Heating
F = Single Serpentine
H = Half Serpentine

Coating
0 = Standard
H = Stainless Steel Coil Casing & Copper Fins
P = Polymer E-Coating
S = Stainless Steel Coil Casing

Heat Capacity
0 = Hot Water Heating Coil
1 = Heat 1
2 = Heat 2
3 = Heat 3
4 = Heat 4
5 = Heat 5
6 = Heat 6
7 = Heat 7
8 = Heat 8
A = Heat A
B = Heat B
C = Heat C
D = Heat D
E = Heat E
F = Heat F
G = Heat G
H = Heat H
J = Heat J
K = Heat K
L = Heat L
M = Heat M
N = Heat N
P = Heat P
Q = Heat Q
R = Heat R
S = Heat S
T = Heat T
U = Heat U
V = Heat V
W = Heat W

Heat Module Feature String Nomenclature

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MDULE ID	POSITION	FUNCTION	FILTERS	ROWS	FPI	CIRCUITING	COATING	HEAT CAPACITY	STAGES	FUEL GAS	COMB INTAKE	FILTER OPTIONS	TYPE
PHA	101	H	00	0	00	0	0	E	**02**	**0**	**0**	**0**	**0**

Stages
00 = Hot Water Heating Coil
01 = 1 Stage
02 = 2 Stage
03 = 3 Stage
04 = 4 Stage
0M = Modulating 5:1 Stage

Fuel Gas
0 = Natural Gas [Hot Water/Electric Heat]
A = LP Gas

Combustion Intake
0 = Open Combustion [Hot Water/Electric Heat]
A = Separated Combustion

Filter Options
0 = Standard
A = Magnehelic Gauge
B = Clogged Filter Switch
C = Options A + B

Type
0 = None
X = Special Pricing Authorization
S = Steam Heating

Blank Module Feature String Nomenclature

MDULE ID	POSITION	DRAIN PAN TYPE	AIRWAY TYPE	SAFETY CONTROL	BLANK	BYPASS OPENING	BLANK	BLANK	TYPE
BBA	- 101	- 0	- AR	- 0	0000	- 0	0000	- 0	- 0

BLANK MODULE DESCRIPTION

Module ID
BBA = Small
BBB = Medium
BBC = Large
BBD = XL
BBE = XXL
BBF = XXXL
BBG = Extended Large

Position
= Level and Position of Module in Air Handling Unit

Drain Pan Type
0 = None
A = Auxiliary

Airway Type
00 = Standard
AR = Top Open, Right Hand End Panel
AL = Top Open, Left Hand End Panel

Safety Control
0 = None
2 = Firestat

Blank
0000 = Standard

Bypass Opening
0 = None
A = Top Opening
B = Bottom Opening

Blank
0000 = Standard

Blank
0 = Standard

Type
0 = None
X = Special Pricing Authorization

Coil Module Feature String Nomenclature

MDULE ID	POSITION	COOLING TYPE	ELECTRIC HEAT kW	ELEC HEAT STAGES	HEATING COIL ROWS	HEATING COIL FPI	HEATING COIL CKT	HEAT COIL COATING	COOLING COIL ROWS	COOLING COIL FPI	COOLING COIL CKT	COOL COIL COATING	DRAIN PAN TYPE	TYPE
CLC	- 101	- C	- 0	0	- 0	00	0	0	- 4	10	F	0	- S	- 0

COIL MODULE DESCRIPTION

Module ID

CLB = Chilled Water or DX
CLC = DX + Hot Gas Reheat
CLF = Hot Water + Chilled Water or DX
CLG = Electric Heat + Chilled Water or DX
CLI = Hot Water, Chilled Water, or DX with Face and Bypass Dampers
CLM = Chilled Water or DX, Optional Size

Position

= Level and Position of Module in Air Handling Unit

Cooling Type

0 = None
C = Chilled Water
F = DX R-410A
G = DX R-410A + Hot Gas Bypass

ELECTRIC HEAT

Capacity

0 = No Electric Heat
A = 7 kW (5.3 kW)
B = 14 kW (10.5 kW)
C = 21 kW (15.8 kW)
D = 28 kW (21.0 kW)
H = 35 kW (26.3 kW)
E = 42 kW (35.0 kW)
F = 56 kW (42.0 kW)
G = 70 kW (52.5 kW)
J = 84 kW (63.1 kW)
K = 112 kW (84.1 kW)
L = 126 kW (94.6 kW)
M = 168 kW (126.2 kW)

Stages

0 = Standard - None
1 = 1 Stage
2 = 2 Stage
3 = 3 Stage
4 = 4 Stage

HEATING COIL

Rows

0 = No Hot Water Heating
1 = 1 Row
2 = 2 Rows

FPI

00 = No Hot Water Heating
08 = 8 Fins Per Inch
10 = 10 Fins Per Inch
12 = 12 Fins Per Inch

Circuiting

0 = No Hot Water Heating
F = Single Serpentine
H = Half Serpentine

Coating

0 = Standard
P = Polymer E-Coating
S = Stainless Steel Coil Casing
H = Stainless Steel Coil Casing & Copper Fins

COOLING COIL

Rows

0 = No Cooling Coil
4 = 4 Rows
6 = 6 Rows
8 = 8 Rows

FPI

00 = No Cooling Coil
08 = 8 Fins Per Inch
10 = 10 Fins Per Inch
12 = 12 Fins Per Inch

Coil Module Feature String Nomenclature

MDULE ID	POSITION	COOLING TYPE	ELECTRIC HEAT kW	ELEC HEAT STAGES	HEATING COIL ROWS	HEATING COIL FPI	HEATING COIL CKT	HEAT COIL COATING	COOLING COIL ROWS	COOLING COIL FPI	COOLING COIL CKT	COOL COIL COATING	DRAIN PAN TYPE	TYPE
CLC	- 101 -	C	- 0	0 -	0	00	0	0	- 4	10	**F**	**0**	- **S**	- **0**

Circuiting
0 = No Cooling Coil
F = Single Serpentine
H = Half Serpentine
S = DX Single Circuit
I = DX Dual Circuit, Interlaced

Coating
0 = Standard
P = Polymer E-Coating
S = Stainless Steel Coil Casing
H = Stainless Steel Coil Casing & Copper Fins

Drain Pan
0 = No Drain Pan
S = Stainless Steel

Type
0 = None
X = Special Pricing Authorization
S = Steam Heating

Controls Module Feature String Nomenclature

MDULE ID	POSITION	BLANK	BLANK	SAFETY CONTROL	BLANK	BLANK	BLANK	TYPE
TRA	- 101 -	0	- 00 -	0	0000	- 00000 -	0	- 0

CONTROLS MODULE DESCRIPTION

Module ID
TRA = Small
TRB = Medium
TRC = Large
TRD = XL
TRE = XXL
TRF = XXXL

Position
= Level and Position of Module in Air Handling Unit

Blank
0 = Standard

Blank
00 = Standard

Safety Options
0 = Standard
2 = Firestat

Blank
0000 = Standard

Blank
00000 = Standard

Blank
0 = Standard

Type
0 = None
X = Special Pricing Authorization

Energy Recovery Module Feature String Nomenclature

MDULE ID	POSITION	WHEEL SIZE	RECOVERY TYPE	BLANK	BLANK	VFD CONTROL	TYPE
HRA	- 101 -	A	- 00 -	00000	- 00000 -	0	- 0

ENERGY RECOVERY MODULE DESCRIPTION

Module ID
HRA = AAONAIRE® Energy Recovery Wheel

Position
= Level and Position of Module in Air Handling Unit

Wheel Size
A = Standard

Recovery Type
00 = Standard
0A = Total Energy Recovery + 1% Purge
A0 = Sensible Only Energy Recovery
AA = Sensible Only Energy Recovery + 1% Purge

Blank
00000 = Standard

Blank
00000 = Standard

VFD Control
0 = Standard
A = VFD Controlled Wheel

Type
0 = None
X = Special Pricing Authorization

Water-Source Heat Pump Module Feature String Nomenclature

MDULE ID	POSITION	REVISION	CAPACITY	COMP STAGING	BLANK	REFRIG OPTIONS	REFRIG ACCESS	BLANK	WATER SIDE	HEAT EXCHANGER	BLANK	TYPE
WHP	- 101	- A	- 25	- D E	000	- D	A	0	B	0	- 0	- 0

WATER-SOURCE HEAT PUMP MODULE DESCRIPTION

Module ID
WHP = Water-source heat pump
WCC = Water-cooled condenser (A/C only)

Position
= Level and Position of Module in Air Handling Unit

Revision
A

Capacity
03 = 3 tons
05 = 5 tons
08 = 8 tons
10 = 10 tons
11 = 11 tons
15 = 15 tons
20 = 20 tons
25 = 25 tons
30 = 30 tons
40 = 40 tons
50 = 50 tons
60 = 60 tons

Compressor Style
A = R-410A Scroll Compressor
B = R-410A 2-Step Capacity Scroll Compressor
D = R-410A Variable Capacity Scroll Compressor
E = R-410A Tandem Scroll Compressor
G = R-410A Tandem Variable Capacity Scroll Compressor

Staging
1 = 1 Stage
2 = 2 Stage
A = 1 Variable Capacity Scroll Compressor + 1 On/Off Scroll Compressor
B = 2 Variable Capacity Scroll Compressors + 2 On/Off Scroll Compressors
E = All Variable Capacity Scroll Compressors
F = 1 Variable Capacity Scroll Compressor + 3 On/Off Scroll Compressors

Blank
000 = Standard

Refrigeration Options
0 = Standard
A = Hot Gas Bypass [HGB] - Lead Stage
B = HGB Lead + HGB Lag
C = HGB Lag
D = Modulating Hot Gas Reheat [MHGR]
E = Options A + D
F = Options A + C + D
G = Options C + D

Refrigeration Accessories
0 = Standard
A = Sight Glass
B = Compressor Isolation Valves
C = Options A + B

Blank
0 = Standard

Water-Side Options
0 = Standard
A = Balancing Valves
B = Water Flow Switch
C = Motorized Shut-off Valve
D = 2 Way Head Pressure Control
E = 3 Way Head Pressure Control
F = Options B + A
G = Options B + C
H = Options B + D
J = Options B + E
K = Options B +A + C
L = Options B + A + D
M = Options B + A + E
P = Options A + C
Q = Options A + D
R = Options A + E

Heat Exchanger Type
0 = Standard
A = SMO 254 Brazed Plate Heat Exchanger
B = Cupronickel Coaxial Heat Exchanger

Blank
0 = Standard

Type
0 = None
X = Special Pricing Authorization

Unit Orientation

Determine left hand or right hand orientation/connections:

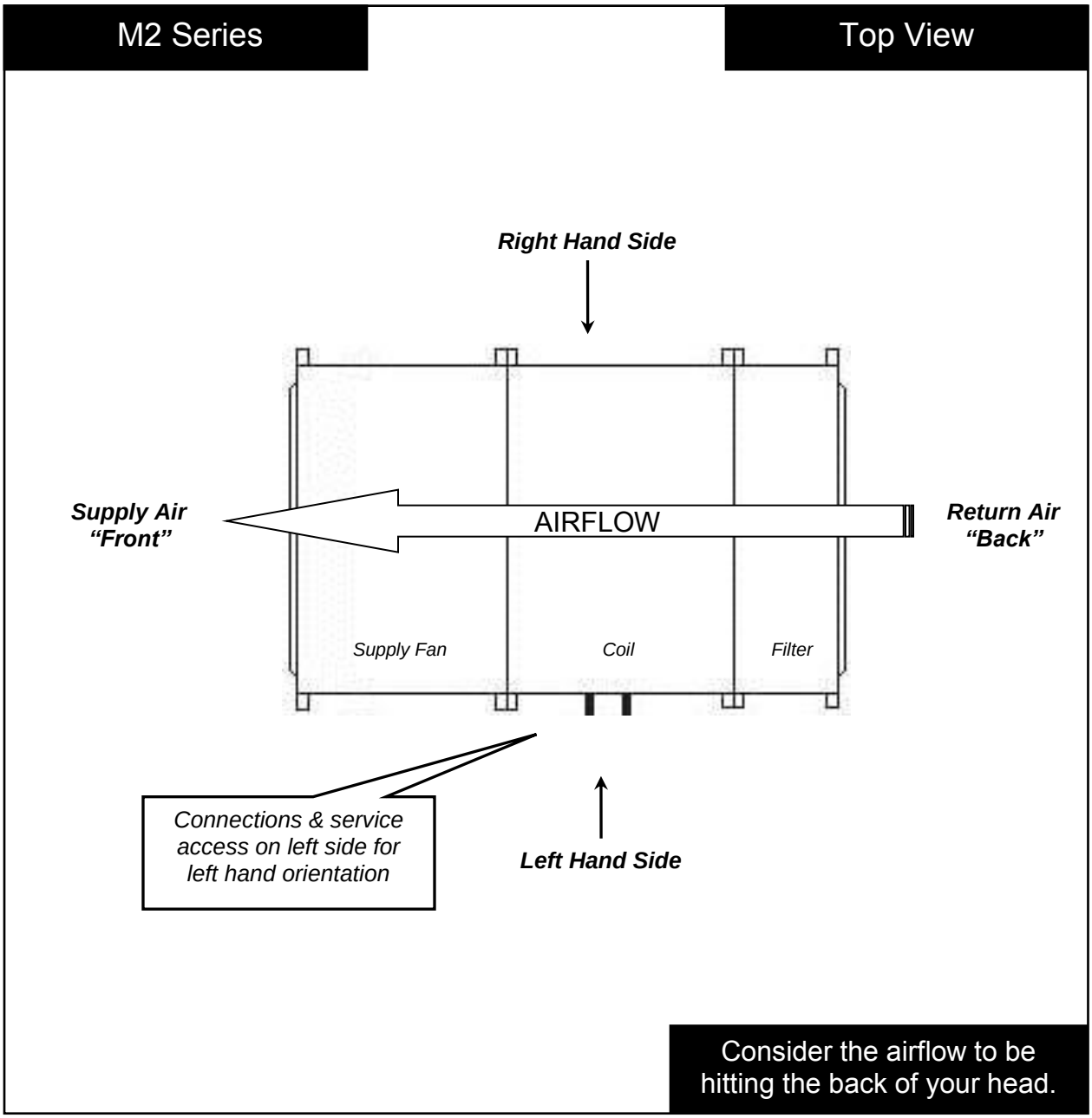


Figure 2 - Unit Orientation

General Information

M2 Series modular indoor air handling units and self-contained units have been designed for indoor installation. Flexible connectors are required on all duct connections to minimize air leaks.

M2 Series units are designed for safe operation when installed, operated and maintained within design specifications and the instructions in this manual. It is necessary to follow these instructions to avoid personal injury or damage to equipment or property during equipment installation, startup, operation and maintenance.

⚠ WARNING

Improper installation, adjustment, alteration, service, or maintenance can cause property damage, personal injury or loss of life. Startup and service must be performed by a Factory Trained Service Technician. A copy of this IOM should be kept with the unit.

⚠ CAUTION

These units must not be used as a "construction heater" at anytime during any phase of construction. Very low return air temperatures, harmful vapors, and misplacement of the filters will damage the unit and its efficiency.

⚠ CAUTION

This equipment is protected by a standard limited warranty under the condition that initial installation, service, startup and maintenance is performed according to the instructions set forth in this manual. This manual should be read in its entirety prior to installation and before performing any service or maintenance work.

Equipment described in this manual is available with many optional accessories. If you have questions after reading this manual in its entirety, consult other factory documentation or contact your AAON Sales Representative to obtain further information before manipulating this equipment or its optional accessories

Certification of Gas Heat Models

a. Certified as a Category III forced air furnace with or without cooling.
b. Certified for indoor and outdoor installation.
c. Certified for installation on a combustible roof with a minimum of 12" high curb.

Certification of Steam or Hot Water Heat Models

a. Certified as a forced air heating system with or without cooling.
b. Certified for indoor and outdoor installation.

Certification of Electric Heat Models

a. Certified as an electric warm air furnace with or without cooling.
b. Certified for indoor and outdoor installation only.

c. Certified for installation on a combustible roof with a minimum of 12" high curb.

Certification of Cooling Models

a. Certified as a commercial central air conditioner with or without electrically operated compressors.
b. Certified for indoor and outdoor installation only.
c. Certified for installation on a combustible roof with a minimum of 12" high curb.
d. Certified with refrigerant R-410A coils or with chilled water cooling coils.

Codes and Ordinances

System should be sized in accordance with the American Society of Heating, Refrigeration and Air Conditioning Engineers Handbook.

Installation of M2 Series units must conform to the ICC standards of the International Mechanical Code, the International Building Code, and local building, plumbing and waste water codes. In the absence of local codes installation must conform to the current (United States) National Fuel Gas Code ANSI-Z223.1/NFPA 54 or the current (Canada) National Fuel & Propane Installation Code CSA B149.1 or B149.2, and Mechanical Refrigeration Code CSA B52. All appliances must be electrically grounded in accordance with local codes, or in the absence of local codes, the current National Electric Code, ANSI/NFPA 70 or the current Canadian Electrical Code CSA C22.1.

⚠ WARNING

Failure to observe the following instructions will result in premature failure of your system and possible voiding of the warranty.

⚠ CAUTION

The Clean Air Act of 1990 bans the intentional venting of refrigerant as of July 1, 1992. Approved methods of recovery, recycling, or reclaiming must be followed.

Receiving Unit

When received, the unit should be checked for damage that might have occurred in transit. If damage is found it should be noted on the carrier's freight bill. A request for inspection by carrier's agent should be made in writing at once. Nameplate should be checked to ensure the correct model sizes and voltages have been received to match the job requirements.

If repairs must be made to damaged goods, then the factory should be notified before any repair action is taken in order to protect the warranty. Certain equipment alteration, repair, and manipulation of equipment without the manufacturer's consent may void the product warranty. Contact the AAON-Longview Warranty Department for assistance with handling damaged goods, repairs, and freight claims: (903) 236-4403.

Note: Upon receipt check shipment for items that ship loose such as filters and remote sensors. Consult order and shipment documentation to identify potential loose-shipped items. Loose-shipped items may have been placed inside unit cabinet for security. Installers and owners should secure all doors with locks or nuts and bolts to prevent unauthorized access.

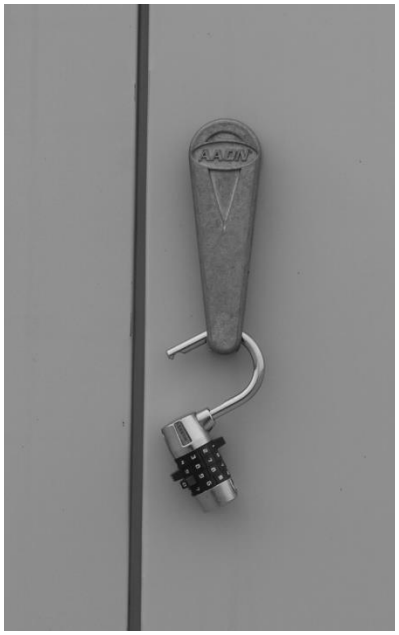


Figure 3 - Lockable Handle

Storage

If installation will not occur immediately following delivery, store equipment in a dry protected area away from construction traffic and in the proper orientation as marked on the packaging with all internal packaging in place. Secure all loose-shipped items.

Packaged Direct Expansion (DX) Units

All DX refrigeration systems are factory assembled, leak tested, charged with refrigerant, and run tested.

All DX refrigerant systems include an evaporator, condenser, liquid line filter driers, thermal expansion valves (TXV) and scroll compressors. Compressors are equipped with a positive pressure forced lubrication system.

Never cut off the main power supply to the unit, except for servicing, emergency, or complete shutdown of the unit. When power is cut off from the unit crankcase heaters cannot prevent refrigerant migration into the compressors. This means the compressor will cool down and liquid refrigerant may accumulate in the compressor. The compressor is designed to pump refrigerant gas and damage may occur when power is restored.

⚠ CAUTION

CRANKCASE HEATER OPERATION

Some units are equipped with compressor crankcase heaters, which should be energized at least 24 hours prior to cooling operation, to clear any liquid refrigerant from the compressors.

If power to the unit must be off for more than an hour, turn the thermostat system switch to "OFF", or turn the unit off at the control panel, and leave the unit off until the main power switch has been turned on again for at least 24 hours for units with compressor crankcase heaters. This will give the crankcase heater time to clear any liquid accumulation out of the compressor before it is started.

Always control the unit from the thermostat, or control panel, never at the main power supply, except for servicing, emergency or complete shutdown of the unit.

During the cooling season, if the air flow is reduced due to dirty air filters or any other reason, the cooling coils can get too cold which will cause excessive liquid to return to the compressor. As the liquid concentration builds up, oil is washed out of the compressor, leaving it starved for lubrication.

The compressor life will be seriously shorted by reduced lubrication and the pumping of excessive amounts of liquid oil and refrigerant.

Note: Low Ambient Operation
Air-cooled DX units without a low ambient option, such as condenser fan cycling, ECM driven condenser fans or the 0°F low ambient option, will not operate in the cooling mode of operation properly when the outdoor temperature is below 55°F. Low ambient and/or economizer options are recommended if cooling operation below 55°F is expected.

Gas or Electric Heating
The unit is designed to heat a given amount of air while operating. If this amount of air is greatly reduced, approximately 1/3 during the heating season, the gas heat exchanger or electric heating coil may overheat, and may cut the burner or heater off entirely by action of the safety high temperature limit devices which are factory mounted at the heat exchanger and supply fan areas.

Airflow should be adjusted after installation to obtain an air temperature rise within the range specified on the unit rating plate at the required external static pressure.

Should overheating occur with a gas heat exchanger, or the gas supply fail to shut off, shut off the manual gas valve to the furnace before shutting off the electrical supply.

Prolonged overheating of the heat exchanger will shorten its life.

If unit has not been selected as a 100% outside air unit (make up air unit) the return air duct must be sealed to the unit and the return air temperature must be maintained between 55°F and 80°F.

Wiring Diagrams
Unit specific wiring diagrams are laminated and affixed inside the controls compartment door.

Condensate Drain Pan
Unit requires drain traps to be connected to the condensate drain pan of the unit.

For condensate drain lines, the line should be the same pipe size or larger than the drain connection, include a p-trap, and pitch downward toward drain. An air break should be used with long runs of condensate lines.

⚠ CAUTION

Unit should not be operated without a p-trap. Failure to install a p-trap may result in overflow of condensate water.

⚠ CAUTION

An auxiliary / emergency drain pan is recommended for all indoor applications where there is a risk of water damage to surrounding structure or furnishings. Refer to local codes.

⚠ WARNING

Coils and sheet metal surfaces present sharp edges and care must be taken when working with equipment.

Installation

AAON equipment has been designed for quick and easy installation.

⚠ WARNING

Improper installation, adjustment, alteration, service, or maintenance can cause property damage, personal injury or loss of life. Startup and service must be performed by a Factory Trained Service Technician. A copy of this IOM should be kept with the unit.

Locating Units

Verify rooftop, foundation or mounting frame can support the total unit weight, including accessory weights.

Before setting the unit into place, caution must be taken to provide clearance for unit doors that must be accessible for periodic service. These areas contain the controls, safety devices, refrigerant or water piping, shut-off valves and filters.

A minimum clearance equal to the width of the unit is required on the access panel side of the unit to ensure there is enough room to slide out coils and energy recovery wheels, and to access filters, fans and other internal components.

Depending on natural gas and propane heating module orientations, the combustion air inlets or vent (flue) gas discharges may be located in the unit roof or sides. There must be 6 feet of clearance between these roofs/sides and building walls, parapets, adjacent buildings, or equipment. If equipment is for replacement and required clearances are not available, contact AAON for recommendations.

⚠ WARNING

When locating gas fired units, it is recommended the unit be installed so that the flue discharge vents are located at least 120 inches away from any opening through which combustion products could enter the building.

⚠ WARNING

Distances from adjacent public walkways, adjacent buildings, operable windows and building openings, shall conform to local codes and/or the National Fuel Gas Code, ANSI Z223.1/NFPA 54, or the National Gas & Propane Code, CSA B149.1

For gas fired unit, do not position flue opening to discharge into a fresh air intake of any other piece of equipment. Unit should also be installed so that the flow of combustion intake air is not obstructed from reaching the furnace.

Outdoor vent opening must not be blocked by snow. A minimum 12” curb must be used or the vent outlet shall be greater than 12” off the ground/roof.

Flue gas is dangerously hot and contains containments. The user is responsible for determining if vent gases may degrade building materials.

The National Gas and Propane Installation Code, B149.1 specifies a 6 ft. horizontal vent terminal clearance to gas and electric meters and relief devices.

Local codes may supersede or further place restrictions on vent termination locations.

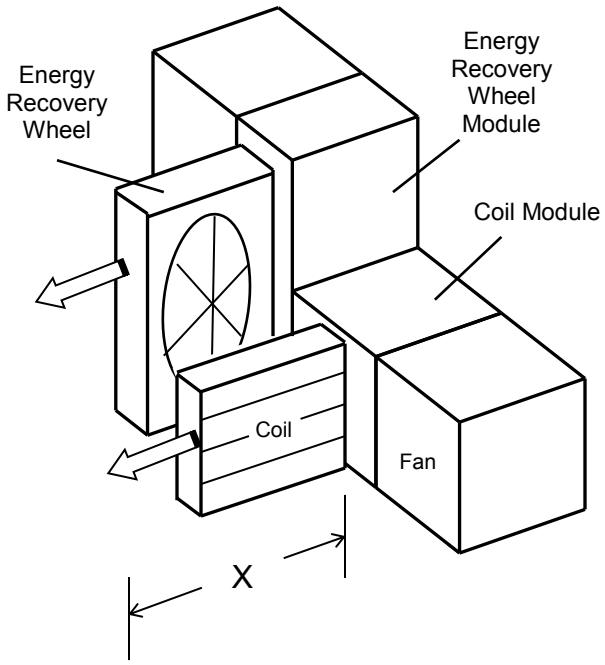


Figure 4 - Service Access Clearance

Table 1 - Minimum Clearances

Unit Size	Minimum Required Service Clearance X =
M2-005	50”
M2-008	50”
M2-011	62”
M2-014	62”
M2-018	84”
M2-022	84”
M2-026	84”
M2-032	96”
M2-036	96”

Lifting the Unit

Units may be delivered in separate module components or completely factory assembled with all modules connected. In the latter case, if the unit was received fully assembled on a skid, then the equipment should be lifted into place using the shipping skid to prevent damage to the modules.

CAUTION

Incorrect lifting can cause damage to the unit.

If cables or chains are used to hoist the unit they must be the same length. Care should be taken to prevent damage to the cabinet, coils and condenser fans.

Before lifting unit, be sure that all shipping material has been removed from unit. Secure hooks and cables at all lifting points / lugs provided on the unit.

Hoist unit to a point directly above the duct openings.

Carefully lower and align the unit with utility and duct openings. Make sure the unit is properly seated and level.

Refer to the following unit lifting figures.

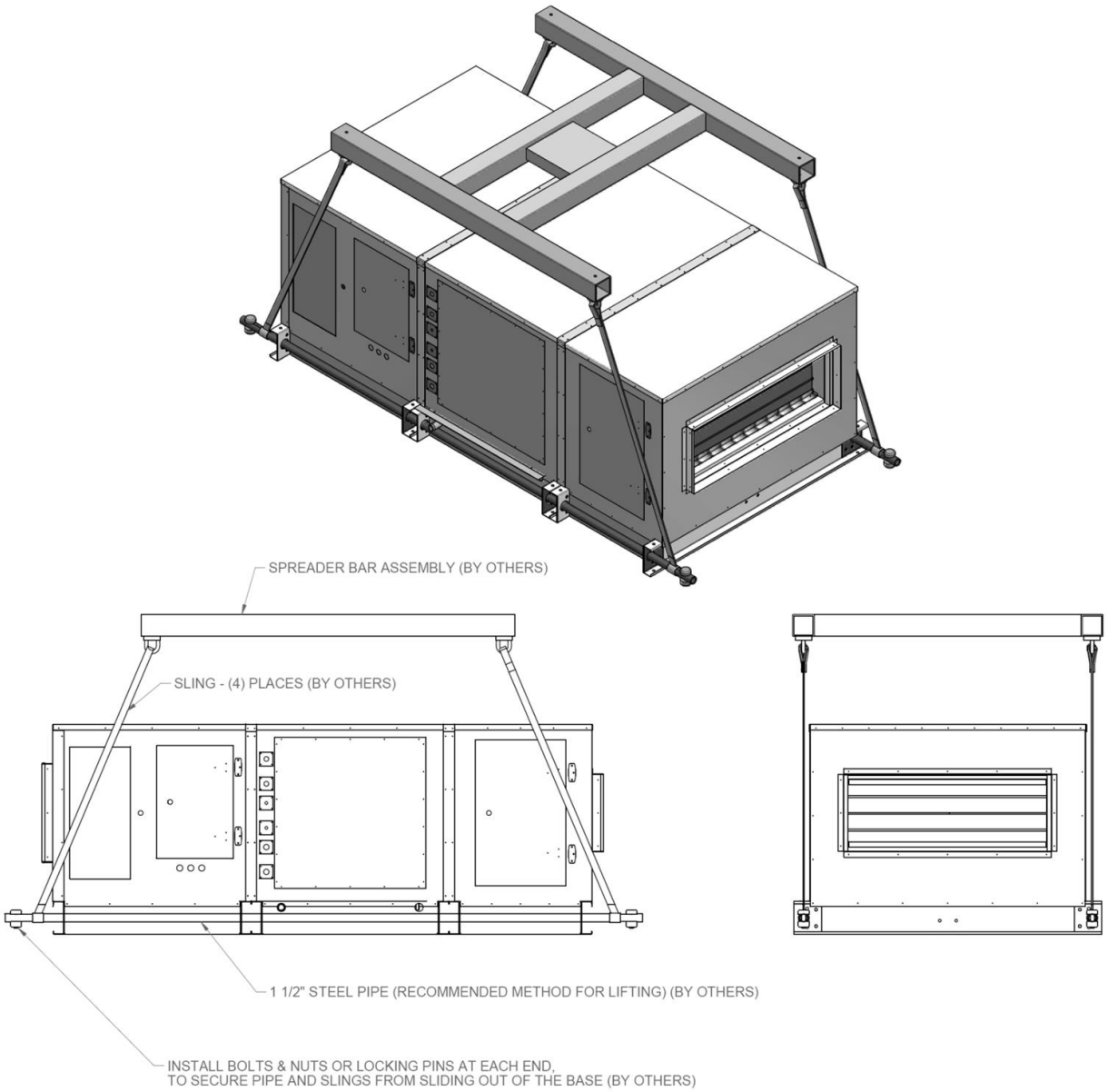


Figure 5 - M2 Series Unit Four Point Lifting

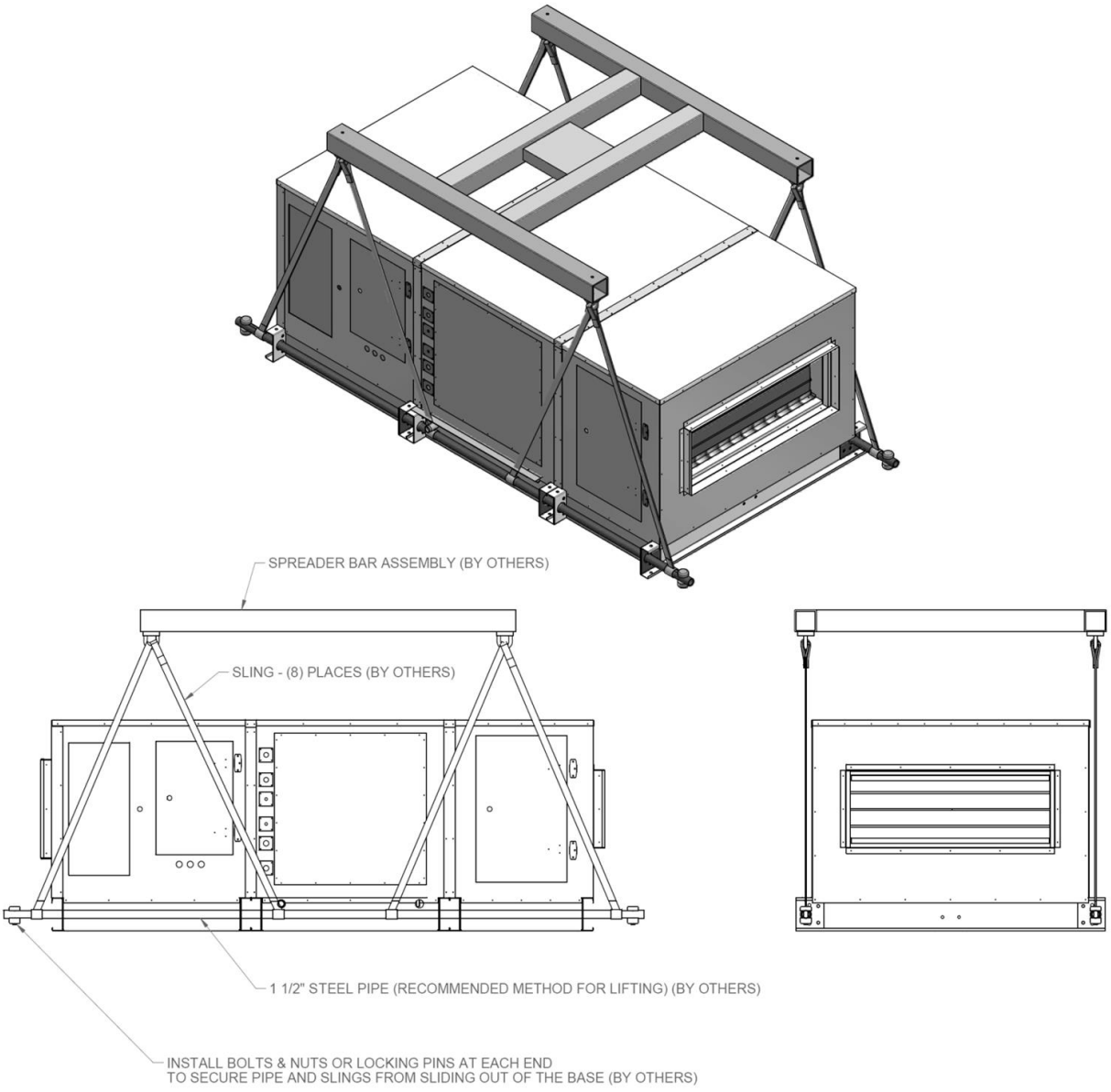


Figure 6 - M2 Series Unit Eight Point Lifting

Indoor Floor Mounted Units
Indoor M2 Series units can be floor mounted.

Dual path units, self-contained units and units over size M2-014 must be floor mounted. Make sure the unit is level, and installed with a minimum height of 6" to allow for proper drainage of the condensate line. Other installation provisions may be necessary according to job specifications.

Indoor Suspended Units
Indoor M2 Series units can be can be suspended. Only single path units of size M2-005 to M2-014 should be suspended. Suspension of dual path units, self-contained units or units over size M2-014 is not recommended.

A ceiling suspended mounting frame must be provided for unit suspension. It is the responsibility of the engineer or installing contractor to design and build a suitable structure based on the load distribution of individual modules. C-channels, or similar structural members, are suggested to be placed parallel to airflow under each base rail of the unit, with appropriate structural cross members as required by weight and design. A 4" minimum c-channel size is recommended. The unit is not designed to be suspended directly from the base rails. An appropriate structural support is required for suspension.

The air handling unit must be installed level as the internal drain pan is manufactured with a slope toward the drain. Other installation provisions may be necessary according to job specifications and requirements.

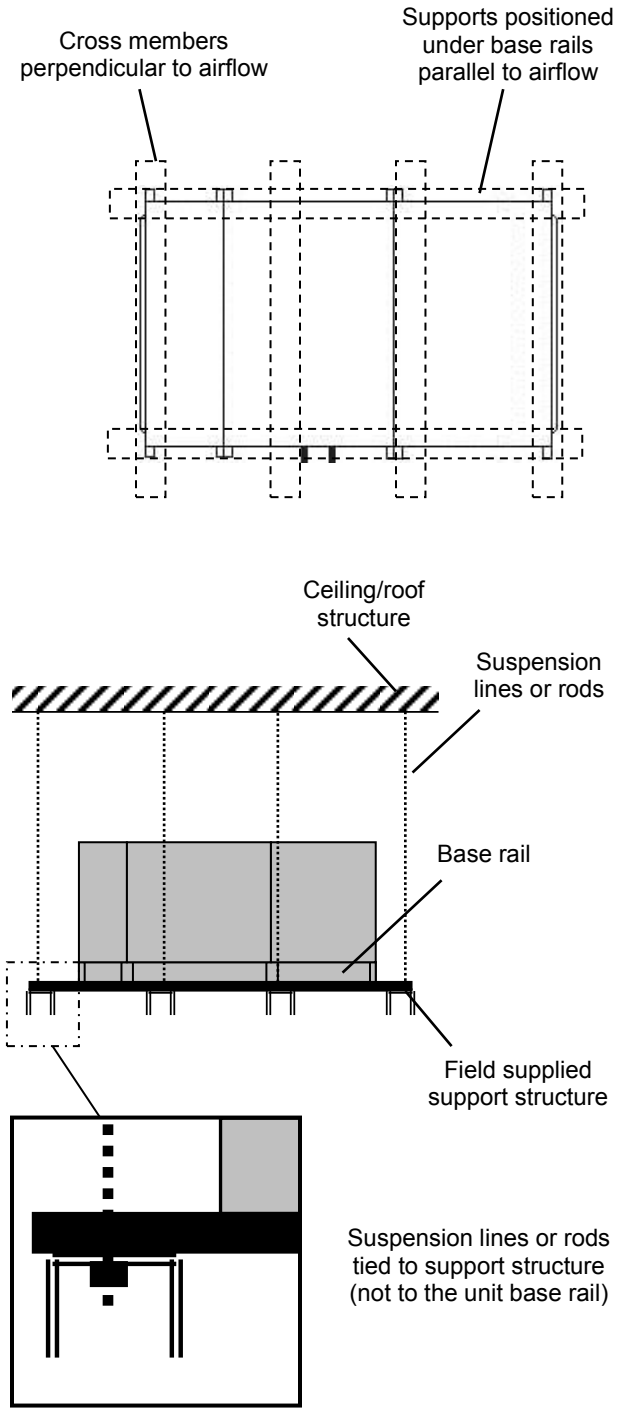


Figure 7 - Unit Suspension

Module Assembly

Although M2 Series modular units are shipped factory assembled as standard, the unit may be ordered as individual modules for certain applications such as for assembly in existing structures where modules must be manipulated separately. If the unit was ordered as individual modules, then they must be connected in the field.

Locate the configuration schematic in the equipment's literature packet. The schematic will have *CONFIGURATION* written in the top left hand corner followed by the unit model number and then the module configuration numbers listed in order.

1. Identify and Situate Modules

Use the Feature String descriptions at the beginning of this manual or in the M2 Engineering Catalog for assistance identifying module types by their three-letter codes.

It is advisable to situate all required modules in the installation location as near as possible to the order in which they will be connected. Be sure to leave enough space to work between modules before connection.

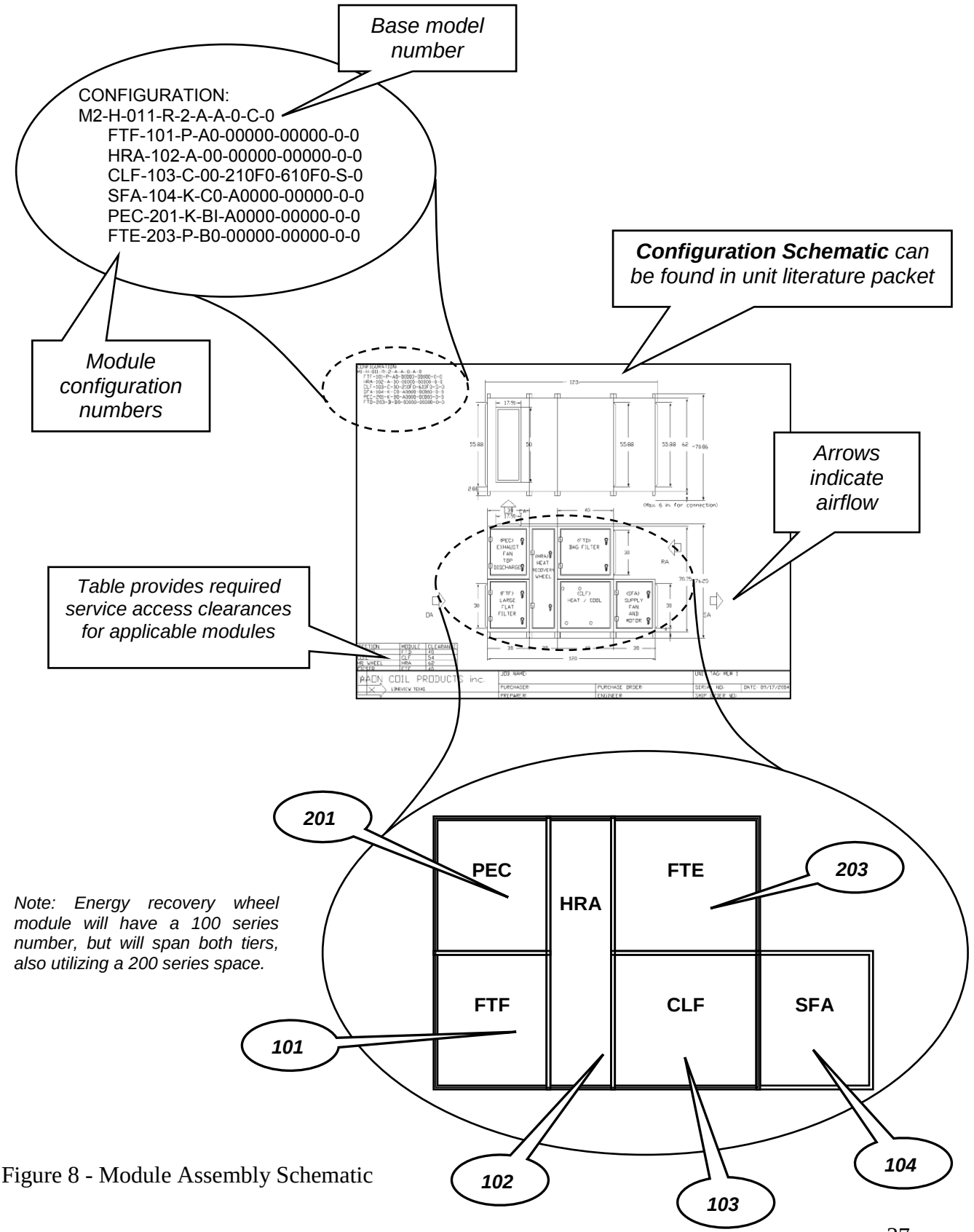
Identify each module by the configuration number on its label. For example, if a module has a configuration number of FTF-101-P-A0-00000-00000-0-0, then it is a large flat filter module "FTF", and should be placed in the first position "101" of the lower tier - the bottom left as you face the access side of a right hand unit, or the bottom right as you face the access side of a left hand unit.

Although the schematic should be available, the configuration numbers have been created so that correct assembly order can be determined without the need for a schematic.

Modules are arranged in order with 100 series modules on the first tier and 200 series modules on the second tier. Module 101 will always be located on the end of the bottom tier - the bottom left as you face the access side of a right hand unit, or the bottom right as you face the access side of a left hand unit. Module 201 will always be located on the end of the top tier - the top left as you face the access side of a right hand unit, or the top right as you face the access side of a left hand unit. Therefore, it is possible to identify the exact module arrangement even without knowing the module type, and without a configuration schematic.

If, for any reason, a module or its position in final assembly is unidentifiable, then consult the project engineer, AAON sales representative, or AAON-Longview Product Support.

After identifying modules and determining module arrangement, modules can be prepared for final assembly.



Note: Energy recovery wheel module will have a 100 series number, but will span both tiers, also utilizing a 200 series space.

Figure 8 - Module Assembly Schematic

2. Connect Modules

Modules are to be connected with nuts and bolts through the base rail and with metal strapping over module joints. Metal straps have adhesive backs and are to be additionally fastened to the unit case with sheet metal screws. All connection hardware is shipped with the unit.

Align modules and insert bolts through the bolt holes in the base rails of two adjacent modules. Secure with nuts to pull the bases of the two modules together tightly.

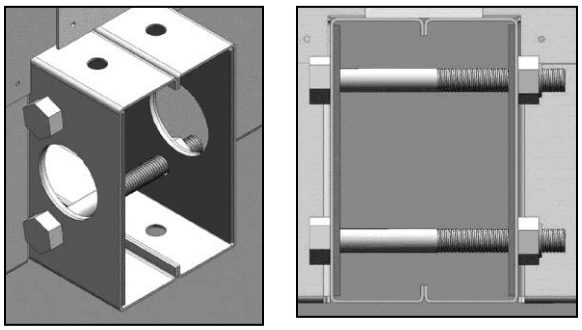


Figure 9 - Bolted Base Rail

Use bar clamps or other non-destructive winching device to pull the tops of the modules together tightly.

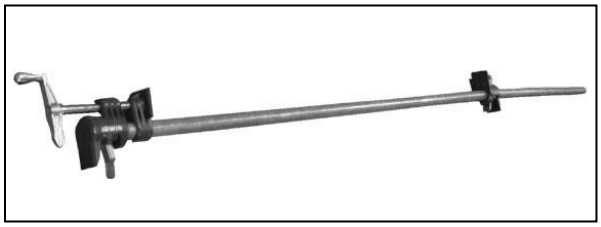


Figure 10 - Bar Clamp

There should now be an airtight joint that needs to be permanently secured in position.

3. Secure Module Joints

The metal straps are to be used to secure module joints in order to maintain the airtight seal. Straps are provided with pre-drilled holes and adhesive backing already affixed. Self-tapping sheet metal screws are provided to attach the straps to the unit cabinet.

Leave bar clamps in place until strap is secure.

Peel away backing from adhesive side of a strap.

Place the strap over a module joint with the adhesive side of the strap against the unit case.

Ensure that strap completely covers the joint and that it is square with the unit casing.

Apply pressure to the strap to affix the adhesive and to hold strap in place.

Insert self-tapping screws through pre-drilled holes in strap and secure screws into unit casing using a power drill. For best results, use the lowest effective power drill torque setting. Be careful not to over tighten the screws.

Remove bar clamps and repeat for all remaining module joints.

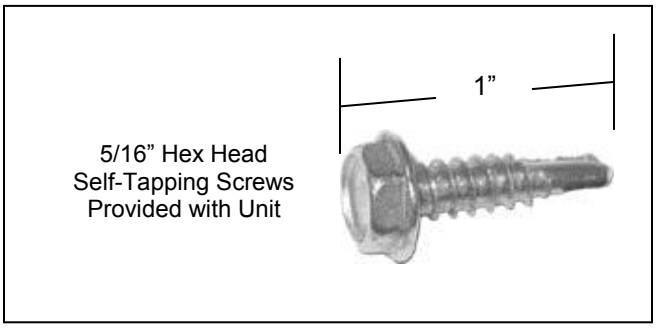


Figure 11 - Self-Tapping Screw

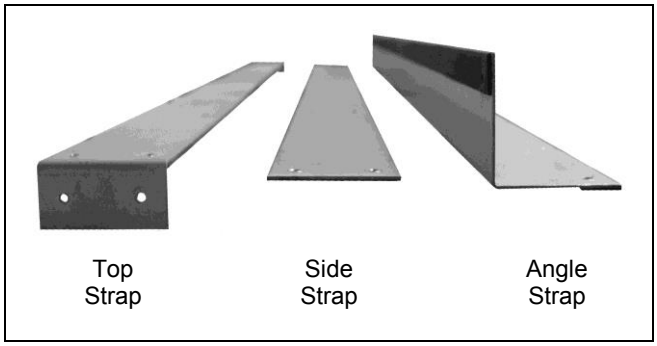


Figure 12 - Strap Types

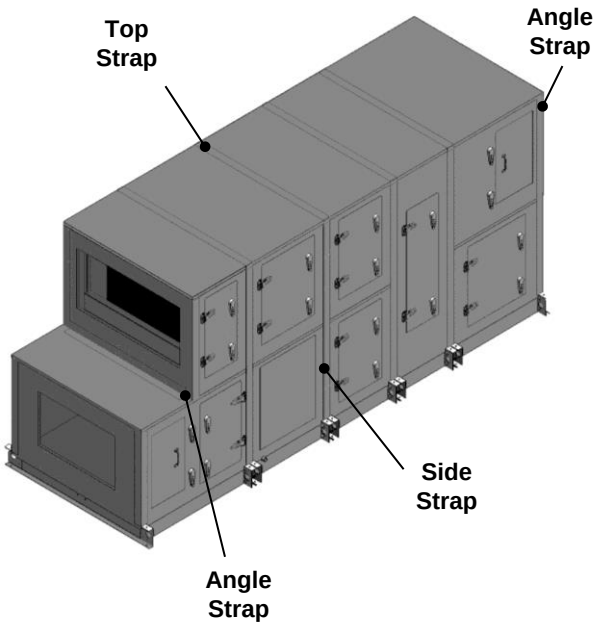


Figure 13 - Strap Locations

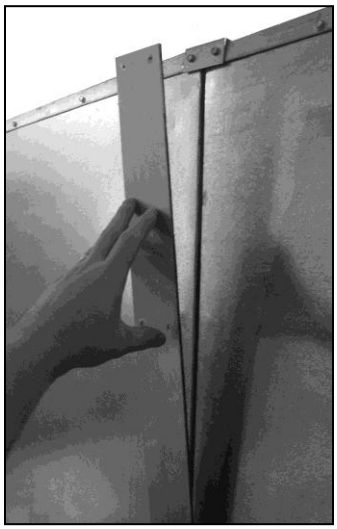


Figure 14 - Strap Positioning

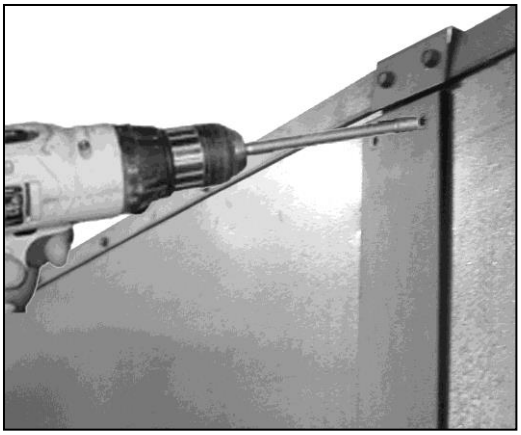


Figure 15 - Strap Installation

4. Run Power and Control Wiring

M2 Series units are equipped with an internal wiring chase, located along the inside top of each module. Wire is provided for power and control wiring inside the unit. Wire from the unit to external controls and power sources must be provided in the field.

A color-coded wiring diagram is laminated and affixed to the inside of the control compartment access door. M2 Series units are equipped with a single point power connection.

5. Final Sealing

It is very important to keep air from infiltrating the unit cabinet. Seal all piping penetrations with Armaflex, Permagum or other suitable sealant. Also seal around drain connections, electrical connections and all other inlets where air may enter the cabinet. This is especially important when the unit is installed in an unconditioned area.

Refrigerant Piping
(See back of the manual for refrigerant piping diagrams and connection sizes.)

Piping from the condensing unit to the air handling unit is the responsibility of the installing contractor.

The Split System Configurator or Refrigerant Piping Calculator in AAONEcat32 should be used to determine acceptable refrigerant line sizes.

The pipe sizes must be selected to meet the actual installation conditions and not simply based on the connection sizes at the evaporator or condensing unit.

⚠ WARNING

Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Startup and service must be performed by a Factory Trained Service Technician. A copy of this IOM should be kept with the unit.

⚠ CAUTION

This section is for information only and is not intended to provide all details required by the designer or installer of the refrigerant piping between the condenser or condensing unit and the air handling unit. AAON is not responsible for interconnecting refrigerant piping. Consult ASHRAE Handbook – Refrigeration and ASME Standards.

Only clean ACR tubing should be used. Piping should conform to generally accepted practices and codes.

The air handling unit coils are pressurized. The copper caps must be punctured to permit a gradual escape of the pressure prior to un-sweating those caps. Immediately couple the tubing to the indoor unit to avoid exposing the coils to moisture. A properly sized filter drier is furnished in the condenser. When making solder connections, make sure dry nitrogen flows through the lines, when heating the copper, to prevent oxidization inside of the copper.

When piping is completed interconnecting piping and air handling unit must be evacuated to 500 microns or less and leak checked. Condenser shutoff valves can then be opened to allow refrigerant to flow to the air handling unit.

Thermal expansion valve bulbs should be mounted with good thermal contact on a horizontal section of the suction line close to the evaporator, but outside the cabinet, and well insulated. On suction lines less than or equal to 7/8" OD, mount in the 12 o'clock position. On suction lines greater than 7/8" OD, mount in either the 4 o'clock or 8 o'clock position.

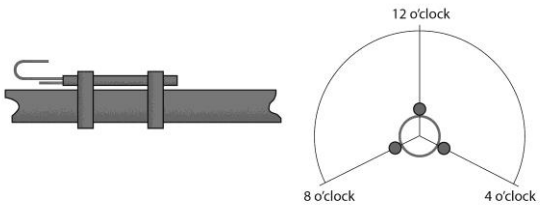


Figure 16 - TXV Bulb Position

Refrigerant lines should be fastened and supported according to local codes.

Unit should be charged based on determination of sub-cooling and superheat.

See *Adjusting Refrigerant Charge* section for more information.

Refrigerant reheat coil for the modulating hot gas reheat option is factory installed. Liquid line receiver should be installed at the condensing unit. Care must be taken not to cross circuits in reheat systems.

Modulating Hot Gas Reheat Piping:
1. Run a hot gas reheat line from the condensing unit and connect it to the inlet of the stub-out on the reheat coil. The inlet connection is the top (or highest) stub-out of the reheat coil. Connect the hot gas line from the outdoor unit to the upper stub-out connection of the reheat coil.

2. Run a liquid line from the discharge of the reheat coil through a tee connection. Run a liquid line from the condenser, through a check valve to the other side of the tee. Run a liquid line from the tee to the liquid line stub-out of the evaporator coil.

3. Run a suction line from the evaporator coil outlet stub-out to the condensing unit.

Determining Refrigerant Line Size

⚠ CAUTION

Line sizes must be selected to meet actual installation conditions, not simply based on the connection sizes at the condensing unit or air handling unit.

The piping between the condenser and low side must ensure:
1. Minimum pressure drop, and

2. Continuous oil return, and

3. Prevention of liquid refrigerant slugging, or carryover

Minimizing the refrigerant line size is favorable from an economic perspective, reducing installation costs, and reducing the potential for leakage. However, as pipe diameters narrow, pressure-reducing frictional forces increase.

Excessive suction line pressure drop causes loss of compressor capacity and increased power usage resulting in reduced system efficiency. Excessive pressure drops in the liquid line can cause the liquid refrigerant to flash, resulting in faulty TXV operation and improper system performance. In order to operate efficiently and cost effectively, while avoiding malfunction, refrigeration systems must be designed to minimize both cost and pressure loss.

Equivalent Line Length
All line lengths discussed in this manual, unless specifically stated otherwise, are Equivalent Line Lengths. The frictional pressure drop through valves, fittings, and accessories is determined by establishing the equivalent length of straight pipe of the same diameter. **Always use equivalent line lengths when calculating pressure drop**. Special piping provisions must be taken when lines are run underground, up vertical risers, or in excessively long line runs.

Liquid Line Sizing
When sizing the liquid line, it is important to minimize the refrigerant charge to reduce installation costs and improve system reliability. This can be achieved by minimizing the liquid line diameter. However, reducing the pipe diameter will increase the velocity of the liquid refrigerant which increases the frictional pressure drop in the liquid line, and causes other undesirable effects such as noise.

Maintaining the pressure in the liquid line is critical to ensuring sufficient saturation

temperature, avoiding flashing upstream of the TXV, and maintaining system efficiency. Pressure losses through the liquid line due to frictional contact, installed accessories, and vertical risers are inevitable. Maintaining adequate sub-cooling at the condenser to overcome these losses is the only method to ensure that liquid refrigerant reaches the TXV.

Liquid refrigerant traveling upwards in a riser loses head pressure. If the evaporator is below the condenser, and the liquid line does not include risers, the gravitational force will increase the pressure of the liquid refrigerant. This will allow the refrigerant to withstand greater frictional losses without the occurrence of flashing prior to the TXV.

A moisture-indicating sight glass may be field installed in the liquid line to indicate the occurrence of premature flashing or moisture in the line. The sight glass should not be used to determine if the system is properly charged. **Use temperature and pressure measurements to determine liquid sub-cooling, not the sight glass.**

Liquid Line Routing
Care should be taken with vertical risers. When the system is shut down, gravity will pull liquid down the vertical column, and back to the condenser when it is below the evaporator. This could potentially result in compressor flooding. A check valve can be installed in the liquid line where the liquid column rises above the condenser to prevent this. The liquid line is typically pitched along with the suction line, or hot gas line, to minimize the complexity of the configuration.

Liquid Line Insulation
When the liquid line is routed through regions where temperature losses are expected, no insulation is required, as this may provide additional sub-cooling to the refrigerant. When routing the liquid line through high temperature areas, insulation of the line is appropriate to avoid loss of sub-cooling through heat gain.

Liquid Line Guidelines
In order to ensure liquid at the TXV, frictional losses must not exceed available sub-cooling. A commonly used guideline to consider is a system design with pressure losses due to friction through the line not to exceed a corresponding 1-2°F change in saturation temperature.

If the velocity of refrigerant in the liquid line is too great, it could cause excessive noise or piping erosion. The recommended maximum velocities for liquid lines are 100 fpm from the condenser to a receiver tank to discourage fluid backup, and 300 fpm from receiver tank to the evaporator to minimize valve induced liquid hammer.

Liquid Line Accessories
Liquid line shut off valves and filter driers are factory provided. Filter driers must be field installed on 2-6 ton units. The total length equivalent of pressure losses through valves, elbows and fittings must be considered when adding additional components in the field. It is a good practice to utilize the fewest elbows that will allow the mating units to be successfully joined.

Suction Line Sizing
The suction line is more critical than the liquid line from a design and construction standpoint. More care must be taken to ensure that adequate velocity is achieved to return oil to the compressor at minimum loading conditions. However, reducing the piping diameter to increase the velocity at minimal load can result in excessive pressure losses, capacity reduction, and noise at full load. The suction line also

dictates the position of the TXV sensing bulb for proper operation of the TXV.

Suction Line Routing
Pitch the suction line in the direction of flow (about 1 foot per 100 feet of length) to maintain oil flow towards the compressor, and keep it from flooding back into the evaporator. Crankcase heaters are provided to keep any condensed refrigerant that collects in the compressor from causing damage or wear. Make sure to provide support to maintain suction line positioning, and insulate completely between the evaporator and condensing unit.
It is important to consider part load operation when sizing suction lines. At minimum capacity, refrigerant velocity may not be adequate to return oil up the vertical riser. Decreasing the diameter of the vertical riser will increase the velocity, but also the frictional loss.

⚠ CAUTION

Circuits with variable capacity scroll compressors require suction riser traps every 10 feet.

A double suction riser can be applied to the situation of part load operation with a suction riser. A double suction riser is designed to return oil at minimum load while not incurring excessive frictional losses at full load. A double suction riser consists of a small diameter riser in parallel with a larger diameter riser, and a trap at the base of the large riser. At minimum capacity, refrigerant velocity is not sufficient to carry oil up both risers, and it collects in the trap, effectively closing off the larger diameter riser, and diverting refrigerant up the small riser where velocity of the refrigerant is sufficient to maintain oil flow.

At full load, the mass flow clears the trap of oil, and refrigerant is carried through both risers. The smaller diameter pipe should be sized to return oil at minimum load, while the larger diameter pipe should be sized so that flow through both pipes provides acceptable pressure drop at full load.

Suction Line Insulation
The entire suction line should be insulated. This prevents condensation from forming on the line, and reduces any potential loss in capacity associated with heat gain.
Suction Line Guidelines
For proper performance, suction line velocities less than a 4,000 fpm maximum are recommended. The minimum velocity required to return oil is dependent on the pipe diameter, however, a general guideline of 1,000 fpm minimum may be applied.

In a fashion similar to the liquid line, a common guideline to consider is a system design with pressure losses due to friction through the line not to exceed a corresponding 1-2°F change in saturation temperature.

At points where small pipe size can be used to provide sufficient velocity to return oil in vertical risers at part loads, greater pressure losses are incurred at full loads. This can be compensated for by over sizing the horizontal runs and vertical drop sections. This will however require additional refrigerant charge.

Circuits with variable capacity scroll compressors require suction riser traps every 15 feet.

Suction Line Accessories
If the job requirements specify suction accumulators, they must be separately purchased and field installed.

Hot Gas Bypass Line
Hot Gas Bypass is available for use with DX systems that may experience low suction pressure during the operating cycle. This may be due to varying load conditions associated with VAV applications or units supplying a large percentage of outside air. The system is designed to divert refrigerant from the compressor discharge to the low pressure side of the system in order to keep the evaporator from freezing and to maintain adequate refrigerant velocity for oil return at minimum load.
Hot discharge gas is redirected to the evaporator inlet via an auxiliary side connector (ASC) to false load the evaporator when reduced suction pressure is sensed. **Field piping between the condensing unit and the evaporator is required.**

Hot Gas Bypass Piping Considerations for Evaporator above Condensing Unit
Pitch the hot gas bypass (HGB) line downward in the direction of refrigerant flow, toward the evaporator.

When installing hot gas bypass risers, a drain leg must be provided at the lowest point in the system. The drain leg must be vertical, its diameter should be the same as the diameter of the riser, and it should be 1 foot long. Install a sight glass in the drain leg for observation. Run an oil return line, using 1/8 inch capillary tube, 10 feet in length, from the drain leg to the suction line. Connect the oil return line below the sight glass and 1 inch above the bottom of the drain leg.

HGB valves are adjustable. Factory HGB valve settings will be sufficient for most applications, but may require slight adjustments for some applications, including some make up air applications.

Insulate the entire length of the HGB line with a minimum 1 inch thick Armaflex insulation.

Hot Gas Bypass Piping Considerations for Evaporator below Condensing Unit
The line must slope downward from the HGB valve toward the evaporator.

Hot Gas Bypass Line Guidelines
Choose a small size line to ensure oil return, and minimize refrigerant charge.

Maintain velocities below a maximum of 4,000 fpm. A general minimum velocity guideline to use is approximately 1,000 fpm.

Hot Gas Reheat
The AAON modulating hot gas reheat system diverts hot discharge gas from the condenser to the air handling unit through the hot gas line. **Field piping between the condensing unit and the air handler is required.**

The line delivers the hot discharge gas to the reheat coil and/or the hot gas bypass valve, so it is sized as a discharge line.

Discharge lines should be sized to ensure adequate velocity of refrigerant to ensure oil return, avoid excessive noise associated with velocities that are too high, and to minimize efficiency losses associated with friction.

Pitch the hot gas line in the direction of flow for oil return.

When installing hot gas reheat risers, a drip leg must be provided at the lowest point in the system. The drip leg must be vertical, its diameter should be the same as the diameter of the riser, and it should be 1 foot long. Run a drip line, using 1/8 inch capillary tube, 10 feet in length, from the drip leg to the suction line. Connect the drip line a

minimum of 1-inch above the bottom of the drain leg.

Insulate the entire length of the hot gas line with a minimum 1 inch thick Armaflex insulation.

Hot Gas Reheat Guidelines
Maintain velocities below a maximum of 3,500 fpm. A general minimum velocity guideline is 2,000 fpm.

Refrigerant-to-Water Heat Exchanger
Condenser water pump, condenser water piping, cooling tower, pressure gauges, strainers and all components of the waterside piping must be field installed.

⚠ CAUTION

WATER-SOURCE HEAT PUMP APPLICATIONS

Water-source heat pump units using 100% outside air must have electric preheat if the application has a potential for heat pump heating operation with air entering the indoor coil below 43°F with an entering water loop temperature of 70°F.

Open Loop Applications
This product contains one or more refrigerant-to-water heat exchangers made of 316 Stainless Steel. 316 Stainless Steel is subject to severe corrosion and failure when exposed to chlorides.

⚠ WARNING

OPEN LOOP APPLICATIONS

Failure of the condenser as a result of chemical corrosion is excluded from coverage under AAON Inc. warranties and the heat exchanger manufacturer's warranties.

Do not allow water containing any form of chlorides to enter this heat exchanger.

Common forms of chlorides include:

1. Sea water mist entering an open cooling tower system.
2. Contaminated make-up water containing salt water.
3. Disinfection the water loop with solutions containing sodium hypochlorite.

Chlorides will result in a premature failure of the condenser.

Failure of the condenser as a result of chemical corrosion is excluded from coverage under AAON warranties and the heat exchanger manufacturer warranties.

Failure of the condenser will allow water to enter the refrigerant circuit and will cause extensive damage to the refrigerant circuit components. Any damage to the equipment as a result of condenser failure from chemical corrosion due the fluid in the condenser is excluded from coverage under AAON warranties and the heat exchanger manufacturer warranties.

⚠ WARNING

OPEN LOOP APPLICATIONS

SMO 254 brazed plated refrigerant-to-water heat exchangers are recommended with all open loop applications. Failure to use a SMO 254 heat exchanger may result in premature failure of your system and possible voiding of the warranty.

⚠ CAUTION

Cleaning the cooling tower or condenser water loop with harsh chemicals such as hydrochloric acid (muriatic acid), chlorine or other chlorides, can damage the refrigerant-to-water heat exchanger. Care should be taken to avoid allowing chemicals to enter the refrigerant-to-water heat exchanger. See Appendix A - Heat Exchanger Corrosion Resistance for more information.

Freezing Water in the Heat Exchanger

This product contains one or more refrigerant-to-water heat exchangers. A refrigerant-to-water heat exchanger contains refrigerant in one passage and water in another passage. Water is subject to freezing at 32°F. When water freezes in a heat exchanger significant forces are exerted on the components of the heat exchanger where the water is confined.

⚠ WARNING

WATER FREEZING

Failure of the condenser due to freezing will allow water to enter the refrigerant circuit and will cause extensive damage to the refrigerant circuit components. Any damage to the equipment as a result of water freezing in the condenser is excluded from coverage under AAON warranties and the heat exchanger manufacturer warranties.

Unit is capable of operating with Entering Water Temperatures (EWT) as low as 50°F during heat pump heating mode without the need for head pressure control. If the EWT is expected to be lower than 50°F or more stable operation is desired, a field provided water regulating valve may be used.

Glycol solution should be used if ambient temperatures are expected to fall below freezing or if the loop water temperature is below 50°F while operating in the heating mode (heat pump units only). Adding glycol to condenser water causes an increase in pressure drop resulting in a decrease in unit performance. A minimum concentration of 20% glycol solution is recommended.

Table 2 - Glycol Freezing Points

% Glycol	Ethylene Glycol	Propylene Glycol
20	18°F	19°F
30	7°F	9°F
40	-7°F	-6°F
50	-28°F	-27°F

Water loop piping runs through unheated areas or outside the building should be insulated.

Water Piping

Installing contractor must ensure a differential pressure switch is installed between the condenser water supply and return connections. This sensor provides a signal to the unit controller that water flow is present in the heat exchanger and the unit can operate without damaging unit components.

⚠ WARNING

WATER PRESSURE

Prior to connection of condensing water supply, verify water pressure is less than maximum pressure shown on unit nameplate. To prevent injury or death due to instantaneous release of high pressure water, relief valves should be field supplied on water piping. Supply water connection may require a backflow preventer to prevent supply makeup water from backing up into the public water system.

Condenser water connections range in size from 1-18"-4" OD copper or black pipe. Only use approved water pipe material. Avoid using galvanized material for water lines/fittings as the material is corrosive and may cause fouling of the water system.

Condenser water pump must be field sized and installed between the cooling tower and self-contained unit. System should be sized in accordance with the ASHRAE Handbook. Use engineering guidelines to maintain equal distances for supply and return piping and limit bend radiuses to maintain balance in the system. Balancing valves, permanent thermometers and gauges may be required.

⚠ CAUTION

Installing Contractor is responsible for proper sealing of the water piping entries into the unit. Failure to seal the entries may result in damage to the unit and property.

⚠ CAUTION

PVC (Polyvinyl Chloride) and CPVC (Chlorinated Polyvinyl Chloride) are vulnerable to attack by certain chemicals. Polyolester (POE) oils used with R-410A and other refrigerants, even in trace amounts, in a PVC or CPVC piping system will result in stress cracking of the piping and fittings and complete piping system failure.

⚠ CAUTION

WATER PIPING

Follow national and local codes when installing water piping. Connections to the unit should incorporate vibration eliminators to reduce noise and vibration and shutoff valves to facilitate servicing. Supply and return water piping must be at least as large as the unit connections and larger depending on length of runs, rise and bends.

Before connection to the unit the condenser water system should be flushed to remove foreign material that could cause condenser fouling. Install a screen strainer with a minimum of 20 Mesh ahead of the condenser inlet to prevent condenser fouling and internal tube damage.

Mineral content of the condenser water must be controlled. All make-up water has minerals in it and as the water is evaporated in the cooling tower, these minerals remain. As the mineral content of the water increases, the conductivity of the water increases.

Field provided and installed water treatment program must be compatible with stainless steel, copper, aluminum, ABS plastic, and PVC. Batch feed processes should never be used as concentrated chemicals can cause corrosion. Never use hydrochloric acid (muriatic acid) or chlorine as it will corrode stainless steel.

⚠ CAUTION

Each heat exchanger is equipped with a refrigerant pressure relief device to relieve pressure should excessive condensing pressures (>675 psig) occur. Codes may require installing contractor to connect and route relief piping outdoors. The relief valve has a 5/8" male flare outlet connection.

Unit is capable of operating with Entering Water Temperatures (EWT) as low as 50°F without the need for head pressure control. If the EWT is expected to be lower than 50°F or more stable operation is desired, a field provided water regulating valve may be used.

Glycol solution should be used if ambient temperatures are expected to fall below freezing or if the loop water temperature is below 50°F while operating in the heating mode (heat pump units only). Adding glycol to condenser water causes an increase in pressure drop resulting in a decrease in unit performance. A minimum concentration of 20% glycol solution is recommended.

Table 3 - Freezing Points

% Glycol	Ethylene Glycol	Propylene Glycol
20	18°F	19°F
30	7°F	9°F
40	-7°F	-6°F
50	-28°F	-27°F

⚠ CAUTION

Do not exceed recommended condenser fluid flow rates shown in above table. Serious damage to or erosion of the heat exchanger tubes could occur.

Piping systems should not exceed 10 ft/sec velocity to ensure tube wall integrity and reduce noise.

Table 4 - Coaxial Heat Exchanger Pressure Drops

2 ton		3 ton		4 ton		5 ton	
gpm	psi	gpm	psi	gpm	psi	gpm	psi
3	1.9	6	2.3	8	3.3	7	1.6
5	4.3	8	3.7	10	4.8	11	2.8
7	7.4	10	5.3	12	6.7	15	4.6
6 ton		8 ton		10 ton		13 ton	
gpm	psi	gpm	psi	gpm	psi	gpm	psi
11	2.6	16	3.8	14	2	20	3.4
16	4.2	20	5.5	22	3.5	28	5.8
20	6.0	24	7.6	30	5.6	36	8.8
16 ton		20 ton		25 ton		30 ton	
gpm	psi	gpm	psi	gpm	psi	gpm	psi
28	3.6	28	2.3	40	3.9	56	4.1
36	5.3	44	3.9	56	6.6	72	6
44	7.8	60	6.1	72	10	88	8.9
40 ton		50 ton		60 ton			
gpm	psi	gpm	psi	gpm	psi		
56	2.6	80	4.2	112	4.33		
88	4.4	112	7.1	144	6.5		
120	6.9	144	10.4	176	9.6		

Table 5 - Brazed Plate Heat Exchanger Pressure Drops

2 ton		3 ton		4 ton		5 ton	
gpm	psi	gpm	psi	gpm	psi	gpm	psi
7.9	2.89	10.0	4.41	12.5	5.46	15	2.37
9.5	4.03	12.1	6.21	15.1	7.69	18.1	3.39
6 ton		8 otn		10 ton		13 ton	
gpm	psi	gpm	psi	gpm	psi	gpm	psi
17.5	3.17	20.0	2.91	25.0	3.34	32.5	4.3
21.1	4.55	24.1	4.71	30.2	4.79	39.2	6.17
16 ton		20 ton		25 ton		30 ton	
gpm	psi	gpm	psi	gpm	psi	gpm	psi
40.0	4.26	50.0	4.72	62.5	4.92	75.0	4.75
48.3	6.11	60.4	6.77	75.4	7.06	90.5	6.82
40 ton		50 ton		60 ton			
gpm	psi	gpm	psi	gpm	psi		
100.0	6.6	125.0	10.1	150.0	9.46		
120.7	9.5	150.9	14.4	181.0	13.6		

Heat Exchanger Safeties
Electronic freeze protection and water flow safeties should be field installed or factory provided. If the leaving water temperature drops below 38°F or water flow has ceased the 24VAC control circuit will be broken to disable the cooling system.

Electrical
Verify the unit name plate agrees with power supply. M2 Series units are provided with single point power wiring connections. Connection terminations are made to the main terminal block. A complete set of unit specific wiring diagrams, showing factory and field wiring are laminated in plastic and located inside the controls compartment door.

⚠ WARNING

Disconnect all electrical power sources before servicing the unit. More than one power source may be provided. Failure to do so may result in injury or death from electrical shock or entanglement in moving parts.

Codes may require a disconnect switch be within sight of the unit.

Note: Do not install the required field installed overcurrent protection or disconnect switch on the unit!

Electrical supply can enter through the bottom or side of the controls compartment. Entry must be field cut into panels of the unit.
A single point connection to a terminal block is provided. Split units may require connection between the units. High voltage conductors should enter the control panel in a separate opening and separate conduit than 24V low voltage conductors.

⚠ WARNING

The foam insulation releases dangerous fumes when it is burnt. Do not cut a foam part with a cutting torch or plasma cutter. Do not weld to a foam filled part.

Note: Locations for field cut electrical entries are marked on the unit. Field cut openings must be a minimum of 6 inches away from all components and wiring to prevent damage due to drilling or cutting.

To pass wires through the wall or roof of the unit, a hole should be cut and conduit passed through it. Use the following procedure to cut a round hole in a foam panel.

Cutting Electrical Openings

1. Locate the placement of the hole. Be sure that the conduit will not interfere with the operation of any component or prevent access of any door or removable panel.
2. Drill a pilot hole all the way through the foam panel.
3. Using a hole saw cut the hole through the metal on both sides of the foam part.
4. With a knife cut the foam out of the hole.
5. After the conduit is installed in the hole caulk the entire perimeter of the hole on both sides with an industrial grade silicone sealant or a duct seal compound.

⚠ CAUTION

Installing Contractor is responsible for proper sealing of the electrical and gas entries into the unit. Failure to seal the entries may result in damage to the unit and property.

If a larger cut-out is needed for additional duct connections not provided by the factory, or for any other reason, it is very important that the foam be completely sealed. Insulation covers should be fabricated from sheet metal to cover the foam at the cut. The edges and corners that are not covered should be sealed using silicone caulking. If a reciprocating saw is used to make the cut out, take care that the metal skins of the foamed part do not separate from the foam, this would result in reduced structural integrity of the part.

Size supply conductors based on the unit Minimum Current Ampacity (MCA) rating. Supply conductors must be rated a minimum of 75°C.

Protect the branch circuit in accordance with code requirements. The unit must be electrically grounded in accordance with local codes, or in the absence of local codes, the current National Electric Code, ANSI/NFPA 70 or the current Canadian Electrical Code CSA C22.1.

Wire power leads to the unit's terminal block or main disconnect. All wiring beyond this point has completed at the factory.

⚠ CAUTION

Three phase voltage imbalance will cause motor overheating and premature failure.

Supply voltage must be within the min/max range shown on the unit nameplate. Available short circuit current should not exceed the SCCR rating shown on the unit nameplate.

Three phase voltage imbalance will cause motor overheating and premature failure. The maximum allowable imbalance is 2.0%.

Voltage imbalance is defined as 100 times the sum of the deviation of the three voltages from the average divided by the average voltage.

Example:
(221V+230V+227V)/3 = 226V, then 100*(226V-221V)/226V = 2.2%, which exceeds the allowable imbalance.

Check voltage imbalance at the unit disconnect switch and at the compressor terminal. Contact your local power company for line voltage corrections.

Installing contractor must check for proper motor rotation and check blower motor amperage listed on the motor nameplate is not exceeded. Motor overload protection may be a function of the variable frequency drive (VFD) and must not be bypassed.

Note: All units are factory wired for 208/230V, 460V, or 575V. If unit is to be connected to a 208V supply, the transformer must be rewired to 208V service. For 208V service interchange the yellow and red conductor on the low voltage control transformer.
Red-Black for 208V
Yellow-Black for 230V

⚠ CAUTION

Rotation must be checked on all MOTORS AND COMPRESSORS at startup by a qualified service technician. Scroll compressors are directional and can be damaged if rotated in the wrong direction. Compressor rotation must be checked using suction and discharge gauges. Fan motor rotation should be checked for proper operation. Alterations should only be made at the unit power connection

Wire control signals to the unit's low voltage terminal block located in the controls compartment.

If any factory installed wiring must be replaced, use a minimum 105°C type AWM insulated conductors.

Thermostat Control Wiring
If a thermostat is used for unit control, thermostat should be located on an inside wall 4-5 feet above the floor where it will not be subjected to drafts, sun exposure, or heat from electrical fixtures of appliances. Control wiring must deliver adequate voltage to components to assure proper operation. Control voltage returning from controller circuit must be a minimum of 21 VAC. To assure proper wiring use the following chart to determine the allowable wiring distances.

Table 6 - Control Wiring

Wire Size (Stranded) - Copper Conductors Only	Total Wire Distance Allowable
20 AWG	200 ft
18 AWG	350 ft
16 AWG	500 ft
14 AWG	750 ft
12 AWG	1250 ft

Total Wire Distance Allowable =
(Quantity of Control Wires) x
(Control Wire Distance)

Take the total wire distance allowable and divide by the number of wires to be connected. This indicates the distance allowable for that size wire. The wiring to the unit must not exceed the total wire distance allowable. If the voltage at the connectors is less than 21 VAC, isolation relays must be installed. If under external control 21 VAC must be field verified.

All external devices must be powered via a separate external power supply.

Example:
A total of 8 wires must be pulled 75ft to a control the unit. What size wire should be used?

According to the Table 2, 16 AWG allows for 63ft (500 ft/8 wires) and 14 AWG allows for 94ft (750 ft/8 wires). Thus, 14 AWG should be used.

Condensate Drain Piping
Unit may be equipped with more than one condensate drain pan connection. A p-trap and drain line must be installed on every drain connection, with the p-trap not to exceed 6" from the drain connection. The lines should be the same pipe size or larger than the drain connection, include a p-trap, and pitch downward toward drain. An air

break should be used with long runs of condensate lines.

⚠ CAUTION

Unit should not be operated without p-traps. Failure to install a p-traps may result in overflow of condensate water.

Draw-through cooling coils will have a negative static pressure in the drain pan area. This will cause an un-trapped drain to back up due to air being pulled up through the condensate drain piping. Blow-through coils will have a positive static pressure in the drain pan. The condensate piping on these drain pans must be trapped to prevent pressure loss through the drain.

Condensate drain trapping and piping should conform to all applicable governing codes.

Note: The drain pan connection is a 1" MPT fitting.

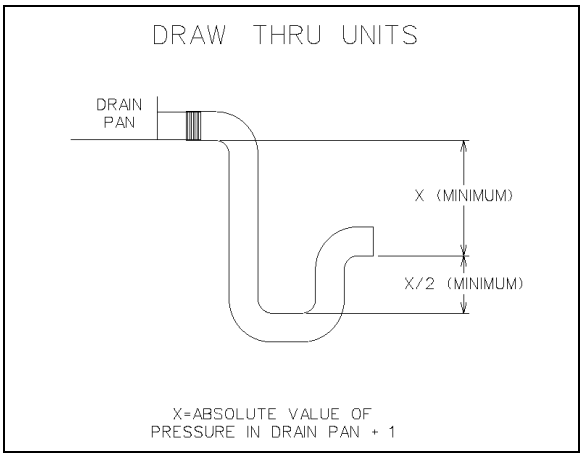


Figure 17 - Draw-Through Drain Trap

The X dimension on the draw-through trap should be at least equal to the absolute value of the negative static pressure in the drain pan plus one inch. To calculate the static pressure at the drain pan add the pressure drops of all components upstream of the drain pan, including the cooling coil, and add the return duct static pressure. Include the dirt allowance pressure drop for the filters to account for the worst-case scenario.

The height from top of the bottom bend of the trap to the bottom of the leaving pipe must be at least equal to one half of the X dimension. This ensures that enough water is stored in the trap to prevent losing the drain seal during unit startup

Note: The absolute value of the fan inlet pressure will always be greater than or equal to the absolute value of the static pressure in the drain pan on draw-through units, so the fan inlet pressure is a safe value to use for the drain pan static pressure.

Table 7 - Drain Trap Dimensions

Draw-Through		
Drain Pan Pressure	Trap Dimensions	
Negative Static	X	X/2
(inches of water)	(inch)	(inch)
-0.50	1.50	0.75
-1.00	2.00	1.00
-1.50	2.50	1.25
-2.00	3.00	1.50
-2.50	3.50	1.75
-3.00	4.00	2.00
-3.50	4.50	2.25
-4.00	5.00	2.50

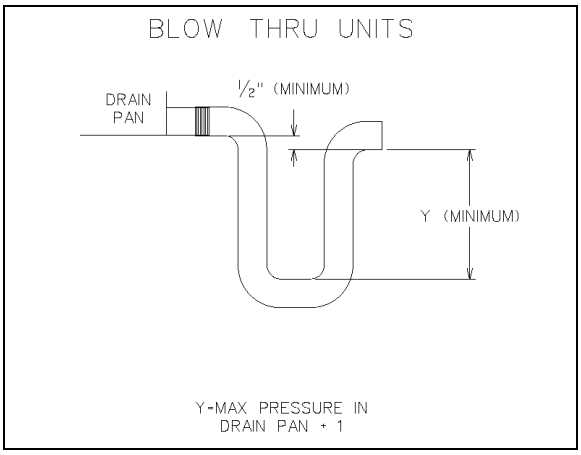


Figure 18 - Blow-Through Drain Trap

The Y dimension of blow-through traps should be at least equal to the value of the positive pressure in the drain pan plus one inch. This ensures that there will be enough water stored in the trap to counter the static pressure in the drain pan. To find the pressure subtract any pressure drops between the drain pan and the supply blower from the blower discharge pressure. The worst-case scenario for blow-through coils is the minimum pressure drop, so do not include dirt allowance pressure drops for filters.

The bottom of the leaving pipe should be at least one half inch lower than the bottom of the drain pan connection. This ensures proper drainage when the unit is not running.

Note: It may be necessary to fill the trap manually, or the trap can be filled automatically by operating the unit until enough condensate collects to fill the trap. The trap will then be filled when the unit is turned off.

Table 8 - Blow-Through Drain Trap Dimensions

Blow-Through	
Drain Pan Pressure	Trap Dimension
Positive Static	Y
(inches of water)	(inch)
0.5	1.5
1.0	2.0
1.5	2.5
2.0	3.0
2.5	3.5
3.0	4.0
3.5	4.5
4.0	5.0

Blower Wheels

AAON units are equipped with a backward curved blower wheels that is set to deliver the air volume specified according to unit size and/or job requirements.

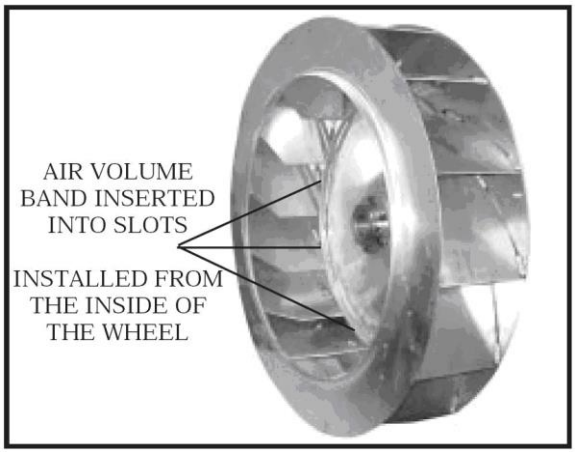
Air Adjustment

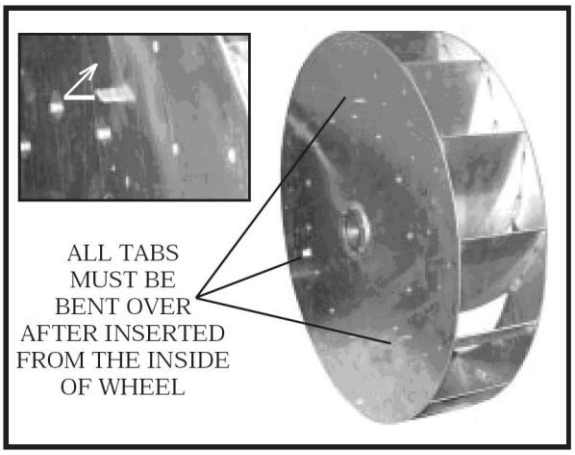
In the event that reduced air volume is required, an air volume band can be installed within the blower wheel to reduce the amount of air delivery. If the unit is factory equipped with the air band but additional air delivery is needed, the band can be removed from the wheel.

The air band is sized according to the air delivery specifications and can be ordered from the factory for field installation.

The related photos of the wheel are provided for practical guidelines only in order to identify the air band location in the wheel. Actual field installation of the air band into the wheel will require access into and through the blower wheel venturi.

The band is made of aluminum, sized and equipped with easy bend tabs that are to be inserted into pre-punched slots provided on the wheel. Once the band has been inserted into the slots, it MUST BE secured by bending the tabs over from the back side of the wheel and also MUST BE secured from the inside by connecting the ends together with a pop-rivet in the holes provided on the ends of the band. If the band is to be field installed, a hand held pop-rivet tool is recommended for connecting the band ends together. Caution must be taken to assure that the band is tightly installed and no damage, denting, or alteration to the wheel or blades occurs during the installation.





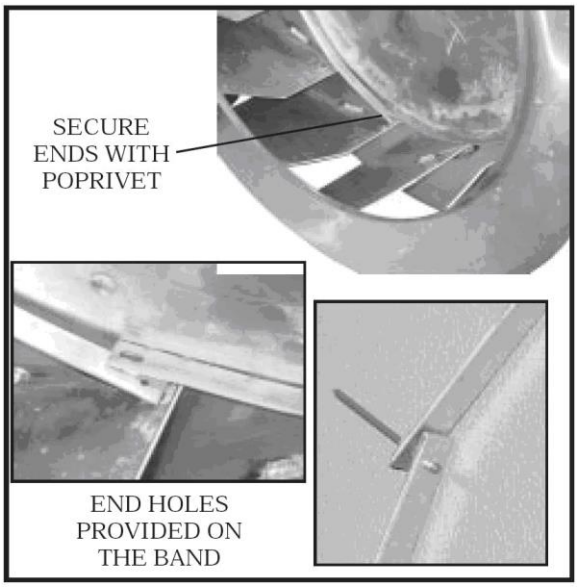


Figure 19 - Supply Fan Banding

Waterside Economizer

Pre-cooling waterside economizer coil is supplied without water piping. A kit to pipe the coil in series with the condenser water circuit along with a valve which diverts condenser water to the coil or around the coil is optional.

During economizer mode cool water passes through the economizer and condenser in series. During standard cooling mode water bypasses the economizer coil and passes through the condenser.

A p-trap must be installed on the coil drain outlet, not to exceed 6" from the drain connection. See the previous section on condensate drain piping for additional p-trap and drain information.

⚠ CAUTION

DRAIN PAN CONNECTION

With a waterside economizer coil a separate drain connection is included. Failure to use this separate drain connection may result in water backup and overflow of drain pan.

An aquastat is included with the field installed water piping kit and is used to modulate water flow through the economizer coil. The controller is mounted in the controls compartment. Electrical connections must be field wired. The temperature bulb requires field mounting. Care should be taken to firmly mount the bulb on the supply water piping, but not to dent the bulb when installing. The aquastat has a temperature calibration range adjustment of -10°F to 100°F and must be field set.

Mineral content of the condenser water must be controlled. All make-up water has minerals in it and as the water is evaporated in the cooling tower, these minerals remain. As the mineral content of the water increases, the conductivity of the water increases.

Field provided and installed water treatment program must be compatible with stainless steel, copper, aluminum, ABS plastic, and PVC. Batch feed processes should never be used as concentrated chemicals can cause corrosion. Never use hydrochloric acid (muriatic acid) or chlorine as it will corrode stainless steel.

Heating Coils

Factory installed one or two row hot water heating coils can be factory mounted. These coils are supplied from a hot water source through separate piping from the condenser water source. All controls for heating operation are field supplied and field installed.

Always connect the supply to the top of the coil and the return to the bottom. Water coils should not be subjected to entering air temperatures below 38°F to prevent coil freeze-up. If air temperature across the coil is going to be below this value, use a glycol solution to match the coldest air expected.

Water supply lines must be insulated, properly fastened, drained, and supported according to local code requirements.

Air handling units with steam heating coils **MUST BE** installed high enough to allow for a minimum of 1 foot condensate drop leg off of the steam coil, or as recommended by the steam trap manufacturer. Lines should be insulated with approved insulation and be properly fastened, sloped, and supported according to local code requirements.

Chilled Water Coils
Factory installed four or six row chilled water cooling coils can be factory mounted. These coils are supplied from a chilled water source through separate piping from the condenser water source. All controls for the cooling coil are field supplied and field installed.

Water supply lines must be insulated with closed cell type pipe insulation or insulation that includes a vapor barrier. Lines should be properly fastened, drained and supported according to local code requirements, and job specifications.

⚠ WARNING

Piping shall be in accordance with national and local codes. Pressure limiting devices, backflow preventers and all other safety requirements are the sole responsibility of the installing contractor.

Electric Heating
Heating is accomplished by passing electrical current through a specified amount of resistance heaters which will produce the required heat. The indoor fan motor will energize at the same time as the heaters. Wiring to the air handling unit must be done in accordance with local electrical codes and standards. Check specified electrical rating and install with proper wire size.

Gas Fired Duct Furnace

⚠ WARNING

Improper installation, adjustment, alteration, service, or maintenance can cause property damage, personal injury or loss of life. Startup and service must be performed by a Factory Trained Service Technician. A copy of this IOM should be kept with the unit.

Inspection on Arrival
1. Inspect unit upon arrival for any damage that may have occurred during shipping.

2. Prior to installation locate rating plate and verify that furnace is equipped for the available fuel supply and power supply at point of installation.

Unit Location and Clearances
1. Be sure unit is located with respect to building construction and other equipment to provide ready access and clearance to access panels or doors that must be opened to permit adjustment and servicing of the heating module.

2. The heating unit provided is listed for installation on the positive side of the circulating air blower only.

3. Do not install unit where it may exposed to potentially explosive or flammable vapors.

4. Do not locate unit in areas where corrosive vapors (such as chlorinated, halogenated, or acidic) are present in the atmosphere or can be mixed with combustion air entering heater.

Indoor Units
1. Locate unit to insure an adequate supply of fresh air to replace air used in the combustion and ventilation process.

2. When locating units, it is important to consider the exhaust vent piping connected to the outside atmosphere. Location should minimize the number of elbows or turns in vent pipe.

Gas Supply, Piping and Connections

Gas piping must be installed in accordance with local codes, or in the absence of local code, installation must conform to the current (United States) National Fuel Gas Code ANSI-Z223.1/NFPA 54 or the current (Canada) National Fuel & Propane Installation Code CSA B149.1 or B149.2.

1. Gas piping must be sized for the total Btu input of all units (heaters) serviced by a single supply.

2. Ensure that gas regulators servicing more than one heater have the proper pipe and internal orifice size for the total input of all heaters serviced by the regulator.

3**.** Duct furnaces require a **minimum** inlet gas pressure of **5.0" w.c.** and limited to a **maximum** inlet gas pressure of **13.5" w.c**. with the furnace operating.

4. A 1/8" NPT tap is provided on the inlet side of the gas valve to the heater. A fitting suitable for connection to a pressure gauge capable of measuring gas pressure should be connected to each heater serviced by a single regulator so that gas pressure at each heater can be measured with all heaters in operation.

5. A drip leg (sediment trap) and a manual shut off valve must be provided immediately upstream of the gas control on the heating unit. To facilitate servicing of unit, installation of a union is recommended.

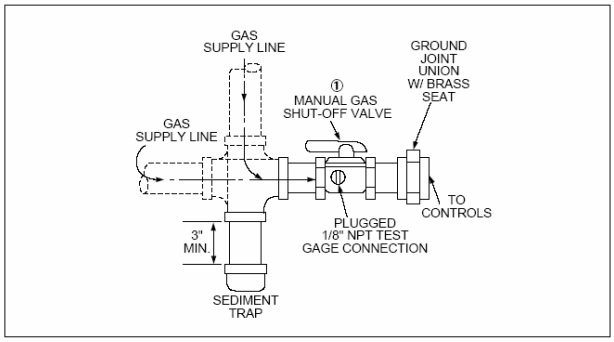


Figure 20 - Sediment Trap

⚠ WARNING

1. All field gas piping must be pressure / leak tested prior to operation. NEVER use an open flame to check for leaks. Use a soap solution or other leak detecting solution for testing.

2. Gas pressure to appliance controls must never exceed 13.5" w.c. (1/2 psi)

⚠ WARNING

1. When pressure testing at 1/2 psi or less, close the manual shutoff valve on the appliance before testing.

2. When pressure testing gas supply line at 1/2 psi or higher, close manual gas valve and disconnect heater from supply line to be tested. Cap or plug the supply line.

Duct Furnace Component Identification

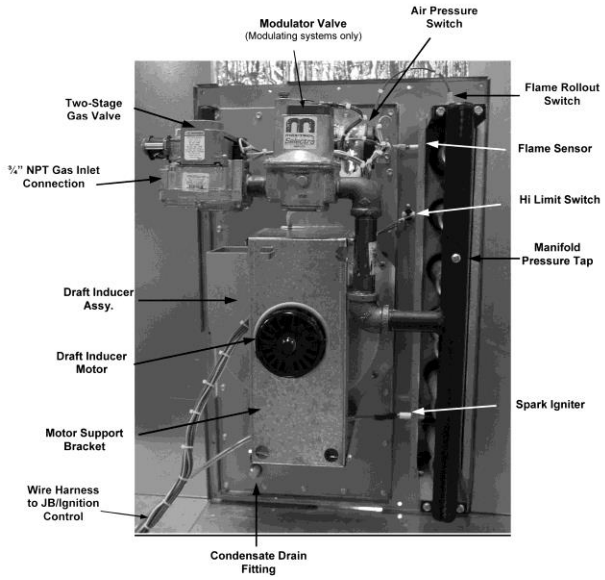


Figure 21 - Horizontal Configuration

Horizontal Airflow Configuration

1. Airflow may be from either right or left for heater as shown, without any difference in system performance.

2. Typically no condensate drain attachment is necessary in "Heat" only applications. Condensation should not occur during heating cycle. However, in applications operating at low temperature rise or with 50% or more outside air, condensation may occur early in the heating cycle. In these applications connection of a condensate drain line is recommended, to avoid condensate buildup and possible heat exchanger damage.

3. If heating section is located downstream of a refrigeration system or cooling coil, condensation can occur during operation of the air conditioning, resulting in condensation from warm, moist air in the heat exchanger tubes and flue collector. This condensate is not harmful to the heat exchanger provided it is drained continuously. For these applications a 1/4 inch NPT connection is provided for attachment of condensate drain line to remove condensate from heat exchanger.

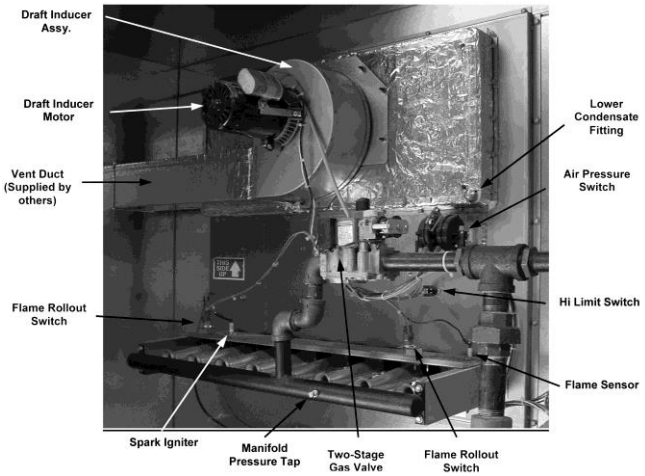


Figure 22 - Vertical Configuration

Vertical Airflow Configuration

1. Airflow may be either upflow or downflow for heater as shown, without any difference in system performance.

2. In this configuration, condensate due to operation of air conditioning system would drain through the open heat exchanger tubes near base of heater. An optional condensate drain pan is available for these applications, if none is incorporated integral to the unit.

3. Some condensation may occur in the flue collector box, and it is recommended that a drain tube be connected to the lower condensate drain fitting as well.

Gas Valve

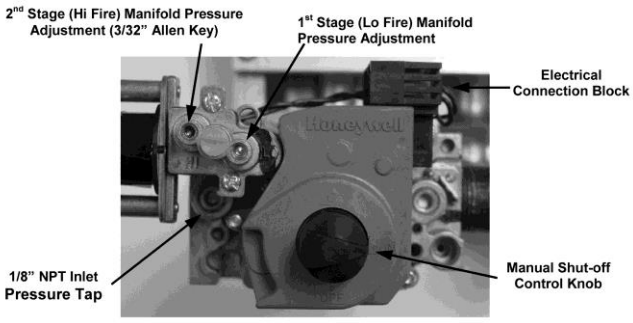


Figure 23 - Gas Valve

Input
The correct heat capacity of the furnace is controlled by the burner orifices and the gas manifold pressure. The manifold pressure is factory set but should be checked at the time of start-up.

Operating and Safety Instructions
1. This duct furnace does not have a pilot. It is equipped with a direct spark ignition device that automatically lights the gas burner. DO NOT try to light burners by hand.

2. BEFORE OPERATING, leak test all gas piping up to heater gas valve. Smell around the unit area for gas. DO NOT attempt to place heater in operation until source of gas leak is identified and corrected.

3. Use only hand force to push and turn the gas control knob to the "ON" position. NEVER use tools. If knob does not operate by hand, replace gas valve prior to staring the unit. Forcing or attempting to repair the gas valve may result in fire or explosion.

4. Do not attempt to operate unit if there is indication that any part or control has been under water. Any control or component that has been under water must be replaced prior to trying to start the unit.

⚠ WARNING

Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

Startup
1. Turn thermostat or temperature controller to its lowest setting.

2. Turn off gas supply at the manual shut-off valve (supplied by others).

3. Turn off power to the unit at the disconnect switch.

4. Open door to unit module housing the gas heater.

5. Move gas control knob to "OFF" position.

6. Install a tapped fitting for attachment to a manometer or other gauge suitable for 14.0" w.c. in the inlet pressure tap, and for 10.0" w.c. in the manifold pressure tap.

7. Wait 5 minutes for any gas to clear out. If you smell gas, turn off gas supply at the manual shut-off valve (field installed). If you don't smell gas or have corrected any leaks, go to the next step.

8. Turn gas control knob to "ON" position.

9. Open all manual gas valves (supplied by others).

10. Turn power on at disconnect switch.

11. Set thermostat or controller to its highest position to initiate call for heat and maintain operation of unit.

12. Draft inducer will run for a 15 to 30 second pre-purge period.

13. At the end of the pre-purge the direct spark will be energized and gas valve will open.

Check and Adjust Manifold Pressure

For 2 stage (TS) and modulating control (MD) systems manifold pressure should be 1.2" w.c. Adjust Lo Regulator on 2 stage gas valve, if necessary. The controls are design to hold operation at this pressure for 2 minutes. After that time manifold pressure should increase to 3.5" w.c. within 30 to 45 seconds.

For On/Off units the manifold pressure should be 3.5" w.c.

Failure to Ignite

1. For the initial start-up, or after unit has been off long periods of time, the first ignition trial may be unsuccessful due to need to purge air from manifold at start-up.

2. If ignition does not occur on the first trial, the gas and spark are shut-off by the ignition control and the control enters an inter-purge period of 15 to 90 seconds, during which the draft inducer continues to run.

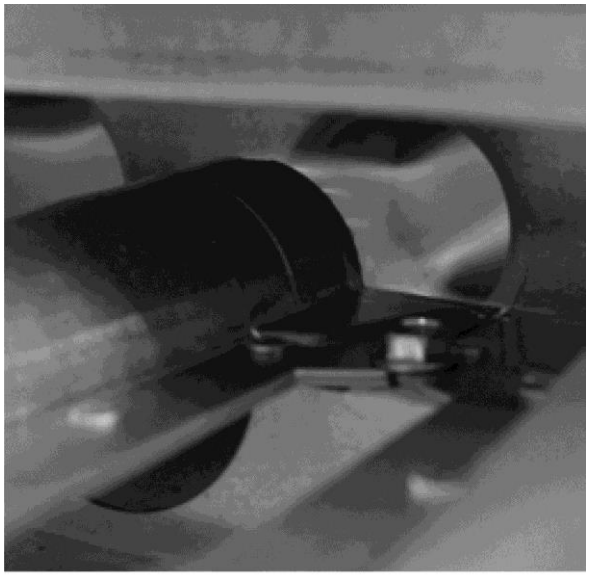
3. At the end of the inter-purge period, another trial for ignition will be initiated.

4. Control will initiate up to three ignition trials on a call for heat before lockout of control occurs.

5. Control can be brought out of lockout by turning thermostat or controller to its lowest position and waiting 5 seconds and then turning back up to call for heat. Some controls provided will automatically reset after one hour and initiate a call for heat.

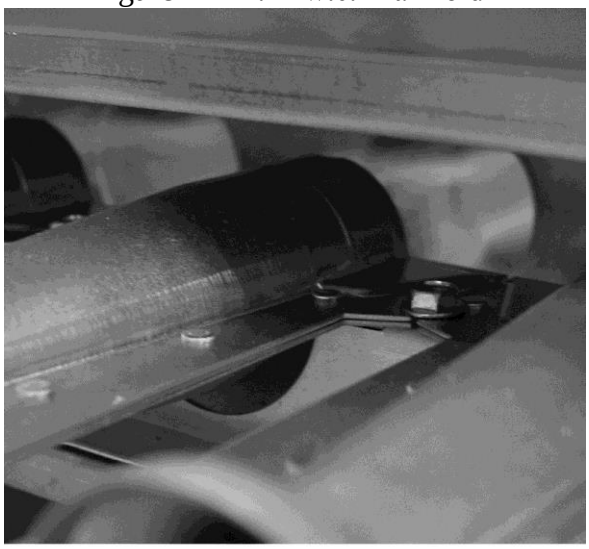
Burner Flames

Prior to completing the start-up, check the appearance of the main burner flame. See Figure 34a and Figure 34b for flame characteristics of properly adjusted natural gas systems.



Burner Flame @ Start-up 1.2" w.c. Manifold Pressure Draft Inducer – High Speed

Figure 24 - 1.2" w.c. Manifold



Burner Flame @ High Fire 3.5" w.c. Manifold Pressure Draft Inducer – High Speed

Figure 25 - 3.5" w.c. Manifold

1. The burner flame should be predominately blue in color and well defined and centered at the tube entry as shown in Figure 34a and Figure 34b. Distorted flame or yellow tipping of natural gas flame, or a long yellow flame on propane, may be caused by lint and dirt accumulation inside burner or at burner ports, at air inlet between burner and manifold pipe, or debris in the main burner orifice. Soft brush or vacuum clean affected areas after performing Shutdown procedure.

2. Poorly defined, substantially yellow flames, or flames that appear lazy, indicate poor air supply to burners or excessive burner input. Verify gas supply type and manifold pressure with rating plate.

3. Poor air supply can be caused by obstructions or blockage in heat exchanger tubes or vent discharge pipe. Inspect and clean as necessary by to eliminate blockage. Vacuum any dirt or loose debris found in the tubes or vents. Clean heat exchanger tubes with stiff brush after performing Shutdown procedure. Poor flame characteristics can also be caused by undersized combustion air openings or flue gas recirculation into combustion air supply. Increase air opening size or re-direct flue products to prevent re-circulation.

4. Reduced air delivery can also be the result of fan blade slippage, dirt accumulation the fan blade or low voltage to draft inducer motor. Inspect draft fan assembly and be sure fan blade is secure to motor shaft. Check line voltage to heater.

⚠ WARNING

Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

Shutdown

1. Set thermostat or controller to lowest setting.

2. Turn off electrical supply to unit at disconnect switch.

3. Turn off manual gas supply (supplied by others).

4. Disconnect manifold and inlet pressure taps and re-install pipe plugs.

5. Close module door.

Normal Operation

1. Turn on electrical supply to unit at disconnect switch.

2. Turn on manual gas supply (supplied by others).

3. Set Thermostat or Temperature controller to desired temperature.

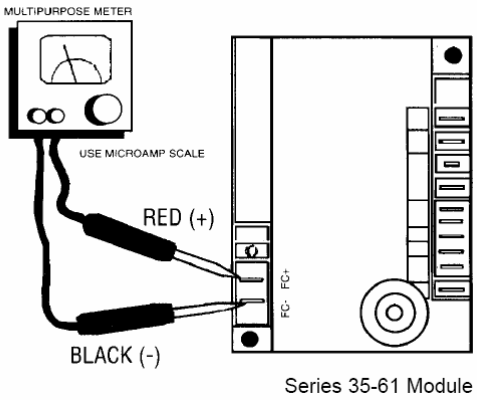


Figure 26 - Flame Sensor Current Check

Service Checks

Flame current is the current which passes through the flame from the sensor to ground. The minimum flame current necessary to keep the system from lockout is 0.7 microamps. To measure flame current, connect an analog DC microammeter to the FC- and FC+ terminals per figure. Meter

should read 0.7 uA or higher. If the meter reads below “0” on scale, meter leads are reversed. Disconnect power and reconnect meter leads for proper polarity.

Air Pressure Switch

An air pressure switch is provided as part of the control system to verify airflow through draft inducer by monitoring the difference in pressure between the draft inducer and the atmosphere. If sufficient negative pressure is not present, indicating lack of proper air movement through heat exchanger, the switch opens shutting off gas supply though the ignition control module. On units with two speed draft inducer operation, a dual air pressure switch is used, monitoring high and low speed pressures. The air pressure switches have fixed settings and are not adjustable.

Rollout Switch (Manual Reset)

The duct furnace is equipped with manual reset rollout switches in the event of burner flame rollout. The switch will open on temperature rise and shut-off gas supply through the ignition control module. Flame rollout can be caused by insufficient airflow for the burner firing rate (high gas pressure), blockage of the vent system or in the heat exchanger. The duct furnace should not be placed back in operation until the cause of rollout condition is identified. The rollout switch can be reset by pressing the button on the top of the switch.

High Limit Switch

The duct furnace is equipped with a fixed temperature high limit switch mounted on the vestibule panel that shuts off gas to the heater through the ignition control module in the event of reduced circulating airflow over the heat exchanger. Reduced airflow can be caused by motor failure of the circulating air blower, dirty or blocked filters or restriction of the air inlet or outlet to the unit. The high limit switch will automatically reset when the temperature drops to 15ºF below the set point. Determine the cause of the reduced air flow and correct.

Ignition Control Diagnostics and Service Guide (Fenwal 35-61 Series). LED flashes on for ¼ second, and off for ¼ second during fault condition. Pause between fault codes is 3 seconds.

Table 9 - Gas Heater Troubleshooting

LED Code	System	Description	Actions
None	No Power to T1	On call for heat nothing happens	1. Check for open fuse or circuit breaker. 2. Check for poor wiring connection. 3. Check for failed 24V transformer.
	Open Limit Switch	Thermostat call for heat. No power across terminals V1 / V2 control.	1. Check for proper operation of circulating air supply system and for air filter blockage. 2. Check manifold pressure when limit cools and closes. Natural gas 3.5" w.c / LP gas 10.0" w.c. 3. Low combustion blower air output. Flue gas temp exceeds 550ºF. Inspect for debris accumulation, proper wheel attachment, and proper voltage to blower.
Steady On	Internal Control Fault (No Operation)	24VAC across Terminal 24VAC / V2-Gnd when Thermostat calling for heat	Control fault – Replace ignition control.
1 Flash	Combustion Air Flow Fault	Pressure switch contacts in **closed** position for 30 seconds with no output to Combustion blower. Remains in this mode with combustion blower off.	1. Check for short in wiring to pressure switch. 2. Check pressure switch for closed contacts (with leads disconnected). 3. Replace pressure switch
		Open pressure switch or flame rollout switch when inducer (IND terminal) is energized. If switch remains open for more than 30 seconds after combustion blower is energized, control will remain in this mode with IND terminal (blower) energized.	1. Failed Combustion blower. 2. Check connections and air tube from draft inducer to air switch for leaks. 3. Check rollout switch manual reset - depress reset. 4. Check supply tube from draft inducer housing to pressure switches for condensate - drain line and re-connect. 5. Check pressure switch for condensate accumulation 6. Replace pressure switch

Table 10 - Gas Heater Troubleshooting Continued

LED Code	System	Description	Actions
2 Flash	Flame Fault (No Call for Heat)	Flame sense failure / flame present with no call for heat.	1. Check for voltage to gas valve with thermostat in off position. Valve should not be powered. 2. If valve is not energized, check for gas flow (manifold pressure reading greater than 0). If gas flow, turn off main shut-off valve and replace gas valve.
3 Flash	Ignition Lockout	Failure to light and or carryover. Loss of flame or flame signal during ignition or operation cycle. Control will initiate up to 3 ignition re-trials before lockout.	1. Verify gas supply available and operation of gas valve - manifold pressure at start of ignition cycle. Check for power to valve terminals LO & COM while spark is energized. 2. Is spark present? - If not check igniter for debris between electrodes, cracked ceramic and check ignition wire for short to ground. 3. Check flame sensor wiring connections to electrode and control and for any abrasions. 4. Check for cracked ceramic on flame sensor or grounded sensor rod. 5. Verify that ample air supply and proper venting of flue gases occurs during operating cycle. 6. Check for circulating air leaks into burner compartment during operation. 7. Check for re-circulation of flue gases into combustion air supply. 8. If all conditions satisfactory – replace ignition control.

Operating Control Systems
Two Stage (TN) - Low / High Fire / High Speed Inducer Only

Modulating (MD) - Modulating (25 to 100%) / 2 Speed Draft Inducer - Mid-Fire Start (55%)

Modulating (MH) - Modulating (25 to 100%) / 2 Speed Draft Inducer - High Fire Start (100%)

Refer to unit wiring diagrams located in unit door.

Furnace Maintenance

⚠ WARNING

Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Startup and service must be performed by a Factory Trained Service Technician. A copy of this IOM should be kept with the unit.

⚠ WARNING

Disconnect all electrical power sources before servicing the unit. More than one power source may be provided. Failure to do so may result in injury or death from electrical shock or entanglement in moving parts.

⚠ CAUTION

If any original wiring needs to be replaced it must be replaced with wiring materials suitable for 105ºC.

Label all wires prior to disconnection when servicing unit. Wiring errors can cause improper or dangerous operation. Verify proper operation after servicing.

Duct Furnace Inspection
1. The duct furnace should be inspected annually by a qualified service agency. The condition of the burners, heat exchanger, draft inducer, vent system, operating controls and wiring should be determined. Check for obvious signs of deterioration, accumulation of dirt and debris and any heat or water related damage. Any damaged or deteriorated parts should be replaced before the unit is put back into service.

2. Clean burners, heat exchanger, draft inducer and vent ducts with a soft brush or vacuum.

3. Check Heat Exchanger for cracks. If any are present, replace heat exchanger before putting unit back into service.

4. Check the attachment point of the duct furnace to the cabinet or ducts to verify that they are air tight.

5. Check the automatic gas valve to insure that the gas valve seat is not leaking.

Duct Furnace Operation Check

1. Turn on power to the unit and set thermostat or heat controller to call for heat, allowing duct furnace to operate.

2. Check for proper start-up and ignition as outlined in Start-Up section.

3. Check the appearance of the burner flame.

4. Check that the circulating air fan is operating and verify the proper airflow through duct furnace.

5. Return thermostat or heat controller to normal setting.

Troubleshooting

Table 11 - Problems, Causes, and Solutions

Problem	Possible Cause	Solutions
Frosted evaporator coil, low suction pressure	Restricted air flow Low fan speed Reversed blower rotation Low refrigerant charge	Clean, or replace filters Check fan drives Correct wiring Add refrigerant
Unit runs, but supplies warm air	Loss of refrigerant Faulty expansion valve element Plugged filter-drier	Check leaks, add refrigerant Replace valve element Replace filter-drier
Compressor starts, but opens high pressure control	Refrigerant over-charged Air in condenser coil Condenser fan faulty Condenser coil dirty	Remove some refrigerant Evacuate and recharge refrigerant Replace fan motor Clean condenser coil
High suction pressure, but low superheat	Oversized expansion valve Poor sensing bulb location Low superheat adjustment	Replace with correct expansion valve Relocate sensing bulb, secure to suction line Adjust expansion valve
Unit operates continuously	Low refrigerant charge Unit undersized	Check and recharge to nameplate Decrease load or resize unit Thermostat set too low, increase temperature setting

Energy Recovery Units

AAONAIRE® units have been equipped with an energy recovery wheel. This section is provided to assure the energy recovery feature will be properly setup to perform in accordance with the job specifications for your particular application.

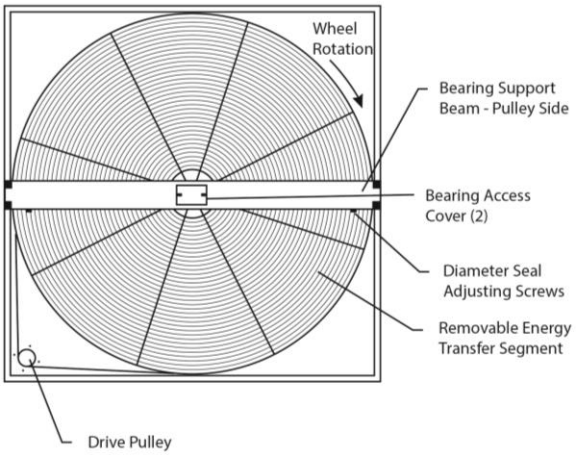


Figure 27 - Energy Recovery Wheel

The Energy Recovery Cassette consists of a frame wheel, wheel drive system, and energy transfer segments. Segments are removable for cleaning or replacement. The segments rotate through counter flowing exhaust and outdoor air supply streams where they transfer heat and/or water vapor from the warm, moist air stream to the cooler and/or drier air stream.

The initial setup and servicing of the energy recovery wheel is very important to maintain proper operation efficiency and building occupant comfort.

Normal maintenance requires periodic inspection of filters, the cassette wheel, drive belts, air seals, wheel drive motor, and its electrical connections.

Wiring diagrams are provided with each motor. When wired according to wiring diagram, motor rotates clockwise when viewed from the shaft/pulley side.

By carefully reviewing the information within this section and following the instructions, the risk of improper operation and/or component damage will be minimized.

It is important that periodic maintenance be performed to help assure trouble free operation.

Initial Mechanical Check and Setup

Outdoor units equipped with outside air intake will have an outside air hood. The outside air hood must be opened prior to unit operation.

Outdoor air intake adjustments should be made according to building ventilation, or local code requirements.

After the unit installation is complete, open the cassette access door and determine that the energy wheel rotates freely when turned by hand. Apply power and observe that the wheel rotates at approximately 30 RPM. If the wheel does not rotate when power is applied, it may be necessary to readjust the “diameter air seals”.

Air Seal Adjustments

Pile type air seals across both sides of the energy wheel diameter are factory adjusted to provide close clearance between the air seal and wheel. Racking of the unit or cassette during installation, and/or mounting of the unit on a non-level support or in other than the factory orientation can change seal clearances. Tight seals will prevent rotation.

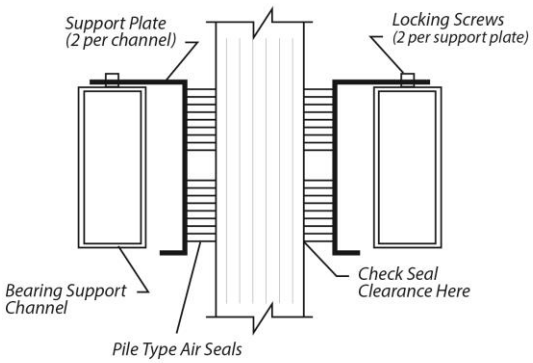


Figure 28 - Cross Section of Air Seal Structure

Wheel to Air Seal Clearance

To check wheel to seal clearance; first disconnect power to the unit, in some units the energy recovery wheel assembly can be pulled out from the cabinet to view the air seals. On larger units, the energy recovery wheel may be accessible inside the walk-in cabinet.

A business card or two pieces of paper can be used as a feller gauge, (typically each .004" thick) by placing it between the face of the wheel and pile seal.

Using the paper, determine if a loose slip fit exist between the pile seal and wheel when the wheel is rotated by hand.

To adjust air seal clearance, loosen all seal plate retaining screws holding the separate seal retaining plates to the bearing support channels and slide the seals plates away from the wheel. Using the paper feeler gauge, readjust and retighten one seal plate at a time to provide slip fit clearance when the wheel is rotated by hand.

Confirm that the wheel rotates freely. Apply power to the unit and confirm rotation.

Airflow Balancing and Checking

High performance systems commonly have complex air distribution and fan systems. Unqualified personnel should not attempt to adjust fan operation, or air circulation, as all systems have unique operations characteristics. Professional air balance specialists should be employed to establish actual operating conditions, and to configure the air delivery system for optimal performance.

Controls

A variety of controls and electrical accessories may be provided with the equipment. Identify the controls on each unit by consulting appropriate submittal, or order documents, and operate according to the control manufacturer's instructions. If you cannot locate installation, operation, or maintenance information for the specific controls, then contact your sales representative, or the control manufacturer for assistance.

⚠ WARNING

Do not alter factory wiring. Deviation from the supplied wiring diagram will void all warranties, and may result in equipment damage or personal injury. Contact the factory with wiring discrepancies.

Routine Maintenance and Handling

Handle cassettes with care. All cassettes should be lifted by the bearing support beam. Holes are provided on both sides of the bearing support beams to facilitate rigging as shown in the following illustration.

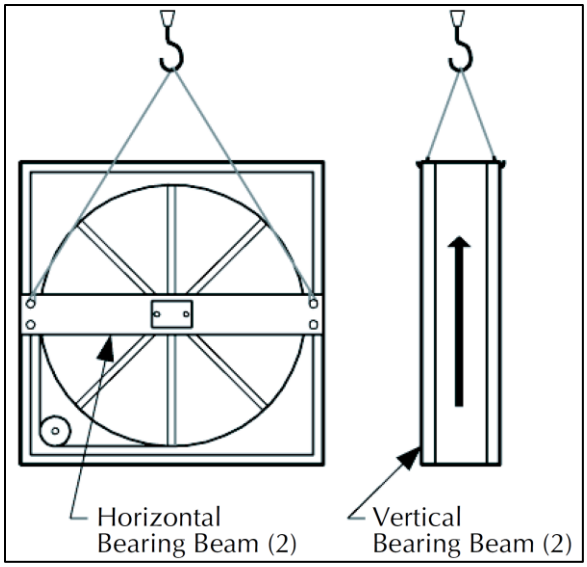


Figure 29 - Lifting Hole Locations

Routine maintenance of the Energy Recovery Cassettes includes periodic cleaning of the Energy Recovery Wheel as well as inspection of the Air Seals and Wheel Drive Components as follows:

Cleaning

The need for periodic cleaning of the energy recovery wheel will be a function of operating schedule, climate and contaminants in the indoor air being exhausted and the outdoor air being supplied to the building.

The energy recovery wheel is "self-cleaning" with respect to dry particles due to its laminar flow characteristics. Smaller particles pass through; larger particles land on the surface and are blown clear as the flow direction is reversed. Any material that builds up on the face of the wheel can be removed with a brush or vacuum. The primary need for cleaning is to remove oil based aerosols that have condensed on energy transfer surfaces.

A characteristic of all dry desiccants, such films can close off micron sized pores at the surface of the desiccant material, reducing the efficiency by which the desiccant can adsorb and desorb moisture and also build up so as to reduce airflow.

In a reasonably clean indoor environment such as a school or office building, measurable reductions of airflow or loss of sensible (temperature) effectiveness may not occur for several years. Measurable changes in latent energy (water vapor) transfer can occur in shorter periods of time in applications such as moderate occupant smoking or cooking facilities. In applications experiencing unusually high levels of occupant smoking or oil based aerosols such as industrial applications involving the ventilation of machine shop areas for example, annual washing of energy transfer may be necessary to maintain latent transfer efficiency. Proper cleaning of the energy recovery wheel will restore latent effectiveness to near original performance.

To clean, gain access to the energy recovery wheel and remove segments. Brush foreign material from the face of the wheel. Wash the segments or small wheels in a 5% solution of non-acid based coil cleaner or alkaline detergent and warm water.

Soak in the solution until grease and tar deposits are loosened (Note: some staining of the desiccant may remain and is not harmful to performance). Before removing, rapidly run finger across surface of segment to separate polymer strips for better cleaning action. Rinse dirty solution from segment and remove excess water before reinstalling in wheel.

⚠ CAUTION

Do Not use acid based cleaners, aromatic solvents, steam or temperatures in excess of 170°F; damage to the wheel may occur!

Air Seals
Four adjustable diameter seals are provided on each cassette to minimize transfer of air between the counter flowing airstreams.

To adjust diameter seals, loosen diameter seal adjusting screws and back seals away from wheel surface. Rotate wheel clockwise until two opposing spokes are hidden behind the bearing support beam. Using a folded piece of paper as a feeler gauge, position paper between the wheel surface and diameter seals.

Adjust seals towards wheel surface until a slight friction on the feeler gauge (paper) is detected when gauge is moved along the length of the spoke. Retighten adjusting screws and recheck clearance with "feeler" gauge.

Wheel Drive Components
The wheel drive motor bearings are pre-lubricated and no further lubrication is necessary.

The wheel drive pulley is secured to the drive motor shaft by a combination of either a key or D slot and set screw.

The set screw is secured with removable locktite to prevent loosening. Annually confirm set screw is secure. The wheel drive belt is a urethane stretch belt designed to provide constant tension through the life of the belt. No adjustment is required. Inspect the drive belt annually for proper tracking and tension. A properly tensioned belt will turn the wheel immediately after power is applied with no visible slippage during start-up.

Installation Considerations
Energy recovery cassettes are incorporated within the design of packaged units, packaged air handlers and energy recovery ventilators. In each case, it is recommended that the following considerations be addressed:

Accessibility
The cassette and all its operative parts; i.e.: motor, belt, pulley, bearings, seals and energy transfer segments must be accessible for service and maintenance. This design requires that adequate clearance be provided outside the enclosure. Where cassettes are permanently installed in a cabinet, access to both sides of the cassette must be provided.

Orientation & Support
The Energy Recovery Cassette may be mounted in any orientation. However, Care must be taken to make certain that the cassette frame remains flat and the bearing beams are not racked.

To verify, make certain that the distance between wheel rim and bearing beam is the same at each end of the bearing beam, to within 1/4 of an inch (dimension A & B). This amount of racking can be compensated for by adjusting the diameter seals.

If greater than 1/4 inch (dimension C), racking must be corrected to ensure that drive belt will not disengage from wheel.

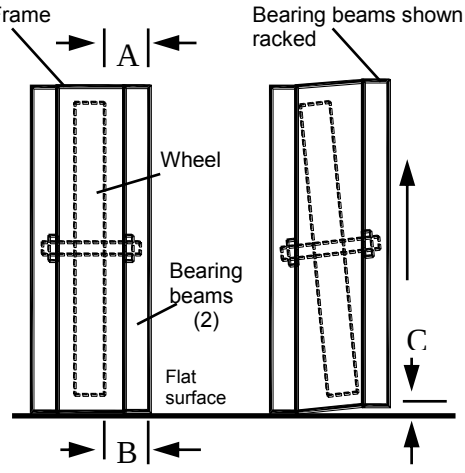


Figure 30 - Avoid Racking of Cassette Frame

Operation

⚠ CAUTION

Keep hands away from rotating wheel! Contact with rotating wheel can cause physical injury.

Startup Procedure

1. By hand, turn wheel clockwise (as viewed from the pulley side), to verify wheel turns freely through 360º rotation.

2. Before applying power to drive motor, confirm wheel segments are fully engaged in wheel frame and segment retainers are completely fastened. (See Segment Installation Diagram).

3. With hands and objects away from moving parts, activate unit and confirm wheel rotation. Wheel rotates clockwise (as viewed from the pulley side).

4. If wheel has difficulty starting, turn power off and inspect for excessive interference between the wheel surface and each of the four (4) diameter seals. To correct, loosen diameter seal adjusting screws and back adjustable diameter seals away from surface of wheel, apply power to confirm wheel is free to rotate, then re-adjust and tighten hub and diameter seals, as shown in hub seal adjustment diagram.

5. Start and stop wheel several times to confirm seal adjustment and to confirm belt is tracking properly on wheel rim (approximately 1/4” from outer edge of rim).

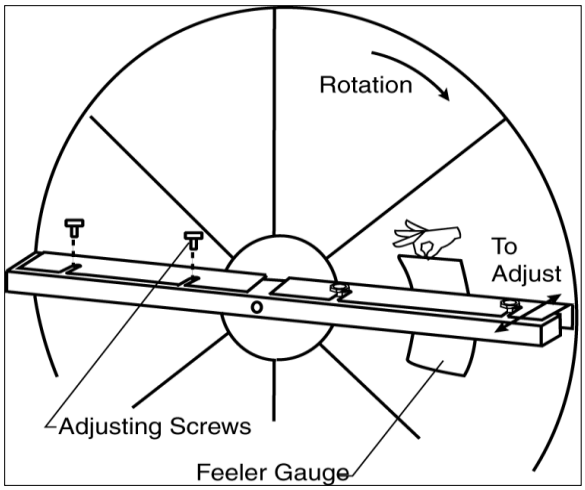


Figure 31 - Diameter Seal Adjustment

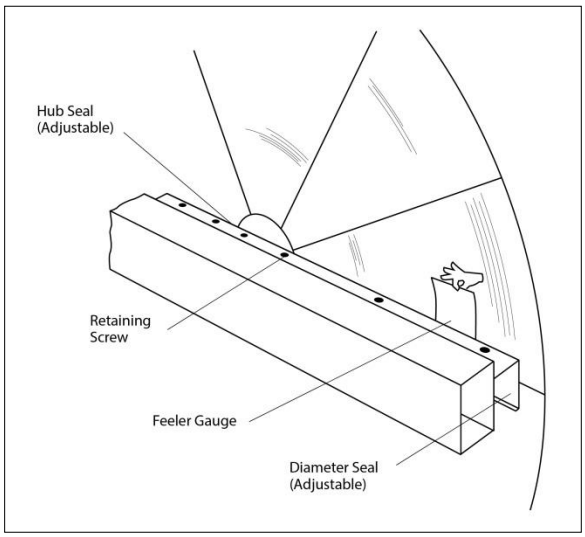


Figure 32 - Hub Seal Adjustment

Service

⚠ CAUTION

Disconnect electrical power before servicing energy recovery cassette. Always keep hands away from bearing support beam when installing or removing segments. Failure to do so could result in severe injury to fingers or hand.

Wheel segments are secured to the wheel frame by a Segment Retainer which pivots on the wheel rim and is held in place by a Segment Retaining Catch.

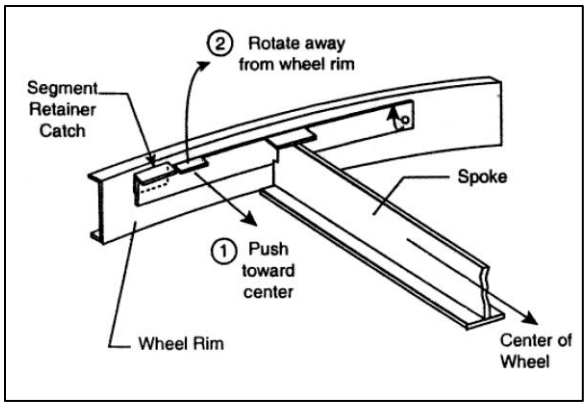


Figure 33 - Segment Retainer

To install wheel segments follow steps one through five below. Reverse procedure for segment removal.

1. Unlock two segment retainers (one on each side of the selected segment opening.

2. With the embedded stiffener facing the motor side, insert the nose of the segment between the hub plates.

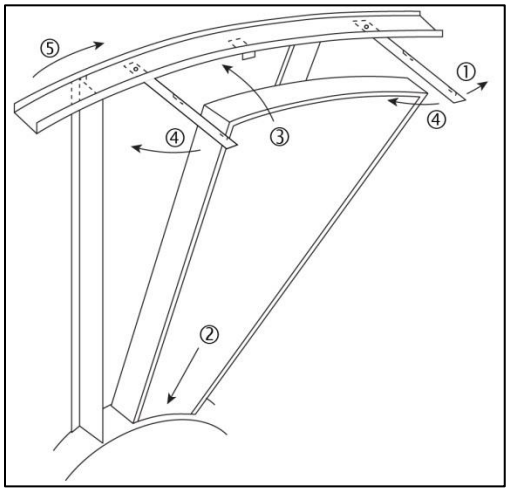


Figure 34 - Segment Installation

3. Holding segment by the two outer corners, press the segment towards the center of the wheel and inwards against the spoke flanges. If hand pressure does not fully seat the segment, insert the flat tip of a screw driver between the wheel rim and outer corners of the segment and apply downward force while guiding the segment into place.

4. Close and latch each Segment Retainer under Segment Retaining Catch.

5. Slowly rotate the wheel 180º. Install the second segment opposite the first for counterbalance. Rotate the two installed segments 90º to balance the wheel while the third segment is installed. Rotate the wheel 180º again to install the fourth segment opposite the third. Repeat this sequence with the remaining four segments.

Wheel Drive Motor and Pulley Replacement

1. Disconnect power to wheel drive motor.

2. Remove belt from pulley and position temporarily around wheel rim.

3. Loosen set screw in wheel drive pulley using a hex head wrench and remove pulley from motor drive shaft.

4. While supporting weight of drive motor in one hand, loosen and remove (4) mounting bolts.

5. Install replacement motor with hardware kit supplied.

6. Install pulley to dimension as shown and secure set screw to drive shaft.

7. Stretch belt over pulley and engage in groove.

8. Follow start-up procedure.

Belt Replacement

1. Obtain access to the pulley side bearing access plate if bearing access plates are provided. Remove two bearing access plate retaining screws and the access plate.

2. Using hexagonal wrench, loosen set screw in bearing locking collar. Using light hammer and drift (in drift pin hole) tap collar in the direction of wheel rotation to unlock collar. Remove collar.

3. Using socket wrench with extension, remove two nuts which secure bearing housing to the bearing support beam. Slide bearing from shaft. If not removable by hand, use bearing puller.

4. Form a small loop of belt and pass it through the hole in the bearing support beam. Grasp the belt at the wheel hub and pull the entire belt down.

Note: Slight hand pressure against wheel rim will lift weight of wheel from inner race of bearing to assist bearing removal and installation.

⚠ CAUTION

Protect hands and belt from possible sharp edges of hole in Bearing Support Beam.

5. Loop the trailing end of the belt over the shaft (belt is partially through the opening).

6. Reinstall the bearing onto the wheel shaft, being careful to engage the two locating pins into the holes in the bearing support beam. Secure the bearing with two self-locking nuts.

7. Install the belts around the wheel and pulley according to the instructions provided with the belt.

8. Reinstall diameter seals or hub seal and tighten retaining screws. Rotate wheel in clockwise direction to determine that wheel rotates freely with slight drag on seals.

9. Reinstall bearing locking collar. Rotate collar by hand in the direction the wheel rotates (see label provided on each cassette for wheel rotation).

10. Lock in position by tapping drift pin hole with hammer and drift. Secure in position by tightening set screw.

11. Reinstall Bearing Access Cover.

12. Apply power to wheel and ensure that the wheel rotates freely without interference.

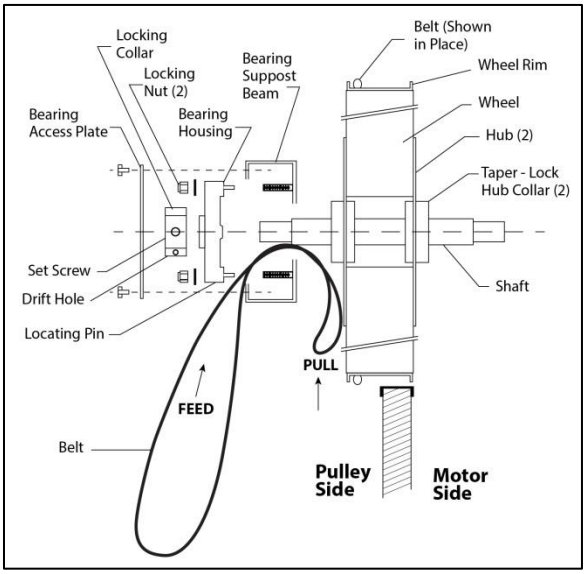


Figure 35 - Belt Replacement

Startup

(See back of the manual for startup form)

⚠ WARNING

Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Installation and service must be performed by a trained, qualified installer. A copy of this IOM should be kept with the unit.

During startup, it is necessary to perform routine checks on the performance of the unit. This includes checking of the air flow, the air filters, condenser water flow and refrigerant charge.

Filters

Units are shipped with the selected filters installed. If filters have been removed during installation, open the filter access door and re-install the correct filters with the airflow indicator arrows pointing in the direction of airflow.

Filters should be checked after a few days of operation after the unit has been started up as dust and debris from construction may cause premature filter loading. Replace the filters if necessary.

Check Out

Equipment should be thoroughly checked for loose wiring, a free spinning blower wheel, and well fitting access panels. Air handlers should not be operated without proper ductwork and access panels installed, except as required during start-up and air balancing.

1. Check all electrical connections to be sure they are tight.
2. Open all access panels, and remove all shipping screws, or restraints.
3. Clean out any debris that may have been left.
4. Check belt alignment and tightness of fan drives.
5. Check bearing locking collars and fan wheel set screws for tightness.
6. Turn fan wheels to assure free rotation.
7. Ensure electrical supply matches the unit nameplate.
8. Ensure condensate lines are connected, glued, and sloped toward building drain.
9. Check local codes for any special provisions.
10. Attach or close all access doors and panels.
11. Ensure that all ductwork dampers are open.
12. Check electrical phasing to ensure that fan rotate in the proper direction.

Electric Heating Section Procedures

1. Perform final visual inspection. Check all equipment, ductwork, and piping to verify that all work is complete and equipment is properly installed and mounted. Improperly installed equipment or ductwork can affect readings.
2. Ensure there is no construction debris in the unit.
3. Check the unit for external damage.
4. Note all accessories installed.
5. Install new filters of the proper size and type.
6. Check all terminal blocks, fuses, fuse blocks, and contactors for correctness.

7. Check all high and low voltage wiring connections for correctness and tightness.
8. Check unit for correct incoming voltage per the data plate.
9. Check the security of the locking system on all blower bearings
10. Turn the unit power on.
11. Turn the unit blower on and check for correct rotation.
12. If correct, take blower amp readings and compare to see if the amp draw is within the safety factor area of the motor. Once correct, turn blower off.
13. Turn on the first stage of heating
    - Check amp draw of each element of each stage
    - Ensure blower started w/ electric heat
    - Check for temperature rise across heating section while all stages are on
    - If temperature rise is within range, turn all heating calls off
    - Check to see that blower stops

Refrigerant (DX) Cooling Section Procedures:

1. Perform final visual inspection. Check all equipment, ductwork, and piping to verify that all work is complete, and equipment is properly installed and mounted. Improperly installed equipment, or ductwork can affect readings.
2. Perform condenser start-up checks in addition to these air handler checks according to the condenser manufacturer's instructions.
3. Ensure there is no construction debris in the unit.
4. Check the unit for external damage.
5. Note all accessories installed.
6. Ensure that drain P-trap is properly installed.
7. Check all terminal blocks, fuses, fuse blocks, and contactors for correctness.
8. Check all high and low voltage wiring connections for tightness. Check unit for correct incoming voltage per the data plate.
9. Check the security of the locking system on all blower bearings
10. Turn the unit power on.
11. Turn the unit blower on and check for correct rotation.
12. If correct, take blower amp readings and compare to see if the amp draw is within the safety factor area of the motor.
13. Check and record ambient temperature.
14. Check for Guaranteed Off Timers (GOT) and Time Delay Relays (TDR).
15. Start the first stage cooling circuit and blower circuit.
16. After all stages of cooling have been on for at least five minutes, record the return air temperature and supply air temperature.
17. Check the temperature difference across the evaporator coil.

Commissioning

The commissioning of an air conditioning system is the process of achieving, verifying, and documenting the performance of that system to meet the operational needs of the building. This may not be a formal process in smaller structures, but some form of owner acceptance will occur. Adjustments made during the commissioning phase may include air or water balancing, or configuration of controls and operational sequences.

Air Balancing
High performance systems commonly have complex air distribution and fan systems. Unqualified personnel should not attempt to adjust fan operation or air circulation, as all systems have unique operating characteristics. Professional air balance specialists should be employed to establish actual operating conditions and to configure the air delivery system for optimal performance.

Water Balancing
A hydronic specialist with a complete working knowledge of water systems, controls, and operation must be employed to properly balance the entire system. Unqualified personnel should not attempt to manipulate temperatures, pressures, or flow rates, as all systems have unique operating characteristics and improper balancing can result in undesirable noises and operation.

Controls
A variety of controls and electrical accessories may be provided with the equipment.

Identify the controls on each unit by consulting appropriate submittal and order documents, and operate according to the control manufacturer's instructions. If you cannot locate installation, operation, or maintenance information for the specific controls, then contact your sales representative, or the control manufacturer, for assistance.

Operation
Immediately following building occupancy, the air conditioning system requires a maintenance schedule to assure continued successful operation. A maintenance program similar to the example given below should be scheduled for routine maintenance of this equipment in order to provide continued efficient and reliable operation for the owner.

Adjusting Refrigerant Charge
Adjusting the charge of a system in the field must be based on determination of liquid sub-cooling and evaporator superheat. On a system with a TXV liquid sub-cooling is more representative of the charge than evaporator superheat but both measurements must be taken.

Before Charging
Unit being charged must be at or near full load conditions before adjusting the charge.

⚠ CAUTION

The Clean Air Act of 1990 bans the intentional venting of refrigerant (CFC's and HCFC's) as of July 1, 1992. Approved methods of recovery, recycling or reclaiming must be followed. Fines and/or incarceration may be levied for non-compliance.

Units equipped with hot gas reheat must be charged with the hot gas reheat valves closed while the unit is in cooling mode to get the proper charge. After charging, unit should be operated in reheat (dehumidification) mode to check for correct operation.

After adding or removing charge the system must be allowed to stabilize, typically 10-15 minutes, before making any other adjustments.

The type of unit and options determine the ranges for liquid sub-cooling and evaporator superheat. Refer to the tables below when determining the proper sub-cooling.

Checking Liquid Sub-Cooling
Measure the temperature of the liquid line as it leaves the condenser.

Read the gauge pressure at the liquid line close to the point where the temperature was taken. Use liquid line pressure as it will vary from discharge pressure due to condenser pressure drop.

Convert the pressure obtained to a saturated temperature using the appropriate refrigerant temperature-pressure chart.

Subtract the measured liquid line temperature from the saturated temperature to determine the liquid sub-cooling.

Compare calculated sub-cooling to the table below for the appropriate unit type and options.

Checking Evaporator Superheat
Measure the temperature of the suction line close to the compressor.

Read gauge pressure at the suction line close to the compressor.

Convert the pressure obtained to a saturated temperature using the appropriate refrigerant temperature-pressure chart.

Subtract the saturated temperature from the measured suction line temperature to determine the evaporator superheat.

Compare calculated superheat to the table below for the appropriate unit type and options.

Table 12 - Acceptable Air-Cooled Refrigeration Circuit Values

	Air-Cooled Condenser
Sub-Cooling	12-18°F
Sub-Cooling with Hot Gas Reheat	15-22°F
Superheat	8-15°F

Table 13 - Acceptable Water-Cooled Refrigeration Circuit Values

	Water-Cooled Condenser
Sub-Cooling	6-10°F
Sub-Cooling with Hot Gas Reheat	8-12°F
Superheat	8-15°F

⚠ CAUTION

Thermal expansion valve must be adjust to approximately 8-15°F of suction superheat. Failure to have sufficient superheat will damage the compressor and void the warranty.

Adjusting Sub-Cooling and Superheat Temperatures

The system is overcharged if the sub-cooling temperature is too high and the evaporator is fully loaded (low loads on the evaporator result in increased sub-cooling) and the evaporator superheat is within the temperature range as shown in the table above (high superheat results in increased sub-cooling).

Correct an overcharged system by reducing the amount of refrigerant in the system to lower the sub-cooling.

⚠ CAUTION

DO NOT OVERCHARGE!

Refrigerant overcharging leads to excess refrigerant in the condenser coils resulting in elevated compressor discharge pressure.

The system is undercharged if the superheat is too high and the sub-cooling is too low

Correct an undercharged system by adding refrigerant to the system to reduce superheat and raise sub-cooling.

If the sub-cooling is correct and the superheat is too high, the TXV may need adjustment to correct the superheat. Before adjusting the TXV, verity the sensing bulb is in the correct position according to Figure 16 and follows the guidelines below.

1. The suction line is clean where the sensing bulb is attached.

2. The entire length of the sensing bulb is in contact with the suction line.

3. The sensing bulb should be placed several inched downstream of the equalizer line.

4. The sensing bulb is fully insulated.

5. If the sensing bulb is installed on a vertical portion of the suction line, the sensing bulb should be placed upstream of a suction line trap.

Table 14 - R-410A Refrigerant Temperature-Pressure Chart

°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG
20	78.3	**47**	134.7	**74**	213.7	**101**	321.0	**128**	463.2
21	80.0	**48**	137.2	**75**	217.1	**102**	325.6	**129**	469.3
22	81.8	**49**	139.7	**76**	220.6	**103**	330.2	**130**	475.4
23	83.6	**50**	142.2	**77**	224.1	**104**	334.9	**131**	481.6
24	85.4	**51**	144.8	**78**	227.7	**105**	339.6	**132**	487.8
25	87.2	**52**	147.4	**79**	231.3	**106**	344.4	**133**	494.1
26	89.1	**53**	150.1	**80**	234.9	**107**	349.3	**134**	500.5
27	91.0	**54**	152.8	**81**	238.6	**108**	354.2	**135**	506.9
28	92.9	**55**	155.5	**82**	242.3	**109**	359.1	**136**	513.4
29	94.9	**56**	158.2	**83**	246.0	**110**	364.1	**137**	520.0
30	96.8	**57**	161.0	**84**	249.8	**111**	369.1	**138**	526.6
31	98.8	**58**	163.8	**85**	253.7	**112**	374.2	**139**	533.3
32	100.9	**59**	166.7	**86**	257.5	**113**	379.4	**140**	540.1
33	102.9	**60**	169.6	**87**	261.4	**114**	384.6	**141**	547.0
34	105.0	**61**	172.5	**88**	265.4	**115**	389.9	**142**	553.9
35	107.1	**62**	175.4	**89**	269.4	**116**	395.2	**143**	560.9
36	109.2	**63**	178.4	**90**	273.5	**117**	400.5	**144**	567.9
37	111.4	**64**	181.5	**91**	277.6	**118**	405.9	**145**	575.1
38	113.6	**65**	184.5	**92**	281.7	**119**	411.4	**146**	582.3
39	115.8	**66**	187.6	**93**	285.9	**120**	416.9	**147**	589.6
40	118.1	**67**	190.7	**94**	290.1	**121**	422.5	**148**	596.9
41	120.3	**68**	193.9	**95**	294.4	**122**	428.2	**149**	604.4
42	122.7	**69**	197.1	**96**	298.7	**123**	433.9	**150**	611.9
43	125.0	**70**	200.4	**97**	303.0	**124**	439.6		
44	127.4	**71**	203.6	**98**	307.5	**125**	445.4		
45	129.8	**72**	207.0	**99**	311.9	**126**	451.3		
46	132.2	**73**	210.3	**100**	316.4	**127**	457.3		

Maintenance

(See back of the manual for maintenance log.)

One week after start-up:

- Check operating pressures.
- Adjust belt tension on all fan drives.
- Check filters for cleanliness. Measure pressure loss if applicable. Replace if necessary.
- Check cycling of compressors, fans, and valves. Correct unusual cycling.

Monthly:

- Lubricate bearings if operating continuously at 1500 rpm, or higher, or in other extreme conditions.
- Check cleanliness of filters and replace if necessary.
- Check cooling coil drain pan to assure proper drainage.
- Inspect all coils. Clean if dirty or obstructed in any way.

Quarterly:

- Lubricate bearings if operating at 1000 rpm, or less, and in temperatures less than 150°F, or other extreme conditions.
- Check damper operation for freedom of movement. Correct any binding that may occur.
- Check belts and pulleys on fan drives for tension and unusual wear.
- Check operation of heating and cooling sections.
- Check inlet and outlet air temperatures.

Annually:

- Clean the coils with steam or non-corrosive coil cleaner.
- Clean the drain line, "P" trap, and condensate pan.
- Check refrigerant pressures and temperatures every Spring.
- Check heating section every Fall. Check all electrical connections for tightness and check heater elements for indications of overheating.

Fan Assembly

M2 Series units use backward curved fan wheels which are non-overloading, energy efficient and easy to clean. Cleaning the wheels is necessary to reduce electrical use, maintain capacity, and reduce stress on the unit. The wheel and fan section need to be inspected periodically and cleaned of dust or debris.

To inspect and clean the blower, set thermostat to the "OFF" position. Turn the electrical power to the unit to the "OFF" position at the disconnect switch. Clean the assembly. Check the bearings. Inspect the belt condition and tightness. Check screws for tightness. Rotate blower wheels while listening closely to each bearing to check for noise or roughness in the bearing, which can indicate a failing bearing.

Bearings

AAON uses pre-lubricated bearings, and bearings that have been sized for an average failure rate of 50% after 200,000 hours, or 22.8 years, of operation (see heading "Lubrication" in this section for more information). The bearing sizing tables below are based on rotational speeds and radial loading. However, the alignment of the bearing to the shaft and the security of the bearing inner race to the shaft will greatly affect bearing life. Even though the manufacturer is responsible for bearing tolerances and mounting design, **the servicer is advised to regularly check the security of the bearing locking system.**

Table 15 - Bearing Setscrew Torque Recommendations

Shaft Size (inches)	Setscrew Locking	
	Thread	Torque (in-lbs.)
1	1/4 - 28	66 - 85
1 3/16	1/4 - 28	66 - 85
1 7/16	5/16 - 24	126 - 164
1 7/8	3/8 - 24	228 - 296
Shaft Size (inch)	Skewzloc Locking	
	Thread	Torque (in-lbs.)
1	8 - 32	63 - 70
1 3/16	8 - 32	63 - 70
1 7/16	10 - 24	81 - 90
1 7/8	1/4 - 20	162 - 180

Belts

Belt drive misalignment is one of the most common causes of premature belt failure. A belt can be destroyed in a matter of days if the drives have been aligned incorrectly.

The most common tool for measuring misalignment is a straightedge. Hold the straightedge flush across one pulley to gauge the degree of misalignment of the two sheaves. The maximum allowed misalignment is one half degree of angular misalignment, and 1/10th of an inch per foot between sheave centers for parallel misalignment.

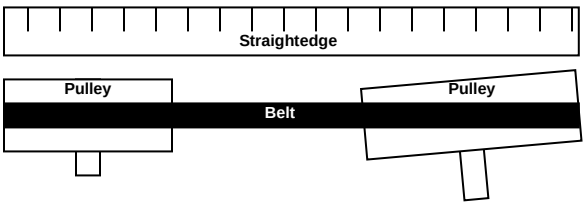


Figure 36 - Angular Misalignment

Correct by moving the position of the motor.

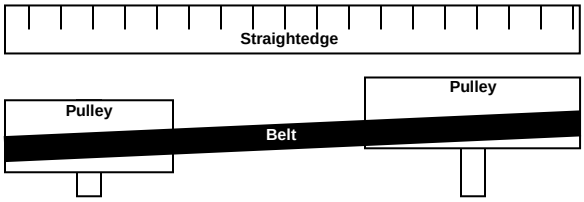


Figure 37 - Parallel Misalignment

Correct by adjusting sheaves on one, or both shafts.

Frequent belt tensioning is highly recommended. Most belt manufacturers would suggest a re-tensioning after as little as 8 hours of operation. A simplified method of adjusting tension is to gauge the amount of force required to deflect the belt by 1/64th of an inch per inch of distance between sheave centers. For example, if the sheaves are 20 inches apart, then the amount of deflection with the forces listed below is 20/64th (5/16th) of an inch.

Deflection required for
"A" belts: 4-6 lbs.
"B" belts: 6-10 lbs.
"C" belts: 10-18 lbs.

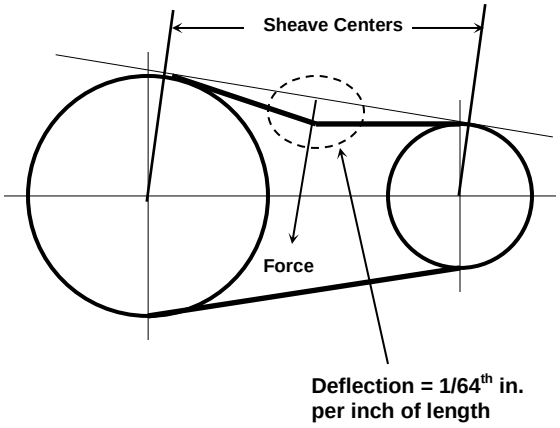


Figure 38 - Belt Deflection

Indoor Coils
Indoor cooling/evaporator coils must be cleaned regularly to maintain unit efficiency and operation. Dirty evaporator coils will eventually freeze up and often result in a time consuming and expensive service call. Clean filters will help to prevent dirt from accumulating on cooling coils, however cooling coils should be cleaned at least annually by an HVAC professional.

Refrigeration Cycle
Satisfactory performance of the refrigeration cycle can be determined by measuring suction line superheat. In order to determine if refrigerant flowing from the evaporator is dry, ensure that the system has enough refrigerant to produce liquid line subcooling, but not so much to cause abnormally high condensing temperatures (and pressures). Refrigerant cycle analysis is best performed in conditions that approach the conditions where the air conditioner will be expected to operate.

E-Coated Coil Cleaning
Documented routine cleaning of e-coated coils is required to maintain coating warranty coverage.

⚠ WARNING

Electric shock hazard. Shut off all electrical power to the unit to avoid shock hazard or injury from rotating parts.

Surface loaded fibers or dirt should be removed prior to water rinse to prevent restriction of airflow. If unable to back wash the side of the coil opposite of the coils entering air side, then surface loaded fibers or dirt should be removed with a vacuum cleaner. If a vacuum cleaner is not available, a ***soft non-metallic*** bristle brush may be used. In either case, the tool should be applied in the direction of the fins. Coil surfaces can be easily damaged (fin edges bent over) if the tool is applied across the fins.

Use of a water stream, such as a garden hose, against a surface loaded coil will drive the fibers and dirt into the coil. This will make cleaning efforts more difficult. Surface loaded fibers must be completely removed prior to using low velocity clean water rinse.

A ***monthly*** clean water rinse is recommended for coils that are applied in coastal or industrial environments to help to remove chlorides, dirt, and debris. It is very important when rinsing, that water temperature is less than 130°F and pressure is than 900 psig to avoid damaging the fin edges. An elevated water temperature (not to exceed 130°F) will reduce surface tension, increasing the ability to remove chlorides and dirt.

⚠ CAUTION

High velocity water from a pressure washer or compressed air should only be used at a very low pressure to prevent fin and/or coil damages. The force of the water or air jet may bend the fin edges and increase airside pressure drop. Reduced unit performance or nuisance unit shutdowns may occur.

Quarterly cleaning is essential to extend the life of an e-coated coil and is required to maintain coating warranty coverage. Coil cleaning shall be part of the unit's regularly scheduled maintenance procedures. Failure to clean an e-coated coil will void the warranty and may result in reduced efficiency and durability.

⚠ CAUTION

Harsh chemicals, household bleach, or acid cleaners should not be used to clean outdoor or indoor e-coated coils. These cleaners can be very difficult to rinse out of the coil and can accelerate corrosion and attack the e-coating. If there is dirt below the surface of the coil, use the recommended coil cleaners.

For routine quarterly cleaning, first clean the coil with the below approved coil cleaner. After cleaning the coils with the approved cleaning agent, use the approved chloride remover to remove soluble salts and revitalize the unit.

Recommended Coil Cleaner
The following cleaning agent, assuming it is used in accordance with the manufacturer's directions on the container for proper mixing and cleaning, has been approved for use on e-coated coils to remove mold, mildew, dust, soot, greasy residue, lint and other particulate:

Enviro-Coil Concentrate, Part Number H-EC01.

Recommended Chloride Remover
CHLOR*RID DTS™ should be used to remove soluble salts from the e-coated coil, but the directions must be followed closely. This product is not intended for use as a degreaser. Any grease or oil film should first be removed with the approved cleaning agent.

Remove Barrier - Soluble salts adhere themselves to the substrate. For the effective use of this product, the product must be able to come in contact with the salts. These salts may be beneath any soils, grease or dirt; therefore, these barriers must be removed prior to application of this product. As in all surface preparation, the best work yields the best results.

Apply CHLOR*RID DTS - Apply directly onto the substrate. Sufficient product must be applied uniformly across the substrate to thoroughly wet out surface, with no areas missed. This may be accomplished by use of a pump-up sprayer or conventional spray gun. The method does not matter, as long as the entire area to be cleaned is wetted. After the substrate has been thoroughly wetted, the salts will be soluble and is now only necessary to rinse them off.

Rinse - It is highly recommended that a hose be used, as a pressure washer will damage the fins. The water to be used for the rinse is recommended to be of potable quality, though a lesser quality of water may be used if a small amount of CHLOR*RID DTS is added. Check with CHLOR*RID International, Inc. for recommendations on lesser quality rinse water.

Electric Heating
Set thermostat in the heat mode; call for heat to engage all electric heat strips. Check blower for proper rotation and voltage. Measure the amperage and voltage. Compare them to the nameplate data.

If applicable, check remote heat pump condenser as per the manufacturer's recommendations.

Steam or Hot Water Heating
Set thermostat in the heat mode. Observe supply blower for proper rotation and voltage. Check boiler or hot water operation according to the manufacturer's instructions. Check control flow valves for correct operation and settings per the manufacturer's instructions.

Cleaning
Inspect and clean unit interior at the beginning of each heating and cooling season and as operating conditions require.

Chilled Water
Check remote chiller operations as per the manufacturer's instructions. Check coolant flow valves for correct operation and settings.

Lubrication
Most motors and bearings are permanently lubricated. Some applications may require that bearings be re-lubricated periodically. The schedule will depend on the operating duty, temperature variations, and other atmospheric conditions.

For bearings equipped with lubrication fittings, the lubrication schedule is dependent on operating temperatures and rotational speeds as shown in the table below. Lithium based grease conforming to an NLGI grade No. 2 consistency is recommended. This medium viscosity, low torque grease is rust inhibiting and water-resistant. It is satisfactory for operating temperatures in the range of –10°F to 250°F.

Bearings should only be re-lubricated when at normal operating temperatures and not running. Rotate the fan shaft by hand, adding only enough grease to purge the seals. A one-inch bearing has a total grease capacity of only .25 ounces. Added grease should be limited to .09 ounces.

DO NOT OVER LUBRICATE.

Recommended greases are:
SHELL OIL - DOLIUM R
CHEVRON OIL - SRI No. 2
TEXACO INC. - PREMIUM RB

Table 16 - Fan Bearing Lubrication Schedule

Fan Speed	Temp.	Environ.	Greasing Interval
500 rpm	Up to 150 °F	Clean	2 to 6 months
1000 rpm	Up to 210 °F	Clean	2 weeks to 2 months
1500 rpm	Up to 210 °F	Clean	Monthly
Any Speed	Up to 150 °F	Dirty	1 week to 1 month
Any Speed	210 - 250 °F	Dirty	Weekly

In the event the unit is not functioning correctly and a service company is required, only a company with service technicians qualified and experienced in both commercial heating and air conditioning should be permitted to service the systems in order to keep warranties in effect. The service tech may call the factory if assistance is required.

Replacement Parts
Parts for AAON equipment may be obtained from your local AAON representative. When ordering parts, reference the unit serial number and part number.

AAON-Longview Product Support
203 Gum Springs Road
Longview, TX 75602
Ph: 903-236-4403
Fax: 903-236-4463
www.aaon.com

Note: Before calling, technician should have model and serial number of the unit available for the service department to help answer questions regarding the unit.

Filter Replacement
Monthly air filter inspection is required to maintain optimum unit efficiency. It is strongly recommended that filter media be replaced monthly. Open access panel and pull filters straight out to inspect all of the filters. Replace filters with the size indicated on each filter. Arrow on the replacement filters must point towards the blower.

⚠ WARNING

Electric shock hazard. Shut off all electrical power to the unit to avoid shock hazard or injury from rotating parts.

Table 17 - M2-005 and M2-008 Filters

Filter Type	(Quantity) Size	
	M2-005	M2-008
2” Pleated - 30% Eff, MERV 8	(2) 20” x 20”	(4) 16” x 20”
4” Pleated - 30% Eff (MERV 8), 65% Eff (MERV 11), 85% Eff (MERV 13), or 95% Eff (MERV 14)		
12” Cartridge - 65% Eff (MERV 11), 85% Eff (MERV 13), or 95% Eff (MERV 14)		

Table 18 - M2-011 and M2-014 Filters

Filter Type	(Quantity) Size	
	M2-011	M2-014
2” Pleated - 30% Eff, MERV 8	(2) 16” x 20” and (4) 20” x 20”	
4” Pleated - 30% Eff (MERV 8), 65% Eff (MERV 11), 85% Eff (MERV 13), or 95% Eff (MERV 14)		
12” Cartridge - 65% Eff (MERV 11), 85% Eff (MERV 13), or 95% Eff (MERV 14)		

Table 19 - M2-018 and M2-022 Filters

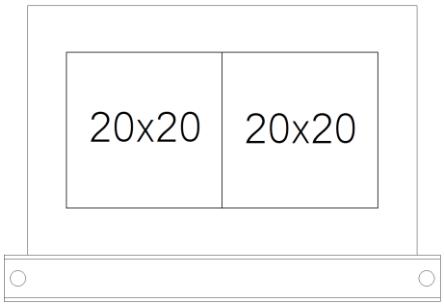
Filter Type	(Quantity) Size	
	M2-018	M2-022
2” Pleated - 30% Eff, MERV 8	(8) 20” x 20”	(4) 25” x 20” (4) 20” x 20”
4” Pleated - 30% Eff (MERV 8), 65% Eff (MERV 11), 85% Eff (MERV 13), or 95% Eff (MERV 14)		
12” Cartridge - 65% Eff (MERV 11), 85% Eff (MERV 13), or 95% Eff (MERV 14)		

Table 20 - M2-026 Filters

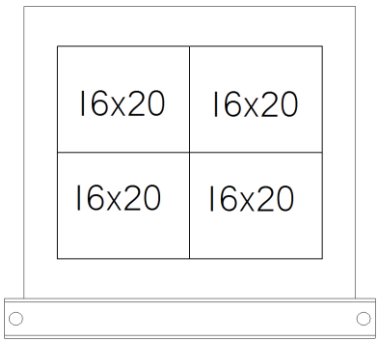
Filter Type	(Quantity) Size
	M2-026
2” Pleated - 30% Eff, MERV 8	(4) 16” x 20” (8) 20” x 20”
4” Pleated - 30% Eff (MERV 8), 65% Eff (MERV 11), 85% Eff (MERV 13), or 95% Eff (MERV 14)	
12” Cartridge - 65% Eff (MERV 11), 85% Eff (MERV 13), or 95% Eff (MERV 14)	

Table 21 - M2-032 and M2-036 Filters

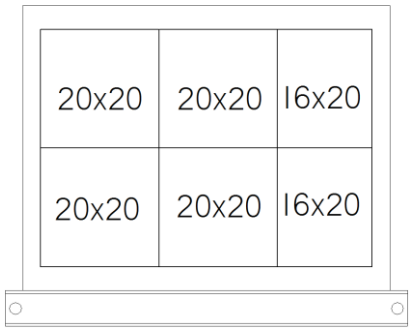
Filter Type	(Quantity) Size	
	M2-032	M2-036
2” Pleated - 30% Eff, MERV 8	(3) 16” x 20” and (12) 20” x 20”	
4” Pleated - 30% Eff (MERV 8), 65% Eff (MERV 11), 85% Eff (MERV 13), or 95% Eff (MERV 14)		
12” Cartridge - 65% Eff (MERV 11), 85% Eff (MERV 13), or 95% Eff (MERV 14)		



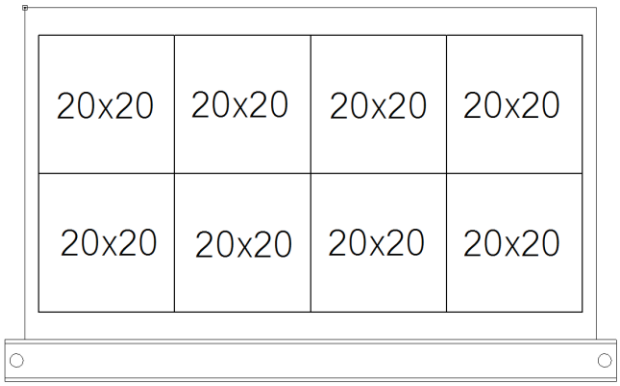
M2-005



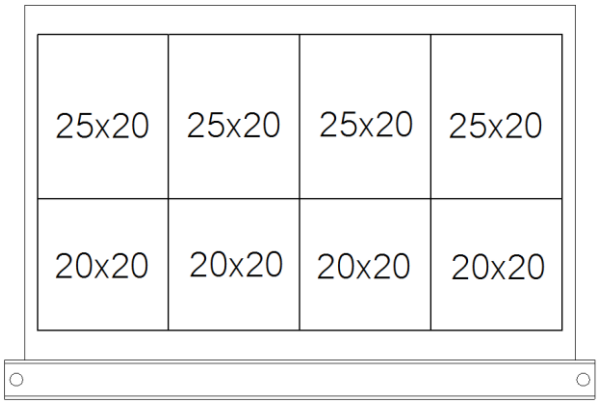
M2-008



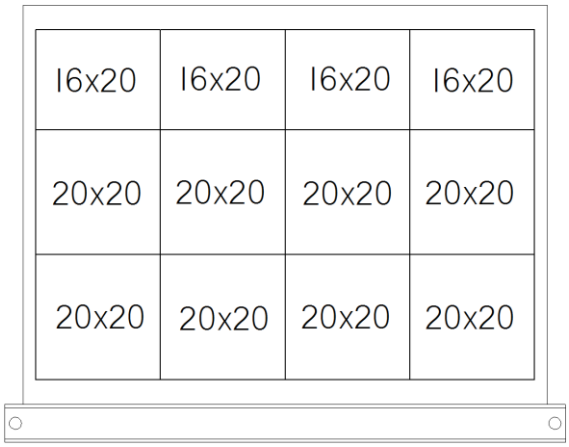
M2-011 / M2-014



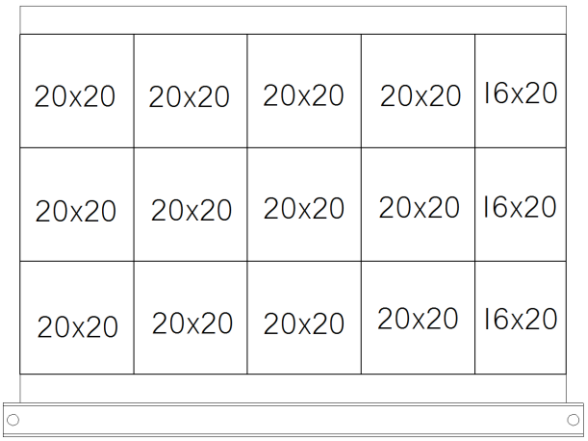
M2-018



M2-022



M2-026



M2-032 / M2-036*

Figure 39 - Filter Layout
(Viewed from the Upstream Side of the Cooling Coil)

*M2-032 and M2-036 are designed with a face load filter rack.

Appendix A - Heat Exchanger Corrosion Resistance

Corrosion Resistance of Copper and Stainless Steel in Brazed Plate Heat Exchangers - Points to Measure and Check in a Water Analysis

The resistance guide provides the corrosion resistance of stainless steel type AISI 316 and pure Copper (99.9%) in water, to a number of important chemical factors. The actual corrosion is a very complex process influenced by many different factors in combination.

Explanations: + Good resistance under normal conditions
0 Corrosion problems may occur especially when more factors are valued 0
- Use is not recommended

Water Containing	Concentration (mg/l or ppm)	Time Limits - Analyze Before	AISI 316	SMO 254	Copper Alloy	Nickel Alloy
Alkalinity (HCO_3^-)	< 70	Within 24 Hours	+	+	0	+
	70-300		+	+	+	+
	> 300		+	+	0/+	+
Sulfate (SO_4^{2-})	< 70	No Limit	+	+	+	+
	70-300		+	+	0/-	+
	> 300		0	0	-	+
HCO_3^-/ SO_4^{2-}	> 1.0	No Limit	+	+	+	+
	< 1.0		+	+	0/-	+
Electrical Conductivity	< 10µS/cm	No Limit	+	+	0	+
	10-500 µS/cm		+	+	+	+
	> 500 µS/cm		+	+	0	+
pH	< 6.0	Within 24 Hours	0	0	0	+
	6.0-7.5		0/+	+	0	+
	7.5-9.0		+	+	+	+
	> 9.0		+	+	0	+
Ammonium (NH_4^+)	< 2	Within 24 Hours	+	+	+	+
	2-20		+	+	0	+
	> 20		+	+	-	+
Chlorides (Cl^-)*	< 300	No Limit	+	+	+	+
	> 300		0	+	0/+	+
Free Chlorine (Cl_2)	< 1	Within 5 Hours	+	+	+	+
	1-5		+	+	0	+
	> 5		0/+	+	0/-	+
Hydrogen Sulfide (H_2S)	< 0.05	No Limit	+	+	+	+
	> 0.05		+	+	0/-	+
Free (aggressive) Carbon Dioxide (CO_2)	< 5	No Limit	+	+	+	+
	5-20		+	+	0	+
	> 20		+	+	-	+

*See Chloride Content Table

Water Containing	Concentration (mg/l or ppm)	Time Limits - Analyze Before	AISI 316	SMO 254	Copper Alloy	Nickel Alloy
Total Hardness (°dH)	4.0-8.5	No Limit	+	+	+	+
Nitrate (NO_3)	< 100	No Limit	+	+	+	+
	> 100		+	+	0	+
Iron (Fe)	< 0.2	No Limit	+	+	+	+
	> 0.2		+	+	0	+
Aluminum (Al)	< 0.2	No Limit	+	+	+	+
	> 0.2		+	+	0	+
Manganese (Mn)	< 0.1	No Limit	+	+	+	+
	> 0.1		+	+	0	+

Chloride Content

Chloride Content	Maximum Temperature			
	60°C (140°F)	80°C (176°F)	120°C (248°F)	130°C (266°F)
= 10 ppm	SS 304	SS 304	SS 304	SS 316
= 25 ppm	SS 304	SS 304	SS 316	SS 316
= 50 ppm	SS 304	SS 316	SS 316	Ti / SMO 254
= 80 ppm	SS 316	SS 316	SS 316	Ti / SMO 254
= 150 ppm	SS 316	SS 316	Ti / SMO 254	Ti / SMO 254
= 300 ppm	SS 316	Ti / SMO 254	Ti / SMO 254	Ti / SMO 254
> 300 ppm	Ti / SMO 254	Ti / SMO 254	Ti / SMO 254	Ti / SMO 254

Split System Piping Diagrams

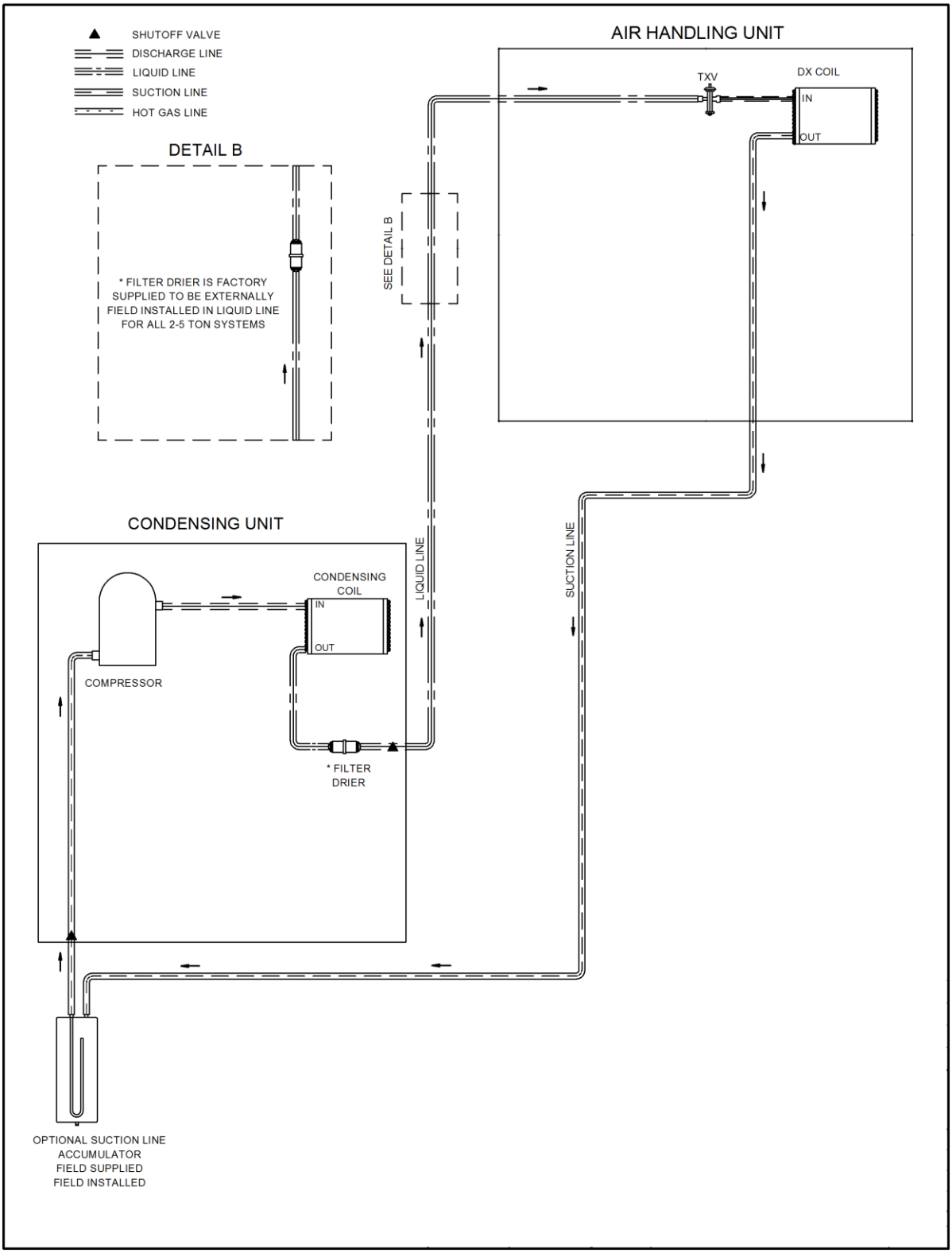


Figure 40 - A/C Split System Piping

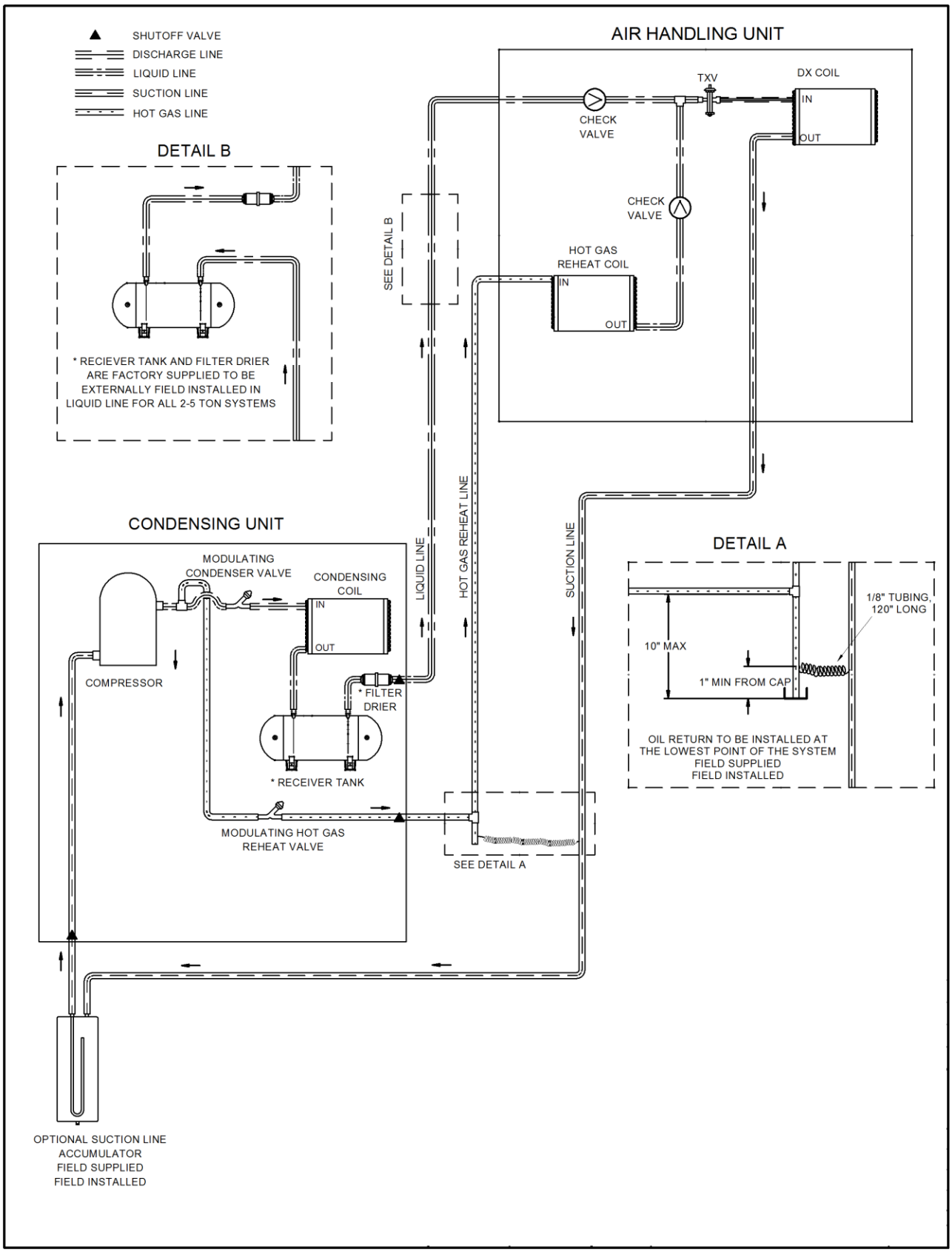


Figure 41 - A/C with Modulating Hot Gas Reheat Split System Piping

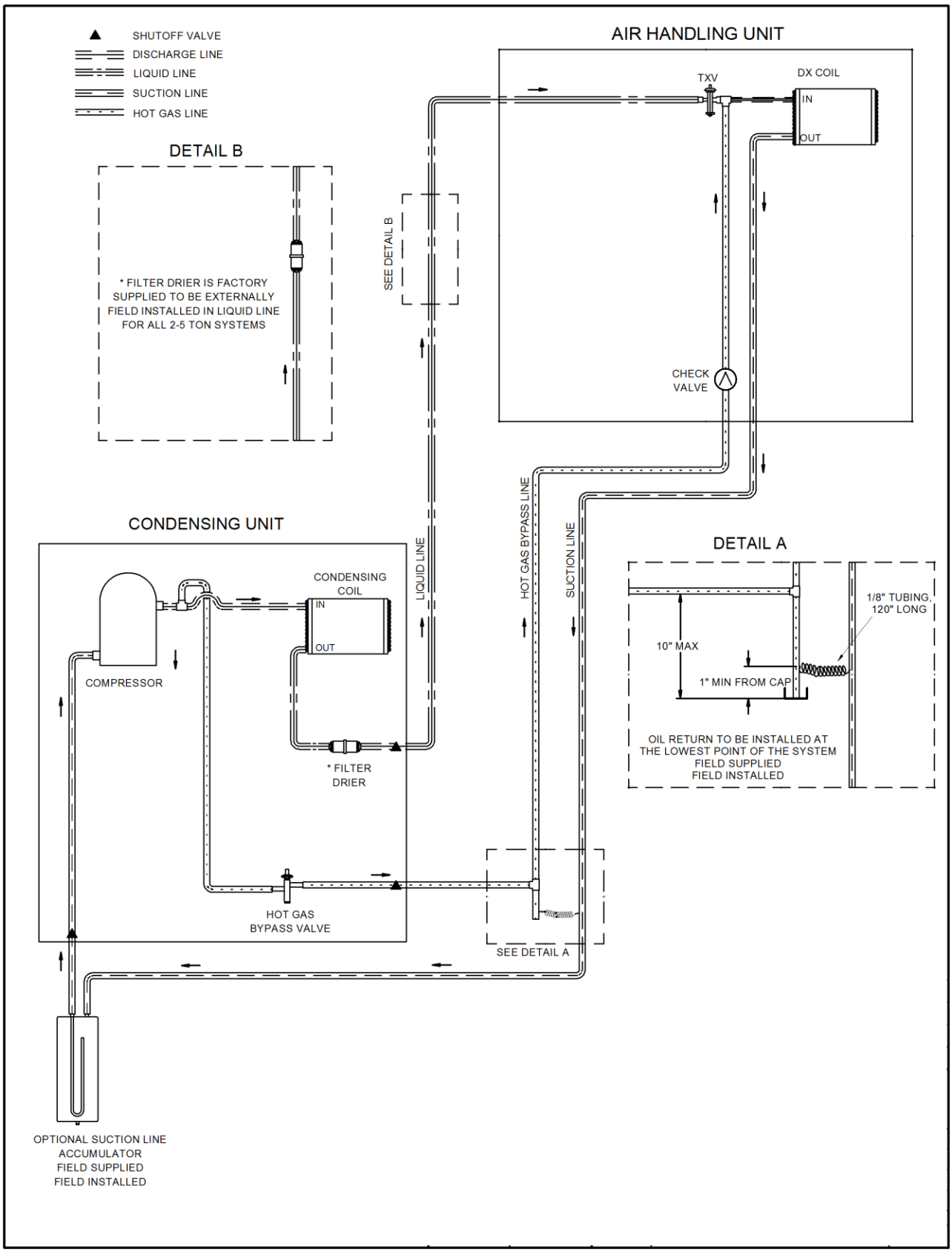


Figure 42 - A/C with Hot Gas Bypass Split System Piping

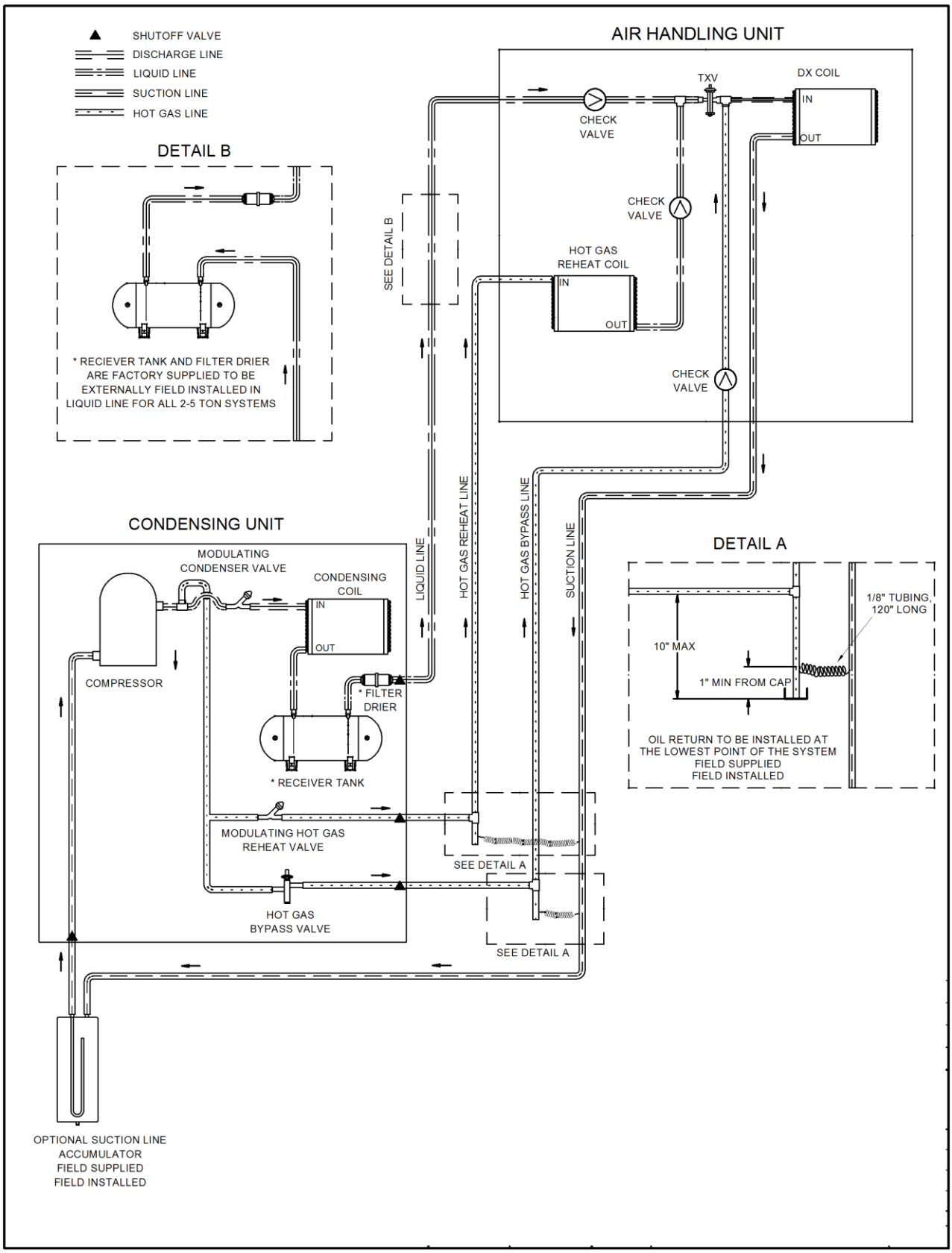


Figure 43 - A/C with Modulating Hot Gas Reheat and Hot Gas Bypass Split System Piping

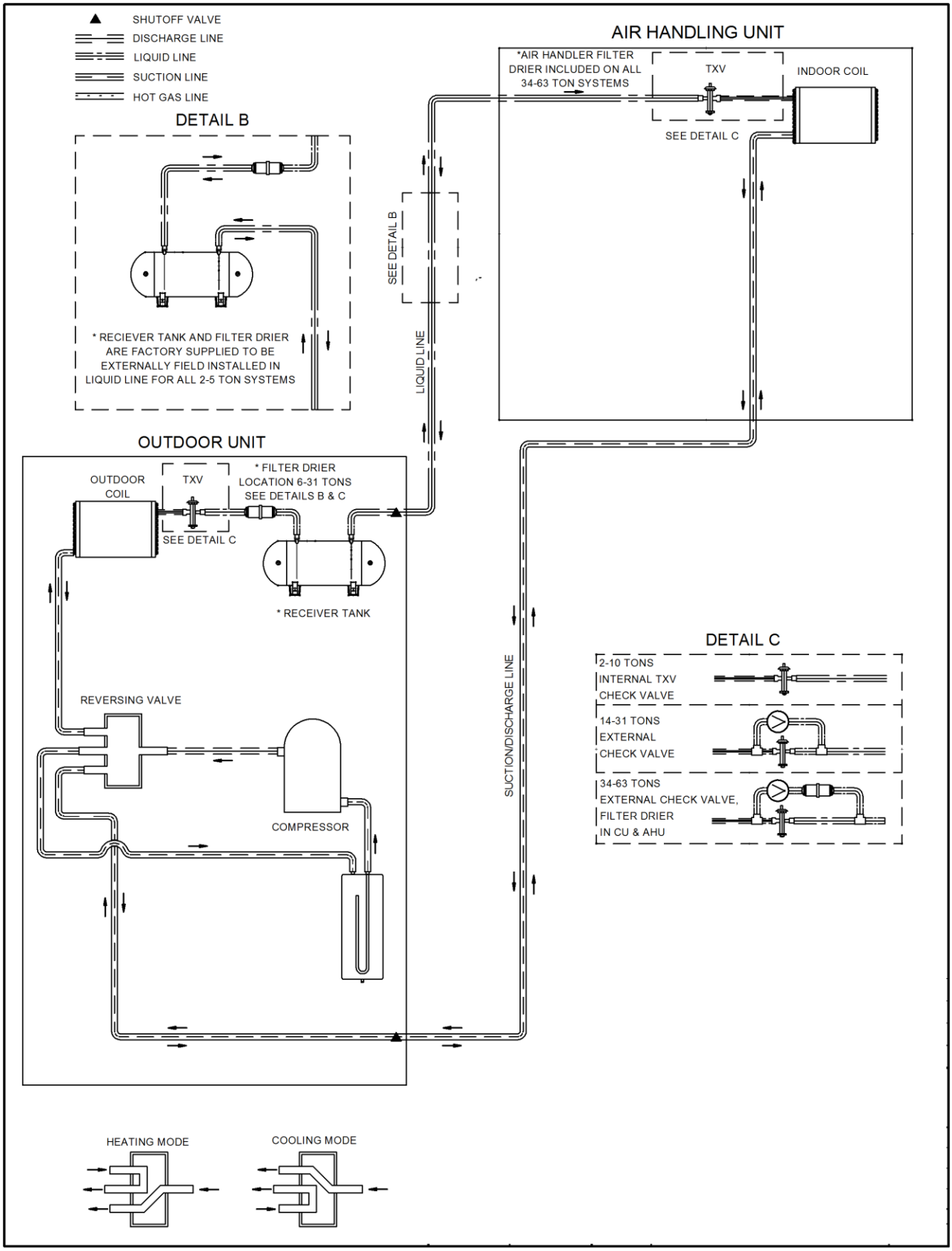


Figure 44 - Heat Pump Split System Piping

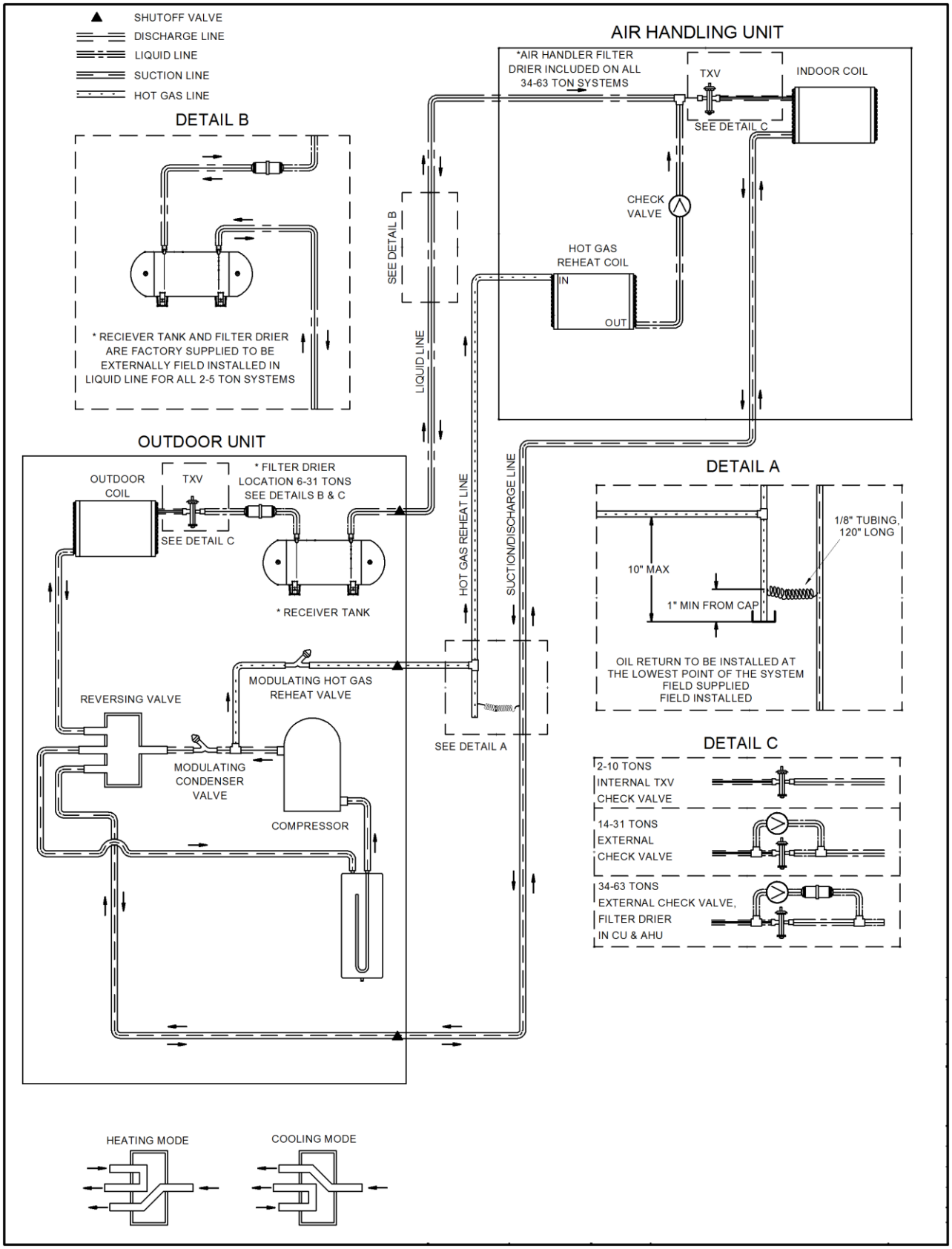


Figure 45 - Heat Pump with Modulating Hot Gas Reheat Split System Piping

M2 Series Startup Form

Job Name:_____ Date:_____

Address:_____

_____

Model Number:_____

Serial Number:_____ Tag:_____

Startup Contractor:_____

Address:_____

_____ Phone:_____

Pre Startup Checklist

Installing contractor should verify the following items.	
1. Is there any visible shipping damage?	☐Yes ☐No
2. Is the unit level?	☐Yes ☐No
3. Are the unit clearances adequate for service and operation?	☐Yes ☐No
4. Do all access doors open freely and are the handles operational?	☐Yes ☐No
5. Have all shipping braces been removed?	☐Yes ☐No
6. Have all electrical connections been tested for tightness?	☐Yes ☐No
7. Does the electrical service correspond to the unit nameplate?	☐Yes ☐No
8. On 208/230V units, has transformer tap been checked?	☐Yes ☐No
9. Has overcurrent protection been installed to match the unit nameplate requirement?	☐Yes ☐No
10. Have all set screws on the fans been tightened?	☐Yes ☐No
11. Do all fans rotate freely?	☐Yes ☐No
12. Does the field water piping to the unit appear to be correct per design parameters?	☐Yes ☐No
13. Is all copper tubing isolated so that it does not rub?	☐Yes ☐No
14. Have the damper assemblies been inspected?	☐Yes ☐No
15. Are air filters installed with proper orientation?	☐Yes ☐No
16. Have condensate drain and p-trap been connected?	☐Yes ☐No
17. Is the TXV sensing bulb in the correct location?	☐Yes ☐No
18. Does the TXV sensing bulb have proper thermal contact and is properly insulated?	☐Yes ☐No

Ambient Temperature

Ambient Dry Bulb Temperature _____°F	Ambient Wet Bulb Temperature _____°F

Supply Fan Assembly

Alignment ☐ Check Rotation ☐ Nameplate Amps_____

Number	hp	L1	L2	L3
1				
2				

Band Size_____ VAV Controls_____

VFD Frequency_____ Springs Operating Correctly ☐

Energy Recovery Wheel Assembly

Wheels Spin Freely☐ Check Rotation ☐ FLA _____

Number	hp	L1	L2	L3
1				
2				

Power Exhaust Fan Assembly

Alignment ☐ Check Rotation ☐ Nameplate Amps_____

Number	hp	L1	L2	L3
1				
2				

Band Size_____

VFD Frequency_____ Springs Operating Correctly ☐

Power Return Fan Assembly

Alignment ☐ Check Rotation ☐ Nameplate Amps_____

Number	hp	L1	L2	L3
1				
2				

Band Size_____

VFD Frequency_____ Springs Operating Correctly ☐

Outside Air/Economizer Dampers

OA Operation Check ☐	Damper Wiring Check ☐	Gears Check ☐
RA Operation Check ☐	Damper Wiring Check ☐	Gears Check ☐
EA Operation Check ☐	Damper Wiring Check ☐	Gears Check ☐
Damper Actuator Type:_____		
Economizer Changeover Type and Operation:_____		

Unit Configuration

Water-Cooled Condenser ☐	Air-Cooled Condenser ☐
No Water Leaks ☐	Condenser Safety Check ☐
Water Flow _____ gpm	
Water Inlet Temperature _____°F	Water Outlet Temperature _____°F

Compressors/DX Cooling

Check Rotation ☐

Number	L1	L2	L3	Head Pressure PSIG	Suction Pressure PSIG	Crankcase Heater Amps
1						
2						
3						
4						

Refrigeration System 1 - Cooling Mode

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Refrigeration System 2 - Cooling Mode

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Refrigeration System 3 - Cooling Mode

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Refrigeration System 4 - Cooling Mode

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Refrigeration System 1 - Heating Mode (Heat Pump Only)

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Refrigeration System 2 - Heating Mode (Heat Pump Only)

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Refrigeration System 3 - Heating Mode (Heat Pump Only)

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Refrigeration System 4 - Heating Mode (Heat Pump Only)

	Pressure	Saturated Temperature	Line Temperature	Sub-cooling	Superheat
Discharge				N/A	N/A
Suction				N/A	
Liquid					N/A

Air-Cooled Condenser

Alignment ☐		Check Rotation ☐		Nameplate Amps_____
Number	hp	L1	L2	L3
1				
2				
3				
4				
5				
6				

Water/Glycol System

1. Has the entire system been flushed and pressure checked?	☐Yes ☐No
2. Has the entire system been filled with fluid?	☐Yes ☐No
3. Has air been bled from the heat exchangers and piping?	☐Yes ☐No
4. Is the glycol the proper type and concentration (N/A if water)?	☐Yes ☐No
5. Is there a minimum load of 50% of the design load?	☐Yes ☐No
6. Has the water piping been insulated?	☐Yes ☐No
7. What is the freeze point of the glycol (N/A if water)? _____	

Gas Heating

Natural Gas ☐	Propane ☐	Purge Air from Lines ☐	Verify Pilot Spark ☐
Stage	Manifold Pressure (w.c.)	Stage	Manifold Pressure (w.c.)
1		3	
2		4	

Electric Heating

Stages_____		Limit Lockout ☐	Aux. Limit Lockout ☐
Stage	Amps	Stage	Amps
1		5	
2		6	
3		7	
4		8	

Electric Preheating

Limit Lockout ☐		Aux. Limit Lockout ☐	
Outside Air Temperature Setpoint_____°F			
Preheat Leaving Air Temperature Setpoint_____°F			
Stage	Amps	Stage	Amps
1		3	
2		4	

Maintenance Log

This log must be kept with the unit. It is the responsibility of the owner and/or maintenance/service contractor to document any service, repair or adjustments. AAON Service and Warranty Departments are available to advise and provide phone help for proper operation and replacement parts. The responsibility for proper startup, maintenance and servicing of the equipment falls to the owner and qualified licensed technician.

Entry Date	Action Taken	Name/Tel.

Literature Change History

March 2010
Update of IOM adding gas heater, self-contained unit and packaged rooftop unit information.

July 2010
Update of IOM adding PVC and CPVC piping Caution and split system piping information.

November 2010
Update of IOM adding control wiring information, correcting M2-022 and M2-026 filter sizes and adding modulating hot gas reheat only piping diagram.

June 2011
Update of the IOM adding additional electric heat capacity options to the heat module, correcting the condensate drain connection to 1" MPT, and adding the electronic startup form.

April 2012
Update of the IOM, changing the suction trap requirement for variable capacity scroll compressor circuits to every 10 feet, correcting the Modulating Hot Gas Reheat and Modulating Hot Gas Reheat with Hot Gas Bypass piping diagrams to show the liquid line tee connection factory installed, adding the Heat Pump with Field Installed Modulating Hot Gas Reheat Split System Piping Diagram, and updating the table of contents.

November 2013
Updated factory trained technician verbiage, updated individual module installation instructions, updated split system piping diagrams, and updated feature string nomenclature.

June 2014
Added water-source heat pump module configurator, updated energy recovery units section, and added caution for 100% outside air water-source heat pumps.

August 2014
Removed dehumidification as a heating function for heat modules.

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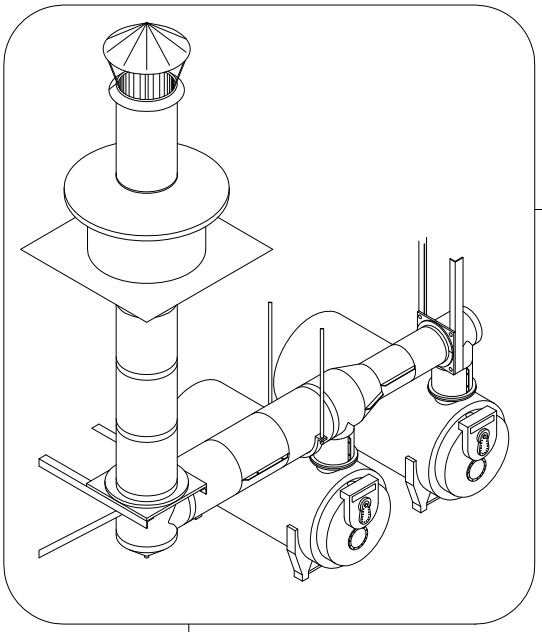
M2 Series
Installation, Operation & Maintenance
R40681 · Rev. C · 140818
(ACP 30752)

It is the intent of AAON to provide accurate and current product information. However, in the interest of product improvement, AAON reserves the right to change pricing, specifications, and/or design of its product without notice, obligation, or liability.

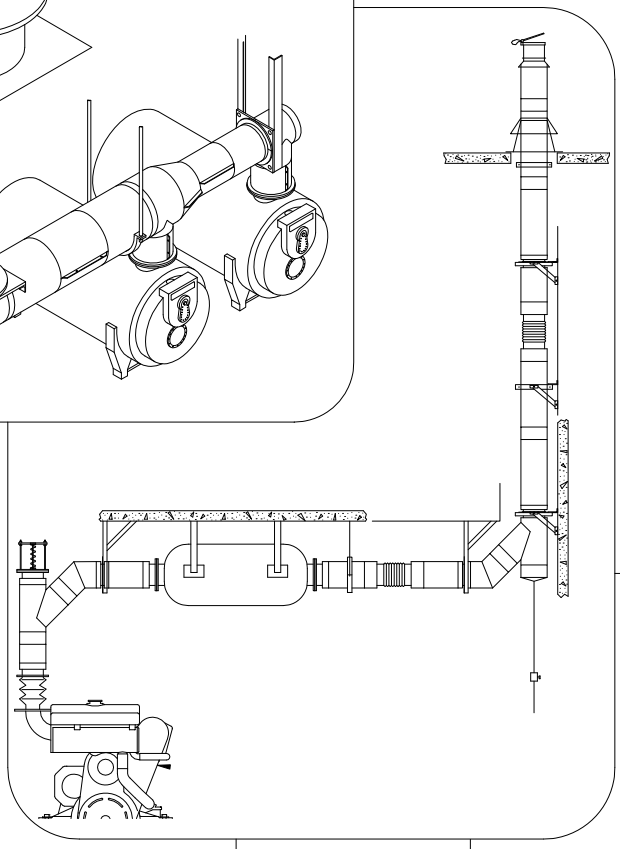
AMPCO®

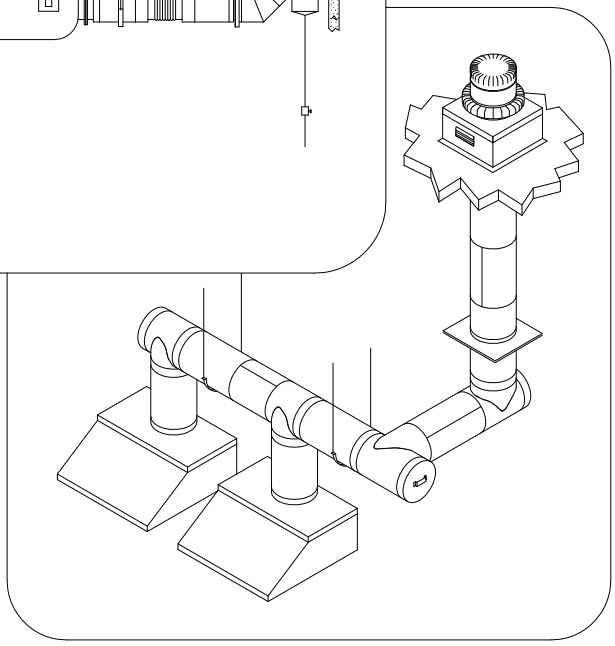
INSTALLATION INSTRUCTIONS
& MAINTENANCE GUIDE

MODEL N, VSI, IVSI & ZC
SINGLE WALL, DOUBLE WALL AIR & CERAMIC FIBER INSULATED POSITIVE PRESSURE PIPING SYSTEMS



- **BOILER STACK**
- **ENGINE EXHAUST**
- **GREASE DUCT**





c UL US
LISTED

A MAJOR CAUSE OF CHIMNEY RELATED FIRES IS FAILURE TO MAINTAIN REQUIRED CLEARANCES (AIR SPACES) TO COMBUSTIBLE MATERIALS. IT IS OF UTMOST IMPORTANCE THAT THIS CHIMNEY BE INSTALLED IN ACCORDANCE WITH THESE INSTRUCTIONS.

Table of Contents

GENERAL INFORMATION

SAFETY PRECAUTIONS

⚠WARNING
Failure to follow these Installation Instructions could cause FIRE, CARBON MONOXIDE POISONING, OR DEATH. If you are unsure of Installation requirements, call the Phone Number listed on the front of these instructions.

Caution-Risk of injury. Sheet metal parts may be sharp. Always wear gloves and appropriate eye, foot, and other protection when handling these products.

Follow these instructions carefully. Failure to follow these instructions could result in an unsafe installation. If you are unsure of any instructions contact the factory at the number indicated on the front page of these instructions.

A major cause of chimney/duct related fires is failure to maintain required clearances (airspace) to combustible materials. It is of utmost importance that this product be installed only in accordance with these instructions.

Reference *Combustion & Ventilation Air* on page 30 for proper air supply guidelines.

FEATURES

Model N, VSI and IVSI products are cylindrical, prefabricated, modular venting systems incorporating flanged joints, designed for both quick assembly and pressure sealing capability. Model N is single wall vent. Model VSI is of double wall construction incorporating a 1" airspace between walls and Model IVSI incorporates 1" to 4" thick ceramic fiber insulation. Their circular cross section and high quality stainless steel inner wall construction provide for a system with high strength-to-weight ratio and low friction losses.

UNDERWRITERS LABORATORIES LISTINGS

Ampco single wall Model N (aka VSI-I) and double wall models VSI (aka VSI-II) and IVSI venting systems are Listed by Underwriters Laboratories, Inc. (UL) under UL File MH6673 in the following product categories and in the diameters indicated:

Model N (Single wall pipe) (aka VSI-1)	
Grease Duct for Restaurant Cooking Appliances	5" - 48"ID
Chimney Liner – Gas/Oil- UL 1777	5"- 48" ID
Chimney Liner for Existing Masonry & Factory-Built Chimneys- ULC S635	5" - 48"ID

Model VSI (Double wall, 1" air insulation) (aka VSI-II)	
Building Heating Appliance Chimney	5"- 48" ID
1400° Fahrenheit Chimney	5"– 48"ID
Grease Duct for Restaurant Cooking Appliances	5" - 48"ID

Model IVSI (Double wall, 1, 2, 3 or 4" thick fiber insulation)	
Building Heating Appliance Chimney	5"- 48"ID
1400° Fahrenheit Chimney	5"–48" ID
Building Heating Appliance Chimney(Type HT)	5"- 24"ID
Low Temperature Venting System, Type L	5" - 24"ID
Grease Duct for Restaurant Cooking Appliances	5" - 48"ID

For Zero clearance grease duct applications (model IVSI-Z3 & IVSI-Z4) see Section G, "Grease Ducts".

APPLICATIONS

Building Heating Appliance Chimney Listing - Under this category (UL 103, ULC-C959), Model VSI and IVSI have been determined suitable for venting flue gases at a temperature not exceeding 1000°F, under continuous operating conditions, from gas, liquid and solid fuel fired appliances. Intermittent operation (less than one hour) at temperatures not exceeding 1400°F, and brief (maximum 10 minute) operation at temperatures not exceeding 1700°F, is also permitted under this application.

Building Heating Appliance Chimney (Type HT) Listing - Under this category (UL 103HT), the 5" through 24" ID Model IVSI has qualified for UL's additional, optional "Type HT" rating (for Building Heating Appliance Chimneys) which indicates they have been evaluated and found suitable for exposure to 2100°F flue gases for a 10 minute duration at **2"** airspace clearance to combustibles (unenclosed). Many local, state and regional code authorities require a "Type HT" rating for chimneys for certain appliance venting applications; especially solid fuel.

Building Heating Appliance Chimneys are suitable for use with Building Heating Appliances and other Low Heat Appliances as described in the Chimney Selection Chart of National Fire Protection Association (NFPA) Standard No. 211.

1400°F Chimney Listing - Under this category (UL 2561, ULC-C959), Model VSI and IVSI have been determined suitable for venting flue gases continuously at a temperature not exceeding 1400°F, and a 10 minute intermittent service at temperatures not exceeding 1800°F. As such, Model VSI and IVSI are suitable for use with ovens and furnaces as described in the Chimney Selection Chart of NFPA No. 211, in addition to other Applications.

Low Temperature Venting System, Type L (L-Vent) Listing - Under this category (UL 641), 5" through 24" ID Model IVSI has been determined suitable for use with gas and oil fueled appliances Listed as suitable for venting with Type L or Type B venting systems. This qualifies the system for handling continuous flue gas temperatures at a maximum of 480°F above ambient, and permits full enclosure in combustible chase construction, assuming the specified minimum airspace clearance-to-combustibles is maintained.

Grease Duct for Commercial Cooking Appliances Listing - Applications and instructions for this category (UL 1978) are covered in Section "G" entitled "Grease Duct".

Based upon the above referenced UL Listings and supplemental, UL confirmed pressure testing, Model VSI and IVSI are also suitable for use as complete exhaust systems for diesel engine and gas turbines. When Model VSI/IVSI is used as an engine or turbine exhaust it is intended to be installed in accordance with NFPA 37 "Stationary Combustion Engines and Gas Turbines". This code states, "When such (flue gas) temperatures do not exceed 1000°F (538°C) except for infrequent, brief periods, the engines shall be classified as low heat appliances". For continuous operation over 1000°F and not exceeding 1400°F the exhaust system should be installed as a 1400°F Chimney.

Model IVSI may be used to meet various needs, such as:

a) Reduce outer pipe surface temperature.
b) Reduce building heat gain by retaining energy inside the duct.
c) Increase the efficiency of energy recovery systems by reducing exhaust gas temperature losses.
d) Increase chimney or exhaust system draft loss performance due to reduced exhaust gas temperature drop.
e) Reduce building noise levels caused by high speed or pulsating exhaust induced noise. NOTE: Specific tests have not been conducted to measure acoustic performance.

Model VSI and IVSI exhaust systems are intended for use in connecting the heating appliance, engine, or turbine to the outdoors, while operating under positive forced draft, negative induced draft or neutral gravity flow internal pressure conditions. Model VSI and IVSI (all insulation thicknesses) may be intermixed in the same chimney system, assuming the proper associated airspace clearances-to-combustibles are maintained.

Complete system sizing and capacity information may be obtained from the "Chimney, Gas Vent, and Fireplace Systems" chapter of the ASHRAE Handbook, or by contacting Ampco Technical Support. In spite of these general sizing guidelines, it is most important that the heating appliance, engine or turbine manufacturer's installation instructions are followed. Not following the equipment manufacturer's instructions may result in inadequate chimney performance and/or a violation of the equipment manufacturer's installation requirements.

ADDITIONAL APPLICATIONS

Model N, VSI & IVSI are also suitable for negative, neutral or positive pressure pre-fabricated piping systems intended for use in a variety of applications including but not limited to the following: Fume Venting, Chutes, Particle Conveying, Dryer Vents and Ventilation Ducts.

SUITABLE FOR POSITIVE PRESSURE VENTING APPLICATIONS WITH MAXIMUM **60"** WATER COLUMN INTERNAL STATIC PRESSURE AT 1000 DEGREES F.

CREOSOTE AND SOOT – FORMATION AND NEED FOR REMOVAL

When wood is burned slowly, it produces tar and other organic vapors, which combine with expelled moisture to form creosote. The creosote vapors condense in the relatively cool chimney flue of a slow-burning fire. As a result, creosote residue accumulates on the flue lining. When ignited this creosote makes an extremely hot fire.

The chimney should be inspected at least once every 2 months during the heating season to determine if a creosote or soot buildup has occurred; if creosote or soot has accumulated, it should be removed to reduce the risk of chimney fire.

Refer to Elbow & Offset section for additional limitations with regards to burning solid fuel.

USE OF INDIVIDUAL PARTS

These instructions comprise both general guidelines and special requirements for all parts in the product line. Before specifying a design or beginning an installation please carefully review these instructions.

SURROUNDINGS / ENCLOSURE

Ampco Model N, VSI and IVSI chimneys are primarily intended to be used in fire resistive, noncombustible surroundings or installed unenclosed. Except as noted elsewhere in these instructions, they are not intended for use in one or two family residences. (CAUTION — Do not enclose these systems in a chase or passageway of ordinary wood or other combustible material, unless noted as acceptable elsewhere in these instructions for a specific application.)

For Type L Vent installations, Model IVSI may be enclosed within a chase fabricated from combustible building materials. Check local codes to determine the required fire rating, if any, for such chase enclosures.

Where the chimney extends through any zone of a building (outside that in which the heating appliance connected to it is located), it shall be provided with an enclosure having a fire resistance rating equal to or greater than that of the floor, ceiling, wall or roof assemblies through which it passes.

Model VSI and IVSI Chimney may penetrate a combustible roof using either the Roof Support Assembly (P-MRS) or the Ventilated Roof Thimble (P-MVT). These are the only parts intended for use with combustible construction. All other parts, such as Plate and Wall Supports, and Floor and Wall Guides, are for attachment to non-combustible construction.

Where, according to local code, no chase enclosure is necessary, Model VSI and IVSI may be placed adjacent to walls of combustible construction at the minimum clearance specified on each pipe section and in the individual Listing; see CLEARANCES section and Tables A-1a through A-1d. Contact local building or fire officials about restrictions and installation inspection requirements in your area.

MULTI-ENGINE EXHAUSTS

A common exhaust system for multiple engine or turbine installations is generally not recommended. Check with your engine or turbine manufacturer prior to common exhaust system design. Exhaust gas from operating units tends to flow to non-operating units where condensation may form. Water in engine or turbines at start-up may cause damage. In general, a separate exhaust system should be provided for each engine or turbine.

PART NUMBERS

These instructions identify major Model N, VSI and IVSI parts by name or part number. Actual parts always carry a prefix to indicate internal diameter. IVSI also includes a suffix to indicate insulation thickness. For example: 24VSI-42 is a 24 inch diameter of model VSI, 42 inches in length; 24IVSI-42C2 is a 24 inch diameter section of Model IVSI, 42 inches long having 2 inches of fiber insulation between the walls.

CLEARANCES

Venting Category	Maximum Continuous Flue Gas Temp	Type Clearance
Type L Vent	480°F over ambient	Enclosed*
Building Heating Appliance Chimney (BHA)	1,000°F	Unenclosed*
B.H.A Chimney (Type HT)(IVSI 5”-24”)	1,000°F	Unenclosed*
1,400°F Chimney	1,400°F	Unenclosed*
Grease Duct	500°F	Unenclosed*
Chimney Liner – ULC S635	1200°F (all fuel)	0” from liner to masonry interior
Chimney Liner – UL 1777	570°F (gas/oil)	1” from liner to masonry interior & 1” from masonry exterior to combustibles**

* = See Section Entitled “Surroundings/Enclosure”
** Masonry chimney construction & surroundings must comply with NFPA 211

Table A-1a: Model N
Min. Airspace Clearance-to-Combustible Construction

See Section “G”, Grease Ducts, or local code for other singlewall uses

Table A-1b: Model VSI
Min. Airspace Clearance-to-Combustible Construction

Pipe I.D.	Type L Vent	Building Heating Appliance Chimney (1,000°F)	1,400°F Chimney	Grease Duct
5-16”	-	6”	6”	A
18”	-	7”	8”	A
20”	-	7”	9”	A
22”	-	8”	10”	A
24”	-	8”	12”	A
26”	-	8”	13”	A
28”	-	9”	14”	A
30”	-	9”	16”	A
32”	-	10”	17”	A
34”	-	10”	19”	A
36”	-	10”	20”	A
42”	-	11”	20”	A
48”	-	12”	20”	A

Table A-1c: Model IVSI-C1
Min. Airspace Clearance-to-Combustible Construction

Pipe I.D.	Type L Vent	Building Heating Appliance Chimney (1,000°F)	1,400°F Chimney	Grease Duct
5-6”	3”	1”	1”	A
8”	3”	1”	2”	A
10-16”	3”	2”	2”	A
18-24”	3”	3”	3”	A
26-32”	-	4”	4”	A
36”	-	5”	5”	A
42-48”	-	6”	6”	A

A = See Section “G” Entitled “Grease Duct”

Table A-1: Model IVSI-C2, Z3, C4, Z4
Min. Airspace Clearance-to-Combustible Construction

Pipe I.D.	Type L Vent	Building Heating Appliance Chimney (1,000°F)	1,400°F Chimney	Grease Duct
5-16”	2”	0.5”	0.5”	A
18”	2”	1”	2”	A
20”	2”	1.5”	2”	A
22-24”	2”	2”	2”	A
26-32”	-	3”	3”	A
36”	-	4”	4”	A
42-48”	-	5”	5”	A

A = See Section “G” Entitled “Grease Duct”

For non-combustible construction, maintain clearances as required for installation, access for inspection or per local code.

OUTER PIPE SURFACE TEMPERATURE

As an aid for estimating expected outer wall surface temperatures, fiber insulated Model IVSI has been tested in a vertical configuration using input energy levels consistent with “UL 103; Standard for Chimneys, Factory-Built, Residential Type and Building Heating Appliance”. Testing with 1, 2 and 4 inch insulation thicknesses resulted in development of Chart A-1 and Table A-2, indicating the maximum expected outer surface temperatures. Compared to vertical configurations, horizontal configurations of Model IVSI will have lower surface temperatures due to a higher convective heat transfer co-efficient. Thus, for horizontal configurations, Chart A-1 and Table A-2 are acceptable to use as they will give conservative answers. The Tables in A-2 give the same results as Chart A-1 for the indicated outer pipe surface temperature, flue gas temperature and pipe size at an ambient temperature of 70°F.

The chart can also be used for other operating conditions. For example, at an actual flue gas operating temperature of 400°F (corresponding to a flue gas temperature rise of 330°F at an ambient temperature of 70°F), all diameters of Model IVSI would require 1 inch of insulation to maintain the outer surface temperature below 140°F.

Note: These tests were all conducted in accordance with UL-103 in a vertical configuration with 1000°F flue gases and air surrounding the pipe. Appreciable higher outer wall surface temperatures would have been reached if insulation had been placed around the outer wall of the pipe.

Do not wrap or place insulation around these systems in an effort to reduce clearances to combustibles, create some type of fire protective enclosure or for any purpose, unless Ampco has reviewed the practical engineering feasibility of such application. Ultimately, the Authority Having Jurisdiction will need to approve any Ampco engineering judgment that is offered since this is not been UL tested and listed.

Chart A-1: Model VSI and IVSI Estimated Maximum Outer Pipe Temperature Rise above Ambient Temperature

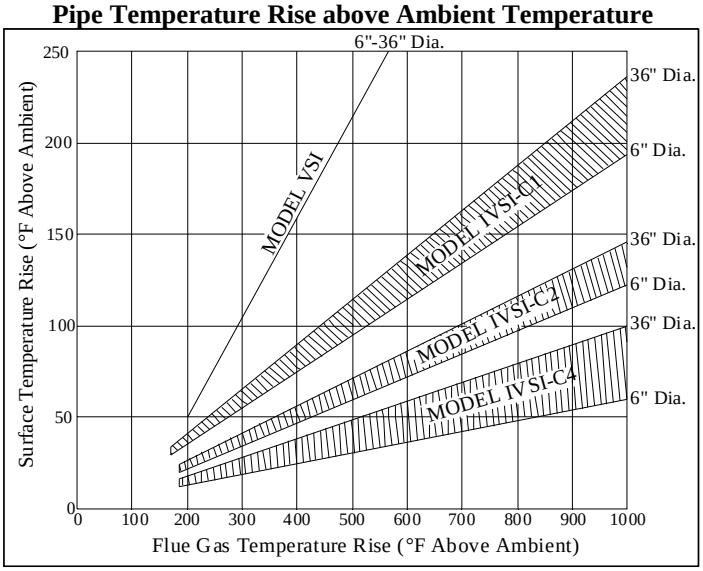


Table A-2a: Required Insulation thickness for 120°F Surface Temp				
	IVSI Duct Diameter			
Flue Temp	6”	12”	24”	36”
1000°F	-	-	-	-
900°F	-	-	-	-
800°F	4	4	-	-
700°F	4	4	-	-
600°F	4	4	4	-
500°F	2	4	4	4
400°F	1	2	2	2
300°F	1	1	1	1

Table A-2b: Required Insulation thickness for 140°F Surface Temp				
	IVSI Duct Diameter			
Flue Temp	6”	12”	24”	36”
1000°F	4	4	-	-
900°F	4	4	-	-
800°F	4	4	4	-
700°F	4	4	4	4
600°F	2	2	4	4
500°F	1	2	2	2
400°F	1	1	1	1
300°F	1	1	1	1

Table A-2c: Required Insulation thickness for 160°F Surface Temp				
	IVSI Duct Diameter			
Flue Temp	6”	12”	24”	36”
1000°F	4	4	4	-
900°F	4	4	4	4
800°F	4	4	4	4
700°F	2	2	2	4
600°F	2	2	2	2
500°F	1	1	1	2
400°F	1	1	1	1
300°F	1	1	1	1

PIPE JOINT ASSEMBLY

All flange-to-flange inner pipe joints are identical (except for Adjustable Lengths, Variable Lengths and Lined Bellows Joints), thus eliminating special orientation for correct use. Assembly is accomplished as follows: (See Section G for Grease Duct Connection)

1. Parallel flanges are brought together (See Fig A-1).
2. Sealant is applied to the groove of the inner “V” Band. Refer to SEALANT USAGE section for proper sealant selection.
3. The inner “V” band is then tightly clamped around the flanges using end clamp hardware. NOTE: Light tapping with a wooden or similar mallet all around the band while tightening the clamp helps to align and pull the flanges together (See Fig A-1).
4. (For Model IVSI only) insert strip of insulation (supplied) in area of V-band, around entire circumference of assembly. Position insulation to insure no void spaces remain (See Fig A-2).
5. The outer channel band is then installed by inserting the edges of the band into the outer pipe grooves and drawing it closed with the screws and nuts. For vertical exterior joints apply sealant to the joint between the Channel Band and the outer pipe (See Figs. A-2 & A-3). *For horizontal/sloping exterior joints, it is recommended to apply sealant (P-600) to both sides of the Channel Band (top side is sufficient (9 o’clock to 3 o’clock position)) with nut/bolt connection pointing down

Caution-Risk of injury. Sheet metal parts may be sharp. Always wear gloves and appropriate eye, foot, and other protection when handling these products.

Fig. A-1 – Pipe Joint Assembly

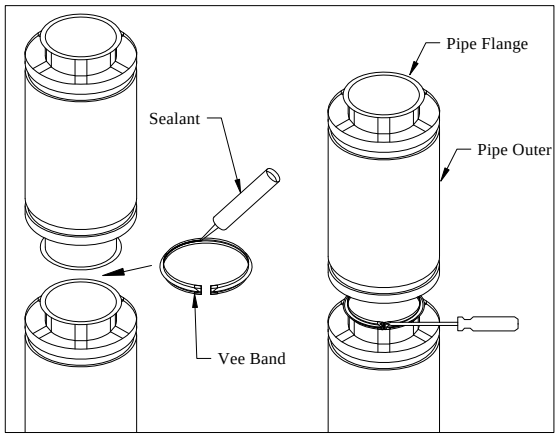


Fig. A-2 – Pipe Joint Assembly

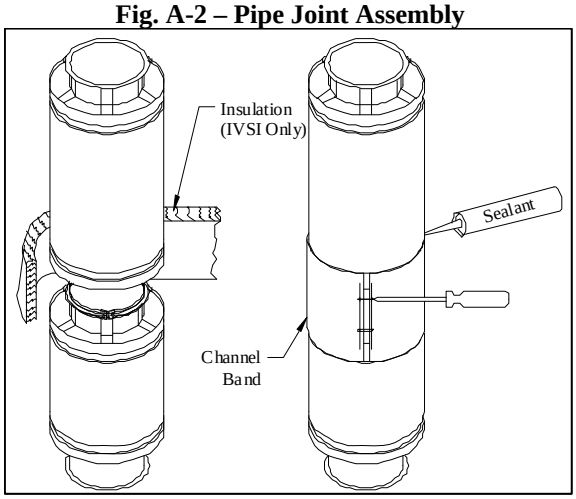
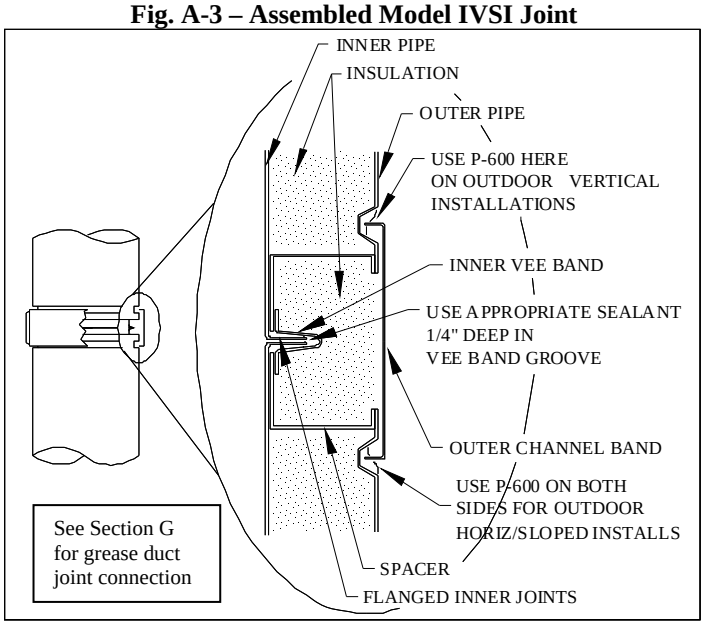


Fig. A-3 – Assembled Model IVSI Joint



CAUTIONS

A. THE OUTER CHANNEL BANDS ARE DESIGNED TO SLIDE IN THEIR MATING GROOVES. DO NOT ATTACH BY SCREWS INTO THE OUTER CASING.
B. DO NOT ALLOW SCREWS TO PENETRATE THE INNER PIPE. THIS CAN CAUSE CORROSION, GAS LEAKAGE OR EXPANSION FAILURE.
C. NEVER USE SCREWS THROUGH THE OUTER JACKET OF AN ADJUSTABLE LENGTH OR EXPANSION JOINT.

SEALANT USAGE

1. Part No. P-600 (Dow Corning® 700 is one of our UL approved sealants): a silicone sealant UL listed for flue gas temperatures up to 600°F. Also used for weathering/sealing on outdoor seams & Channel Bands where necessary.
2. Part No. P-2000: a high temperature pre-mixed sealant for flue gas temperature up to 2000°F. P2000 IS WATER SOLUBLE AND SHOULD NOT BE USED WHERE EXPOSED TO WEATHER.

Sealant Coverage (Expected Number of Joints Sealed per Tube)	
Inner Dia.	# of Joints
5-6”	10
8-10”	9
12”	8
14-16”	7
18-20”	6
22-24”	5
26-28”	4
30-32”	3
36”	2
42-48”	1

PIPE WEIGHT

The approximate weight of the pipe in lbs. per foot is equal to its Multiplier multiplied by its inside diameter (in inches). See chart below

Weight of Pipe	
Model	**Multiplier**
N	0.5
VSI	0.9
IVSI-C1	1.1
IVSI-C2	1.3
IVSI-C4	1.7
IVSI-Z3	1.7
IVSI-Z4	2.0

Example:
36”IVSI-C1 weighs approximately 36 x 1.1 = 39.6 Lbs/Ft.

SUPPORT METHODS

Vertical Installations require one of following methods of support. Refer to the corresponding section for proper installation instructions.

1. Pier or Appliance outlet (See Section B for details)
2. Base supported tee (See Section B)
3. Plate Support Assembly (P-PA) (See Section D for details)
4. Roof Support Assembly (P-MRS). (See Section F for details)
5. Wall Support Assembly (P-WA) (See Section E for details)
6. Fan Adapter Termination (FAT) (See Section G for details)
7. Roof Support Section (RSS) (See Section G for details)

Table A-3, (Support Methods & Height Limits), shows the maximum height limits for each support method.

Full Rings (P-FR) are used in vertical installations as wall guides to maintain proper alignment of the system and are for lateral support for wind loads. Proper spacing of full ring guides and supports must be maintained. Requirements can be found in Table A-4, (Vertical Support & Guide Spacing), under the columns designated “S-V”.

The vertical freestanding height above the roof or top guide is limited due to wind considerations. The limitations for “Free Standing Height”, can be found in Table A-4 under the columns designated “F”. The table includes height limits for all vertical support methods based on model designation and diameter.

Horizontal installations or horizontal portions of vertical installations are supported primarily by use of Half Rings (P-HR) or Support Straps (P-SS) that are installed using minimum ½” threaded rod or structural steel provided by other. See Table A-5 for maximum spacing between horizontal supports. Plate Supports (P-PA) are also used to support and stabilize the system at changes in direction. For further details on the use of the Plate Supports, see section D.

Table A-3 Support Methods and Height Limits

	Parts Used	IVSI-C1	IVSI-C2	IVSI-C4, Z3	IVSI-Z4	VSI	N
Pier or Appliance Outlet Sizes 5 thru 48" [1]	P-CF & P-BK	82'	56'	30'	26'	100'	150'
Base Supported Tee [2]	P-MT & P-JL	29'	20'	16'	14'	35'	50'
Plate Support Assembly: Sizes 5"- 10"	P-PA	275'	200'	100'	85'	325'	475'
Sizes 12"- 16"	P-PA	203'	135'	69'	59'	250'	375'
Sizes 18"- 20"	P-PA	162'	108'	55'	47'	200'	300'
Sizes 22"- 28"	P-PA	141'	96'	51'	44'	180'	257'
Sizes 30"- 36"	P-PA	109'	75'	40'	35'	140'	200'
Sizes 38"- 48"	P-PA	82'	56'	30'	26'	105'	150'
Plate Suppt Ass'y w/ High Strength Base (See Fig. D-3): Sizes 5"- 10"	P-PA (field mod)	375'	280'	155'	120'	450'	NA
Sizes 12"- 16"	P-PA (field mod)	304'	203'	103'	88'	375'	NA
Sizes 18"- 20"	P-PA (field mod)	243'	162'	82'	70'	300'	NA
Sizes 22"- 28"	P-PA (field mod)	211'	144'	77'	65'	257'	NA
Sizes 30"- 36"	P-PA (field mod)	164'	112'	60'	51'	200'	NA
Sizes 38"- 48"	P-PA (field mod)	123'	84'	45'	38'	150'	NA
Roof Support Assembly	P-MRS	8'	7'-10"	7'-7"	6'-6"	8'	NA
Wall Support Assembly: Sizes 5"- 10"	P-WA	144'	96'	72'	62'	144'	NA
Sizes 12"- 16"	P-WA	90'	60'	45'	39'	90'	NA
Sizes 18"- 20"	P-WA	72'	48'	36'	31'	72'	NA
Sizes 22"- 28"	P-WA	51'	34'	26'	22'	51'	NA
Sizes 30"- 36"	P-WA	40'	27'	20'	17'	40'	NA
Sizes 38"- 48"	P-WA	30'	20'	15'	13'	30'	NA
Fan Adapter Termination, Roof Suppt Sect	P-FAT, P-RSS	Models Z3 & Z4 Only – See Table G-3					
Full Angle Ring, Guy Section, Wall Guide, Floor Guide	P-FR, P-GS, P-WG, P-FG	See Table A-4: Dimension S-V (See Fig. A-6, A-7, A-8, D-6 for examples)					

Notes:

1. Pier or appliance must be able to support pipe weight (and guy loads, if any) regardless of maximum height.
2. For supporting structure used below Tee fitting, but in general, base supported tees are the least desirable option. P-MT and P-JL with integral internal stiffener posts are available for increasing base supported tee heights. Consult factory for details.

Table A-4
Vertical Guide Spacing Support & Free Standing Limits

Dia.	VSI & IVSI-C1		IVSI-C2		IVSI-C4, Z3 & Z4		Model N	
(In.)	S-V	F	S-V	F	S-V	F	S-V	F
5	17'0"	8'6"	15'4"	7'8"	12'8"	6'4"	23'10"	NA
6	17'6"	8'9"	15'10"	7'11"	13'4"	6'8"	23'4"	NA
8	18'6"	9'3"	16'10"	8'5"	14'6"	7'3"	23'2"	NA
10	19'4"	9'8"	17'10"	8'11"	15'6"	7'9"	23'2"	NA
12	20'4"	10'2"	18'10"	9'5"	16'8"	8'4"	23'9"	NA
14	21'2"	10'7"	19'10"	9'11"	17'10"	8'11"	24'2"	NA
16	22'2"	11'1"	21'0"	10'6"	19'0"	9'6"	24'2"	NA
18	23'2"	11'7"	22'	11'	20'2"	10'1"	25'9"	NA
20	24'	12'	23'	11'6"	21'4"	10'8"	26'5"	NA
22	24'10"	12'4"	23'8"	11'10"	22'	11'	27'1"	NA
24	25'6"	12'9"	24'6"	12'3"	23'	11'6"	27'1"	NA
26	26'4"	13'1"	25'	12'6"	23'8"	11'10"	28'4"	NA
28	27'	13'6"	26'2"	13'1"	24'8"	12'4"	28'11"	NA
30	27'-10"	13'10"	26'10"	13'5"	25'4"	12'8"	29'9"	NA
32	28'6"	14'3"	27'8"	13'10"	26'4"	13'2"	30'3"	NA
36	30'	15'	29'2"	14'7"	27'10"	13'11"	31'8"	NA
42	26'6"	13'3"	25'10"	12'11"	24'10"	12'5"	27'9"	NA
48	23'	11'6"	22'8"	11'4"	21'10"	10'11"	23'11"	NA

S-V = Maximum spacing between two guides or a support and a guide in a vertical position.

F = Maximum height above a guide or support for free standing system above a roof or parapet wall.

Table A-5: S-H
Horizontal Support Spacing
Half Rings (P-HR), Full Rings (P-FR) & Support Straps (P-SS)

Dia.	VSI & IVSI-C1	IVSI-C2	IVSI-C4, Z3 & Z4	Model N
5"-12"	16'	14'	12'	20'
14"-24"	14'	12'	10'	17'
26"-48"	11'	9'	7'	11'

EXTERIOR CORROSION PROTECTION: IT IS RECOMMENDED TO APPLY AN EXTERIOR GRADE HIGH HEAT PAINT TO ANY PLATE SUPPORTS, FULL/HALF ANGLE RINGS, WALL SUPPORTS/GUIDES, ALUMINIZED OUTER WALLS & ROOF/WALL FLASHING COMPONENTS, EXPOSED OUTDOORS TO ENSURE MAXIMUM CORROSION PROTECTION AGAINST THE ELEMENTS. (Ex. Rustoleum V2100 series High Heat Industrial Aerosol)

THERMAL EXPANSION

Good installation practice requires that any length of exhaust system between two fixed points subject to more than 1/4 inch expansion must have an Adjustable Length (P-AG) or Bellows Joint (P-BJ) to compensate for expansion. VSI/IVSI will expand approximately 1 inch for every 100°F temperature rise per 100 feet of pipe.

For Grease Duct applications any length over 12 feet installed between two fixed points i.e.: Hood Outlet and Elbow, Plate and Wall Support, etc., must be provided with an Adjustable Length (P-AG) to compensate for expansion and contraction.

It is essential that these parts be properly installed and provided with adequate guidance to prevent binding or excessive bending forces. (See detailed installation information contained in Section C, Thermal Expansion.)

The exhaust system designer must be aware that the inner joints have negligible flexing capability, and in addition, Tees and Elbows are not designed to withstand excessive bending forces. Because the amount of outer casing axial movement is less than the inner casing movement, but still significant, the outer jackets of piping and Adjustable Lengths must also slide to avoid excessive forces on Tees, Elbows or Fixed Joints. To accommodate outer casing movements, external guides along walls, at floors, or in lateral breechings, must allow for movement of the pipe. Further; Full/Half Rings, Wall Guides or Floor Guides must be so located that Outer Channel Band movements will be away from the ring.

CHIMNEY GUYING AND BRACING

Model N, VSI, IVSI, Z3 & Z4 Grease Duct has thin pipe walls relative to its diameter (t/D<0.006 for all sizes) and has the characteristics of a continuous pipe of 300 Series Stainless Steel. Therefore it will expand and contract along its entire length with changes in temperature. Thus, unless properly supported and guided, structural damage to the exhaust system will occur. For these reasons, conventional methods of attaching guides and braces to the outer pipe cannot be used. Correctly installed Angle Rings (P-FR and P-HR), Wall Guides (P-WG), Floor Guides (P-FG), Guy Sections (P-GS), Plate Support Assemblies (P-PA) and Wall Support Assemblies (P-WA) will serve to keep the chimney aligned and supported, provide for adequate wind load resistance and allow for axial thermal expansion and contraction.

Stabilization of the part of the chimney which extends above the roof or a parapet wall requires special consideration. For low, freestanding installations (up to Dimension F in Table A-4) the chimney needs no special guying or bracing. However, to protect the roof flashings from loads caused by wind against the exposed chimney, the installation must be stabilized with a Full Angle Ring (P-FR) as illustrated in Fig. A-6.

In addition to the requirement for alignment and stabilization of the chimney, the need often exists for guying or otherwise bracing taller chimneys to resist upsetting forces. The Model VSI or IVSI part that can be used for this purpose is called a Guy Section (P-GS). It is composed of two pieces of standard 18 inch long pipe welded together and rigidly captured between two heavy duty steel flanges that are welded together about their entire perimeter (see A-4 for details). With holes every 30°, the heavy duty attachment allows great flexibility of multiple cable guys (a minimum of three). In all but the simplest installation, contact the factory for complete guy tension and preload calculations.

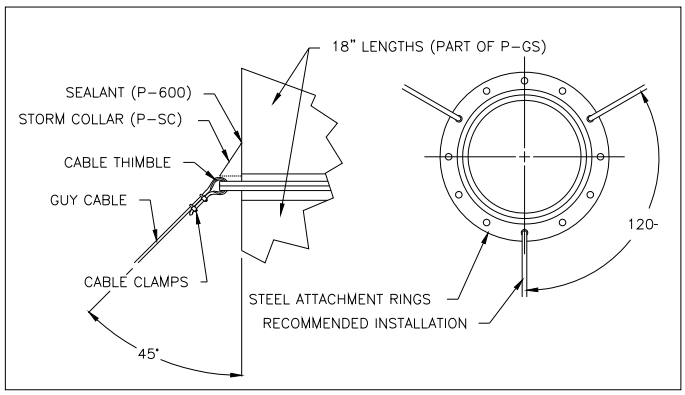
The purpose of guying or bracing is to prevent wind effects from developing excessive bending forces or horizontal displacements in exposed chimneys. This means that cables which are attached to the guy section must be slightly slack or loose, allowing for thermal expansion to occur without damaging fasteners or attachments. Some stack configurations require spring loaded Guy Tensioners (P-GT) to preload the guy cables for a satisfactory installation (See Fig. A-9). These displacement limiting tension devices must be incorporated in cable guys if expected thermal expansion exceeds allowable slack in the cables.

For stack heights above the roof requiring guy wires or rigid bracing to minimize thermal expansion effects, a Plate Support Assembly (P-PA) or Wall Support Assembly (P-WA) must be installed at or near the roof line. If necessary, Guy Tensioners should be used.

The height limit of a Model VSI/IVSI stack above the roof can vary depending on the Stack Support involved (see Table A-3) and whether the stack is welded, braced or guyed. Using the Roof Support (P-MRS), the maximum height allowed is dependent on size as indicated in Fig. A-6 and its accompanying Table A-4

For stacks greater than those specified for single Guy Section configurations (See Fig. A-6) such as two level guying or those that will be located in severe weather locations, a welded Model IVSI assembly is recommended. The availability of multi-level guying (as shown in Fig. A-7) depends on wind load, height, pipe diameter and material thickness. Not all multilevel guying height and diameter combinations are possible. Contact the factory for a detailed design of welded multi-guyed Model VSI/IVSI stacks.

Fig A-4. Guy Section details and cable attachments



Guy wires should be attached to flanges of the Guy Section at appropriate locations. If the exposed stack is to expand by sliding vertically within a fixed structural framework of either wall guides or floor guides, the rings for those parts should be located just below the upper channel band of the involved pipe section. Wire cable, pipe or angle-iron are all suitable materials for guying or bracing. Galvanized or stainless steel is recommended for durability and ease of maintenance.

Fig. A-6. Height Limits for single set of Rigid Braces

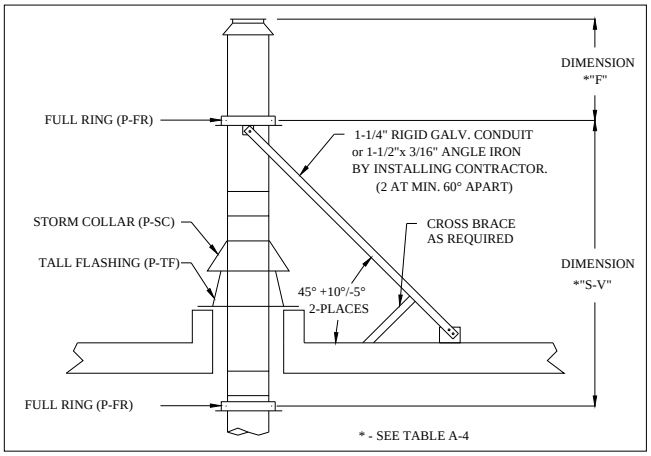


Fig. A-7. Guying Requirements Example for Maximum Height above roof for multiple sections of Model VSI/IVSI

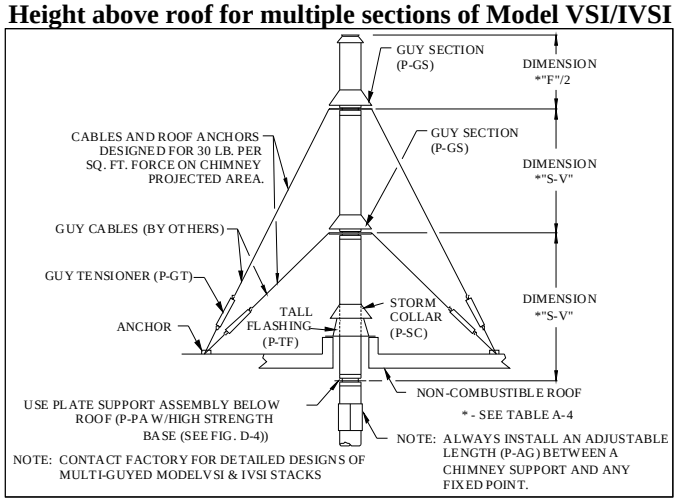
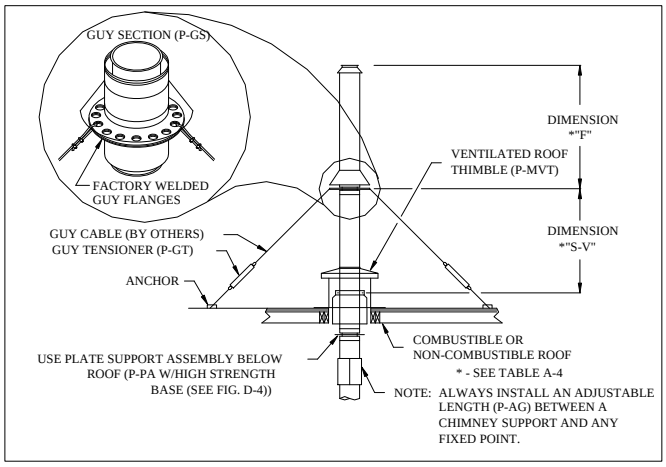


Fig. A-8. Guying Requirements for Chimneys Supported at Roof



CHIMNEY GUYING AND BRACING (cont'd)

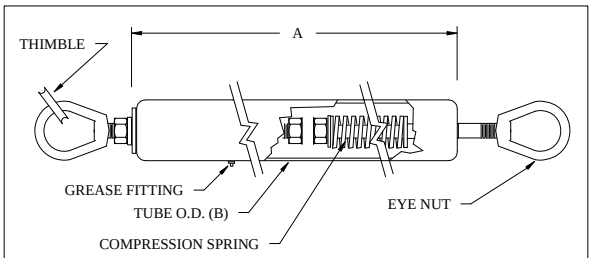
Cable guying is often not as desirable as pipe or angle iron bracing. Cable tensioning requires periodic adjustment and a minimum of three points are required at each guying level. Where guying is used, usual thermal expansion and contraction must be carefully considered to avert excessive loads on points of attachment and supports.

When rigid braces are used in conjunction with a Full Angle Ring, often only two braces are required, with a minimum plan view angle between them of not less than 60°. See fig. A-6 for an example using rigid braces with a Full Angle Ring.

Another structurally equivalent alternative to guy wires and one which puts less load on the stack and its support structure is to use a Full Ring (P-FR) firmly attached to three rigid legs in a tripod arrangement in lieu of a Guy Section and guy wires (see Fig. A-8). Many other structurally equivalent solutions are possible.

NOTE: All guying materials, except Guy Sections and Tensioners, are by others and normally can be readily and economically obtained locally.

Fig. A-9. Guy Tensioner



GUY TENSIONER DIMENSIONS

TENSIONER SIZE	TUBE LENGTH A	TUBE O.D. B	MAX. SPRING COMPRESSION TRAVEL	WEIGHT
1050	24"	1 7/8"	3"	15 lbs.
1350	24"	1 7/8"	3"	22 lbs.
2100	38"	2 3/8"	3"	25 lbs.
2700	38"	2 3/8"	3"	37 lbs.

SEISMIC REQUIREMENTS

In certain areas of the country, local codes contain requirements to address seismic risks. Seismic requirements for chimneys and grease ducts usually include specifications for additional "sway bars" / bracing, or similar devices in order to help stabilize the system in the event of an earthquake.

Specific guidelines (including spacing, location, size and method of attachment of bracing / sway bars or other devices) for addressing seismic requirements vary depending upon the adopted code, seismic zone, duct size, location in building, etc. and are not within the scope of these installation instructions.

Consult with a design professional in order to determine compliance options for these potentially complex requirements when this product is to be installed in a building where these additional requirements apply.

The support methods described in these instructions have been proven adequate (via UL certification) for locations where there are no additional seismic zone requirements. In order to address additional seismic requirements they may be further supplemented with a variety of generic sway bars or braces that attach to or around the outer wall of the grease duct system. Full Angle Rings (P-FR), Half Angle Rings (P-HR) and Support Straps (P-SS) may be included as components of such supplemental bracing.

45° LATERAL TEE (P-JL)

For systems that require a 45° entry to the vertical chimney, the 45° Lateral Tee may be supported or suspended similar to a 90° Tee, (see next item). Use of this part necessitates an additional 45° Elbow if there is a horizontal breeching (see Fig. B-1b). When base supported, the 45° Tee will carry a maximum of 30 feet of chimney height (see support methods in Section A), and may be installed with a cap or cleanout exactly the same as the 90° Tee. See Fig. B-5 for an example of the use of 45° Lateral Tees in a manifold breeching. This system has lower flow losses than using 90° Tees and thus, for any given set of appliances, a smaller diameter manifold can be used.

90° TEE (P-MT)

The 90° Tee will support up to 30 feet of vertical chimney height when it is supported from below. This tee fitting is used to join horizontal connectors into a vertical chimney as well as a drain or inspection fitting. For the latter purpose, the Drain Tee Cap (TC) is installed at the base of the tee, and piped to a suitable drain. NOTE: The 90° Tee should not be used on engine or turbine exhausts except when used as an inspection access where there is no change in flow direction.

TEE PRECAUTIONS

1. Use an expansion joint in all horizontal breechings or laterals.
2. Provide access for easy removal of Tee Cap.
3. Use two axis support as in Fig. B-2a and B-2b to protect Tees or Elbows, if over 1/4 inch of expansion is expected in the lateral or breeching.
4. Never support any Model VSI/IVSI pipe from the outer casing.
5. Always install system so that sliding of expansion joints takes place, rather than bending at fittings.
6. Never allow more than 35 feet of chimney / duct above a base supported tee without resupporting.

DRAIN TEE CAP (P-TC)

The Drain Tee Cap is used as an end cap in horizontal runs, as an inspection fitting cover, and as a drain for vertical stacks. When not used as a drain the nipple shall be closed off with a pipe cap supplied by the installer. When used as a drain, a trap or a valve should be used in the drain line.

Always connect the drain fitting of the Drain Tee Cap to a suitable drain. This will allow rain entering the chimney to wash down, dilute and remove any corrosive combustion condensate. Also, always install the Tee Cap with sealant on mating surfaces of the flanged joint as well as in the groove of the Vee Bands. This will prevent leaks and assure that the drain functions as intended.

When placed on top of a supporting framework or flat plate, the Tee Cap closure becomes inaccessible and cannot be removed. Thus where access is desired into the tee or chimney, there are several options:

a) Suspended Tee. Use a Plate Support Assembly (P-PA) or Wall Support Assembly (P-WA) at the upper tee joint or higher (see Fig. B-4a and B-4b).

b) Support the Tee from its lower joint with a Plate Support Assembly (P-PA) and use an additional 18" pipe length below the Plate Support as a cleanout section to carry the Tee Cap (see Fig. B-3a and B-3b).

c) Use a Wall Support Assembly above or below the Tee in the same manner as the Plate Support in step a) and b) above.

Fig. B-1a – Single axis support for short lateral run

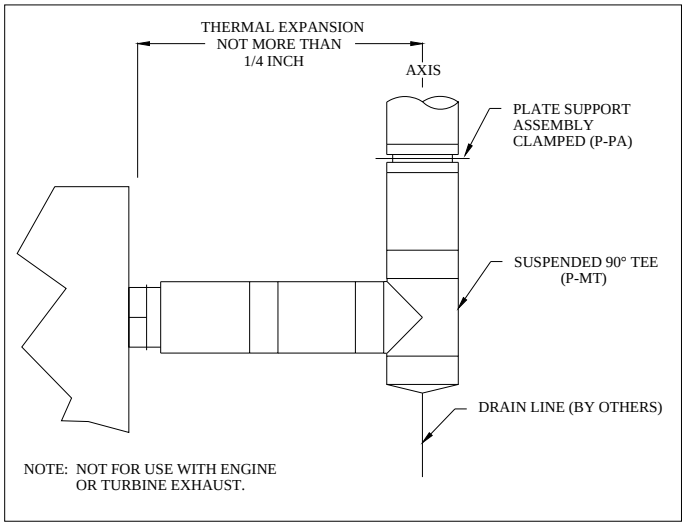
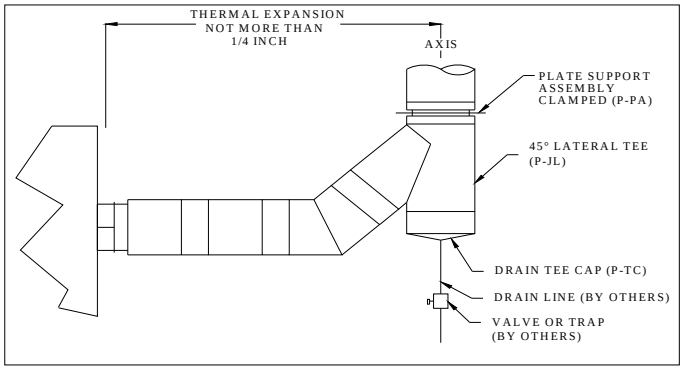


Fig. B-1b – Single axis support for short lateral runs



THERMAL EXPANSION LENGTHS

Based on temperature and length, if more than 1/4" of thermal expansion is expected in the horizontal run between an appliance connection and a tee, the use of two axis support (see Fig. B-2a and B-b) is recommended. This enables the Adjustable Length to absorb expansion movement and prevents distortion or damage to the Tee. See Section C for complete thermal expansion design requirements and suggested details.

Allowable lengths for 1/4" thermal expansion (see Fig. B-1a and B-1b).

Gas Temperature Rise	Length
200°F	12'6"
300°F	8'4"
400°F	6'3"
500°F	5'0"
600°F	4'2"
700°F	3'7"
800°F	3'1"
900°F	2'9"
1,000°F	2'6"

Fig. B-2a – Two axis support protects fittings from bending stress due to long lateral runs.

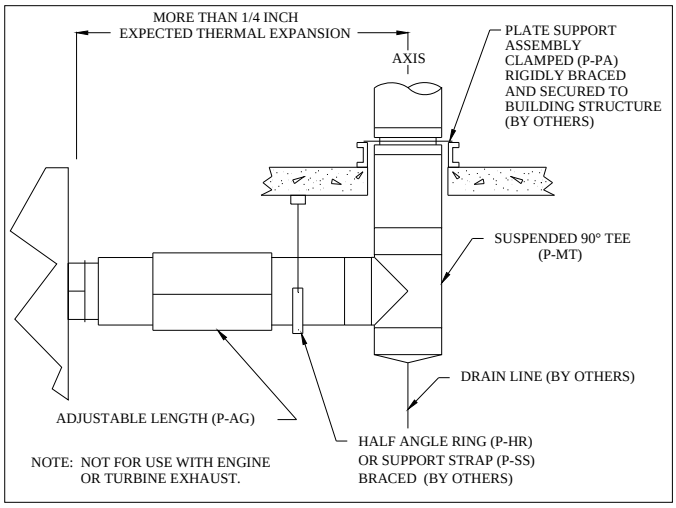
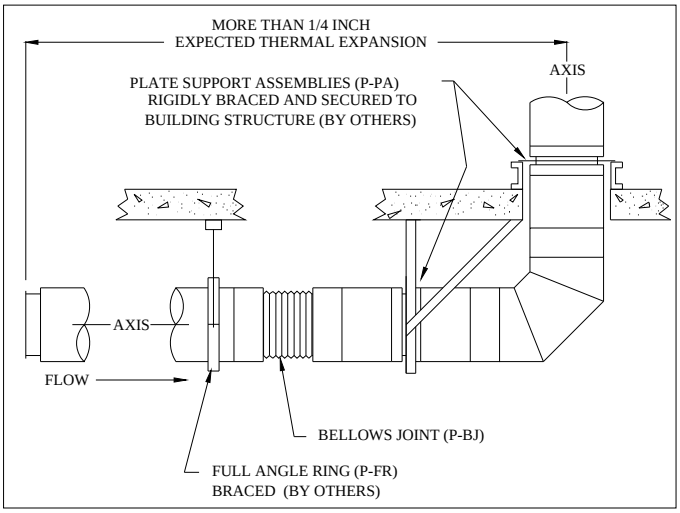


Fig. B-2b - Two axis support protects fittings from bending stresses due to long laterals



90° WYE (P-JY)

The Wye fitting is useful where the vertical chimney must be located between two boilers, and a low pressure loss system is needed. The Wye fitting can also be used to make connections from engines with dual exhaust outlets into a larger single exhaust system. It may be suspended by a Plate or Roof Support, and the usual precautions for avoiding thermal expansion deformation must be observed for breechings and manifolds.

INCREASERS: STEPS (P-OS) & TAPERED (P-OT)

Where space is limited, the Step Increaser (OS) provides the necessary increase, in a lineal distance of 2 inches from end to end. It should be installed so as to avoid deflection from static loads or thermal expansion forces. This is a nonstructural part.

Tapered Increasers (P-OT) are made with a standard side angle of 14° (28° included angle of cone) for low pressure losses, and provide increases of one, two or three sizes. Length varies (see catalog) from 6 inches for the 6 x 8 size to 26 inches for 24 x 36 Tapered Increaser.

Outer jackets of Tapered Increasers are conical and span the distance between outer pipe jackets to maintain double wall construction. Tapered Increasers are considered to have the same strength in side and axial loads as straight pipe.

ELBOWS

All Elbows feature the standard flanged Vee Band end joints. The 15° Adjustable Elbow is made in two halves, each with a 7 1/2° included angle and an internal flanged joint which can be opened and rotated from straight to the maximum 15° angle. For any angle adjustment, this Elbow provides a joint which can be used in tension or compression and sealed as necessary for the operating temperature and pressure.

The fixed 30°, 45° and 90° Elbows can be used to make up fixed 60°, 75° and 90° turns, and can be combined with the Adjustable Elbow for other angles. All elbows must be protected from thermal expansion and bending forces.

Fig. B-3a - Two axis base support with Tee Cap Access

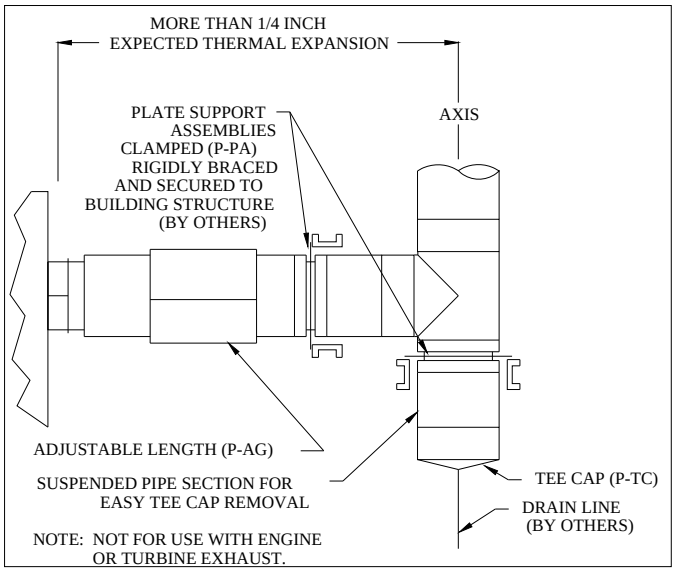
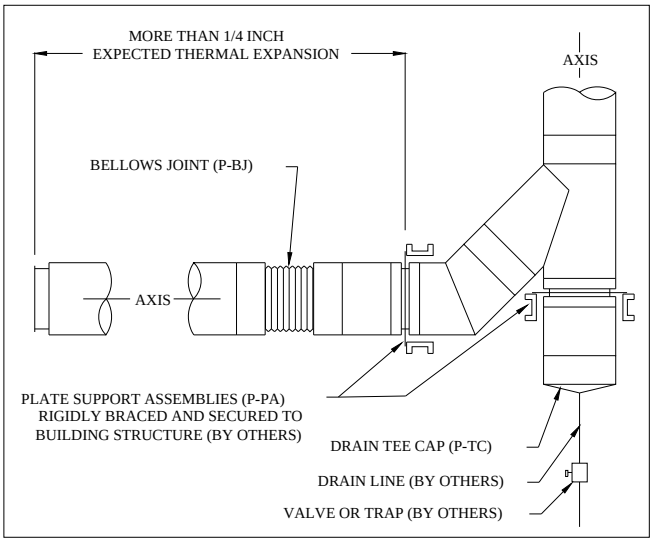


Fig. B-3b - Two axis base support with Tee Cap Access



USE OF ELBOWS, OFFSETS AND MANIFOLDS

Sloped or horizontal offsets in the vertical portion of a chimney above the breeching should be avoided except where absolutely necessary. Sloped offsets require more expansion joints and secure bracing above and below elbows. Special care should be exercised in designing the bracing for elbows because elbows (and fittings) can only take limited forces due to any bending moments. Structural parts such as posts or beams may also be needed to hold chimney supports in position (see Fig. B-6).

Fig. B-4a - Tee suspended from Wall Support

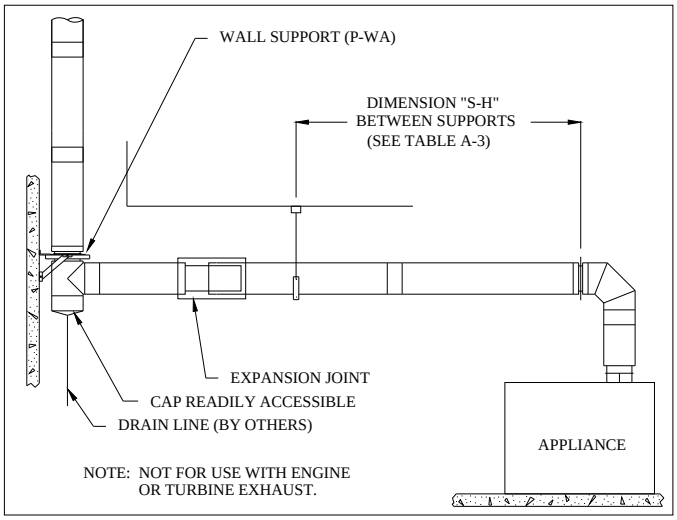
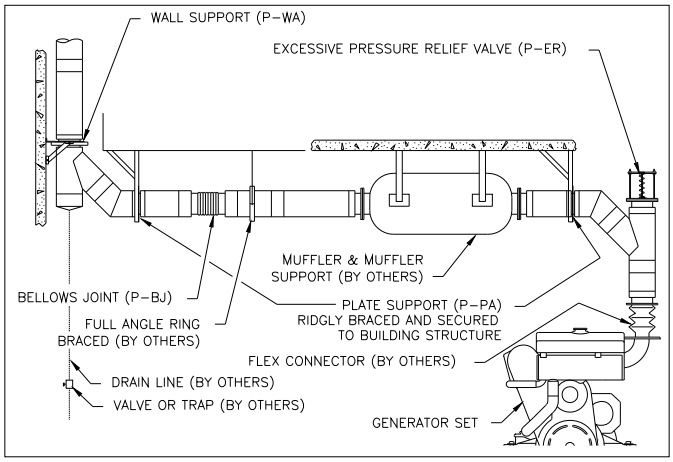


Fig. B-4b - Lateral Tee suspended from Wall Support



There is no limit on the angle or slope of an offset for gas or liquid fuel burning appliances, but with a solid fuel burning appliance the slope must not be greater than 30° from the vertical. Chimneys for combination fuel heating appliances which are capable of burning solid fuel or are convertible to solid fuel are limited to the same 30° slope even if the current choice of fuel is gas or oil.

The length of offset, if one is necessary, is determined by strength considerations. The maximum dimension between supports, given as the "S-H" Dimension in Table A-5 of these instructions, is applicable to all horizontal and sloped orientations. To assure proper guidance of expansion joints and to prevent unnecessary joint bending, use an adequate number of supports such as Full Rings, at closer intervals.

Fig. B-5 - Multiple appliance manifold using 45° Tees

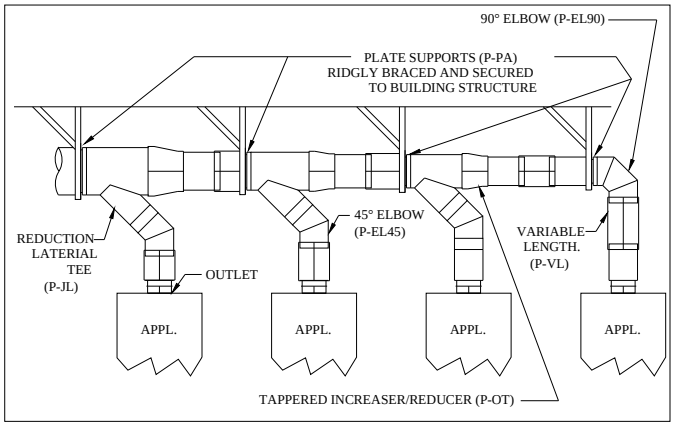
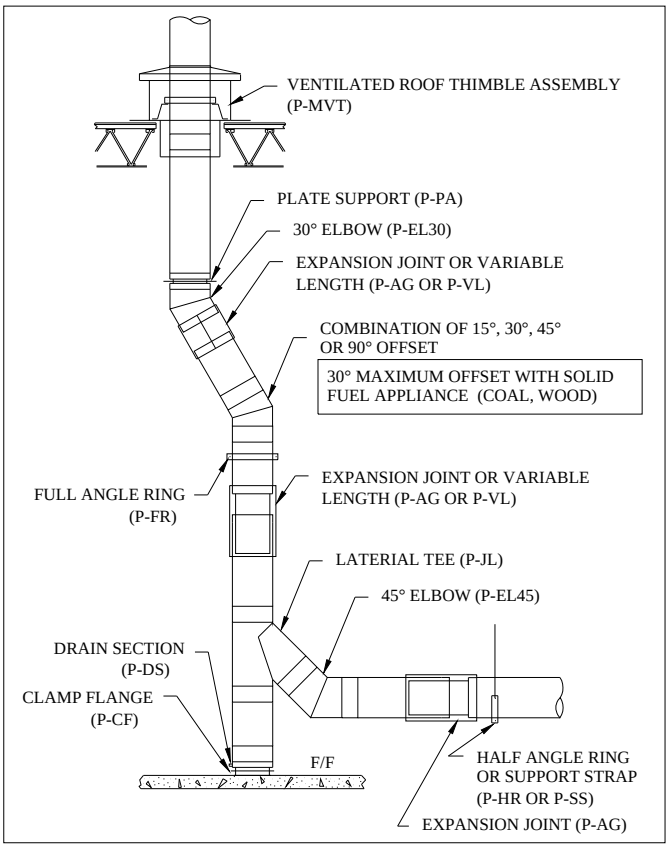


Fig. B-6 – Base Supported Stack with Offset



When it is necessary to provide additional structural stiffening at the elbows or fittings, rigidity can be provided by using an additional Plate Support Assembly (See Fig. B-7) located at the other end of the elbow or fitting and bolting lateral braces across the corners using standard brackets.

With frequent resupport, there is no structural or operating limit to the length of horizontal or sloped portions of a Model VSI/IVSI chimney, providing the system meets the capacity, pressure drop or available draft requirements of the appliance or equipment. The carrying capacity of Model VSI/IVSI supports and their structure attachments must consider the weight of the offset plus whatever vertical pipe is carried by that support. Height limits for supports are tabulated in Section A of these instructions.

The ends of any sloped or horizontal offset must be anchored to prevent overstressing elbows and to assure proper operation of expansion joints. The vertical sections of chimney above the offset must also be supported or anchored and guided where necessary. Model VSI/IVSI Roof Supports, Ventilated Thimbles, Wall Supports, Plate Supports, Wall Guides and Full Rings may be used in a variety of ways for offset support to obtain a structurally stable chimney system. Selected methods of using Model VSI/IVSI supports are shown in Fig. B-7, B-8.

Resupports must be securely anchored to walls, posts, or locally fabricated rigid framework. This framework must be designed to assure stability of attached Model VSI/IVSI supports, such as Plate Supports and Wall Supports. Supports suspended by threaded rod or from small size angles or straps are usually not satisfactory to resist bending moments due to offsets. The horizontal portion of a Model VSI/IVSI chimney system between the appliance and the vertical chimney is defined by most building codes as a “connector”, and such connectors may be horizontal without any impairment of system function. Frequently in boiler or equipment rooms, headroom is limited and there is generally some access for inspection and maintenance. Thus horizontal breechings or manifolds using Model VSI/IVSI are not subject to any fuel restrictions.

The 30° limitation on offset slope for solid fuels also does not apply to breeching or manifolds in the boiler equipment room.

Fig. B-7

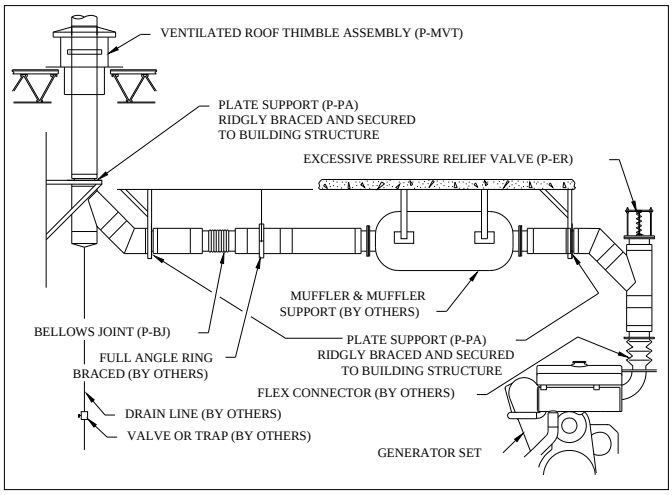


Fig. B-8

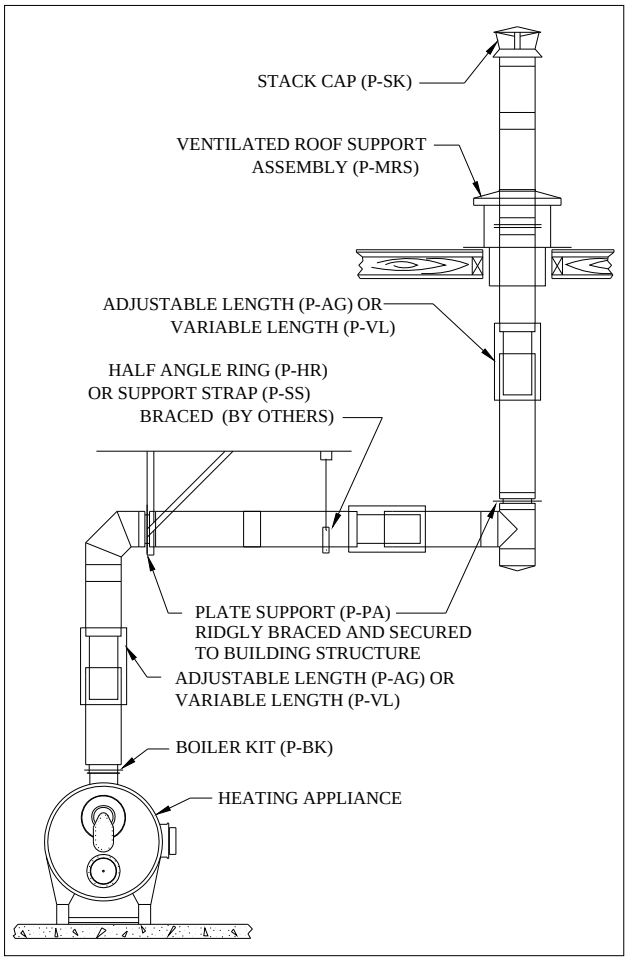
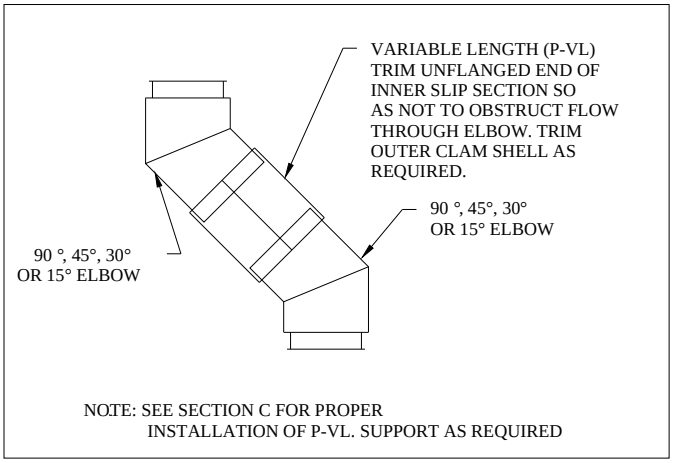


Fig. B-9 Short Offset using a P-VL



Thermal Expansion, Bellows Joints, Adjustable & Variable Lengths

Installation Instructions Section C

THERMAL EXPANSION

The inner pipe of Model VSI/IVSI is load bearing and its thermal expansion is the same as that of a continuous pipe. A simplified rule for exhaust pipe expansion estimation is that the axial growth will be approx. 1" per 100' of pipe length for each 100°F the flue gas temperature is above the surrounding air temperature.

When assembled in any orientation, the amount of thermal expansion of the inner pipe is directly dependent on the inner wall temperature and the length of pipe between fixed points. Good installation practice requires that expansion greater than 1/4 inch will be compensated for using a Bellows Joint or Adjustable Length, depending on the maximum pressure encountered.

The flanged inner piping joints have negligible flexing capacity, and in addition, tees and elbows are not designed to withstand bending moment forces. Because the amount of outer casing axial movement is the same as inner casing movement, the outer jackets of piping must slide to avoid excessive forces on tees, elbows or fixed points. To accommodate outer casing movements, external guides along walls at floors, or in lateral breechings, must allow for movement of pipe.

NOTE: When resupporting a high rise exhaust system, Adjustable Lengths (AG) or Bellows Joints (BJ) must be used just below every support above the first to compensate for thermal expansion. For engine and turbine exhaust systems requiring pressures to 60 inches of water column, or where the construction must be absolutely gas tight, all welded Bellows Joints (BJ) are recommended for expansion and vibrational movements of the exhaust piping. Out-of-doors construction or low pressure systems, such as boilers (to 6 inches of water column), can effectively use the Adjustable Length (AG).

Spacing of guides and supports, when a thermal expansion part is used, should be not greater than specified in Section A. Proper guiding and support of expansion parts often requires closer spacing.

BELLOWS JOINTS: LINED (BJ)

For exhaust pressure to 60 inches of water column, Bellows Joints are recommended for expansion and vibrational movements of the piping. See Fig. C-2 for an illustration of a Bellows Joint (BJ). (Ref assembly instructional packaged with part).

Fig. C-1 illustrates the use of Bellows Joints in a typical installation. The use of the Lined Bellows Joints (BJ) is shown to compensate for the axial expansion of the long horizontal run.

The Lined Bellows (BJ) has a 0.035" thick or heavier straight stainless steel liner to protect the thinner Bellows material from heat and flow effects. It is used anywhere in a system for axial and vibrational movements only and must be accurately supported and guided. This part has limited lateral movement (1/8" max.) and lateral offsets and parallel misalignments should be eliminated. The purpose of the liner is to minimize contact, smooth flow, control erosion and eliminate resonance caused by exhaust gases passing through the bellows.

The Lined Bellows requires careful placement of piping guides to avoid interference on thermal expansion. Bellows should not be installed w/ any compression, but at its full uncompressed length in ambient state.

Fig. C-1 - Location of Bellows Joint in Typical System

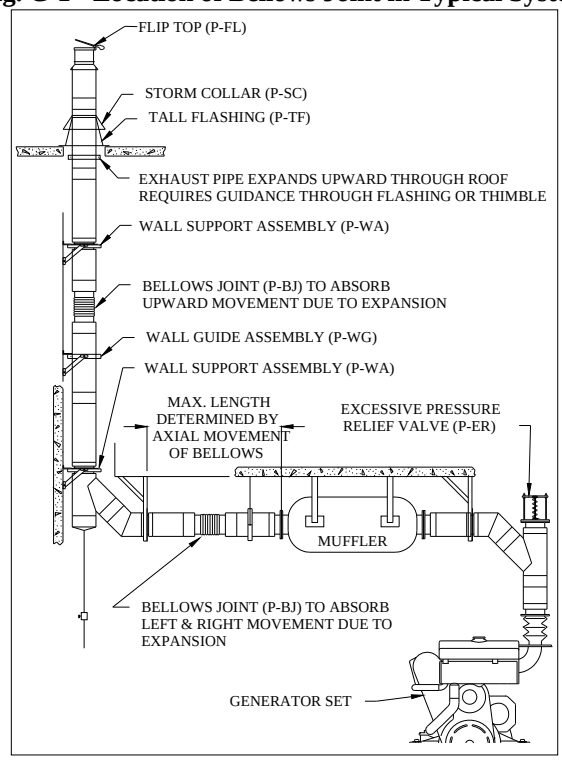
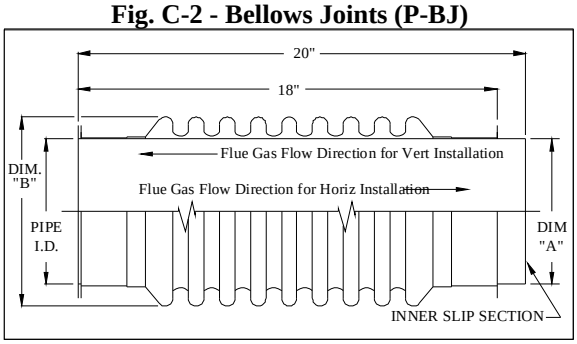


Fig. C-2 - Bellows Joints (P-BJ)



(Ref assembly instructional packaged with Bellows part).

Pipe I.D.	Dim. A Stub End O.D.	Dim. B O.D.	Bellows No. Conv.	Mat'l Thick-ness	Axial Spring Rate (Lb/in)	Axial Compr.
6"	6.07"	7.10"	16	0.012"	113	3.0"
8"	8.07"	9.25"	12	0.012"	116	3.0"
10"	10.07"	11.25"	12	0.012"	125	3.0"
12"	12.07"	13.25"	22	0.018"	153	3.0"
14"	14.07"	16.25"	11	0.018"	158	3.0"
16"	16.07"	18.25"	11	0.018"	161	3.0"
18"	18.07"	20.25"	11	0.018"	180	3.0"
20"	20.07"	22.25"	11	0.020"	210	3.5"
24"	24.07"	26.50"	11	0.020"	250	3.5"
28"	28.07"	30.50"	11	0.020"	290	3.5"
32"	32.07"	34.75"	9	0.025"	553	3.5"
36"	36.07"	38.75"	9	0.025"	620	3.5"
42"	42.07"	44.75"	9	0.025"	710	3.5"
48"	48.07"	50.75"	9	0.025"	819	3.5"

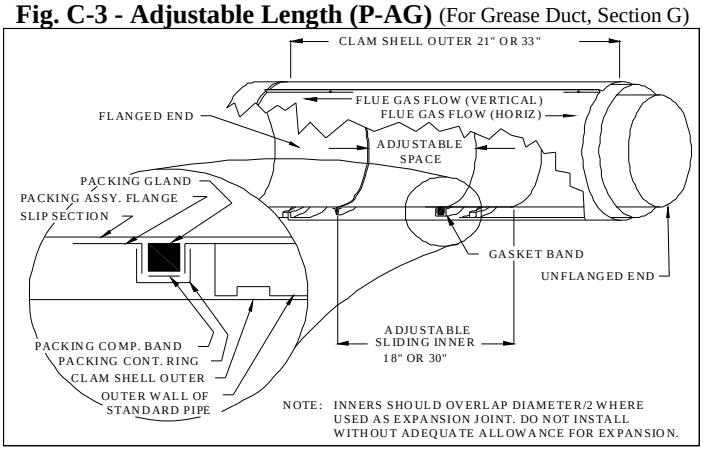
For any VSI/IVSI piping system requiring low axial expansion forces the Bellows Joints (P-BJ) will deflect with minimum friction at a known "spring rate." The values for spring rates given in the table assumes there are no other frictional constraints and proper alignment of the liner of the (P-BJ).

At an operating gas temperature of 1000°F (70°F, ambient) the VSI inner pipe in a typical engine exhaust system will be at a temperature rise of approximately 750°F. The same 1,000°F gas temperature will create higher inner pipe temperatures for model IVSI because it is better insulated.

Allowable expansion movements for Bellows Joints BJ are given in Figure C-2. For the following Bellows sizes, estimated cycle life is 6" - 12" = 4000 and 16" - 36" = 30,000 at 750°F.

The system operating pressure of 60 inches water column (2.08 psi) is based on the estimated capability of ceramic sealed Vee Band joints. The actual pressure limit of the welded bellows will be 10 psi for 6" to 12" diameter and 5 psi for 16" to 48" diameter at 750°F.

Fig. C-3 - Adjustable Length (P-AG) (For Grease Duct, Section G)



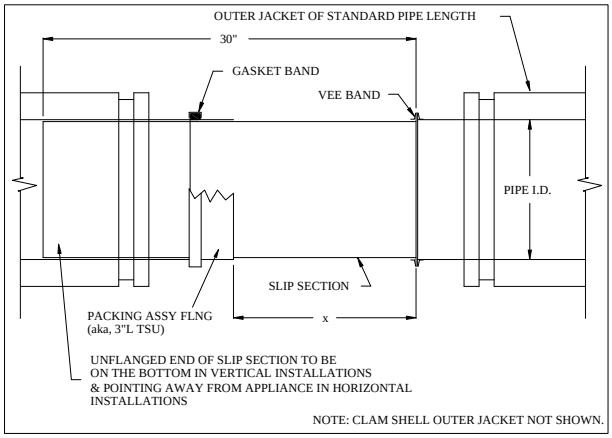
ADJUSTABLE LENGTH (P-AG) (For Grease Duct, See Section G)

The Adjustable Length has two major functions: To make up odd lengths of pipe as needed in short runs, and to serve as an expansion joint for thermal expansion in longer runs of pipe. The Adjustable Length may be used when pressures do not exceed 6" water column or in well ventilated areas. When used in systems of any orientation, it can perform both functions simultaneously.

The Adjustable Length comprises a sliding inner section, flanged on one end only (see Fig. C-3). This sliding piece is sized to fit closely inside a standard pipe section. At the sliding joint the assembly as shipped is fitted with a special graphited packing seal. The sliding outer jacket is the same thickness as that used on piping outer casings. It is placed around the sliding inner joint and must also slide in order to avoid expansion stresses.

For proper installation, an Adjustable Length must have adequate overlap and sufficient allowance for thermal expansion movement (see Fig. C-4). An Adjustable Length sliding inner pipe may be trimmed to ensure correct mating to a fitting or other short part. Care must be exercised so that proper penetration is maintained at low temperatures and no interferences occur at high temperatures.

Fig. C-4 - Diagram for Exposed Length "X" (P-AG)

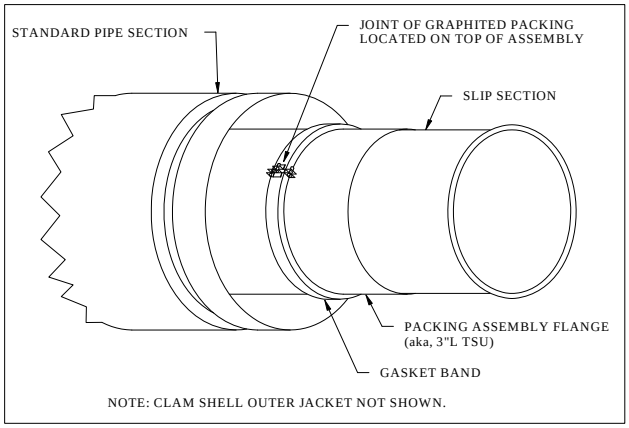


Maximum "X" Dimension												
Pipe Size	6"	8"	10"	12"	16"	20"	24"	28"	32"	36"	42"	48"
Max X	25.5"	24.5"	22"	21"	19"	17"	15"	13"	11"	9"	7.5"	4.5"

Minimum "X" Dimension								
Operating Temperature*	200	300	400	500	800	1000	1200	1400
Min X for 50' Length	0.7"	1.2"	1.7"	2.2"	3.7"	4.7"	5.7"	6.7"
Min X for 100' Length	1.4"	2.4"	3.4"	4.4"	7.4"	9.4"	11.4"	13.4"

* Temperature of 60°F assumed at time of installation, thus a temperature of 400 is a 340° rise and 100 feet will expand 3.4 inches. 30ft of pipe would expand: (30/100) * 3.4 = 1"

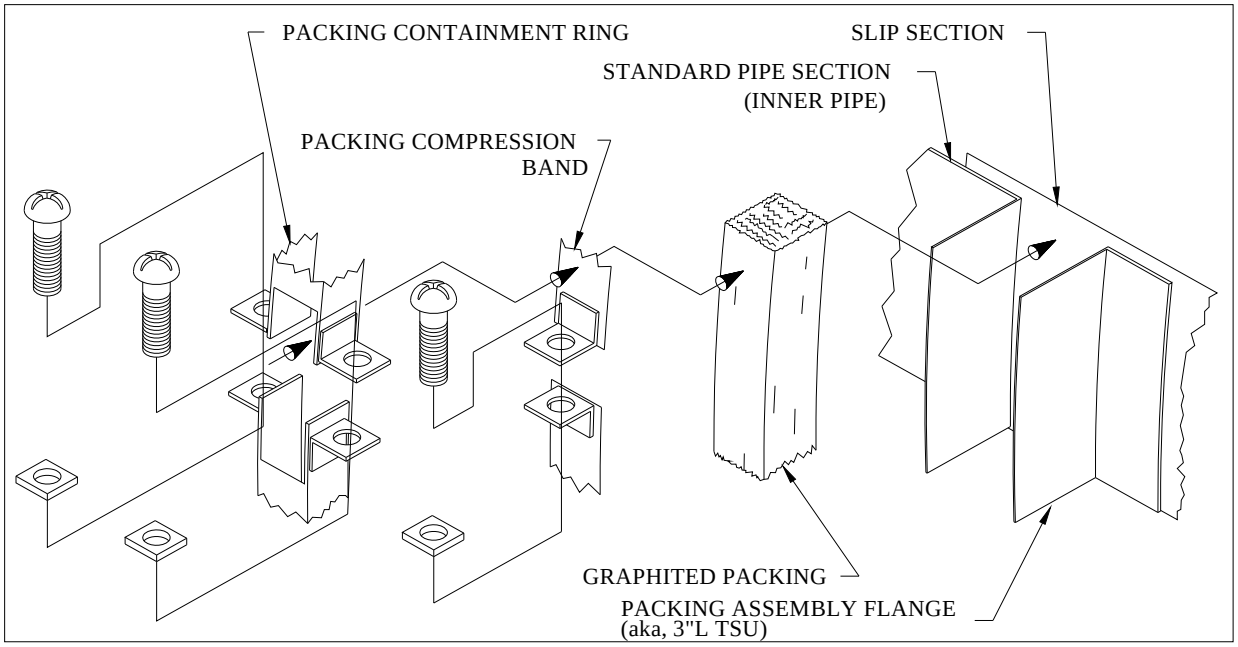
Fig. C-5.
Gasket Band assembled on Adjustable Length (P-AG)



VERTICAL INSTALLATION OF BELLOWS AND ADJUSTABLE LENGTHS

When a Bellows Joint (P-BJ) or an Adjustable Length (P-AG) is installed in a vertical position between two fixed points, such as between a P-PA and a P-MRS, it should be installed immediately below or one pipe length below the higher support. To assure proper axial alignment, guides (P-WG or P-FR or P-FG) must be installed at the pipe section below the bellows or adjustable length (see Fig. C-1). This combination of parts will assure proper movement of bellows and adjustable lengths and thus relieve loads due to thermal expansion. It is desirable to install bellows and adjustable lengths near the top of a vertical section to ensure that they do not bottom out during installation and thus become ineffective at relieving thermal expansion loads. This arrangement of parts will also resist wind loads on installations which run up building exterior walls.

Fig. C-6. Gasket Band Assembly Parts for Adjustable Length (P-AG)



HORIZONTAL INSTALLATION OF BELLOWS AND ADJUSTABLE LENGTHS

Horizontal or sloped installations of Bellows (P-BJ) or Adjustable Lengths (P-AG) use the same parts, assembled in the same relationship, as a vertical assembly. These expansion joints, when required may be placed anywhere between two fixed points of horizontal or sloped installation as long as they are properly guided, properly supported; and for sloped installations in particular, as long as bottoming out is prevented. It is recommended, but not required; that the Lined Bellows inner shield and the Adjustable Length sliding inner be attached to the upstream end of a horizontal installation (the free end is downstream, away from appliance). When the adjustable is put in place for horizontal runs, the packing joint must be on the top of the pipe (see Fig C-4).

ADJUSTABLE LENGTH PACKAGING

Adjustable Lengths are shipped with their outer pipe clam shell jacket inside the sliding inner pipe. The gasket band assembly is preassembled at shipment on the inner pipe. It only needs to be loosened for attachment to an adjacent piece of pipe and then tightened for a leak resistant fit. (See “Thermal Expansion” in this section.)

INSTALLATION OF ADJUSTABLE LENGTH PACKING

Normally, disassembly of the Adjustable Length is not necessary; but if the gasket band must be removed for any reason, it can be reassembled using the following procedure. (Some of this procedure can be done with the hardware conveniently placed on the floor. Performing this procedure with the Adjustable Length in this position could be difficult for a person working alone.)

a) Prepare the sliding inner section for assembly by placing the packing assembly flange over the sliding inner section (Refer to Fig. C-3, C-5, and C-6 for a description of all parts involved.) Make sure the packing assembly flange is oriented correctly.
b) Place the sliding inner slip section into a standard section of IVSI Duct.
c) Wrap the graphited packing around the slip section of the Adjustable Length between the standard section pipe flange and the packing assembly flange. (Using an ordinary staple to hold both ends of the graphited packing together aids in the assembly.)
d) Clearly mark on the packing assembly flange the location of the joint of the graphited packing. (See Fig. C-5 for the ultimate location of the joint.)
e) Slide the packing assembly flange toward the standard section inner pipe flange so that graphited packing is captured between those two flanges.
f) Place the packing compression band around the graphited packing with the graphited packing joint located at the midpoint of either half of the band. Tightly secure the compression band with the hardware provided, but Do Not Over-tighten.
g) Both halves of the packing containment ring can now be placed over the graphited packing and compression band so that the compression band joints are exposed at the notched-out section at the ends of the containment ring halves (See Fig. C-6).
h) Fasten both joints of the containment ring with appropriate hardware and secure (Do not over-tighten because the sliding inner must still remain movable.)
i) This whole assembly can now be put in place, extended to its correct length and secured with a Vee Band.
j) Tighten both joints of the compression band so that the graphited packing is firmly registered against the sliding inner.
k) Retighten both joints of the containment ring.
l) Install the outer pipe covering jacket (and insulation strip if IVSI) so it fits loosely and can slide freely when the duct expands or contracts.

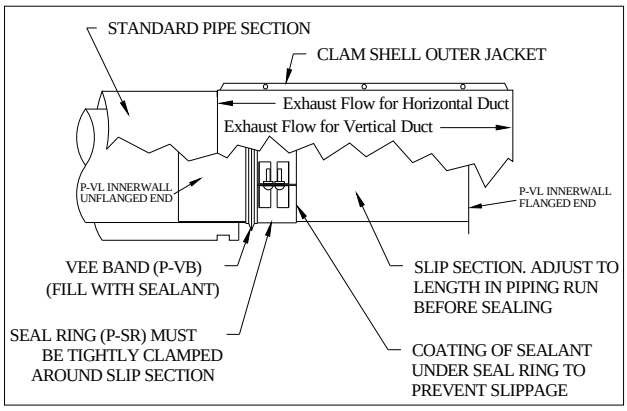
VARIABLE LENGTH (P-VL) (For Grease Duct, See Section G)

In straight runs of Model VSI/IVSI, the Variable Length serves two major functions: 1) to make up for odd lengths of pipe in short runs, and 2) to provide for joint sealing. This part adjusts to a needed fixed exact length. Its internal joint must be sealed by working sealant under the seal ring, as well as between this ring and the flange to be joined by the Vee Band (See Fig. C-7).

Observe all precautions for cleaning surfaces to be sealed and carefully follow the Variable Length installation procedures specified below.

The Variable Length comprises a sliding inner section, flanged at one end only. This sliding piece is sized to fit closely inside a standard pipe section. A seal ring is provided to prevent the inner section from slipping after assembly. The sliding outer jacket is aluminized steel of the same thickness as that used on piping outer casings. It is placed around the assembled inner and finishes the appearance of the Variable Length. For detailed methods of installation see instructions contained below in this section.

Fig. C-7 - Variable Length (P-VL) (For Grease, Sect G)



SHORT AND ODD LENGTHS ADJUSTABLE LENGTH (P-AG) AND VARIABLE LENGTH (P-VL) (Grease, Sect G)

The following data is for any Pressure Stack system where a short length (4" to 26") is needed. This applies in horizontal runs between the appliance and tee, between two fittings, and similar situations. For gaps of 4" to 26" both the inner and outer pipes of the Adjustable Length may need to be trimmed. The Variable Length has a corresponding gap 4" to 26".

Observe these steps in making up a short length assembly for the Adjustable Length.

1. If the Adjustable Length has been pre-assembled into a standard pipe section, disassemble carefully, observing the position of the gasket band and the gasket.
2. For Adjustable Lengths shipped unassembled, refer to Fig. C-4 prior to starting any cutting.
3. Check both the foregoing table and the Adjustable Length table prior to cutting, and make sure that the inner pipe is as long as possible with due allowance for thermal expansion. The outer pipe should be 3 inches longer than the inner.
4. Cut and finish the pipe ends carefully to avoid burrs which would interfere with reassembly or thermal expansion movements.
5. Assemble the inner section and gasket band in accordance with Fig. C-4, checking again for possible interference.
6. Check the fit of the gasket to be sure there are no gaps between it and the inner pipe.
7. Install outer pipe (and insulation strip if model IVSI). It may face the same or the opposite direction of the inner, providing there is adequate room for expansion movement.

Observe these steps in making up a short length assembly for the Variable Length:

1. Prior to installation in the run of chimney, clean the Vee Band and surfaces to be cemented.
2. Install slip connection and adjust to length in run.
3. Install sealed Vee Band, joining flanged end of slip section to next length of pipe.
4. Work in sealant between slip section and its external section of pipe.
5. Apply thin layer of sealant to inside of Seal Ring.
6. Position Seal Ring as shown in Fig. C-7 and clamp tightly before cement sets.
7. Fill Vee Band with sealant and install over flanges of joint between pipe and Seal Ring.

Fig. C-8 - Variable Length used as appliance connector

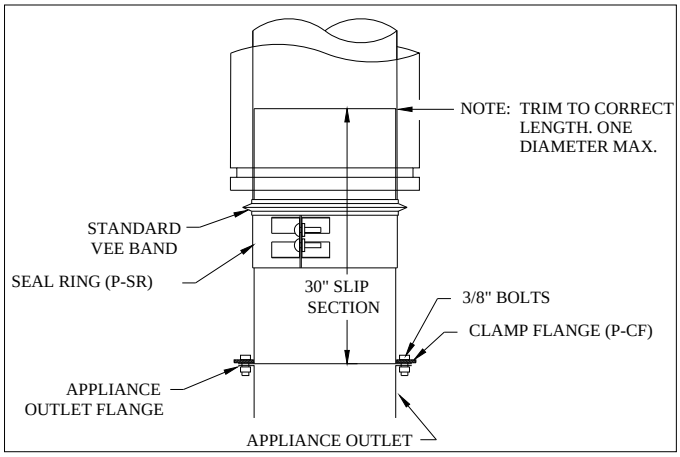


Fig. C-9 - Variable Length used to terminate into an existing Masonry Chimney

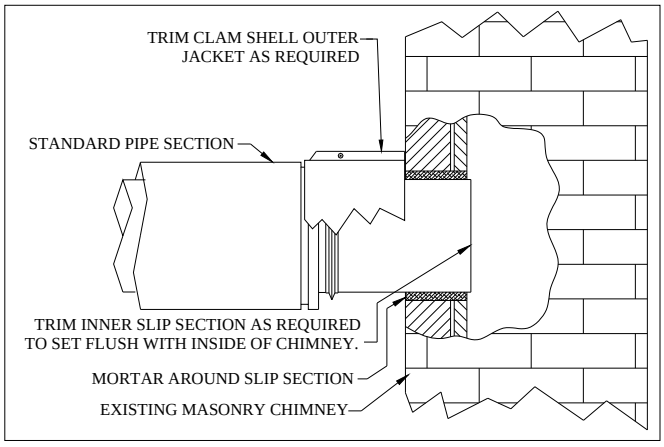


PLATE SUPPORT ASSEMBLY (P-PA)

The Plate Support Assembly consists of a Clamp Flange (P-CF) (located above the Vee Band), bolted into a Plate Support (located below the Vee Band). The clamping force between these parts is applied to the Vee Band. The Plates secured to structural steel framing thus, the assembly and the pipe are anchored against upward, downward and angular displacements. Joints of the plates and flanges must be located 90° apart, with notches aligned for relief at Vee Band end clips.

The Plate Support Assembly is the maximum strength support for a vertical VSI/IVSI chimney. It is also used to maintain positive joint alignment and support for expansion joints in horizontal chimneys. Between any two fixed points in a system or wherever an expansion joint must slide to prevent bending of tees or elbows, locate and secure Plate Support Assemblies as necessary by means of structural ties to the building. This may require supports both upstream and downstream of a tee, which then protects the tee from excessive bending stresses.

Support height limits for plate assemblies are given in Section A of these instructions.

Greater stability may be obtained by resupporting above with additional Plate Support Assemblies, using an Adjustable Length or Expansion Joint below each point of Support. To obtain these strengths, all holes must be bolted with 3/8 inch bolts (see Fig. D-1).

Fig. D-1 - Plate Support Assembly

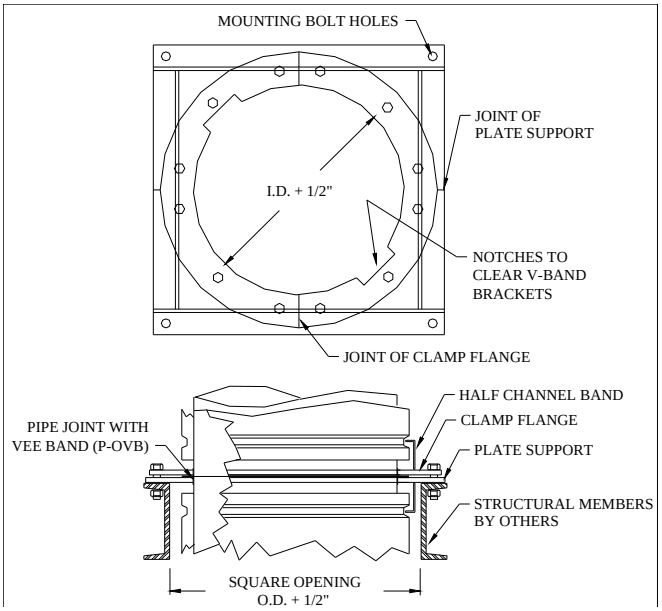


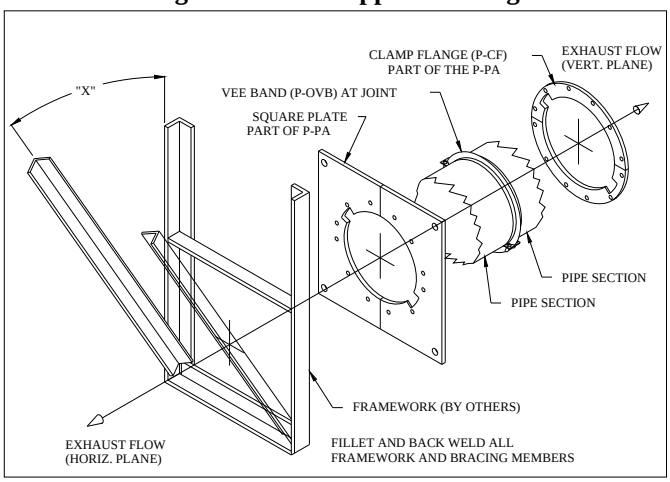
Plate Support Height Limits:
See Section A

The notches in the Plate Support and in the Clamp Flanges are to accommodate Vee Band end clips, thus allowing the Vee to rest solidly on the Plate. The bolt circle and spacing of the plates and flanges are identical, providing a variety of options in supporting and reinforcing a chimney.

The Plate Support method is intended only for attachment to NONCOMBUSTIBLE surroundings such as steel structure, concrete block or other masonry at clearances adequate for access and assembly. Heat conduction through supporting brackets can be reduced by use of spacers such as insulating millboard. The Plate Support is not suitable for attachment to wood or combustible walls. Exception: In an L Vent application, the PA may be attached to wood framing if non-combustible millboard is placed between the two surfaces.

The Plate Support Assembly must be secured to the building with a rigid structural framework. Under no circumstances should a plate support be secured with threaded rods since this will not prevent pipe sway. See Fig D-2 for proper bracing techniques.

Fig. D-2 - Plate Support Bracing



Satisfactory performance and long service life of Model VSI/IVSI systems requires the product be rigidly braced and supported. Every installation presents unique support and bracing requirements and the following guidelines will provide minimum acceptable sizes for the mechanical hardware supplied by others.

Note: IF BRACING IS USED, MINIMUM "X" ANGLE (IN FIG. D-2) IS 30°. IF BRACING IS NOT USED, WELDED FRAME MEMBERS MUST BE ATTACHED TO STRUCTURAL MEMBERS TO PROVIDE EQUIVALENT RIGIDITY OF FRAMEWORK.

Pipe Size	PA Thickness	Framework (in.)	Bracing
5" – 20"	3/16"	2x1x3/16 to 5x1-3/4x3/16 Channel or equivalent	2x2x3/16
24" – 36"	1/4"	5x1x3/4 to 6x2x5/16 Channel or equivalent	3x3x1/4
42" – 48"	3/8"	6x2x5/16 Channel or equivalent	4x4x3/8

CLAMP FLANGE (P-CF)

The heavy steel Clamp Flange is pre-drilled with bolt holes to match those in the plate Support and the Full Ring. Each Flange half has a notch for relief at Vee Band clamp locations.

The Clamp Flange may be used to hold down an Adjustable or standard pipe length on a round flanged appliance outlet. Holes for 3/8" bolts should be drilled as necessary, or one set of flanges may be welded to the top of the boiler flange, with the other set used around the inner pipe above the pipe flange. The inside diameter of the Clamp Flange is not intended to fit below a round boiler outlet flange.

When used in this manner at a boiler outlet, the inner cutouts should be filled with suitable refractory cement.

The Clamp Flange may be used as a hold down on a refractory base or oven, given the proper size opening hole for support and correctly placed bolts or masonry anchors.
See Model VSI/IVSI System Catalog for Clamp Flange dimensions including bolt circle dimensions.

HIGH STRENGTH PLATE SUPPORT BASE

Greater height limits and stability can be gained for pipe sizes by using a High Strength Plate Support Base as shown in Fig. D-3. The structural base as shown has been tested by Underwriters' Laboratories, Inc. and has a minimum factor of safety of 4. Follow all of the design guidelines illustrated in Fig. D-3 to obtain maximum strength in the assembly. Rigidly attach the assembly to the support structure. To minimize construction time and assure alignment of all parts, use the plate support as a template and predrill the bolt holes in the structural base.

Fig. D-3 - High Strength Plate Support Base

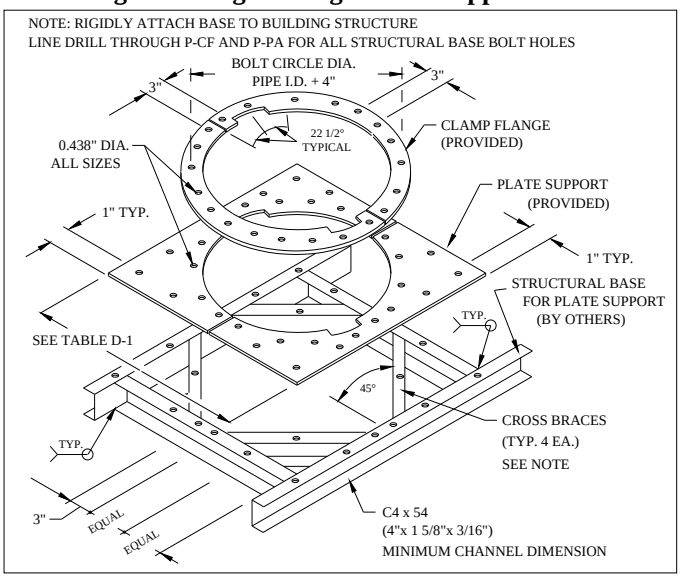


Table D-1. P-PA Assembled Overall Size		
Insulation Thickness/Size	PA Size (in.)	Bolt Circle dia.(in.)
VSI & IVSI-C1	Pipe Size + 6"	Pipe Size + 4"
IVSI-C2	Pipe Size + 8"	Pipe Size + 6"
IVSI-Z3,C4,Z4	Pipe Size + 12"	Pipe Size + 10"

WALL SUPPORT ASSEMBLY (P-WA)

The Wall Support Assembly consists of a Full Angle Ring, Brackets and Struts, plus two Clamp Flanges. These Flanges are clamped over and under the Vee Band of an inner joint, and against the Ring for secure attachment to the inner chimney pipe, as shown, in Fig. D-4.

To assemble the two Flanges and Ring, use the Clamp Flange in the middle, to hold the outer parts together by placing it to span the split in the Ring. To provide clearance for the clamp ends of the inner band, the 4 inch wide notches of both Clamp Flanges should be in alignment and 180° apart. All holes should be completely and tightly bolted, using the hardware provided. Full strength is attained with this assembly whether the Ring is located above or below the joint being supported (see Fig. D-5).

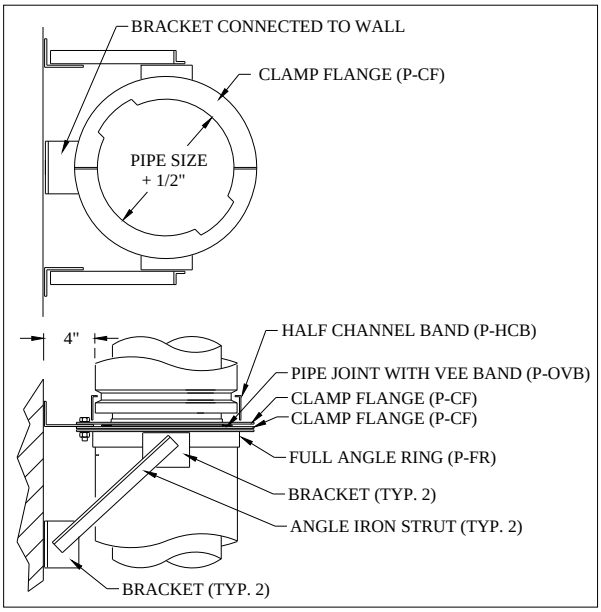
When attached to a masonry wall or suitable non-combustible structure, the Wall Support forms a fixed point in the chimney system, thus expansion movement above and below must be considered during system planning.

The Wall Support Assembly is suitable for use as the support just below the point where the chimney becomes freestanding. For such use, a Full Angle Ring or Wall Guide Assembly should be installed a distance of 6 to 10 feet below the Wall Support. This stabilizes the exposed end and thus resists side forces due to wind (see Fig. D-6).

VSI and IVSI C-1 Wall Supports may be used at 30 foot spacings. Use IVSI C-2 Wall Supports at 20 foot spacings for chimney resupport. Use appropriate expansion joints and Full Rings or Wall Guides for lateral stability at appropriate spacings. The height of a chimney between supports is measured from the Adjustable Length, which must be used below each support.

Clearance from a non-combustible wall to chimney outer casing varies slightly with the size of the Wall Support, but will be between 4 and 4-1/2 inches.

Fig. D-4 - Wall Support Assembly (P-WA)



WALL GUIDE ASSEMBLY (P-WG)

The Wall Guide Assembly (P-WG) comprises a Full Angle Ring (P-FR) plus brackets, angle struts and hardware for assembly (but does not include anchor bolts for attachment to a wall). The Ring, which is split in two halves for ease of assembly, is 1/8 inch larger than the outside diameter of the chimney pipe to allow for sliding movement during thermal expansion. In any Guide application the proper position of the Ring, when assembled around any pipe section, is at a joint but below the outer band. This allows the outer band to move away from the Ring.

The Wall Guide Assembly (P-WG) is designed for 2 to 10 inches of clearance from pipe outer casing to noncombustible walls. The side struts may be placed either up or down as convenient.

This Assembly is intended to resist lateral or side loads only, and is not for carrying the weight of a vertical chimney.

The horizontal struts allow for attachment to the wall after the chimney has been positioned. The angle of attachment may vary as needed for the chimney-to-wall clearance.

The Wall Guide Assembly is not for attachment to wood walls, wood structure or other combustible materials. If the stack must be attached to an interior or exterior combustible wall, spacers should be used to maintain proper clearance and minimize heat conduction through supporting metal parts.

Fig. D-5 -Exploded view of Wall Support Assembly (P-WA)

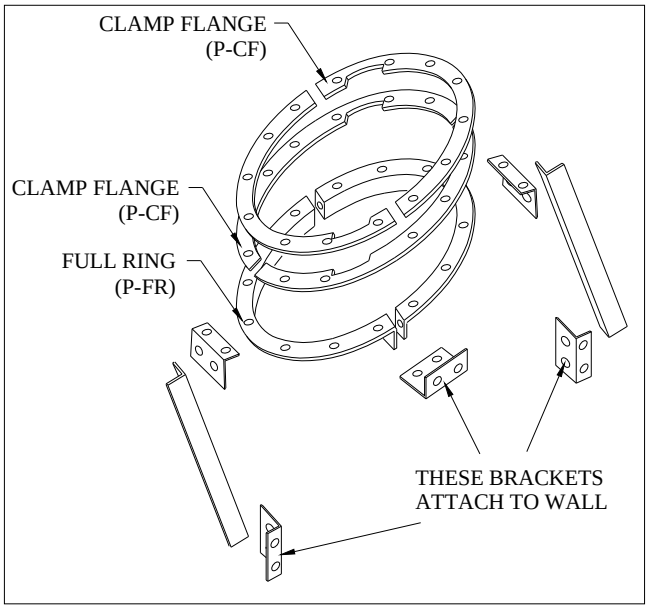
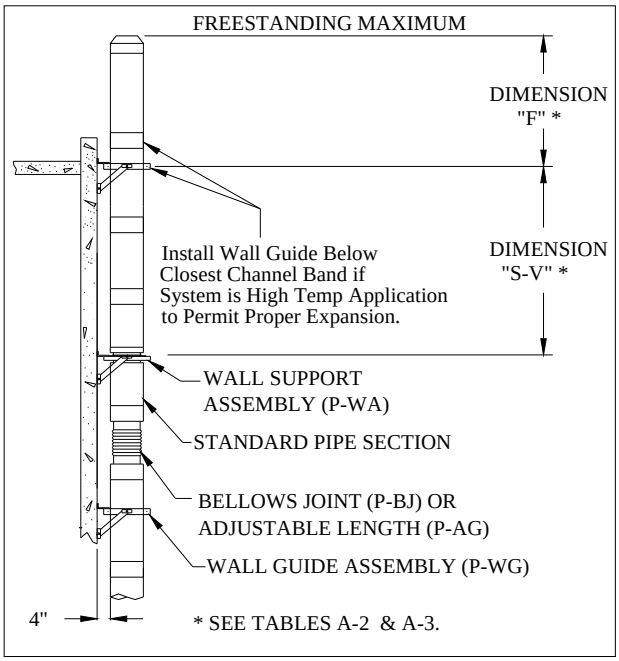


Fig. D-6 - Upper end of exhaust system using Wall Support (P-WA)



Note: Important - Location of Wall Guides and Full Rings on Tall systems serving as engine exhaust or other high temperature applications.

In order to avoid potential problems due to thermal expansion, Wall Guides (P-WG) and Full Rings (P-FR) on tall engine (and other high temperature) exhaust systems must ALWAYS be installed at an elevation BELOW the closest Channel Band (P-CB).

Mistakenly installing a WG or FR directly (or some minimum distance) above a Channel Band could result in obstruction of the natural vertical “growth” in height of the system when the appliance is operated and result in physical damage. Contact the factory if there are any questions. (See Fig D-6)

Fig. D-7 - View of Wall Guide, facing wall (P-WG)

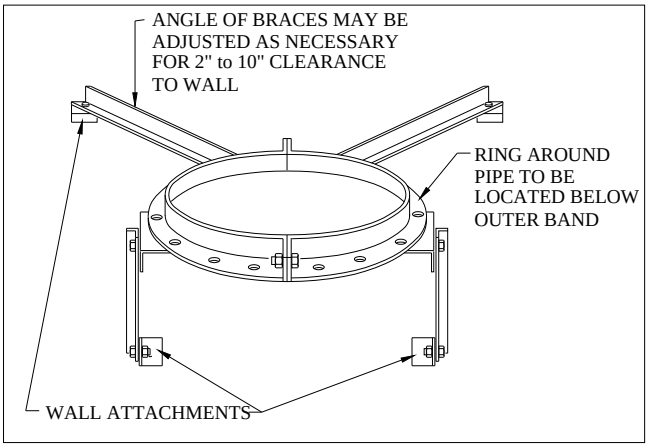
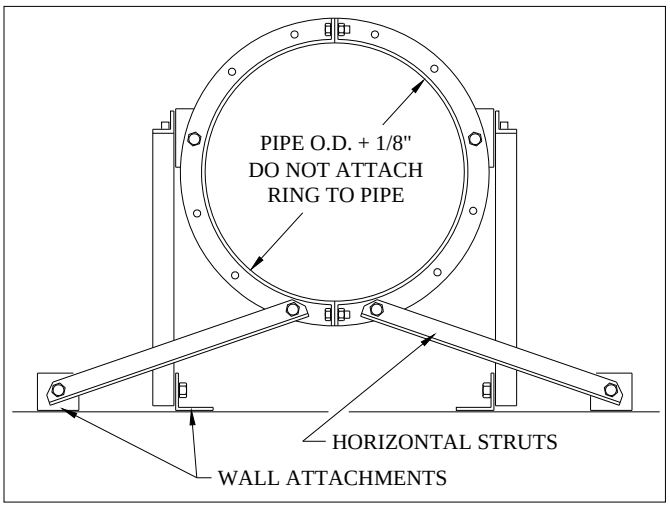


Fig. D-8 - Plan view of Wall Guide (P-WG)



FLOOR GUIDE (P-FG)

The Floor Guide comprises a Full Ring, two long angles, and two flat straps, and is used where the system can be braced within a floor opening. As shown in the plan view, the flat straps provide bracing to prevent sideways bending of the long angles.

Fig. D-9: Floor Guide (P-FG)

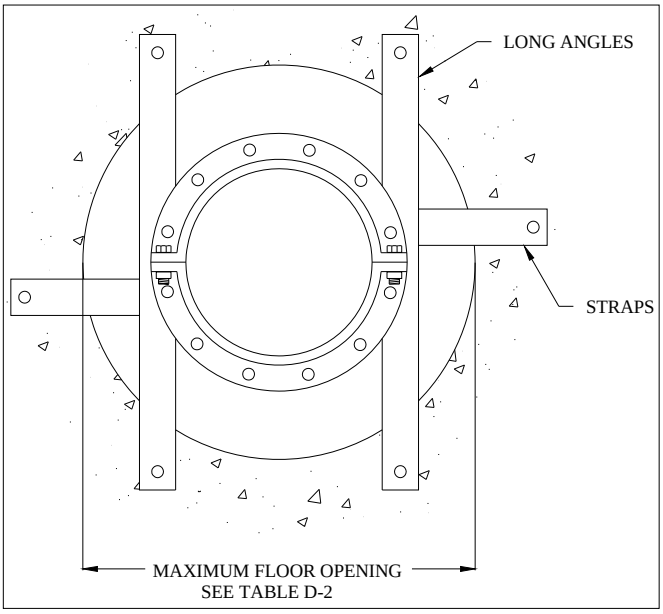


Table D-2: Floor Guide Maximum Floor Opening	
Insulation Thickness/Size	Maximum Floor Opening
VSI & IVSI-C1	Pipe Size + 10”
IVSI-C2	Pipe Size + 12”
IVSI-Z3	Pipe Size + 14”
IVSI-C4	Pipe Size + 16”

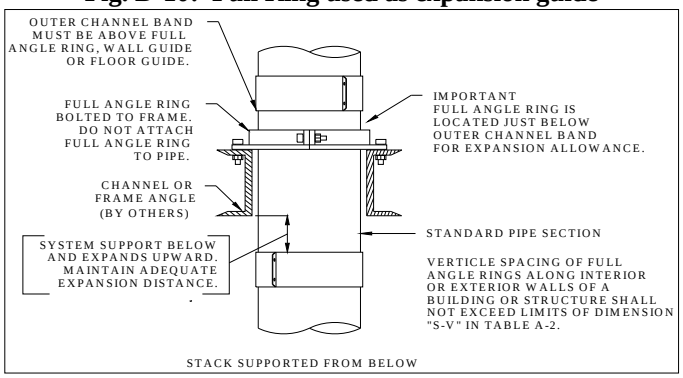
FULL ANGLE RING (P-FR)

The Full Angle Ring may also be used as an expansion guide by attachment to a suitable structural steel frame. For a support cradle for horizontal run, half ring or Support Straps may be suspended by rods.

IMPORTANT CAUTION: The Supports and Guides described here are only suitable for attachment to noncombustible construction.

MAINTENANCE OF STRUCTURAL STEEL USED OUTDOORS: IT IS RECOMMENDED TO APPLY AN EXTERIOR GRADE HIGH HEAT PAINT TO ANY PLATE SUPPORTS, FULL/HALF ANGLE RINGS, WALL SUPPORTS/GUIDES, EXPOSED OUTDOORS TO ENSURE MAXIMUM CORROSION RESISTANCE. (Ex. Rustoleum V2100 series High Heat Industrial Aerosol)

Fig. D-10: Full Ring used as expansion guide



ROOF SUPPORT ASSEMBLY (P-MRS)

The Roof Support Assembly is primarily for penetration of roofs of combustible construction. It can be installed with wood framing at two inch minimum clearance to the Thimble structural shield (see Fig. E-2 & Fig. E-4).

Nominal framing dimensions are given in Table E-1 (see also Fig. E-1). For pitched roofs it is necessary to construct a level curb suitable for attachment of the support brackets.

The vertical length of this assembly allows penetration of roof structure up to 8 inches deep.

Air circulation through the Roof Support should not be blocked off if the chimney is being used for high temperature applications (1,000°F and above) and is installed through combustible roof structure. In small boiler rooms with gravity air supply, it may also serve as a ventilation air outlet.

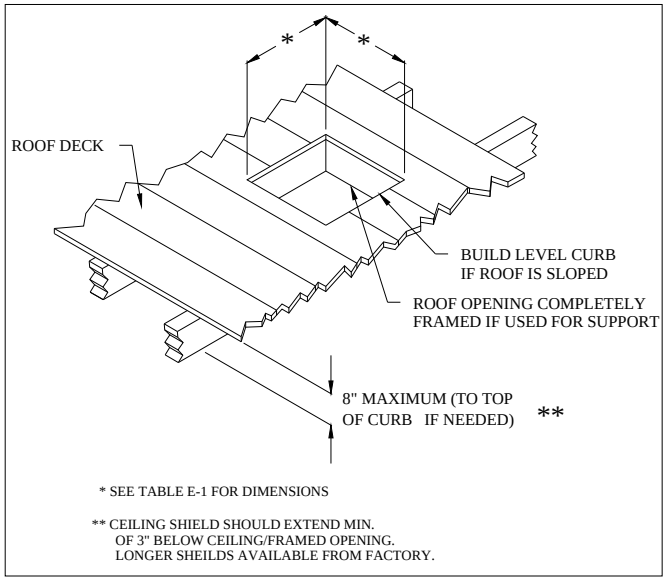
See Table A-3 for Roof Support Capacities.

Use of a Full Angle Ring or a Wall or Floor Guide Assembly is recommended, just below the Roof Support.

The Roof Support Assembly mounts directly to combustible structure using four 1/4 X 2 1/2 inch lag screws in each support bracket. The holes for the lag bolt at the bottom of the brackets may not be factory predrilled and will require to be done in the field . The VSI/IVSI pipe from below and the next pipe section above are attached to the Roof Support using the Clamp Flange provided (Fig E-2). The Flashing is then centered over the opening. The Storm Collar is placed on the pipe and in contact with the Flashing. Use silicone sealant at the joint between pipe and collar.

The ceiling shield is then attached to the support body using the fasteners provided.

Fig. E-1: Framing dimensions for Thimble and Roof Support Assembly. (P-MVT & P-MRS)



VENTILATED ROOF THIMBLE (P-MVT)

The Ventilated Roof Thimble, which does not include a pipe section, is primarily for penetration of building roofs of combustible construction. It can be installed with wood framing at two inch minimum clearance to the Thimble structural shield (see Fig. E-3 & E-5). It may be used with all types of roofs.

Nominal framing dimensions are given in Table E-1 and shown in Fig. E-1. For pitched roofs, it is necessary to construct a level curb.

The Thimble mounts directly to a level combustible structure using four 1/4 X 2 1/2 inch lag screws in each external bracket. Pipe is assembled from below and inserted up through the Full Ring provided with the Ventilated Thimble. The Flashing is then centered over the framed opening. The Storm Collar is placed on the pipe and in contact with the Flashing. Use silicone sealant at the joint between pipe and collar.

The Storm Collar has internal spacers, and when placed over the pipe will rest on the Flashing to maintain clearance for the ventilation air exit. The ceiling shield is then attached to the thimble body using the fasteners provided.

This Thimble includes a Full Ring (Part No. P-FR) which provides lateral chimney support to resist outdoor wind loads; follow the “F” dimension shown in Section A for maximum free standing heights above the Full Ring which is secured to the Thimble body.

For the Ventilated Roof Thimble (as with the Roof Support) do not block off air circulation through the Thimble if the stack is installed through combustible roof structure.

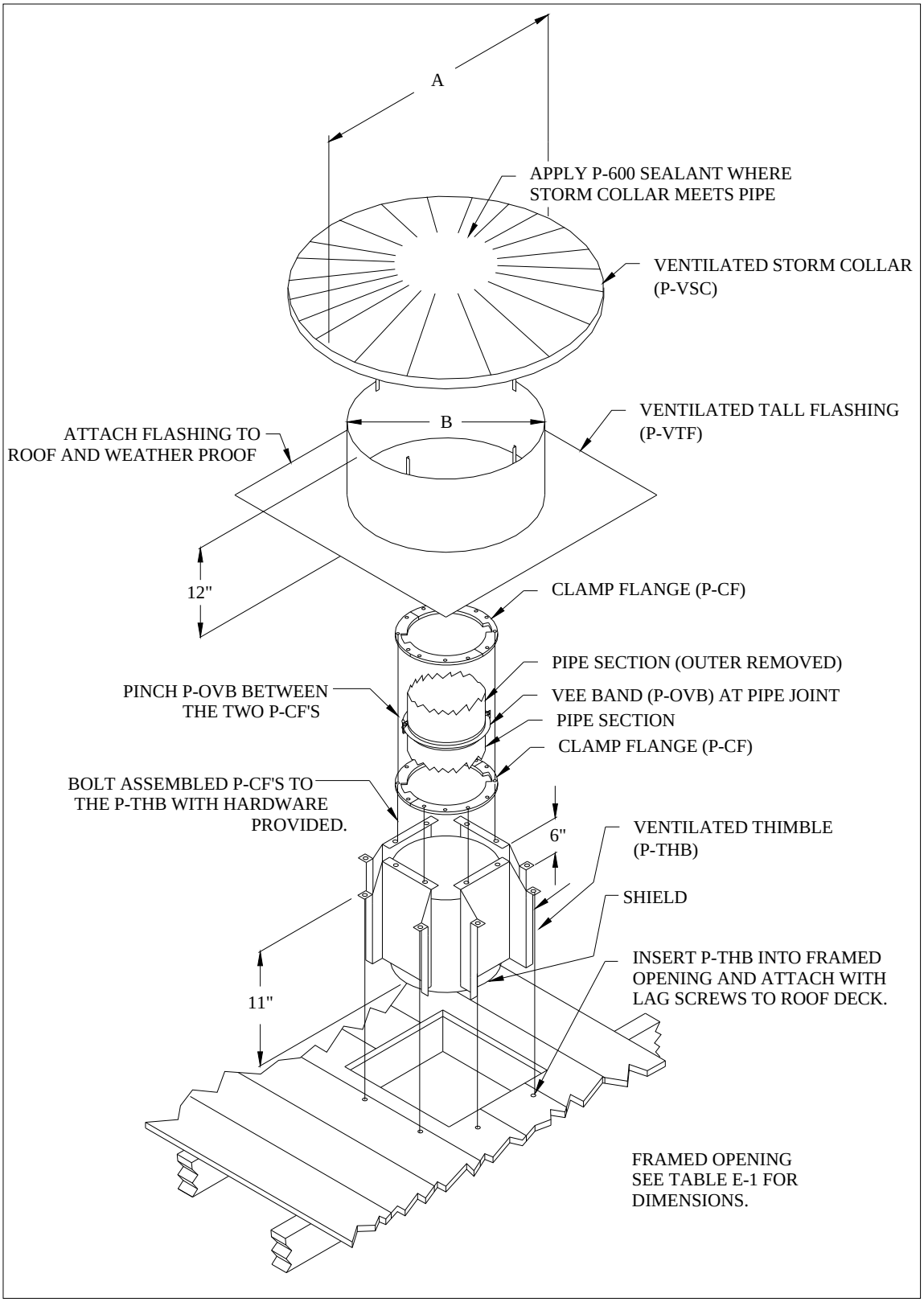
When installing VSI pipe through the Thimble, be certain there is adequate vertical expansion allowance between pipe Outer Channel bands and the Full Ring supplied with the Ventilated Thimble. If an Outer Channel Band is directly below this Full Ring, on upward expansion, the Ring may distort or damage the tabs on the assembled Channel Bands.

Table E-1: Roof Support and Ventilated Thimble Dimensions (P-MRS & P-MVT)

Wall Thickness /Designation	Framing Dimension	Collar Diameter Dim ‘A’	Flashing Diameter Dim ‘B’
1”/VSI & IVSI-C1	Pipe Size + 8”	Pipe Size +20.5”	Pipe Size +14.5”
2”/IVSI-C2	Pipe Size + 10”	Pipe Size + 22.5”	Pipe Size +16.5”
3”/IVSI-Z3	Pipe Size + 12”	Pipe Size + 24.5”	Pipe Size +18.5”
4”/IVSI-C4	Pipe Size + 14”	Pipe Size + 26.5”	Pipe Size +20.5”
*See Figs. E-2 through E-5.			

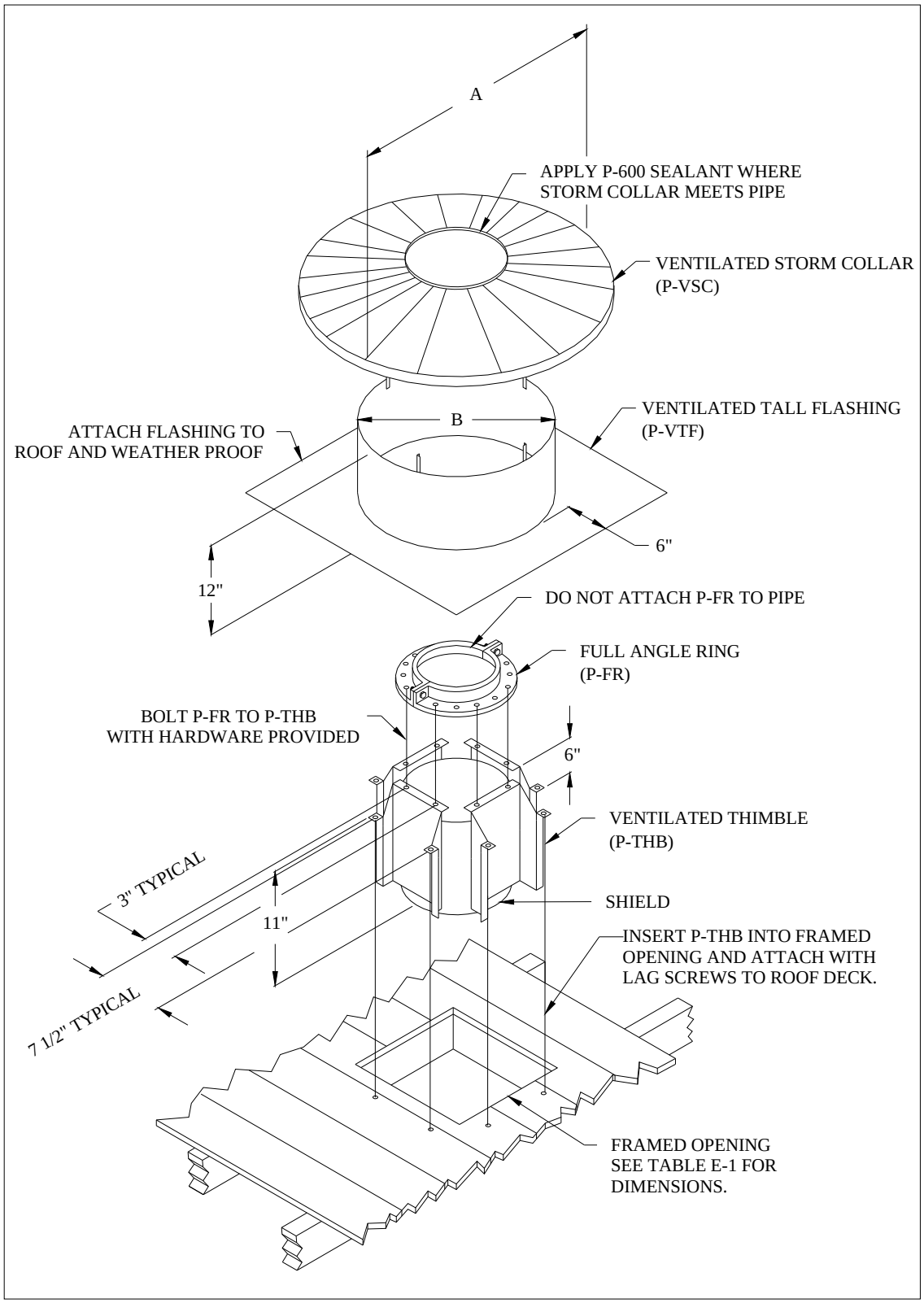
EXTERIOR CORROSION PROTECTION: IT IS RECOMMENDED TO APPLY AN EXTERIOR GRADE HIGH HEAT PAINT TO ANY ALUMINIZED OUTER WALLS & ROOF/WALL FLASHING COMPONENTS, EXPOSED OUTDOORS TO ENSURE MAXIMUM CORROSION PROTECTION AGAINST THE ELEMENTS. (Ex. Rustoleum V2100 series High Heat Industrial Aerosol)

Fig. E-2 - Roof Support Installation (P-MRS)



NOTE: SEE TABLE E-1 FOR A, B AND FRAMING DIMENSIONS. SHIELD SHOULD EXTEND MIN. 3" BELOW CEILING/FRAMED OPENING. LONGER SHIELDS ARE AVAILABLE FROM THE FACTORY.

Fig. E-3 - Installation of Ventilated Roof Thimble (P-MVT)



NOTE: SEE TABLE E-1 FOR A, B AND FRAMING DIMENSIONS. SHIELD SHOULD EXTEND MIN. 3" BELOW CEILING/FRAMED OPENING. LONGER SHIELDS ARE AVAILABLE FROM THE FACTORY.

Fig. E-4 – Roof Support Installation (P-MRS)

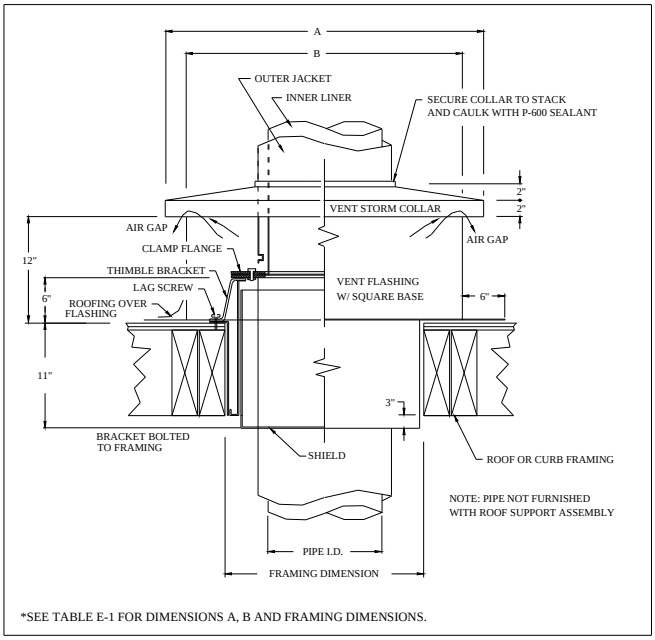
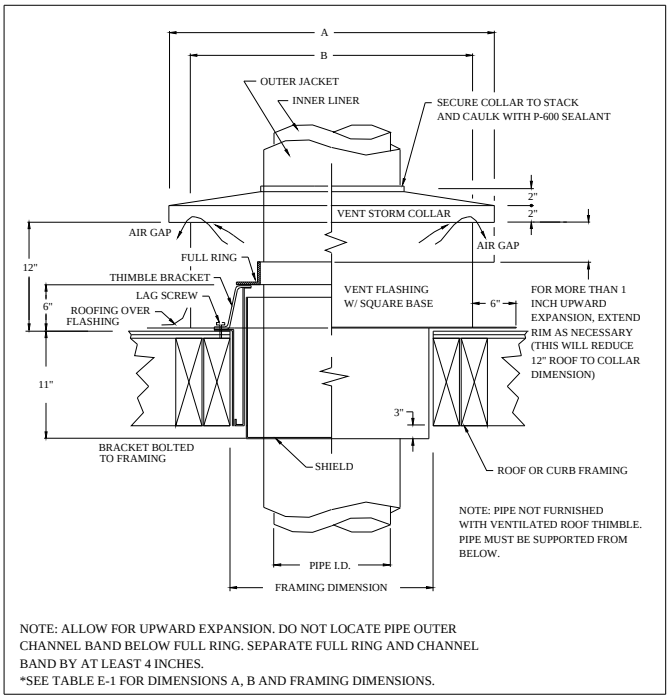


Fig. E-5 – Installation of Ventilated Roof Thimble (P-MVT)



FLASHINGS AND STORM COLLARS (P-TF AND P-SC)

The Flashing Assembly consists of a square base Tall Cone Flat Roof Flashing, plus a Storm Collar counter flashing. Both of these fit the outside diameter of Model VSI/IVSI pipe. These parts are made of galvanized steel, which should be cleaned and painted after installation to help resist corrosion. These parts are optionally available in stainless steel for ease of maintenance.

This nonventilated Flashing is for use only on completely noncombustible, flat or slightly pitched roofs. The Flashing is not intended to take any side load or wind loads, thus a Full Angle Ring below the roof is used for lateral stability. For heights above the angle ring exceeding the Dimension F freestanding limit, external guiding or guying is required to stabilize against wind loads.

To allow for thermal expansion upward through the Flashing, the first outer band below the Flashing must be down far enough to avoid interference. Further, if more than 5 inches of expansion is expected, the Storm Collar should be extended downward with an added ring of galvanized steel.

For maximum height above the roof, use a Plate Support Assembly (P-PA) just below the roof with appropriate guying or bracing above the roof.

The Storm Collar mounts on the pipe immediately above the Flashing. The joint between Storm Collar and pipe should be sealed with silicone sealant.

Fig. E-6 - Installation of Tall Cone Flashing (P-TF)

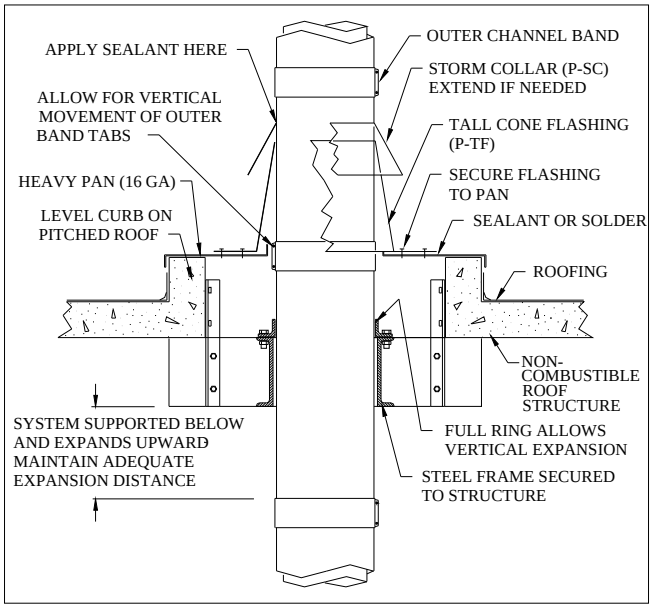
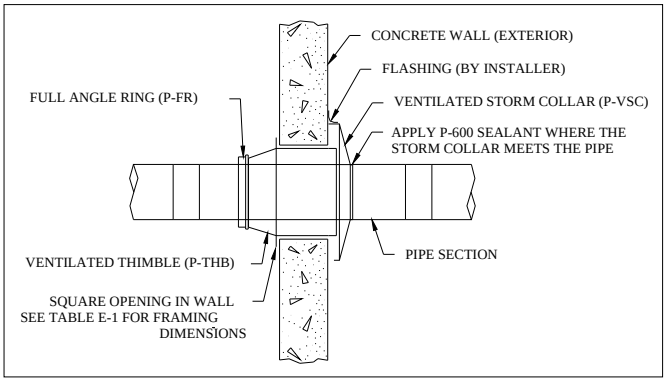


Fig. E-7 - Masonry Wall Detail



OTHER PENETRATIONS

In many engine exhaust and other applications, Model IVSI may pass through an exterior masonry wall horizontally. Fig. E-7 shows a simple solution which can be easily incorporated.

GENERAL

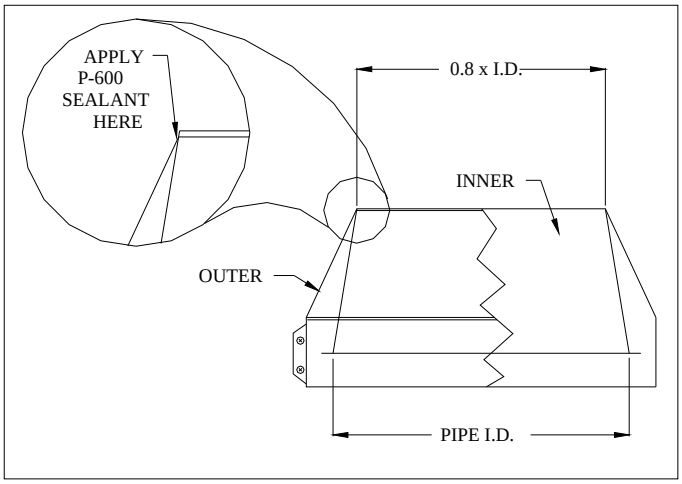
An upward discharge (such as with an Exit Cone or Open Top) provides the most effective means of dispersing chimney gases into the atmosphere and away from immediate surroundings. Such terminations however, will allow entry of rain unless there is upward flow at high velocity. A Stack Cap is only partially effective in excluding rain. Its effectiveness depends on chimney gas flow rate, raindrop characteristics and wind velocity.

With all VSI/IVSI Chimney terminations, where rain may enter the chimney outlet, the following precautions must be taken:

1. All inner joints must be sealed with sealant.
2. Install a Drain Section at least 5 pipe diameters below the chimney outlet, but above any Tee or Elbow.
3. If a 90° or 45° Tee is used to catch rain, connect the Tee Cap drain fitting to a suitable drain. Use a trap in the drain if the system is under positive pressure.

Note: The Drain Section and Tee Cap drain may both be used.

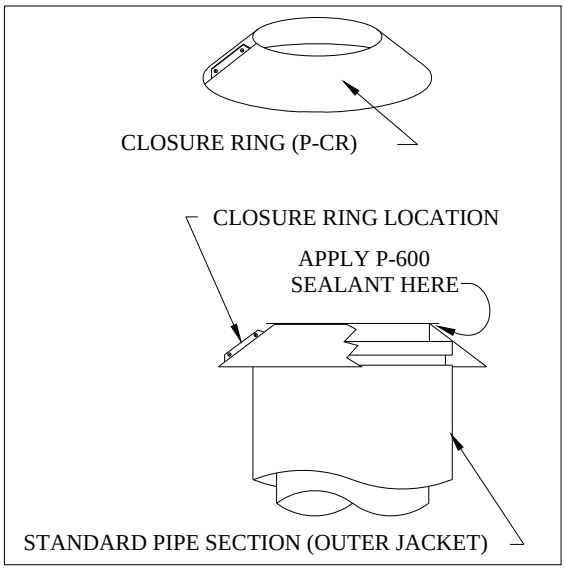
Fig. F-1 - Exit Cone (P-EC)



EXIT CONE (P-EC)

The Exit Cone is of double wall construction, with separable inner and outer cones. The inner cone has a 28° included cone angle and is sized to increase outlet velocity to 1.5 times chimney velocity. It attaches with a standard Inner Vee Band to the uppermost chimney pipe section. The outer cone is then pushed down into contact with the inner cone, clamped to the outer pipe, and the gap between cones is sealed with silicone. To prevent rain from reaching an appliance, this installation requires use of a Drain Section (DS), drained Tee or both in the vertical chimney. It is recommended to fasten (3) self-tapping screws around the bottom circumference of the exit cone outer wall (120° apart) into the upper outer wall of the pipe section below. Do not penetrate the inner wall.

Fig. F-2 - Open top using Closure Ring (P-CR)



OPEN TOP USING CLOSURE RING (P-CR)

A vertical Model VSI/IVSI Chimney can be terminated above the roof with a standard pipe length using a Closure Ring (CR) provided that rain entering is collected and drained from a Tee at the base of the vertical, or by a Drain Section located indoors at least 5 pipe diameters down from the chimney outlet. The Closure Ring fits under the flanged end of the pipe and provides protection against rain entering the space between inner and outer jackets. The Ring is secured by means of screws through end tabs. It should be sealed with sealant underneath the flange and at closure tab area.

STACK CAP (P-SK)

NOTE: Stack Caps are not recommended for use with engine or turbine exhausts.

The Stack Cap combines partial protection against rain entry with low exit flow resistance. (Resistance coefficient is roughly 0.05 velocity heads.) It is mounted to the end of a standard pipe section by use of the standard Vee Band. A Closure Ring is provided as part of the Stack Cap so that the insulating air space is maintained through the upper end of the chimney. A Closure Ring should be installed as described above. See Fig. F-3.

REMOVAL OF TERMINATION CAP FOR INSPECTION & CLEANING

Termination Caps can be removed for inspection and cleaning of the chimney system. To remove termination, reverse the order of installation procedure. See sections corresponding to the termination cap and Pipe Joint Assembly.

DRAIN SECTION (P-DS)

The Drain Section is a short length of inner pipe having an internally welded rain collection ring. As indicated in the cross sectional drawing (Fig. F-4), rain entering the chimney and running down the pipe wall will be collected and piped down into a trap, jar, or shallow sump. A distance of at least 5 diameters of pipe (more improves performance) should be used between the Drain Section and the chimney outlet to assure effective operation.

It is recommended to install the Drain Section indoors in a vertical chimney, thus avoiding freeze-ups. It eliminates the problems inherent in the use of air gap, above-the-roof types of stack drains by minimizing gas cooling and blow back problems. It can be used in conjunction with a Stack Cap or an Exit Cone for even greater effectiveness. Flow resistance of the rain collection ring is 0.25 velocity heads. The drain line should be run to a water seal or trap located below the top of the Drain Section gutter to prevent internal overflow due to back pressure. *If it must be used outdoors, then the gap between the hole in the outer wall and the drain port protrusion must be sealed w/ silicone.

Fig. F-3 - Installation of Stack Cap (P-SK)

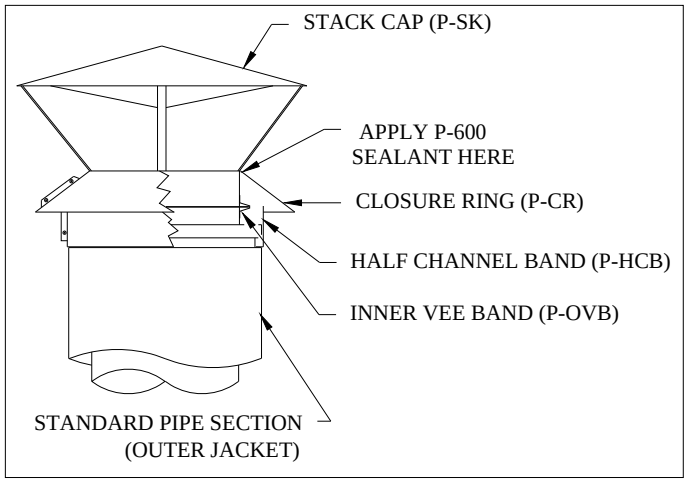


Fig. F-4 - Construction of Drain Section

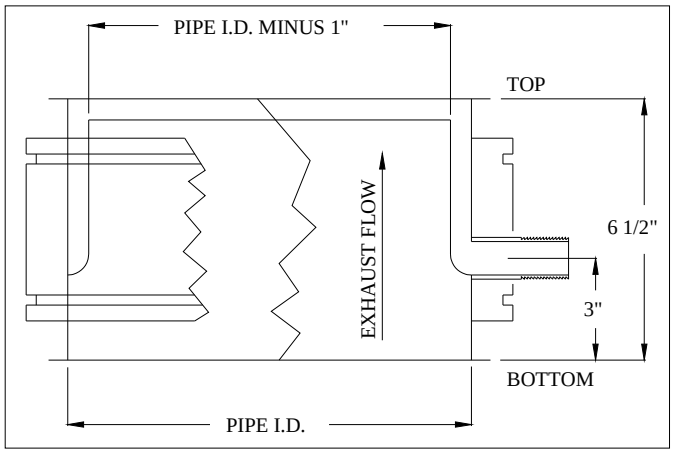
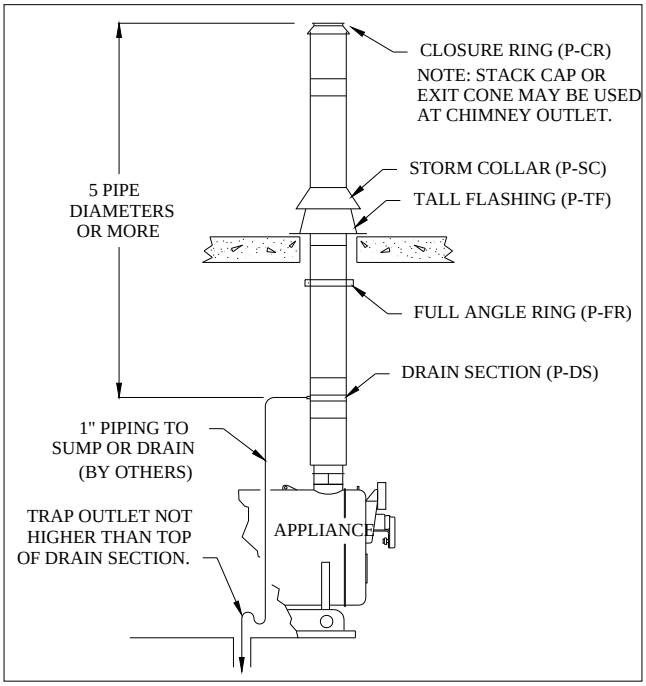


Fig. F-5 - Installation required for Drain Section (P-DS)



TERMINATION HEIGHT

A minimum chimney height of 8 feet above the roof it penetrates or above all nearby flat roof, wall or deck is recommended for any VSI/IVSI Chimney terminations. This will help disperse exhaust gases away from the building, and will minimize contamination of nearby air intakes. Gases will be discharged above working and breathing level and there will be little chance of debris being dropped into the chimney. The additional height will also improve the effectiveness of a Drain Section.

Regardless of the foregoing recommendation, height of a chimney should meet the following requirements.

a) Proper height for the category of appliance to which it is connected. (See NFPA 211.)
b) Adequate for the draft needs of the appliance.
c) Complies with applicable building or fire codes.
d) Complies with applicable air pollution regulations for height and velocity.

FLANGE ADAPTER (P-FD)

Attachment of a Bellows Joint to the silencer outlet or any flanged connection uses the Flange Adapter. It has a 3/8" thick steel flange with appropriate 125/150 lb. ANSI bolt pattern (bolts/nuts by others). An outer band is furnished to cover the air space around this adapter. (See Fig. F-6 for the actual configuration of the Flange Adapter and Fig. F-7 for an illustration of an assembled unit.).

MAINTENANCE OF FLANGE ADAPTER IF USED OUTDOORS: It is RECOMMENDED to apply an exterior grade high heat paint to the Flange Adapter to ensure maximum corrosion resistance. (Ex. Rustoleum V2100 series High Heat Industrial Aerosol)

Fig. F-6 - Flange Adapter (P-FD)

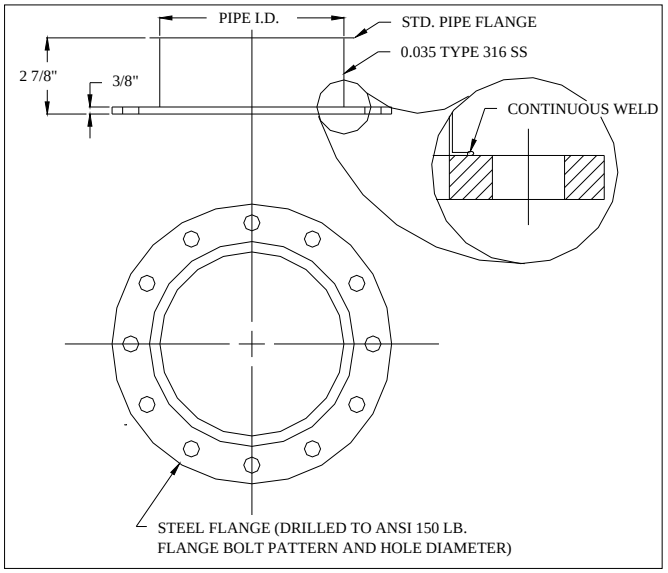
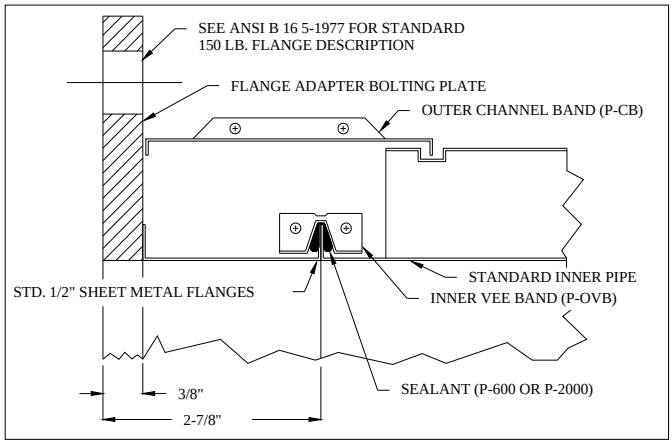


Fig. F-7 - Assembled Flange Adapter



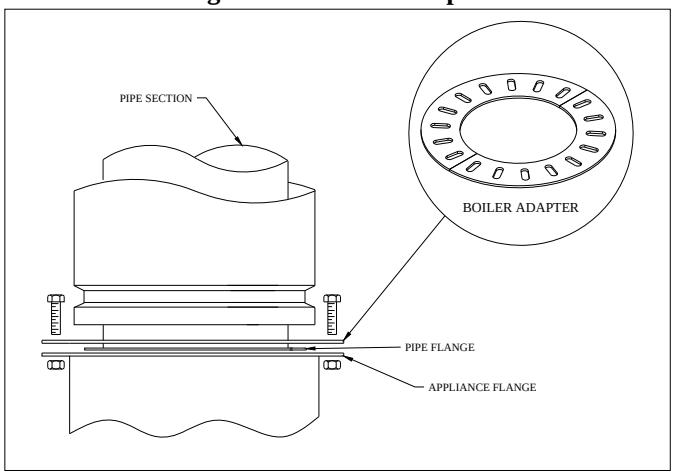
BOILER KIT ADAPTER (P-BK)

A Boiler Kit Adapter is designed to connect VSI/IVSI pipe to a boiler or other appliance having a flanged outlet with a 4, 6, 8 or 12 bolt hole pattern. The Boiler Adapter is a flat ¼" thick steel ring supplied in two half-circle pieces with twenty four 3/8" x1" slots equally spaced around the face of the adapter (See Fig. F-8).

To Install:

1. Apply a continuous bead of sealant to the face of the pipe flange and to the appliance flange.
2. Align the pipe flange with the appliance and position one half of the Boiler Adapter ring over the pipe's inner wall flange, aligning the bolt slots in the P-BK with bolt holes in the appliance and secure ring with bolts.
3. Install second half of the ring as described in step 2.
4. Tighten all nuts and bolts (by others) in an alternating pattern until the pipe flange is seated firmly between the appliance and the adapter.

Fig. F-8 Boiler Kit Adapter



SEAL RING (P-SR)

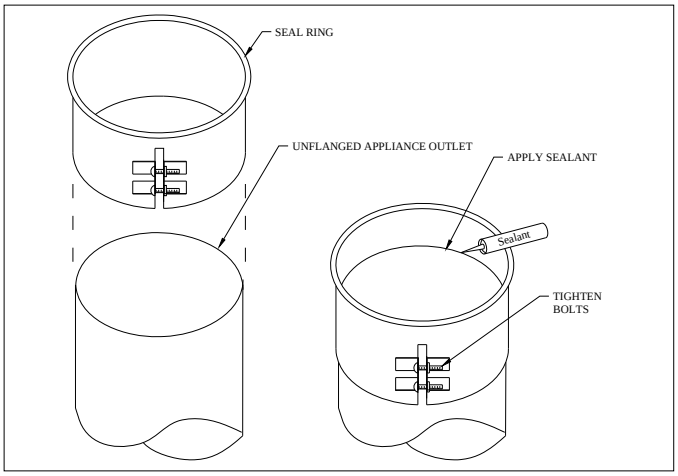
The Seal Ring is designed to seal the VSI/IVSI flanged inner wall to an appliance equipped with an unflanged outlet collar. The Seal Ring collar has a joint that allows the diameter of the collar to adjusted and tightened down on an adjoining collar (See Fig F-9).

Note: The P-SR does not provide any load bearing support and must be isolated from loads and expansion forces. This is done by installing a support assembly above (vertical runs) or beside (horizontal runs) the P-SR. Refer to Support Section for details.

To Install:

1. Loosen the hardware on the side of the P-SR collar.
2. Slide the SR over the adjoining pipe segment. The P-SR must engage a minimum of 2.5 inches.
3. Tighten the bolts on the P-SR collar.
4. Apply a continuous bead of sealant to the inside seam of the collar and P-SR.
5. Connect the inner wall flange of the first pipe section to the P-SR using the standard Joint Assembly Procedure.

Fig. F-9 – Seal Ring



EXCESSIVE PRESSURE RELIEF VALVE (P-ER)

Excessive Pressure Relief Valves are intended to help control the venting of pressure which may occur during an exhaust system backfire. Engines have the potential to inject unburned fuel into an exhaust system during start up or due to an engine malfunction.

This unburned fuel creates a condition where a backfire could occur. The Explosion Relief Valve will help prevent damage to other parts such as Flex Connectors, Silencers, Catalytic Converters, Convoluted Bellows and Heat Recovery Equipment.

Further precedence for use of Excessive Pressure Relief Valves can be found in NFPA 37, "Standards for the Installation and Use of Stationary Combustion Engines and Gas Turbines".

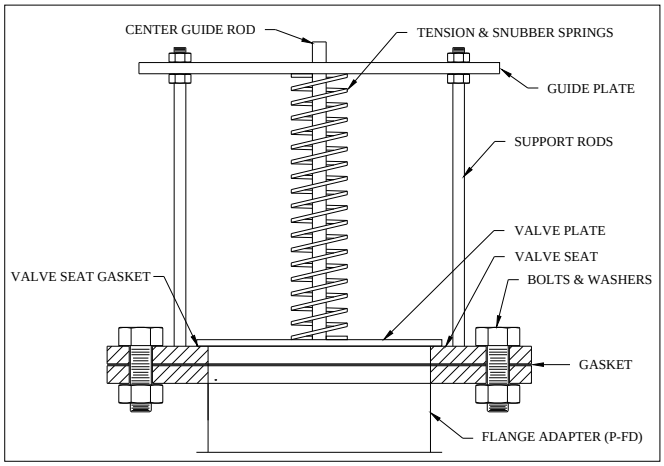
The Excessive Pressure Relief Valve should be located in the beginning of the system (see Fig. B-7 and Fig. C-1) and is supplied with bolts, washers, nuts, and gasket to provide a complete gas tight connection to the 125/150 lb. ANSI flanged Flange Adapter (see Fig. F-10). *The orientation of the Relief Valve should be positioned upright, as shown below for optimum performance.

MAINTENANCE OF ER VALVE IF USED OUTDOORS: It is RECOMMENDED to apply an exterior grade high heat paint to the Guide Plate, Valve Seat, Valve Plate, and Flange Adapter to ensure maximum corrosion resistance. (Ex. Rustoleum V2100 series High Heat Industrial Aerosol)

Caution: This device is designed to relieve excessive pressure (27" w.c. with standard spring) in the case of an engine malfunction for the sole purpose of protecting the physical integrity of the exhaust system and related parts. If such malfunction occurs, the device will release hot gases, sparks and/or flames into the immediate vicinity of the P-ER.

As such, this device should never be installed where human contact with any such release is possible, or near any flammable or combustible materials.

Fig. F-10 - Excessive Pressure Relief Valve (P-ER)



Combustion & Ventilation Air

In order for appliances and their vent / chimney systems to operate properly they require a plentiful supply of clean combustion and ventilation air. Requirements for such combustion and ventilation air are found in the installation and maintenance instructions accompanying the appliance as well as in vent manufacturer's literature and various mechanical codes. Seek and follow guidelines provided there when installing an appliance / vent system.

In addition to a plentiful source, it is very important for the combustion air to be free of certain chemical contaminants that can be very corrosive in nature to the appliance and / or venting system during and as a result of the combustion process.

In some cases, the use of indoor air is acceptable with the exceptions stated below. However, wherever possible, it is best to take combustion air directly from the outside, unless outdoor air has contaminant vapors nearby as listed below.

The following common list of substances need to be avoided in all instances since vapors associated with them – if mixed with the combustion air – can be extremely corrosive to the appliance and / or venting system. *Please note this list is not exclusive as to substance or effect and may be supplemented at any time.

a. Permanent wave solutions
b. Chlorinated waxes and cleaners
c. Chlorine based swimming pool chemicals
d. Water softening chemicals
e. De-icing salts or chemicals
f. Carbon tetrachloride
g. Halogen type refrigerants
h. Cleaning solvents (i.e. perchloroethylene)
i. Printing inks, paint removers, varnishes, etc.
j. Hydrochloric acid
k. Cements and glues
l. Laundry room detergents, fabric softeners, etc.
m. Masonry acid washing materials

Corrosion of the vent / chimney caused by the use of contaminated combustion air voids the warranty on these products.

INSTRUCTIONS AND SAFETY STANDARDS

Listings:

Ampco Model N (aka VSI-I), VSI (aka VSI-II), IVSI and Z-Clear (ZC) Grease Ducts are Listed (safety certified) by Underwriters Laboratories, Inc. (UL) in accordance with UL1978, the "Standard for Grease Ducts". They are intended to be installed in accordance with the following installation instructions and NFPA 96, the (National Fire Protection Association) "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations".

Ampco Model Z-Clear IVSI-Z3 (Also known as ZC or Z3) and Z-Clear Plus IVSI-Z4 (Also known as ZC+ or Z4) Grease Duct Systems are Listed with a minimum zero inch clearance to combustibles. Ampco Models N, VSI and IVSI grease duct systems are Listed for use at certain minimum airspace clearance to combustibles, as identified on the labels and in these instructions.

Classifications:

Ampco Model Z-Clear (IVSI-Z3/ZC) and Z-Clear Plus (IVSI-Z4/ZC+) Grease Ducts are also Classified by UL in accordance with UL2221, the "Standard for Fire Tests for Fire Resistant Grease Duct Enclosure Assemblies" and ASTM-E2336 , the "Test Methods for Fire Resistive Grease Duct Enclosures". Z-Clear (ZC/Z3) is Classified for a maximum 2 hour fire resistance rating per UL2221 and a maximum 1 hour fire resistance rating per E2336. Z-Clear Plus (Z4/ZC+) is Classified for a maximum 2 hour fire resistance rating per ASTM-E2336. These ratings qualify the insulation and the outer wall of the Z-Clear (ZC) products as an alternate to the specified hourly rated fire resistive shaft enclosures (therefore eliminating the need for a separate fire resistive enclosure) and for installation at zero clearance to combustibles. See Table G-1.

Table G-1 – Grease Duct Certifications

Model	Certification Per UL1978	Certification/ Fire Rating Per UL2221 (accepted by all current codes)	Certification / Fire Rating per ASTM-E2336
N, VSI, IVSI	Yes	No	No
IVSI-Z3/ZC	Yes	Yes: 2 Hour	Yes: 1 Hour
IVSI-Z4/ZC+	Yes	Yes: 2 Hour	Yes: 2 Hour

Model N, VSI, IVSI, Z3 and Z4, Grease Duct Systems are based on the same construction. While Model VSI employs a 1" insulating airspace between walls, Model IVSI incorporates a 1", 2" or 4" of fiber insulation between walls and Model ZC (IVSI-Z3) incorporates 3" of special fiber insulation between walls. Model ZC+ (IVSI-Z4) incorporates 4" of special fiber insulation between walls. Component assembly is basically the same for each system. Model N is a single wall system, composed of the inner liner of Model VSI, IVSI, Z3 and Z4.

APPLICATION

Model N, VSI, IVSI, Z3 and Z4 are suitable for use in installations using exhaust system components for the removal of smoke and grease-laden vapors from commercial, industrial, institutional and similar type applications. There are also some limited residential applications that can utilize IVSI, Z3, Z4 (i.e pizza ovens requiring UL listed grease duct: see "Surroundings" on next page). Model N, VSI, IVSI, Z3 and Z4 Grease Ducts are intended for use as complete systems. They connect the hood or grease extractor system to the outdoors through an exhauster or blower system.

Round Ampco Grease Ducts provide for efficient airflow (lower friction loss compared to rectangular or square ducting) and superior structural integrity achieved using lighter gauge stainless steel material and fewer reinforcing members. These systems are completely integrated for a very efficient mechanical design and have the additional benefit of providing a very clean appearance on final assembly.

System installation specifications are as described in the NFPA96 and these grease ducts are to be installed to conform to that standard or as described in these installation instructions. (Grease duct systems are not to be interconnected with any other building ventilating or exhaust system.) Systems installed in accordance with these instructions comply with NFPA96, the International Mechanical Code (IMC), Uniform Mechanical Code (UMC) and other codes.

Round Ampco Grease Ducts are permitted to be installed in accordance with the clearances shown in Table G-2. Some special provisions for Grease Ducts are necessary and, in particular, cleanout openings must be provided. Cleanout openings should: 1) be provided at each change in direction of grease ducts, unless the entire length of duct can be inspected and cleaned from either the hood or discharge end or from both ends, 2) be at the sides of the duct, and 3) have the lower edge of the opening at least 1/2 above from the bottom of the duct.

System size and capacity information can be obtained from: the "Duct Design" chapter in the ASHRAE Fundamentals Handbook and/or the "Kitchen Ventilation" chapter in the ASHRAE HVAC Applications Handbook. Refer to Ampco Model VSI, IVSI, ZC Product Catalog for descriptions of all necessary parts.

INTERMIXING OF SYSTEM PARTS

Model N, VSI, IVSI, Z3 and Z4 may be intermixed within a system, assuming proper clearances are maintained for the respective components. When penetrating a roof, Model VSI, IVSI, Z3 or Z4 duct sections and appropriate roof penetration components must be used. Do not use Model N sections to penetrate the roof.

SURROUNDINGS

Ampco Models N, VSI and IVSI are primarily intended to be used in commercial noncombustible surroundings. In certain applications (i.e. pizza ovens), models IVSI, Z3 and Z4 may be used in residential construction where the use of plate supports (PA) and wall supports (WA) must be connected to a noncombustible structure. All other guides/supports (FR, HR, SS, WG) may be connected to combustible structure. Residential surroundings may be of combustible or noncombustible construction, but fully enclosed systems, when required, must be of noncombustible construction as defined by local code.

Where the ducting is installed in an open room and does not require an enclosure it must have a minimum clearance to adjacent combustible walls as shown in the section titled "Clearances". The ducting may be located in corners formed by two combustible walls under the above condition.

Interior installations in all buildings should be installed as follows:

1) If a ceiling or wall has a fire resistance rating and is penetrated by a Models N, VSI, or IVSI Grease Duct, then the duct shall be enclosed with a continuous enclosure extending from the penetration, through any concealed spaces, to or through the roof so as to maintain the integrity of the fire separations required by the applicable building code. NOTE: If penetrated by Z3 or Z4 no additional enclosure is required however the appropriate Through Penetration Firestop (TPF) must be used. See Through Penetration Section.
2) If a ceiling or wall does not have a fire resistance rating and is penetrated by a Model N, VSI or IVSI Grease Duct installed at the correct minimum clearance for unenclosed duct, then no enclosure is required.
3) Where the Model N, VSI and IVSI ducting extends through any story of a commercial building above that in which the connected appliances are located, it must be enclosed in the upper stories with walls having a fire resistance rating of not less than one hour for buildings of two or three stories in height. If the commercial building is four stories or more in height, the enclosure wall shall have a fire resistance rating of not less than two hours.

NOTE: Based on its qualifications model Z-Clear (Z3 and Z4) may be used in place of a separate fire rated enclosure in situations where fire rated enclosures would normally be required.

CLEARANCES

Table G-2: Minimum Airspace Clearance to Combustibles for Grease Duct

Pipe ID	Model VSI	Model IVSI-C1	Model IVSI-C2	Model IVSI-C4	Model Z3 & Z4	Model N
5"	5"	2"	1"	1"	0"	18" Or Per Local Code For single Wall construction Per NFPA 96
6"	5"	2"	1"	1"	0"	
8"	5"	3"	1"	1"	0"	
10"	5"	3"	1"	1"	0"	
12"	6"	3"	1"	1"	0"	
14"	7"	3"	1"	1"	0"	
16"	8"	3"	1"	1"	0"	
18"	9"	4"	2"	2"	0"	
20"	10"	4"	2"	2"	0"	
22"	11"	4"	3"	3"	0"	
24"	11"	4"	3"	3"	0"	
26"	12"	5"	4"	4"	0"	
28"	12"	5"	4"	4"	0"	
30"	13"	5"	4"	4"	0"	
32"	13"	5"	4"	4"	0"	
36"	14"	6"	5"	5"	0"	
42"	16"	7"	6"	6"	N/A	
48"	17"	7"	6"	6"	N/A	

For noncombustible construction maintain clearances as required for installation, access for inspection, or per local code.

Combustible roofs may be penetrated by using either the Roof Support Assembly (P-MRS), Roof Support Section (RSS), the Ventilated Roof Thimble (P-MVT), Ventilated Roof Curb (See Fig. G-5) or Fan Adapter Termination (P-FAT). Vertical walls or combustible materials may be penetrated using the Wall Penetration Assembly (THB). These are the only parts intended for use with combustible construction. All other parts, such as Plate and Wall Supports, Floor and Wall Guides, are for attachment to noncombustible construction.

SLOPE

The mechanical codes dictate 1/4 inch per foot (1"/foot for over 75 feet) for flat bottom duct (i.e. welded rectangular). Flat bottom ducts do not have the same flow characteristics that round bottom ducts inherently do.

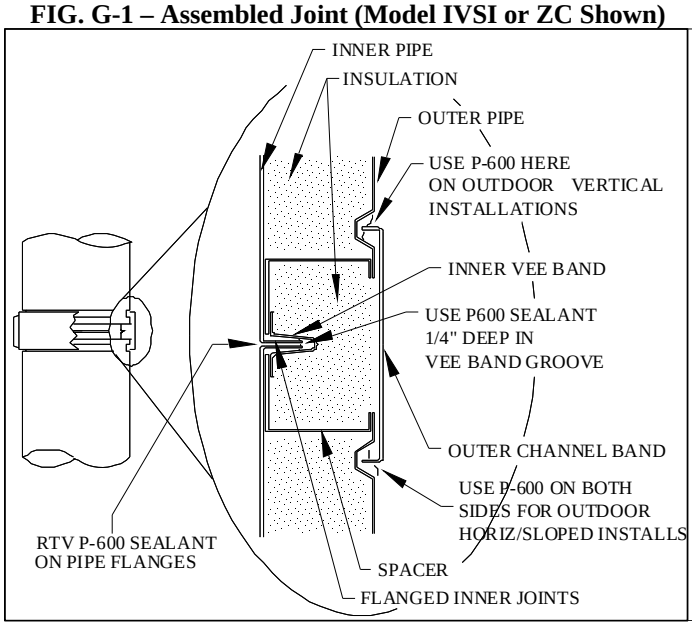
Because of this round duct shape benefit, when installing round Model N, VSI, IVSI, Z3 or Z4 grease ducts in a horizontal run, install at a slope not less than 1/16 inch per 12 inches toward the hood or toward a grease reservoir. If horizontal ducts exceed 75 feet in length (in one direction), the slope shall not be less than 0.2 inches per 12 inches. This is based upon engineering analysis, and fluid hydraulic calculations comparing round and flat bottom ducts, associated with the product's UL Listing. Normal factory-built system components will permit the slopes mentioned above.

PIPE & FITTING JOINT ASSEMBLY

All grease ducts must be liquid tight according to NFPA 96. The following procedure can be used to assure that all joints in the installation meet that requirement. Assembly is accomplished as follows:

1. Clean all pipe flanges and Vee Band inner surfaces with an appropriate organic solvent, such as Acetone, MEK, or other commercial degreaser (Caution: Observe adequate safety measures when using).
2. Apply a thin layer of RTV P-600 silicone sealant to the face of each pipe flange (Caution: The use of any other sealant on flange surface may impair sealing effectiveness).
3. Parallel flanges are brought together immediately.
4. Joint sealant is applied to the groove of the Inner Vee Band. Use P-600 Joint Sealant.
5. Plan to locate the clamp and tightening flanges of the Vee Bands on the sides of the grease duct horizontal run to eliminate possibility of leaks.
6. As soon as possible or within 15 minutes of applying the sealant, install the Vee Band and tightly clamp it around the flanges using end clamp hardware. (Visegrip welding pliers are extremely useful for holding the Vee Bands in place while installing the end clamp tightening bolts.) NOTE: Light tapping with a hammer all around the band while tightening the end clamp bolts helps to align and pull the flanges together.
7. (For IVSI, Z3 and Z4 only), install a 4" wide strip of insulation (supplied) over the entire Vee Band, filling the space between the spacers as shown in Fig. A-2.
8. The outer channel band is then installed by inserting the edges of the band into the outer pipe grooves and drawing it closed with the screws and nuts. For exterior joints apply sealant to the joint between the Channel Band and the outer pipe (See Figs. A-2 & A-3 & Pipe Joint Assy).

FIG. G-1 – Assembled Joint (Model IVSI or ZC Shown)



Note: Flange to flange inner pipe joints are identical except for Adjustable Lengths (P-AG) and Variable Lengths (P-VL). These require special orientation for correct use.

NOTE: DO NOT SEAL THE CLEANOUT ACCESS COVERS. THEY MUST REMAIN FREE OF SEALANT FOR FREQUENT INSPECTION PURPOSES.

CAUTIONS

1. The outer channel bands are designed to slide in their mating grooves. Do not attach by screws into the outer casing.
2. Do not allow screws to penetrate the inner pipe. This can cause corrosion, gas leakage or expansion failure.
3. Never use screws through the outer jacket of an adjustable length or expansion joint.

FIG. G-1a –Adjustable Length (AG)

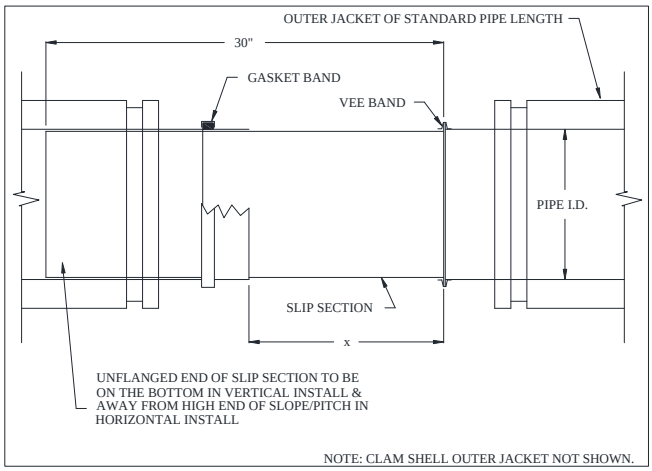
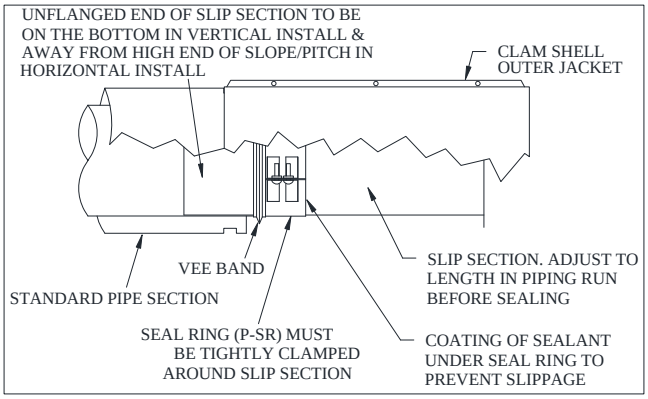


FIG. G-1b –Variable Length (VL)



GREASE DUCT JOINT SEALANT

Ampco Joint Sealant (P-600) is a pre-mixed, one-part, acetoxy cure silicone adhesive. Properly made joints are gas tight and highly resistant to oil, water, solvents and all acids except hydrofluoric. P600 has a “Tack-Free” time of 15 minutes at 77° F and a “Cure” time of 24 hours.

When stored in original, unopened containers below 90°F, P600 has a shelf life of 30 months from date of manufacture. After a container has been opened, a plug of cured material may form in the nozzle or tube tip during storage. Remove the cured material and the remaining sealant is ready to use.

MAINTENANCE AND SAFETY

The Model N, VSI, IVSI, Z3 and Z4 Grease Duct System have a special group of parts which are specifically designed to create a safe and reliable system. Those special parts include:

- Nozzle/Port Section (special part code) to integrate a fire suppression system or act as an interface for hot water/detergent maintenance section
- Grease Tee's (P-GMT) - Provide access to the duct at a 90° changes of direction for cleaning and inspection. Includes a 1" required dam to prevent liquids from spilling out when opened.
- Cleanout Doors (P-TCN) – Allows for access to the snout of a tee for inspecting and cleaning the duct.
- No-Tool Access Cap (P-NTAC) – Similar to the TCN but does not require tools to open.
- Inline Access Door (IAD) – Provides access to a straight length of grease duct for cleaning or inspection.

NFPA96 contains some very specific requirements concerning the safety features which must be incorporated into grease duct systems. This document includes guidelines to be followed related to the operation, inspection and cleaning of grease ducts and it indicates that the system shall be cleaned at frequent intervals prior to surfaces becoming heavily contaminated with grease or oily sludge. Depending on the amount of cooking equipment usage there should be a daily or weekly inspection to determine if grease or other residue has been deposited within the section. When the grease or other residues are in evidence as deposits, the entire system should be cleaned in accordance with accepted procedures. The Cleanouts and Access Components (mentioned above) are specifically designed to aid in this process and should be located at each change in direction. Long straight vertical and horizontal runs may need additional cleanouts to allow the system to be completely inspected and cleaned.

AUTOMATIC CLEANING

An automatic hot water/detergent injection system can be integrated into the N, VSI, IVSI, Z3 and Z4 Grease Duct systems by using the dual purpose Nozzle/Port Section (which is also used for fire suppression) and Tees with nippled Base Drains. All of these related parts have standard NPT hardware so that conventional nozzles and piping can easily be attached. Please keep in mind that if plumbing is connected to cleanout inspection caps, flexible high temperature, high pressure plumbing must be provided with shutoff valves so that the inspection process can be completed on a regular basis.

A typical installation would provide hot water at approximately 160°F and use a detergent injected by conventional hardware so that the entire grease duct system can be scrubbed down daily (using jet spray characteristics) for the removal of grease, dirt and dust. Normally the automatic cleaning system is designed as a unit, however a modular design would prove satisfactory.

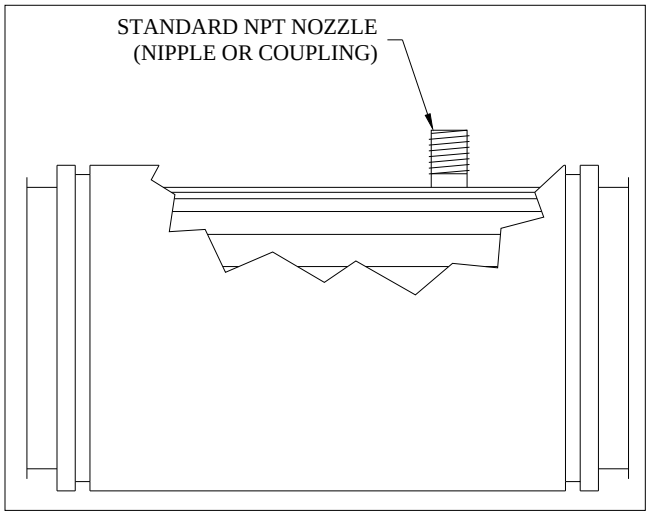
Automatic cleaning implies that the grease drains are connected to appropriate hardware so that the residues of the cleaning process are piped directly to drains and not grease traps or fixed size buckets.

FIRE SUPPRESSION

The practice of NFPA 96 concerning fire safety requires that fire extinguishing equipment shall be provided for the protection of duct systems, grease removal devices and hoods, especially if all the cooking equipment is not served by Listed grease extractors. The use of a special Pipe Section w/ Port/Nozzle allows various types of fire extinguishing equipment to be integrated into the grease ductwork, if necessary. Some of the various types are: 1) CO2 extinguishing systems (NFPA 12), 2) Sprinkler systems (NFPA 13), 3) Foam-Water Sprinkler/Spray Systems (NFPA 16), and 4) Dry Chemical Extinguishing Systems (NFPA 17). The Nozzle Section (See Fig. G-2) can be positioned so that the nozzle fitting is either on the sides or top of the section consistent with good fire protection design practice. Various diameter NPT couplings offered allow for flexibility when making the required connections (See Fig. G-2).

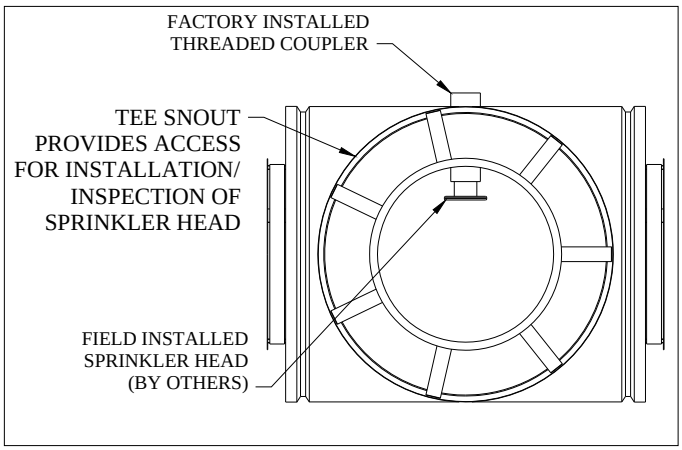
Nozzle Grease duct tee sections with sprinkler port (P-NTS) are also available for installations requiring sprinkler heads with access for inspection / cleaning. The P-NTS tee sections include a coupling to accept standard ½" (or ¾") NPT sprinkler heads (See Fig. G-3).

Fig. G-2 Nozzle/Port Section (special part code)



Note: The access port of the tee section should be located/oriented horizontal to upward to avoid the possibility of collecting grease.

Fig. G-3 Sprinkler Section (P-NTS)



HOOD TRANSITION

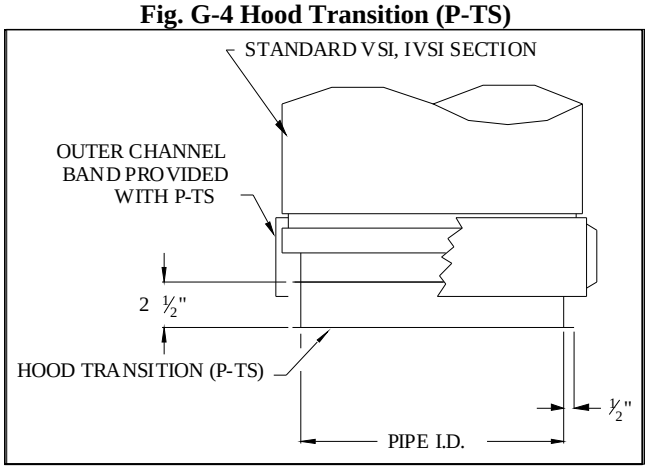
The Model N, VSI, IVSI, Z3 and Z4 Grease Duct Hood Transition (P-TS or P-TSU) Stubs are stainless steel extensions of the standard inner pipe used in normal Model N, VSI, IVSI, Z3 and Z4 Duct Sections. The P-TS is furnished as a single wall piece with 1/2 inch flanges at both ends. The P-TSU (Unflanged Hood Transition Stub) is available for those installations where the flange is needed only on one end.

The P-TS or P-TSU Stub can be welded directly to the hood or to a transition which has been fabricated to match the opening in the hood. The transition must be constructed so that it does not create a high air flow loss. A third alternative, when required, is to fabricate a special transition piece which tapers the exhaust hood port into the Model N, VSI, IVSI, Z3 and Z4 Grease Duct stack diameter so that a smooth, low loss connection occurs.

The use of Model N, VSI, IVSI, Z3 and Z4 Grease Duct Transition Stub allows many different termination methods to be considered for high quality, simple, practical installations.
Provision should be made to have transition welded to hood or attached per NFPA 96 bolt on system.

When appropriate, special tapered hood transitions (rectangular to round or round to round) are produced to order. They are fabricated as a welded, stainless steel unit and may be provided with or without flanges for direct field attachment via welding. They are provided with the appropriate insulation and a two piece, “clam shell” type outer wall / protective enclosure for around the insulation.

Fig. G-4 Hood Transition (P-TS)



CLEANOUT TEE CAP (P-TCN)

The Cleanout Tee Cap provides access for inspection into the grease duct. Both the inner and outer has handles for easy removal.

When using with part numbers P-MT, P-JL, and P-JY, a step Increaser (P-OS) is required to assure the cleanout opening is at least 1 inch from the bottom of the duct.
When using cleanouts, always prevent leaks and assure that the grease duct functions as intended (see Joint Assembly Procedures).

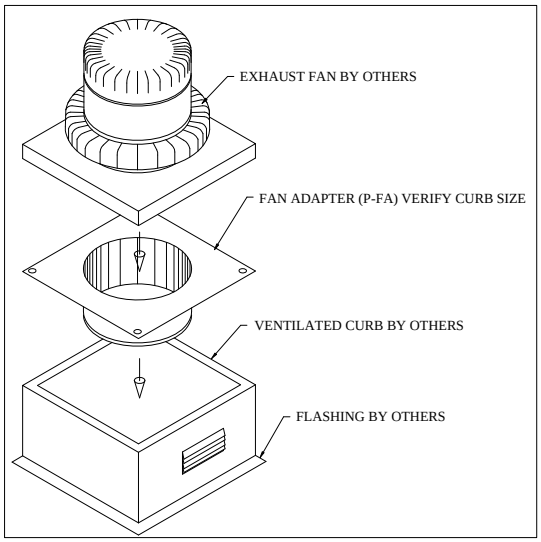
FAN ADAPTER (P-FA)

The Fan Adapter is used, in many installations, to provide for the final connection between the grease duct system and an “upblast” fan. The adapter incorporates a square plate (on the top or outlet end) and a short section of duct incorporating a flanged end (on the bottom or inlet end). It is designed to set directly on top of the roof curb (by others) and directly beneath the fan base (by others). (See Fig. G-5)

The Fan Adapter is first attached to the roof curb using bolts or screws through the square plate and into the curb. The inlet end connects to the remainder of the grease duct system using a Vee Band and typical assembly methods described under “Pipe Fitting Joint Assembly”.

A vented curb should be used if the roof construction being penetrated is of combustible construction.

Fig. G-5 Fan Adapter (P-FA)



ROOF SUPPORT SECTION & FAN ADAPTER TERMINATION (RSS & FAT)

The Roof Support Section (RSS) is a section of ZC grease duct that is designed to penetrate through the roof and attaches to the roof surface, providing support for the duct system parts suspended below, or extended above the RSS.

Similarly, The Fan Adapter Termination (FAT) is a section of a ZC grease duct that incorporates a fan curb and provides a surface for mounting and installing an up-blast discharge fan. The FAT eliminates the need for a separate welded fan curb termination assembly. The square curb is specifically designed to accommodate hinged type exhaust fans, commonly used for extraction of cooking fumes. The FAT also provides vertical support for the duct system and in some applications, when installed and supported properly, the weight of the hood and duct system may be suspended from the FAT.

The RSS & FAT are non-ventilated roof penetration components that are only available in model Z3 or Z4. However they can be used with other systems provided the proper clearances are maintained for the other grease duct parts.

To Install:

1. Prior to installation, refer to WEIGHT OF PIPE section and hood manufacturer to determine the total combined weight of the hood and the duct system. If the total weight of the entire system exceeds the Maximum Suspended Weight specified in Table G-3, the duct system will require additional vertical support. Refer to SUPPORT METHODS section of instructions
2. Determine the total length of the Grease Duct System. If total length of duct exceeds 12 feet, an Adjustable Length (P-AG) and additional support will be required to compensate for thermal expansion. Refer to THERMAL EXPANSION section for proper installation instructions.
3. Determine the exact location where the grease duct system will penetrate the roof. Prepare an opening in the roof ¼" larger than the diameter of the outer casing.
4. Determine if adequate support is available to bear the load of the RSS or FAT and other duct system parts. If necessary, add additional steel roof joists and bracing, creating a framework to support the load of the duct (see Figs. G-6 & G-7). Refer to Table G-3 (RSS & FAT Suspended Weight & Length Limits) and WEIGHT OF PIPE section to determine load bearing capacity and compare it to the anticipated total load to make certain the grease duct system is properly supported and that the component parts and structural members are not overloaded.
5. Once adequate support is established and any supplemental bracing / framing is fabricated, install inlet end of RSS & FAT into roof opening. Ensure that the top surface of the RSS or FAT is level, and secure roof plate to structural members of roof using the appropriate fasteners (by others).
6. Apply roofing material over roof plate to seal off any openings in the roof.
7. For the FAT, see fan instructions for proper installation of the fan assembly. For the RSS, refer to Section "A" PIPE & FITTING JOINT ASSEMBLY for instructions on attaching additional duct sections to the top of the RSS. Once sections are properly attached, install the Storm Collar (SC) included with the RSS so that it shields the top plate of the RSS (See Fig G-6).
8. Refer to instructions for installing remaining grease duct system components

Table G-3. RSS & FAT Suspended Weight Limit	
Pipe Size	**Max Weight Suspended from RSS & FAT**
8" – 14"	400 Lbs.
16" – 20"	500 Lbs.

Fig. G-6. Roof Support Section (RSS)

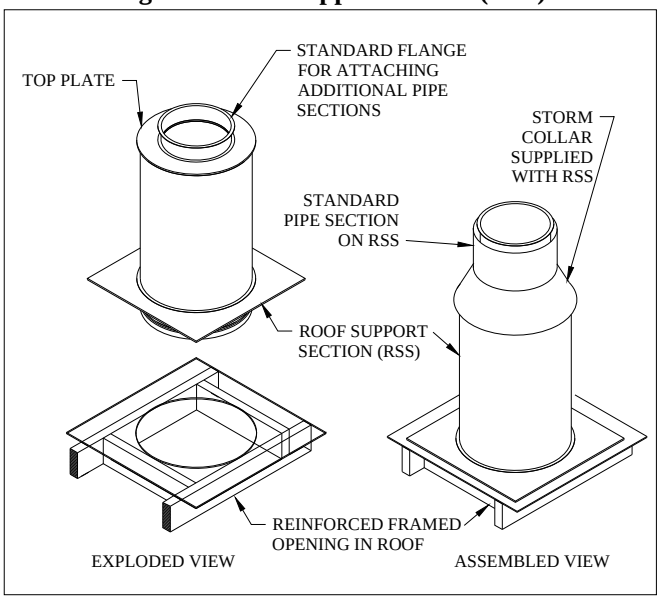
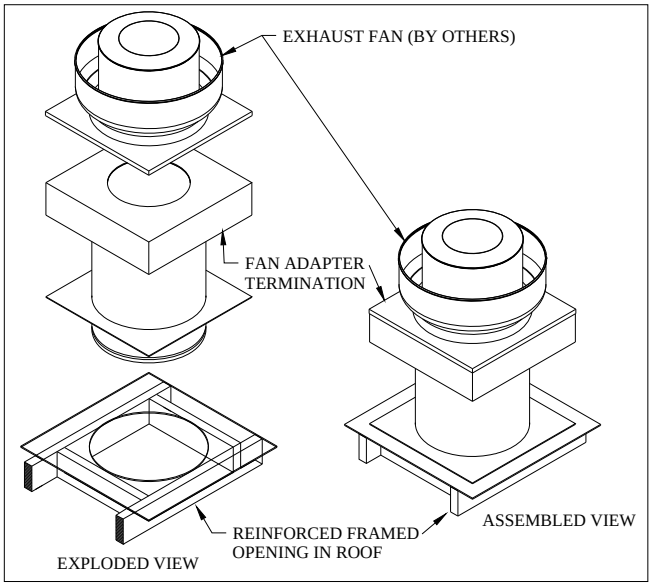


Fig. G-7. Fan Adapter Termination (FAT)



THROUGH-PENETRATION FIRESTOP (UL SYSTEM C-AJ-7101) (TPF)

Through-Penetration Firestop (UL System C-AJ-7101) for Model Z-Clear and Z-Clear Plus

Fire Resistance Rating: 2 Hour (F & T)

Whenever the Z-Clear (Z3) or Z-Clear Plus (Z4) grease duct passes through a fire rated wall or floor, a Through-Penetration Firestop Kit must be used to retain the fire rating. Use one Through-Penetration Firestop Kit for a floor penetration and two Through-Penetration Firestop Kits for a wall penetration.

Kit Contents:

- Closure Band (1)
- Cover Plate Half (2)
- 12” Wide Insulation Strip (1)
- 4” Wide Insulation Strip (1)

Note: Firestop Putty / Caulk Not Included

To Install:

1. Cut a circular hole into the fire rated floor or wall that is 2" greater in diameter than the OD of the duct.
2. Center the Z3 or Z4 grease duct within the hole and support to maintain position.
3. Tightly pack the 1” gap between the outer wall of the duct and the hole with the 4” Wide 6 pcf ceramic fiber insulation strip provided. This insulation must encircle the outer wall of the duct and fill the gap to within ½” of the floor surface or to within ½” of both surfaces of the wall (See G-9).
4. Apply a minimum ½” depth of 3M Fire Barrier Moldable Putty or 3M CP25WB+ caulking, flush with the top surface of the floor or flush with both surfaces of the wall (See G-9).
5. Install the two piece rectangular Cover Plate. The two piece rectangular Cover Plate is designed to fit over the Putty or caulk and around the outer wall of the duct. There will be a nominal 1/4” gap around the pipe and the two parts of the plate must overlap each other a minimum of 1”. Secure in place with appropriate hardware (See G-8 & G-10).
6. Wrap a 12" wide strip of the ceramic fiber insulation around the grease duct. The insulation must butt up to the cover plate and outer wall of the duct. Secure in place with the closure band using the hardware provided.
7. Note that cover plates, wrap insulation and closure bands are installed on the top surface of a floor penetration and on both surfaces of a wall penetration.

Caution: Do not use the Adjustable Length (P-AG) with the Through Penetration Firestop.

Note: Other non-Ampco Through Penetration Firestops may be applicable after Ampco’s assessment with 3rd Party consultation.

Fig. G-8 Floor Penetration

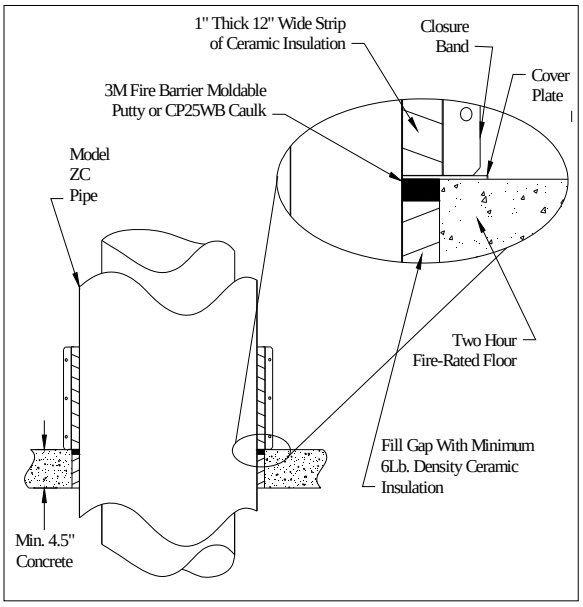


Fig. G-9 Wall Penetration

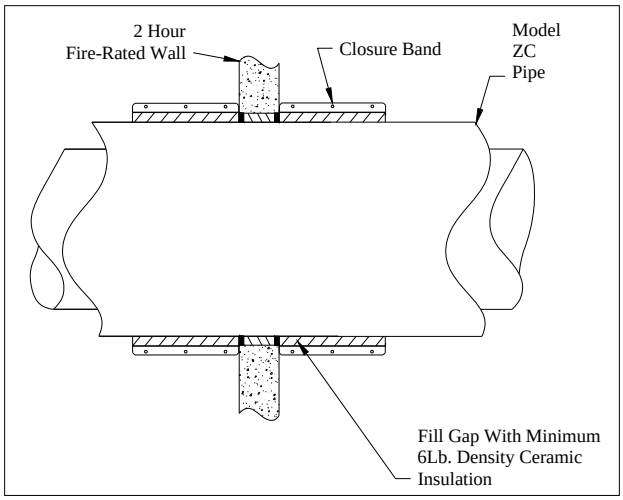
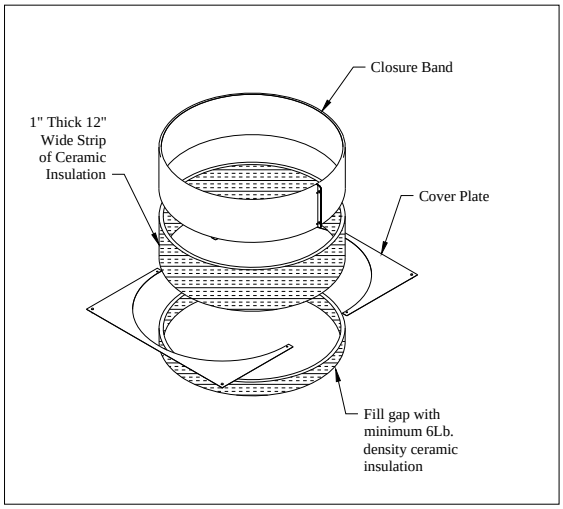


Fig. G-10 Isometric View of Through Penetration Firestop Kit



NO-TOOL ACCESS CAP (P-NTAC)

The No-Tool Access Cap provides no tool access for inspection and cleaning of the grease duct. When connected to an MT, JL or JY, the NTAC functions as a no tool substitute to a 90° Grease Tee (GMT) and a standard Cleanout Tee Cap (P-TCN).

Parts List

1 x NT-Cover
1 x NT-Cap
1 x NT-Dam
2 x 1/2 Vee-Band
4-11 x Wing Nuts (based on pipe diameter)
1 x Insulation Disc (IVSI and ZC only; Factory Installed)
1 x Insulation Wrap (IVSI and ZC only)
1 x Insulation Shield (IVSI and ZC only)
1 x Hex Bolt (IVSI and ZC only)
1 x Hex Nut (IVSI and ZC only)

Installation Procedure

1. The No-Tool Cap is factory installed to the NT-Dam with the use of several wing nuts. Using the Vee-Band and sealant (as specified in main instructions) secure the NT-Dam and the NT-Cap to the flange of the Manifold Tee MT (not included). Be sure the handle of the NT-Cap faces outward as shown (See Fig. G-12).
2. (IVSI & ZC Models only) Insert the insulation Wrap into the cavity between the spacer clips of the tee section and the Vee-Band. Wrap insulation around the entire circumference of the assembly filling the entire cavity. Excess insulation may be trimmed and discarded (See Fig. G-13).
3. (IVSI & ZC Models only) Install the Insulation Shield over the Insulation Wrap and outer wall of the tee section, using care not to pinch the insulation in the process. Use the Hex Nut and Bolt to tighten the tabs on the Insulation Shield, securing it to the outer of the tee section. (See Fig. G-13 & G-14)
4. Slide the NT-Cover over the P-NTAC assembly. Using the Wing Nut and Bolt supplied, tighten the tabs to secure the NT-Cover to the tee section. (See Fig. G-15)

Note: The access cap of the tee section should be positioned/oriented horizontal to upward to avoid the possibility of it collecting any grease.

Fig. G-11. No-Tool Access Cap (P-NTAC)

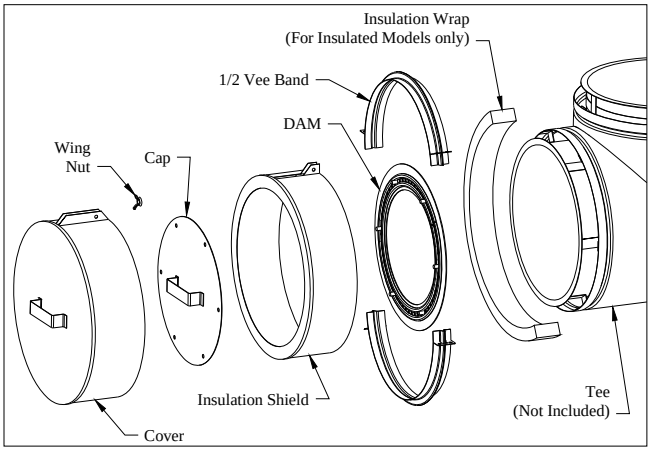


Fig. G-12.

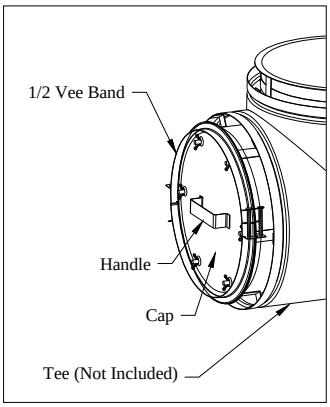


Fig. G-13.

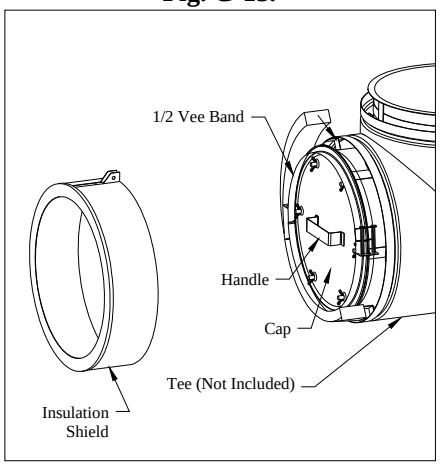


Fig. G-14.

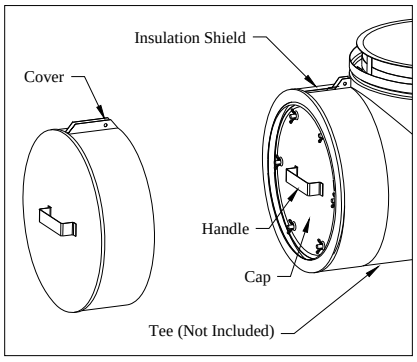
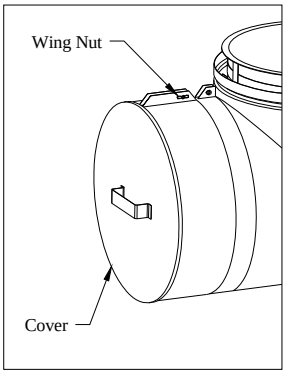


Fig. G-15



(No-Tool Access Cap Continued)
To Remove Cap for Inspection and Cleaning

1. Unscrew bolt / wing nut securing No-Tool Cover to assembly. Remove No-Tool Cover from assembly by pulling straight out. Place aside in safe place during inspection / cleaning (See Fig. G-14).
2. Unscrew wing nuts securing No-Tool Cap to No-Tool Dam. Remove No-Tool Cap from assembly by pulling straight out. Place wing nuts and cap aside in safe place during inspection / cleaning (G-16).

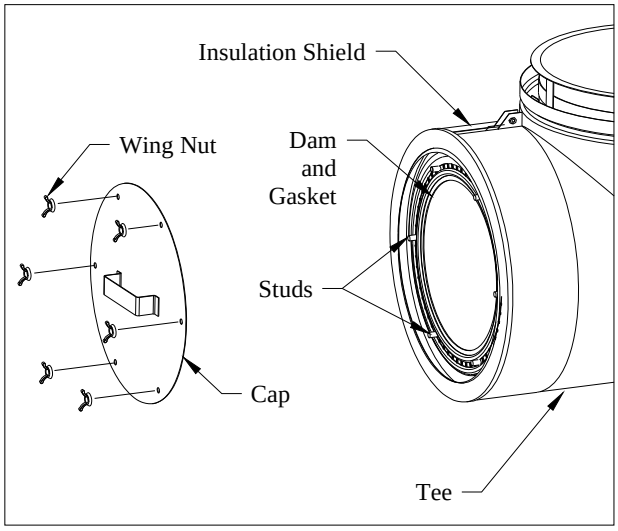
NOTE: IVSI and ZC models include a band of insulation around the circumference of the inner duct. Removal of this insulation is not required for access to duct for inspection / cleaning.

To Replace Cap After Inspection and Cleaning

(Replace assembly in reverse order of removal process.)

1. Align holes in No-Tool Cap over studs on dam. Guide cap over holes until cap contacts dam. Secure cap in place with wing nuts, insuring that all wing nuts are secured and pulling cap tightly against dam. (See Fig. G-16)
2. Carefully Guide No-Tool Cover back in place over assembly until it extends over outer wall of tee assembly. Secure in place by tightening bolt / wing nut. (See Fig. G-14 & G-15)

Fig. G-16



FIELD INSTALLED GREASE DUCT ACCESS DOORS

For Model N installations, it is permissible to install Listed Grease Duct Access Doors provided they are installed per the manufacturer's installation instructions.

INTERCONNECTION WITH RECTANGULAR GREASE DUCTS

As a general rule, Ampco grease duct systems are intended to be installed as complete systems without the use of other manufactured or generic components. However, Ampco recognizes the occasional need for a rectangular portion of the grease duct due to space limitations at certain locations within the system. In such case, it is permissible to transition to / from the Ampco grease duct to a code compliant, rectangular, welded steel grease duct system (by others) and back again. When such situations occur, either Ampco or the installing contractor can fabricate a code compliant rectangular-round transition. If the installing contractor chooses to fabricate the transition, a stainless steel round collar (TSU or TS) can be sourced from Ampco ahead of time for the contractor to weld to his/her transition, thus providing the optimum connection piece to Ampco round duct. Otherwise, Ampco can supply a code compliant stainless steel transition of the required dimensions. Specific dimensional details of the transition will need to be furnished to Ampco.

Maintain proper minimum airspace clearances between any single wall rectangular duct and rectangular/round transitions and combustibles per applicable code. In most cases this minimum airspace clearance will be 18".

Where required by code, these transitions (and the rectangular portion of the system) are to be protected with a fire rated enclosure. Such enclosure may be either a field applied wrap system or separate fire protective shaft enclosure with an appropriate fire resistance rating. When installed with Model Z-Clear the fire rated enclosure system must extend to and overlap the adjacent section of Z-Clear a minimum of 6" and be mechanically secured to insure it remains in place.

INLINE ACCESS DOOR

Removal Procedure for Duct Inspection and Cleaning.

To remove Access Door for inspection and Cleaning:

1. NOTE: For Installations on single wall Model N Product proceed to step #3. Locate the Snap-Down latches securing the Outer Cover to the outer wall of the duct. Using your thumb or device such a flat head screwdriver, rotate the Arm of the Snap-Down latch to the open position (See Fig. G-17). Once all the Snap-Down latches are opened, remove Outer Cover and set it aside in a safe place during inspection / cleaning of the duct.
2. NOTE: For uninsulated model VSI ducts, proceed to step #3. For insulated IVSI and ZC models, a foil encapsulated Insulation Plug is used to insulate the duct and access door. Carefully remove the insulation plug from the wall cavity of the duct. (See Fig. G-18). Once the Insulation Plug is removed, set it aside in a safe place during inspection / cleaning of the duct.
3. Unscrew the Wing Nuts securing the Access Door to the Duct and remove Inner Access Door. Place Access Door and all fasteners aside in a safe place during inspection and cleaning of the duct (See Fig. G-19).

To replace Access Door after inspection and cleaning:

NOTE: Replace assembly in reverse order of removal process.

1. Install the Inner Access Door by aligning the bolt holes in the door with the studs protruding from the duct. Secure the Access Door in place with the Wing Nuts that were removed earlier (See Figs. G-18 & G-19).

2. NOTE: For uninsulated model VSI ducts, proceed to step #3. For insulated IVSI and ZC models, install the Insulation Plug (removed earlier), into the wall cavity of the duct, making sure that the entire opening in the duct is filled with the insulation (See Fig. G-20).

3. Center the Outer Cover (removed earlier), over the hole in the duct, making sure that an even amount of the outer wall is covered around the perimeter of the hole. Hold the cover in this location and rotate the Arm of the Snap-Down Latches to the closed position (See Fig. G-17). Ensure that all the Snap-Down Latches are in the closed position and that the outer cover is held securely in place.

Fig. G-17 – Inline Access Door

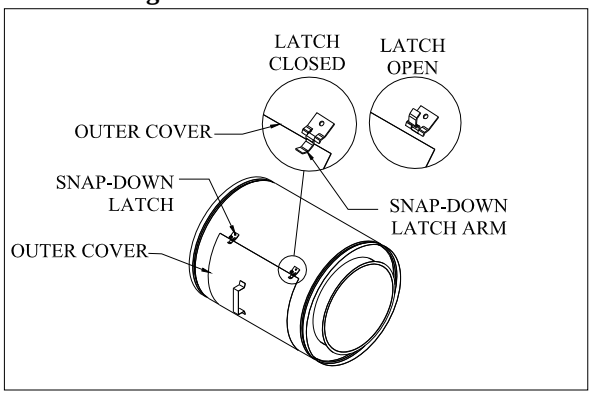


Fig. G-18

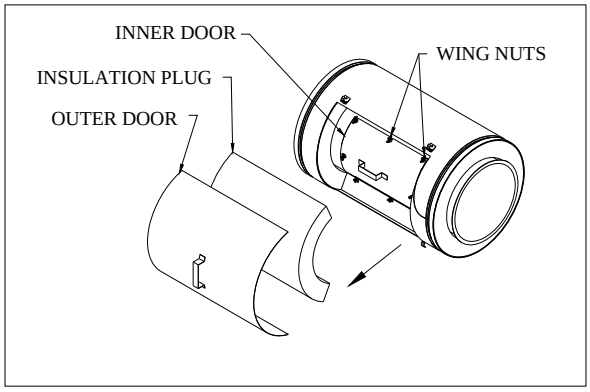


Fig. G-19

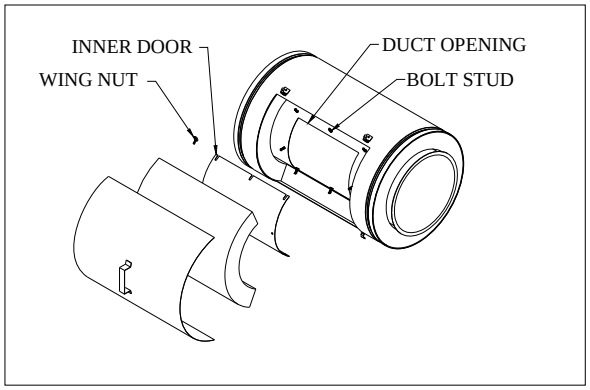
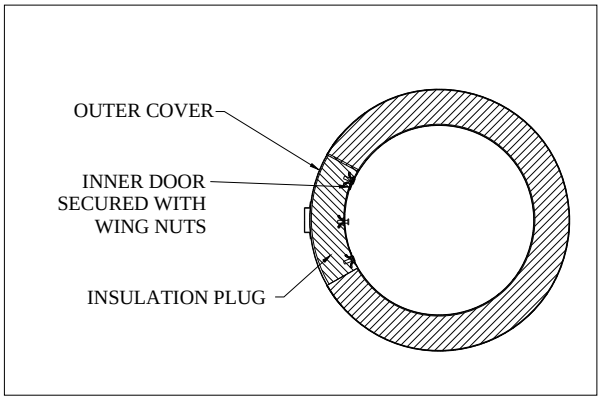


Fig. G-20 – Section View of IAD



GREASE DUCT SAMPLE DRAWINGS

Fig. G-21 Sample Drawing (Grease Duct Installation)

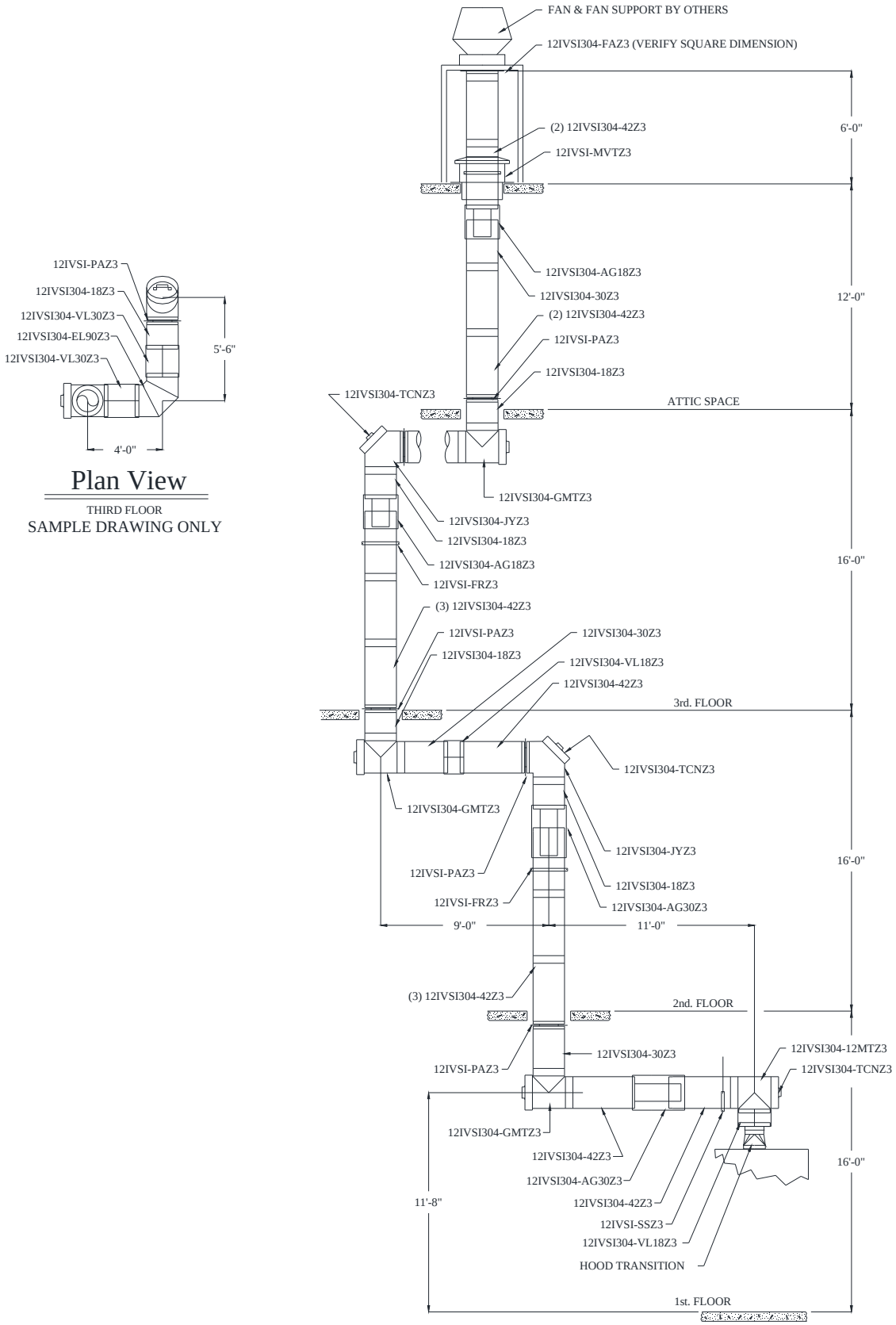
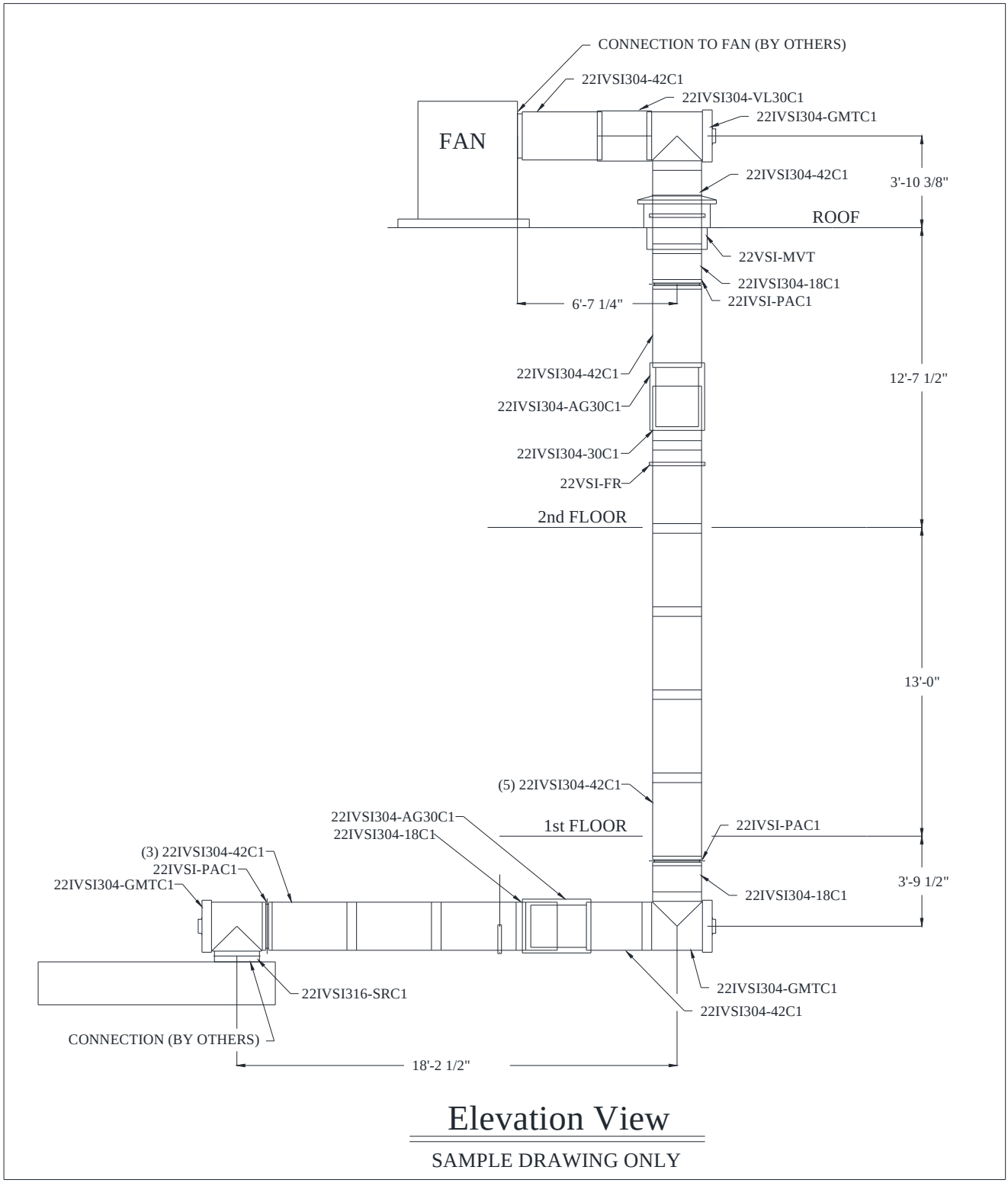


Fig. G-22 Sample Drawing (Grease Duct Installation)



AMPCO®

INSTALLATION INSTRUCTION

MODEL VSI & IVSI FOR TYPE B GAS VENT

c UL us LISTED

⚠WARNING
Failure to follow these Installation Instructions could cause FIRE, CARBON MONOXIDE POISONING, OR DEATH. If you are unsure of Installation requirements, call the Phone Number listed on the front of these instructions.

READ AND FOLLOW THESE SUPPLEMENTAL INSTRUCTIONS IF THE MODEL VSI OR IVSI SYSTEM BEING INSTALLED INCLUDE LABELS CONFIRMING LISTING AS TYPE B GAS VENT.

Model VSI and IVSI vent systems are also Listed by Underwriters Laboratories, Inc. (UL) for use as a Type B Gas Vent in accordance with the Standard for Gas Vent, UL-441.

This Installation Instruction Supplement includes very important information specific to the Type B Gas Vent application for use with Model VSI & IVSI systems. This information is intended only to supplement the main instructions found in this document. For complete guidelines for installation and maintenance of Model VSI & IVSI, see the main section of this document in conjunction with this instruction supplement.

Type B Gas Vent is intended for use only with Listed gas appliances incorporating draft hoods and other Listed gas appliances specified for use with Type B gas vent. When used in an application where the appliance is Listed for use with Type B Gas Vent, Model VSI and IVSI may be installed as Type B gas vent with the following clearances to combustibles:

Clearances for Type B Gas Vent		
Model	**Diameter**	**Minimum Airspace Clearance to Combustibles**
VSI	5” – 24”	1”
VSI	26” – 48”	2”
IVSI	5” – 48”	1”

If the appliance to which Model VSI or IVSI is attached is not Listed for use with Type B gas vent, refer to the main VSI/IVSI Installation Instructions and follow the installation guidelines for the flue gas temperature and pressure ratings applicable. VSI / IVSI installation as a Building Heating Appliance or 1400°F chimney may be required. If the application involves maximum flue gas temperatures in the range suitable for Type B gas vent (400°F maximum above ambient) but the appliance is not Listed for use with Type B gas vent, the Local Authority having Jurisdiction may accept the installation / use of such, at the clearances specified above, as an “Engineered System” per local code.

REQUIRED PARTS

When installed as Type B Gas Vent in sizes 5” through 12” diameter, the Model VSI / IVSI system should incorporate either a Listed Type B Gas Vent termination cap or a Model “CT” termination cap in order to comply with UL441 wind test / cap requirements. Also, when installed as a Type B gas vent, ventilated roof assemblies are not required. However, proper minimum airspace clearances as noted above must be maintained.

SURROUNDINGS / ENCLOSURE

When used as a Type B Gas Vent, Model VSI and IVSI may be enclosed in a chase fabricated from combustible materials. Check local codes to determine the required fire rating, if any, for such enclosures. When used as a Type B gas vent and extending up through any zone of a building outside that in which the heating appliance to which it is connected is located, Model VSI and IVSI should be provided with a fire rated enclosure. Such enclosure should have a fire resistance rating equal to or greater than that of the floor, wall, or roof assemblies through which it passes.

POSTING OF NOTICES

When used as a Type B Gas Vent, a notice should be posted near the connection to the appliance indicating that the Model VSI / IVSI system, as installed, is to be used only with gas appliances producing flue gas temperatures not exceeding 400°F above ambient. The notice should also include a recommendation that the vent be inspected prior to the heating season to assure an unrestricted flue. For such purposes the cap may need to be removed and replaced after inspection.

Ampco Commercial/Industrial representatives throughout North America are qualified to provide field service to assist contractors, builders, engineers and architects in designing Boiler Stacks and Breechings, Grease Ducts, Diesel and Turbine Exhausts, Freestanding Stack Systems, and Residential Chimney and Gas Vent Systems. Contact the Ampco Regional Office nearest you for assistance.

Commercial/Industrial Venting Products Sales Office

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Tel: 888.735.5475

www.ampcostacks.com

GREENHECK
Building Value in Air.

Document 479870
Model USF-200, 300 and 400
Model CSW
Utility and Centrifugal Fans

Installation, Operation and Maintenance Manual

Please read and save these instructions for future reference. Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage!

USF-200

USF-300

USF-400

Model CSW

General Safety Information

Only qualified personnel should install this fan. Personnel should have a clear understanding of these instructions and should be aware of general safety precautions. Improper installation can result in electric shock, possible injury due to coming in contact with moving parts, as well as other potential hazards. Other considerations may be required if seismic activity is present. If more information is needed, contact a licensed professional engineer before moving forward.

1. Follow all local electrical and safety codes, as well as the National Electrical Code (NEC) and the National Fire Protection Agency (NFPA), where applicable. Follow the Canadian Electric Code (CEC) in Canada.
2. The rotation of the wheel is critical. It must be free to rotate without striking or rubbing any stationary objects.
3. Motor must be securely and adequately grounded.
4. Do not spin fan wheel faster than max cataloged fan RPM. Adjustments to fan speed significantly effects motor load. If the fan RPM is changed, the motor current should be checked to make sure it is not exceeding the motor nameplate amps.
5. Do not allow the power cable to kink or come in contact with oil, grease, hot surfaces or chemicals. Replace cord immediately if damaged.
6. Verify that the power source is compatible with the equipment.
7. Never open access doors to a duct while the fan is running.

DANGER
Always disconnect, lock and tag power source before installing or servicing. Failure to disconnect power source can result in fire, shock or serious injury.
CAUTION
When servicing the fan, motor may be hot enough to cause pain or injury. Allow motor to cool before servicing.
CAUTION
Precaution should be taken in explosive atmospheres.
DANGER
Pour écarter les risques d'incendie, de choc électrique ou de blessure grave, veiller à toujours débrancher, verrouiller et étiqueter la source de courant avant l'installation ou l'entretien.
ATTENTION
Lors de toute intervention sur la soufflante, le moteur peut être suffisamment chaud pour provoquer une douleur voire une blessure. Laisser le moteur refroidir avant toute maintenance.
ATTENTION
Faire preuve de précaution dans les atmosphères explosives.

Receiving

Upon receiving the product, check to ensure all items are accounted for by referencing the delivery receipt or packing list. Inspect each crate or carton for shipping damage before accepting delivery. Alert the carrier of any damage detected. The customer will make a notation of damage (or shortage of items) on the delivery receipt and all copies of the bill of lading which is countersigned by the delivering carrier. If damaged, immediately contact your Greenheck Representative. Any physical damage to the unit after acceptance is not the responsibility of manufacturer.

Unpacking

Verify that all required parts and the correct quantity of each item have been received. If any items are missing, report shortages to your local representative to arrange for obtaining missing parts. Sometimes it is not possible that all items for the unit be shipped together due to availability of transportation and truck space. Confirmation of shipment(s) must be limited to only items on the bill of lading.

Handling

Fans are to be rigged and moved by the lifting brackets provided or by the skid when a forklift is used. Location of brackets varies by model and size. Handle in such a manner as to keep from scratching or chipping the coating. Damaged finish may reduce the ability of the fan to resist corrosion. Fans should never be lifted by the shaft, fan housing, motor, belt guard, windband or accessories.

Storage

- Rotate fan wheel monthly and purge bearings once every three months
- Energize fan motor once every three months
- Store belts flat to keep them from warping and stretching
- Store unit in location which does not have vibration
- After storage period, purge grease before putting fan into service.

If storage of fan is in a humid, dusty or corrosive atmosphere, rotate the fan and purge the bearings once a month. Improper storage which results in damage to the fan will void the warranty.

Fans are protected against damage during shipment. If the unit cannot be installed and operated immediately, precautions need to be taken to prevent deterioration of the unit during storage. The user assumes responsibility of the fan and accessories while in storage. The manufacturer will not be responsible for damage during storage. These suggestions are provided solely as a convenience to the user.

INDOOR - The ideal environment for the storage of fans and accessories is indoors, above grade, in a low humidity atmosphere which is sealed to prevent the entry of blowing dust, rain or snow. Temperatures should be evenly maintained between 30° to 110°F *(-1° to 43°C)*, wide temperature swings may cause condensation and “sweating” of metal parts. All accessories must be stored indoors in a clean, dry atmosphere.

Remove any accumulations of dirt, water, ice, or snow and wipe dry before moving to indoor storage. To avoid “sweating” of metal parts allow cold parts to reach room temperature. To dry parts and packages use a portable electric heater to remove any moisture build up. Leave coverings loose to permit air circulation and to allow for periodic inspection.

The unit should be stored at least 3½ inches *(89 mm)* off the floor on wooden blocks covered with moisture proof paper or polyethylene sheathing. Aisles between parts and along all walls should be provided to permit air circulation and space for inspection.

OUTDOOR - Fans designed for outdoor applications may be stored outdoors, if absolutely necessary. Roads or aisles for portable cranes and hauling equipment are needed.

The fan should be placed on a level surface to prevent water from leaking into the fan. The fan should be elevated on an adequate number of wooden blocks so it is above water and snow levels and has enough blocking to prevent it from settling into soft ground. Locate parts far enough apart to permit air circulation, sunlight and space for periodic inspection. To minimize water accumulation, place all fan parts on blocking supports so rain water will run off.

Do not cover parts with plastic film or tarps as these cause condensation of moisture from the air passing through heating and cooling cycles.

Fan wheels should be blocked to prevent spinning caused by strong winds.

Inspection and Maintenance During Storage

While in storage, inspect fans once per month. Keep a record of inspection and maintenance performed.

If moisture or dirt accumulations are found on parts, the source should be located and eliminated. At each inspection, rotate the wheel by hand ten to fifteen revolutions to distribute lubricant in motor and bearings. If paint deterioration begins, consideration should be given to touch-up or repainting. Fans with special coatings may require special techniques for touch-up or repair.

Machined parts coated with rust preventive should be restored to good condition promptly if signs of rust occur. Immediately remove the original rust preventive coating with petroleum solvent and clean with lint-free cloths. Polish any remaining rust from surface with crocus cloth or fine emery paper and oil. Do not destroy the continuity of the surfaces. Thoroughly wipe clean with Tectyl® 506 (Ashland Inc.) or the equivalent. For hard to reach internal surfaces or for occasional use, consider using Tectyl® 511M Rust Preventive, WD-40® or the equivalent.

Removing from Storage

As fans are removed from storage to be installed in their final location, they should be protected and maintained in a similar fashion until the fan equipment goes into operation.

Prior to assembly and installation of the unit and system components, inspect the fan assembly to make sure it is in working order.

1. Check all fasteners, set screws on the fan, wheel, bearings, drive, motor base and accessories for tightness.
2. Rotate the fan wheel by hand and assure no parts are rubbing. Access to the wheel is obtained through a bolted panel located on the side of the fan housing.
3. Ensure proper wheel settings for radial gap and alignment. Refer to Radial Gap, Overlap and Wheel Alignment section on page 9.

Table of Contents

General Information

To ensure a successful installation, the instructions in this manual should be read and adhered to. Failure to comply with proper installation procedures may void the warranty.

Unit and System Identification Tags

Each fan has a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number.

The tag shown is an example of an identification nameplate on the fan. The information provides general details about the fan, as well as containing specific information unique to the unit. When contacting your Greenheck representative with future needs or questions, please have the information on this label available. Tags are mounted in an area which is clearly visible, usually on the side of the fan cabinet.

Pre-Installation Information

Before installation, it is important to be certain the mounting surface will bear the operating weight of the unit. For proper unit operation, it is also important that it be operated in a completely level position.

For further details on safety practices involving industrial and commercial fans, please refer to AMCA Publication 410.

Electrical Disconnects

All fan motors should have disconnects located in close visual proximity to turn off electrical service. Service disconnects shall be locked-out when maintenance is being performed.

Moving Parts

All moving parts must have guards to protect personnel. Refer to local codes for requirements as to the number, type and design. Fully secure fan wheel before performing any maintenance. The fan wheel may start "free wheeling" even if all electrical power has been disconnected. Before the initial start-up or any restart, check the following items to make sure that they are installed and secure.

- Do not spin fan wheel faster than the maximum cataloged fan rpm.
- Adjustments to fan speed significantly affects motor load. If the fan RPM is changed, the motor current should be checked to make sure it is not exceeding the motor nameplate amps.

Guards – Motor Cover, Weatherhood, Shaft, Belt, Inlet or Outlet Guard

Do not operate fans without proper protective devices in place. Failure to do so may result in serious bodily injury and property damage. Check local codes to ensure compliance for all protective devices.

Access Doors

Before opening access doors, ensure the fan wheel has stopped moving and that the wheel has been secured from being able to rotate. Do not operate fan without access door in its fully closed position.

Air Pressure and Suction

In addition to the usual hazards associated with rotating machinery, fans also create a dangerous suction at the inlet. Special caution needs to be used when moving around a fan, whether it is in operation or not. Before start-up, make sure the inlet area is clear of personnel and loose objects.

Fans – Rigging and Lifting

CAUTION

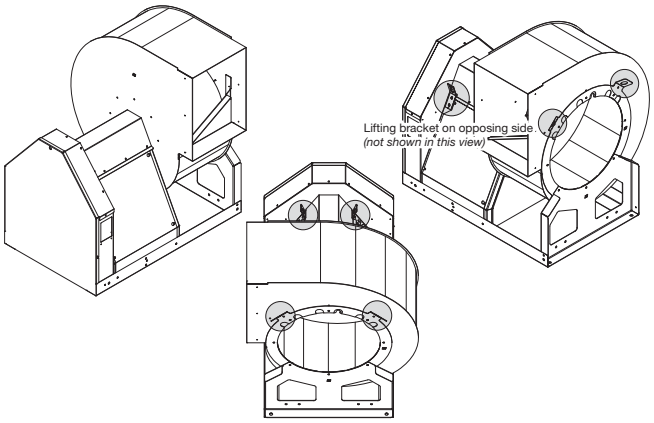
Fans should never be lifted by the shaft, motor, motor cover or accessories.

Fans are to be rigged and moved by the lifting brackets provided or by the skid when a forklift is used. Location of brackets varies by model and size. Handle in such a manner as to keep from scratching or chipping the coating. Damaged finish may reduce ability of fan to resist corrosion. See coating repair section of this manual for details involving touch-up of damaged surfaces.

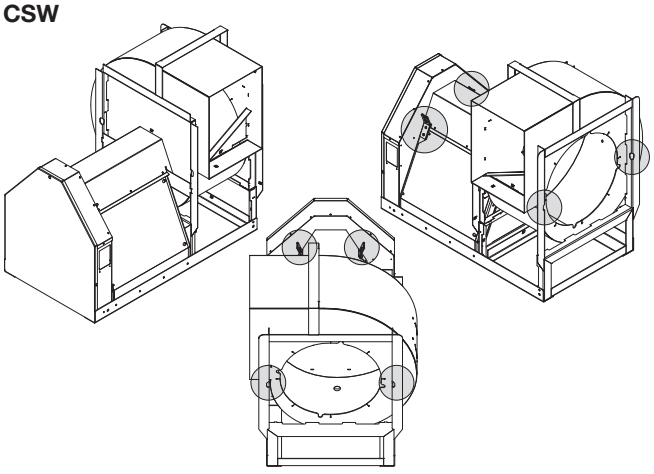
- Use standard lifting and rigging practices.
- **ALL** lifting brackets on each component must be utilized at the same time.
- Fan to be kept level during lifting and installation.

Shading indicates lifting point locations

USF-200 and USF-300



USF-400
CSW



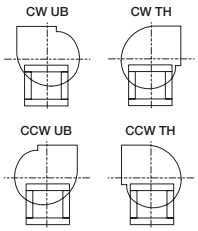
Installation

Move the fan to the desired location. Check and tighten fasteners throughout the unit and then fasten securely through mounting holes provided in the base angles. The unit must be set level (shimming may be necessary). Flexible duct connections and vibration isolators should be used where noise is a factor.

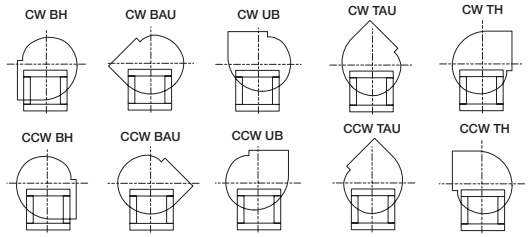
The motor voltage and ampere rating must be checked for compatibility with the electrical supply prior to final electrical connection. Supply wiring to the fan must be properly fused, and conform to local and national electrical codes.

Discharge Positions

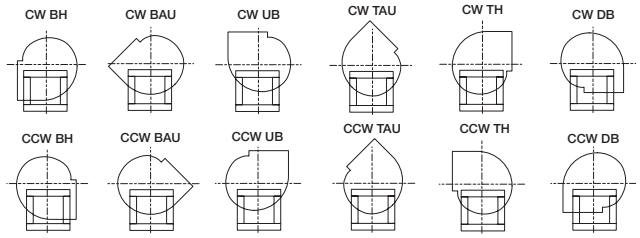
USF-200



USF-300 and USF-400



CSW



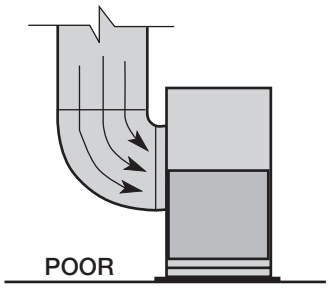
The discharge is factory set as specified by customer order, however, certain sizes can be rotated to other discharge positions in the field if necessary. If rotating the fan housing, accommodations may need to be made for the fan to drain properly. The USF-200, all sizes and USF-300, sizes 24 and less, have field rotatable housings. For the USF-400 and CSW, rotatable housings are standard sizes 30 and less, arrangements 1, 9 and 10, and Class 0, I and II. Class III and IV are not field rotatable. Removal of the housing bolts allows the discharge to be rotated to the clockwise positions above. For DB discharge position, a portion of the frame angle must be removed.

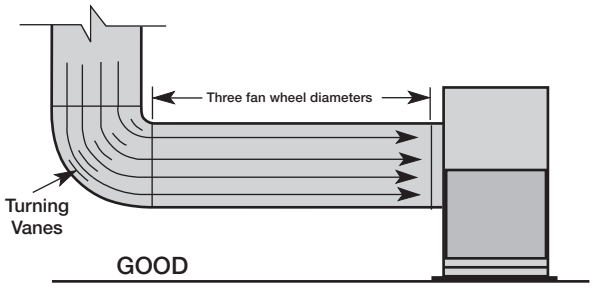
Fan rotation is always specified from the drive side of the housing.

Installations with inlet or discharge configurations that deviate from this manual may result in reduced fan performance. Restricted or unstable flow at the fan inlet can cause pre-rotation of incoming air or uneven loading of the fan wheel yielding large system losses and increased sound levels. Free discharge or turbulent flow in the discharge ductwork will also result in system effect losses. Refer to the following diagrams for the most efficient installation conditions.

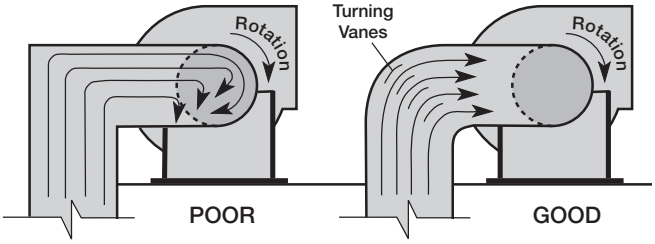
Ducted Inlet Installations

Inlet Duct Turns - Installation of a duct turn or elbow too close to the fan inlet reduces fan performance because air is loaded unevenly into the fan wheel. To achieve full fan performance, there should be at least three fan wheel diameters between the turn or elbow and the fan inlet.





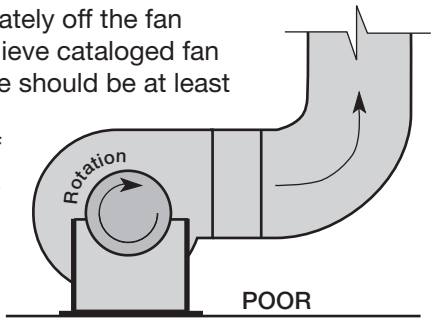
Inlet Spin - Inlet spin is a frequent cause of reduced fan performance. The change in fan performance is a function of the intensity of spin and not easily defined. The best solution is proper duct design and airflow patterns. Turning vanes reduce the effects of inlet spin.

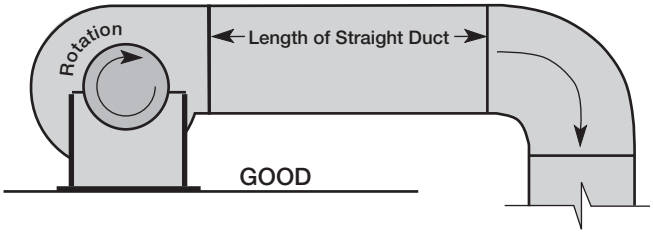


Ducted Outlet Installations

Discharge Duct Turns - Duct turns located near the fan discharge should always be in the direction of the fan rotation.

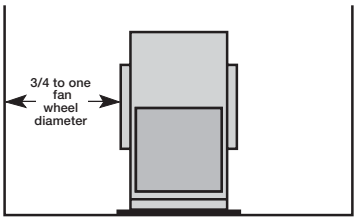
Fan performance is reduced when duct turns are made immediately off the fan discharge. To achieve cataloged fan performance there should be at least three equivalent duct diameters of straight ductwork between the fan discharge and any duct turns.





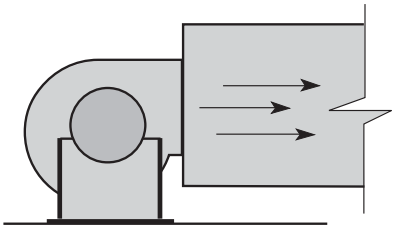
Non-Ducted Installations

Inlet Clearance - Installation of a fan with an open inlet too close to a wall or bulkhead will cause reduced fan performance. It is desirable to have a minimum of three-fourths of a wheel diameter between the fan inlet and the wall.



Single Fan Installation

Free Discharge - Free or abrupt discharge into a plenum results in a reduction in fan performance. The effect of discharge static regain is not realized.



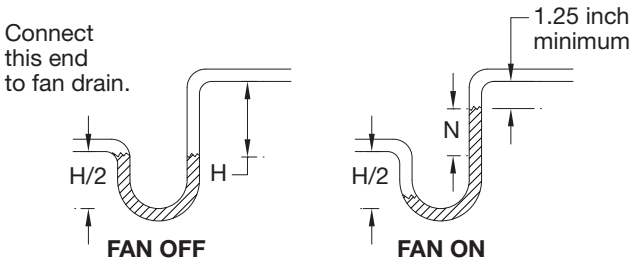
Fan Drainage Piping and Trap Detail (by others)

Fans may have been supplied with an optional drain. Drains are located at the underside of the scroll housing. The drain may need to be connected to a drainage system to ensure proper disposal of any water or condensate that may occur.

- Drain connections are 1.0 inch MNPT
- Installed piping to have a downward angle to allow for drainage
- Fill traps to recommended level before start-up

Note: A conservative method of trap design is to set N = total static pressure.

Positive Pressure Trap on Centrifugal Fan Housing



N = Negative fan pressure (inches W.C.)
H = N - 0.5 inches minimum)

Check local codes for proper disposal of drain water which has been in contact with the exhaust air.

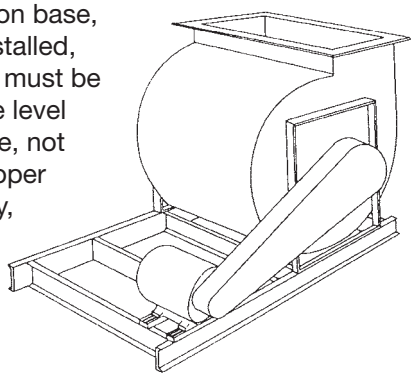
Fans used for grease exhaust need to be equipped with a separate grease collector.

Bases (Foundation and Isolation)

Critical to every fan installation is a strong, level foundation. A reinforced poured concrete pad with a steel base or inertia base provides an excellent foundation. Bases must be sturdy enough, with welded construction, to prevent flexing and vibration.

To eliminate vibration and noise from being transferred to the building, vibration isolators should be used. The fan is mounted directly on the isolation base and must be supported for the entire length of the fan base angle. (Refer to the Centrifugal Fan Isolation Base Assembly Instructions if the base was supplied by Greenheck). Isolators are installed between the isolation base and the foundation.

After the fan, isolation base, and isolators are installed, the entire assembly must be leveled. Position the level on the isolation base, not the fan shaft, for proper leveling. Additionally, the motor and fan shafts must be level and parallel relative to each other for proper alignment.



Typical Fan on Isolation Base

CAUTION

When installing a fan, ensure the proper protective devices are used to protect personnel from moving parts and other hazards. A complete line of protective accessories are available from Greenheck including: inlet guards, outlet guards, belt guards, shaft guards, protective cages and electrical disconnects.

Electrical Disconnects

All fan motors should have disconnects located in close visual proximity to turn off electrical service. Service disconnects shall be locked out when maintenance is being performed.

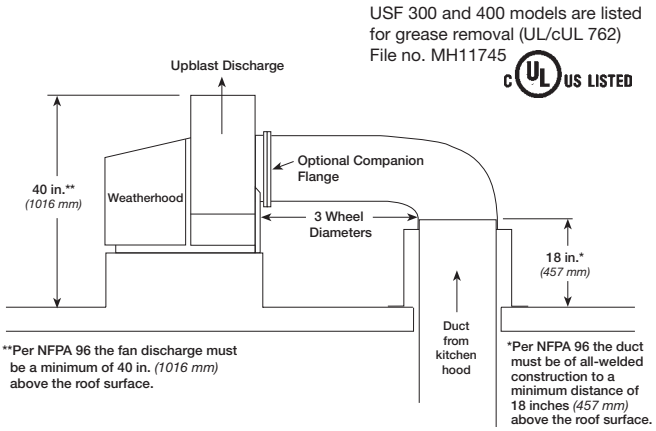
Moving Parts

All moving parts must have guards to protect personnel. Refer to local codes for requirements as to the number, type and design. Fully secure fan wheel before performing any maintenance. The fan wheel may start “free wheeling” even if all electrical power has been disconnected. Before the initial start-up or any restart, check the guards (belt, shaft, inlet and outlet) and check the access doors to ensure that they are installed and secure.

Installation of UL/cUL 762 Listed Fans for Restaurant Exhaust

The UL/cUL 762 listing for restaurant exhaust is available on the USF-300 and 400 and CSW.

UL/cUL 762 fans are listed for a maximum operating temperature of 375°F *(191°C)* and includes an access door and 1 inch *(25.4 mm)* drain connection. An outlet guard is strongly recommended when the fan discharge is accessible. An upblast discharge is recommended. The fan discharge must be a minimum of 40 inches *(1016 mm)* above the roof line and the exhaust duct must be fully welded to a distance of 18 inches *(457 mm)* above the roof surface.

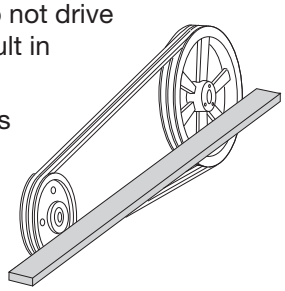


This drawing is for dimensional information only. See the latest edition of NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations for detailed installation instructions, materials, duct connections and clearances.

V-Belt Drives

V-Belt Drive Installation

1. Remove the protective coating from the end of the fan shaft using mineral spirits or another similar solvent. Check to ensure that the shaft is free of nicks and burrs.
2. Slide sheaves on shafts. Do not drive sheaves on as this may result in bearing damage.
3. Align fan and motor sheaves with a straight edge or string and tighten.
4. Place belts over sheaves. Do not pry or force belts, as this could result in damage to the cords in the belts.



Aligning Sheaves with a Straight Edge

5. Adjust the tension until the belts appear snug. Run the unit for a few minutes and allow the belts to "Set" properly.
6. With the fan off and disconnect locked out, adjust the belt tension by moving the motor pivot plate. When in operation, the tight side of the belts should be in a straight line from sheave to sheave with a slight bow on the slack side.

Alignment of Pulleys and Belts

Check pulleys and belts for proper alignment to avoid unnecessary belt wear, noise, vibration and power loss. Motor and drive shafts must be parallel and pulleys in line as shown in Figure 1.

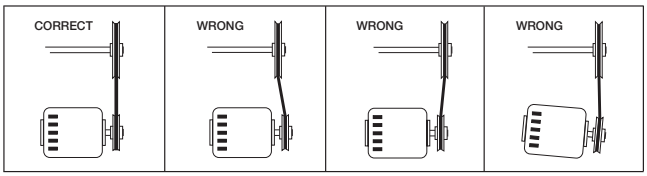


Figure 1

The adjustable motor pulley is set at the factory for the fan RPM specified by the customer. Fan RPM can be increased by closing or decreased by opening the adjustable motor pulley. Multi groove variable pitch pulleys must be adjusted an equal number of turns open or closed. Any increase in fan speed represents a substantial increase in load on the motor.

To avoid motor overheating and possible burnout, motor load amperes should always be checked and compared to nameplate rating when fan speed is increased.

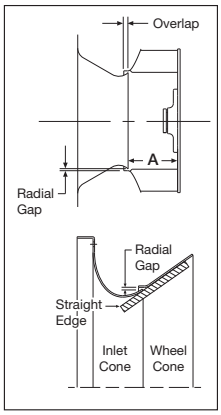
Radial Gap, Overlap and Wheel Alignment

Wheels must rotate freely and not rub on the inlet cone. Model USF and CSW wheels overlap the inlet cone. Refer to the table for the proper dimension.

Radial Gap and Alignment

Efficient fan performance can be maintained by having the correct radial gap, overlap and wheel alignment. These items should be checked after the fan has been in operation for 24 hours and before start-up when the unit has been disassembled.

Radial Gap: Adjust inlet cone position such that the radial gap between the wheel cone and inlet cone is evenly distributed around the wheel.



Radial gap is adjusted by loosening the inlet cone/ring bolts and centering the cone/ring on the wheel. If additional adjustment is required to maintain a constant radial gap, loosening the bearing bolts and centering the wheel is acceptable as a secondary option.

Overlap: Overlap is adjusted by loosening the wheel hub from the shaft and moving the wheel to the desired position along the shaft.

The transition between the inlet cone and wheel should be as shown; there is a smooth feel to the profile when moving from one component to the other.

Method for Centering Wheel: On belt drive units, centering can be accomplished by (a) loosening the inlet cone bolts to move the inlet cone or by (b) loosening the bearings in order to move the shaft. Wheel and inlet cone overlap can be adjusted by loosening the wheel hub set screws and moving the wheel to the desired position. Tighten all fasteners and set screws securely and realign drive pulleys after adjustment.

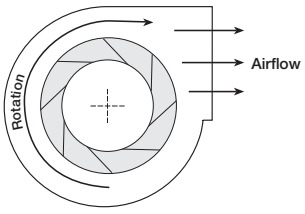
Radial Gap and Overlap Dimensions						
USF-200	USF-300	USF-400	CSW	A	Overlap	Overlap Tolerance
				inches (mm)		
206	306			-	-	-
207	307			-	-	-
208	308			-	-	-
210	310			4 15/16 (125)	3/8 (10)	1/8 (3)
		407	7	1 7/16 (37)	2 15/32 (63)	1/8 (3)
		408	8	2 11/16 (68)	1 7/32 (31)	1/8 (3)
		409	9	3 11/16 (94)	7/32 (6)	1/8 (3)
		410	10	3 11/16 (94)	7/32 (6)	1/8 (3)
212	312	412	12	4 1/4 (108)	11/32 (9)	1/8 (3)
213	313	413	13	4 11/16 (119)	3/8 (10)	1/8 (3)
215	315	415	15	5 3/16 (132)	7/16 (11)	1/8 (3)
216	316	416	16	5 3/4 (146)	7/16 (11)	1/8 (3)
218	318	418	18	6 3/8 (162)	15/32 (12)	1/8 (3)
220	320	420	20	7 (178)	1/2 (13)	3/16 (5)
222	322	422	22	7 13/16 (198)	17/32 (13)	3/16 (5)
	324	424	24	8 5/8 (219)	9/16 (14)	1/4 (6)
	327	427	27	9 7/16 (240)	11/16 (17)	1/4 (6)
	330	430	30	10 9/16 (268)	11/16 (17)	3/8 (10)
	333	433	33	11 7/16 (291)	15/16 (24)	3/8 (10)
	336	436	36	12 3/4 (324)	15/16 (24)	3/8 (10)
	340	440	40	14 3/16 (360)	29/32 (23)	3/8 (10)
	344	444	44	15 9/16 (395)	1 1/8 (29)	3/8 (10)
	349	449	49	17 1/8 (435)	1 1/4 (32)	1/2 (13)
			54	18 13/16 (478)	1 17/32 (39)	1/2 (13)
			60	20 15/16 (532)	1 9/16 (40)	1/2 (13)
			66	22 7/8 (581)	1 29/32 (48)	1/2 (13)
			73	25 1/2 (648)	1 29/32 (48)	1/2 (13)

Wheel Rotation

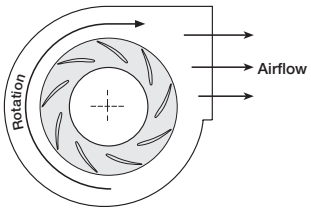
Rotation direction of the wheel is critical and incorrect rotation will result in reduced air performance, increased motor loading and possible motor burnout.

Check wheel rotation by momentarily energizing the unit and noting if rotation is in the same direction as the airflow at the outlet and conforms to the rotation decal affixed to the unit.

Wheels as viewed from the drive side:



Backward Inclined



Airfoil

NOTE

Model USF and CSW units should be operated only when attached to the system for which they were designed. Without proper system static pressure, the motor could be overloaded.

Field Coating Touch-Up Procedure for Scratched Areas

Standard coating and color is Greenheck's RAL 7023 Concrete Grey. The procedure outlines the correct method for repairing minor scratches in the coating.

TOUCH-UP PAINT REPAIR KIT CONTENTS

- One pint of Kem Kromik primer
  - including a technical data sheet
- One pint of industrial enamel
  - including a technical data sheet
- Four disposable foam brushes
- One sheet sandpaper
- Repair procedure details

1. Scuff affected area to be repaired using medium sandpaper (provided) or medium scotch brite pad. Feather the edges.
2. Clean affected area to be touched up using an alkaline based cleaner and rinse.
3. Apply Kem Kromik primer using 1 inch foam brush (provided). Follow technical data sheet instructions.
4. Allow primer to dry a minimum of 2-1/2 hours before top coating.
5. Apply topcoat with industrial enamel using 1 inch foam brush (provided). Follow technical data sheets instructions. Allow painted units to air-dry and cure before putting into service. See enclosed Technical Data sheets for detailed drying and cure schedules at different temperatures.

To order additional coating repair kits please reference Greenheck's part number HAZ2597 PNT FIELD REPAIR KIT, RAL 7023 CONCRETE GREY. Please contact factory with your fan's serial number for colors other than our standard.

Electrical Connections

Before electrical connections are made, the supply voltage, phase and ampere capacity must be checked for compatibility with the fan motor. In addition, the supply wiring must be properly fused and conform to local and national electrical codes. If the unit is supplied with a safety disconnect switch, ensure proper wiring to the fan motor. Be sure the disconnect is switched to the "OFF" position before connecting supply wires. If no disconnect is supplied, ensure the supply wire is not live before connection. Supply wires are then connected to the optional safety disconnect switch (if supplied) or motor.

Unit Start-Up

WARNING

Disconnect and secure to the **OFF** position all electrical power to the fan prior to inspection or servicing. Failure to comply with this safety precaution could result in serious injury or death.

Visual Inspection of Equipment

The equipment type and arrangement should be verified as ordered at once when it arrives at the jobsite. When a discrepancy is found, the local Greenheck Fan Corporation Sales Representative must be notified immediately so that corrective action may be investigated, also verify electrical conformance to specifications. Unauthorized alterations and unauthorized backcharges will not be recognized by Greenheck Fan Corporation.

After the unit has been assembled, installed and all utilities have been hooked up, the unit is now ready for operation.

Check

Before starting the unit, check the following:

1. Confirm that building supply voltage matches the voltage for which the unit is wired.
2. Check all piping and wiring penetrations made by contractors for water tightness. All penetrations must be made watertight to prevent water damage to the unit and building.
3. Rotate the fan wheel manually to be sure that it is free to operate. Remove any dirt or debris that may have accumulated during installation.
4. Check the fan bearing setscrews for tightness.
5. Check alignment of sheaves and V-belts (See maintenance section).
6. Inspect all fasteners to ensure that none have loosened during shipment.
7. Check flex coupling for proper alignment and connect between motor shaft and fan shaft (direct drive).
8. Check all guarding to ensure that it is securely attached and not interfering with rotating parts.
9. Check all electrical connections for proper attachment.
10. Check housing and ductwork, if accessible, for obstructions and foreign material that may damage the fan wheel.
11. Fill drainage piping trap.

Additional Steps for Initial Start-Up

1. Check for proper wheel rotation by momentarily energizing the fan. Access to view the wheel can be gained through the blower housing access panel.

One of the most frequently encountered problems are motors that are wired to rotate the wheel in the wrong direction. This is especially true with 3-phase installations where the motor will run in either direction, depending on how it has been wired. To reverse rotation of a 3-phase motor, interchange any two of the three electrical leads. Single phase motors can be reversed by changing internal connections as described on the motor label or wiring diagram.

2. Fans with multi-speed motors should be checked on low speed during initial start-up.
3. Check for unusual noise, vibration or overheating of bearings. Refer to the “Troubleshooting” section of this manual if a problem develops.
4. Grease may be forced out of the bearing seals during initial start-up. This is a normal self-purging feature for the type of bearing used on this product.

Vibration

On start-up and during operation, the unit should operate smoothly with minimal vibration. It is possible that a higher degree of vibration may be experienced. Excessive vibration if left unchecked, can cause a multitude of problems, including structural and/or component failure. The most common sources of vibration are listed.

Common Sources of Vibration

1. Wheel Unbalance
2. Drive Pulley Misalignment
3. Incorrect Belt Tension
4. Bearing Misalignment
5. Mechanical Looseness
6. Faulty Belts
7. Drive Component Unbalance
8. Poor Inlet/Outlet Conditions
9. Foundation Stiffness

Many of these conditions can be discovered by careful observation. Refer to the troubleshooting section of this manual for corrective actions. If observation cannot locate the source of vibration, a qualified technician using vibration analysis equipment should be consulted. If the problem is wheel unbalance, in-place balancing can be done through the access panel located on the side of each fan's tubular housing. Any correction weights added to the wheel should be welded to either the wheel back (single-plane balance) or to the wheel back and wheel cone (two-plane balance).

Routine Maintenance and Operation

CAUTION

When performing any service to the fan, disconnect the electrical supply and secure fan impeller.

Once the unit has been put into operation, a routine maintenance schedule should be set up to accomplish the following:

1. Lubrication of bearings and motor.
2. Wheel, housing, bolts and set screws on the entire fan should be checked for tightness.
3. Any dirt accumulation on the wheel or in the housing should be removed to prevent unbalance and possible damage.
4. Inspect fan impeller and housing looking for fatigue, corrosion, or wear.

Fan Operation

All fans should be run every thirty (30) days, or at least "bumped" every thirty days. It is preferred that each fan is run as this causes all electrical and mechanical components to get up to temperature, displacing any formed condensation, redistributes load on bearings, and redistributes grease in the bearings (motor and shaft bearings).

CAUTION

When operating conditions of the fan are to be changed (speed, pressure, temperature, etc.), consult manufacturer to determine if the unit can operate safely at the new condition.

Motors

Motor maintenance is generally limited to cleaning and lubrication. Cleaning should be limited to exterior surfaces only. Removing dust and grease buildup on the motor housing assists proper motor cooling. Never wash-down motor with high pressure spray.

Greasing of motors is only intended when fittings are provided. Many fractional motors are permanently lubricated for life and require no further lubrication. Motors supplied with grease fittings should be greased in accordance with the manufacturer's recommendations. When motor temperature does not exceed 104°F (40°C), the grease should be replaced after 2000 hours of running time.

Direct drive systems have extended grease lines to lubricate the motor without removal of any guarding.

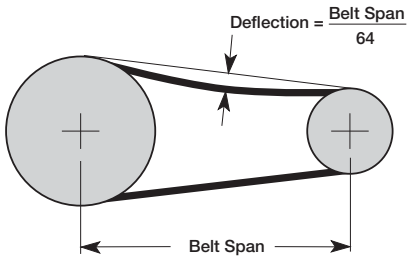
Belt Drive Maintenance

V-belt drives must be checked on a regular basis for wear, tension, alignment and dirt accumulation. Premature or frequent belt failures can be caused by improper belt tension (either too loose or too tight) or misaligned sheaves. Abnormally high belt tension or drive misalignment will cause excessive bearing loads and may result in failure of the fan and/or motor bearings. Conversely, loose belts will cause squealing on start-up, excessive belt flutter, slippage and overheated sheaves. Either excessively loose or tight belts may cause fan vibration.

When replacing V-belts on multiple groove drives all belts should be changed to provide uniform drive loading. Use a set of matched belts whenever possible. Do not pry belts on or off the sheave. Loosen belt tension until belts can be removed by simply lifting the belts off the sheaves. After replacing belts, ensure that slack in each belt is on the same side of the drive. Belt dressing should never be used.

Do not install new belts on worn sheaves. If the sheaves have grooves worn in them, they must be replaced before new belts are installed.

The proper tension for operating a V-belt drive is the lowest tension at which the belts will not slip at peak load conditions. Belts are adjusted by raising or lowering the motor pivot plate. For initial tensioning, the proper belt deflection halfway between sheave centers is 1/64-inch for each inch of belt span.



For more information about measuring belt tension, refer to Greenheck's Product Application Guide, FA/127-11, Measuring Belt Tension, found online at www.greenheck.com in the library section.

Check belt tension two times during the first 24 hours of operation and periodically thereafter.

Variable Frequency Drive Operation

For operation with variable frequency drive (VFD), always check motor amps when adjusting the operating frequency. Motor may be sized for the original selected operating speed under 60 Hz. Bypassing the VFD or increasing the speed from this original selection, even if less than 60 Hz, may cause motor to overload or failure. Consult factory with fan serial number, before increasing the upper limiting frequency.

Always check the fan rpm when adjusting the operating frequency. Do not exceed maximum class fan rpm of the wheel.

Bearing Lubrication Schedule

Shaft bearings are the most critical moving part of a fan. Therefore, special attention should be given to keeping the bearings clean and well lubricated. Proper lubrication provides for reduction in friction and wear, transmission and dissipation of heat, extended bearing life and prevention of rust.

In order for a lubricant to fulfill these tasks, the proper grease applied at regular intervals is required. See the recommended bearing lubrication schedule below.

If unusual conditions exist (temperatures below 32°F or above 200°F), moisture or contaminants - more frequent lubrication is required.

Recommended Bearing Lubrication Schedule Relubrication Schedule in Months					
Standard Grease					
Fan RPM	Bearing Bore (inches)				
	1/2 -1	1⅛ - 1½	1⅝ - 1⅞	1¹⁵⁄₁₆ - 2³⁄₁₆	2⁷⁄₁₆ - 3
To 250	12	12	12	12	12
500	12	12	11	10	8
750	12	9	8	7	6
1000	12	7	6	5	4
1250	12	6	5	4	3
1500	12	5	4	3	2
2000	12	3	3	2	1
2500	12	2	2	1	0.5
3000	12	2	1	0.5	0.25
3500	12	1	0.5	0.25	x
4000	12	0.5	0.25	x	x
5000	12	0.25	x	x	x
Number of Shots	4	8	8	10	16

- Lubrication interval is based on 12 hour per day operation and maximum 160°F housing temperature. For 24 hour per day operation, the interval should be cut in half.
- Lubricant should be added with the shaft rotating and until clean grease is seen purging from the bearing. The lubrication interval may be modified based on the condition of the purged grease. If bearing is not visible to observe purged grease, lubricate with number of shots indicated in chart for bore size.
- For conditions including high temperatures, moisture, dirt or excessive vibration, consult the factory for a specific lubrication interval for your application.
- Lubricant should be a high quality lithium complex grease conforming to NLGI Grade 2. Factory recommends Mobilux EP-2.
- The use of synthetic lubricants will increase lubrication intervals by approximately 3 times.

In addition to lubricating the bearings at specified intervals, set screws in the bearing collars should be checked for tightness. A bearing collar which has loosened will cause premature failure of the fan shaft. Fasteners attaching the bearings to the drive frame should also be checked.

Wheel and Fastener Maintenance

Wheels require very little attention when exhausting clean air, however, air heavily laden with grease or dirt will tend to accumulate on the wheel causing unbalance. Wheels exhausting dirty or grease-laden air require frequent cleaning to assure smooth and safe operation.

All fasteners, including set screws in the bearing collars, should be checked for tightness each time maintenance checks are performed.

A proper maintenance program will help preserve the performance and reliability designed into the fan.

Bearing Replacement

For Arr. 1, 3, 8, 9 or 10

The intent of this procedure is to allow a field service technician to replace bearings with the fan remaining in place in its intended application. All work can be conducted by accessing the bearings by either removing a shaft guard, a weatherhood or working under a weatherhood. This is dependent on the size of the unit. This procedure assumes the power source has been locked out prior to removing guards and covers, belts and pulleys have been loosened and removed properly and extended lubrication lines have been disconnected at the bearing. In some cases, it may be necessary to remove the fan inlet cone and wheel if the bearings cannot be removed due to corrosion or damage. See Radial Gap, Overlap and Wheel Alignment on page 9 to the realign wheel upon installation.

Bearing Removal

This procedure assumes proper safety measures have been taken.

- Read and follow all instructions carefully.
- Disconnect and lock-out power before installation and maintenance.
- Driven sheaves and belts have already been removed.
- **Arr. 8 fans** will need the coupler removed, the motor feet marked, and slid back far enough for bearing removal. For reinstallation of coupler, follow the coupler manufacturers' installation procedures.
- **Arr. 3 fans** will need the inlet ducting removed to access the non-drive bearing removal.
- Shaft black coating can be removed with a solvent similar to a brake/carburetor cleaner.

1. Scribe a line around the shaft by both bearings and around the bearing base to the bearing support or write down the measurement from the end of the shaft to the bearings. This will help in repositioning the new bearing and wheel cone overlap.
2. Follow the bearing manufacturers' procedures for removal and installation.
3. Before removing the bearing bolts, make sure the shaft is supported slightly. Remember to consider the wheel weight on the shaft. (Arr. 3 may need the wheel to be suspended through an access door on top of the fan.)
4. Remove both bearings from the shaft and clean/remove any burrs using an emery cloth or file.
5. Clean mounting surface of any dirt or grease.

Bearing Installation

1. Before installing, read bearing manufacturers' procedures. Before putting the new bearings on the shaft, you may need to break what is called swivel torque on the bearings (depending on style of bearing). This is done by holding the bearing housing securely and being able to move the inner bearing race around freely.
2. Apply light film of oil on shaft, then gently slide the new bearings onto the shaft.

   Do not hammer bearing onto shaft!
3. Align bearings on shaft with the previous scribe marks that are on the shaft and lock bearing to shaft.
4. Put bolts into mounting surface and bearings. Do not tighten.
5. Remove blocks if shaft is supported. (Arr. 3 release the weight of the wheel onto the bearing).
6. Set bearings on support with the scribed marks locating the bearings. Make sure bearings are square and level with the shaft.
7. Tighten bolts and torque bearing bolts, bearing set screws/locking collars as per bearing manufacturers' procedures.
8. Rotate shaft by hand to help allow the bearings to help set in. Also at this time, listen for any unusual noises such as wheel rubbing on cone and any bearing noise.
9. Connect extended lube lines in new bearings if needed.
10. Reinstall the drive sheaves and belts. Check the belt alignment.
11. Make sure to reinstall all guards and follow proper safety measures before starting up the fan.

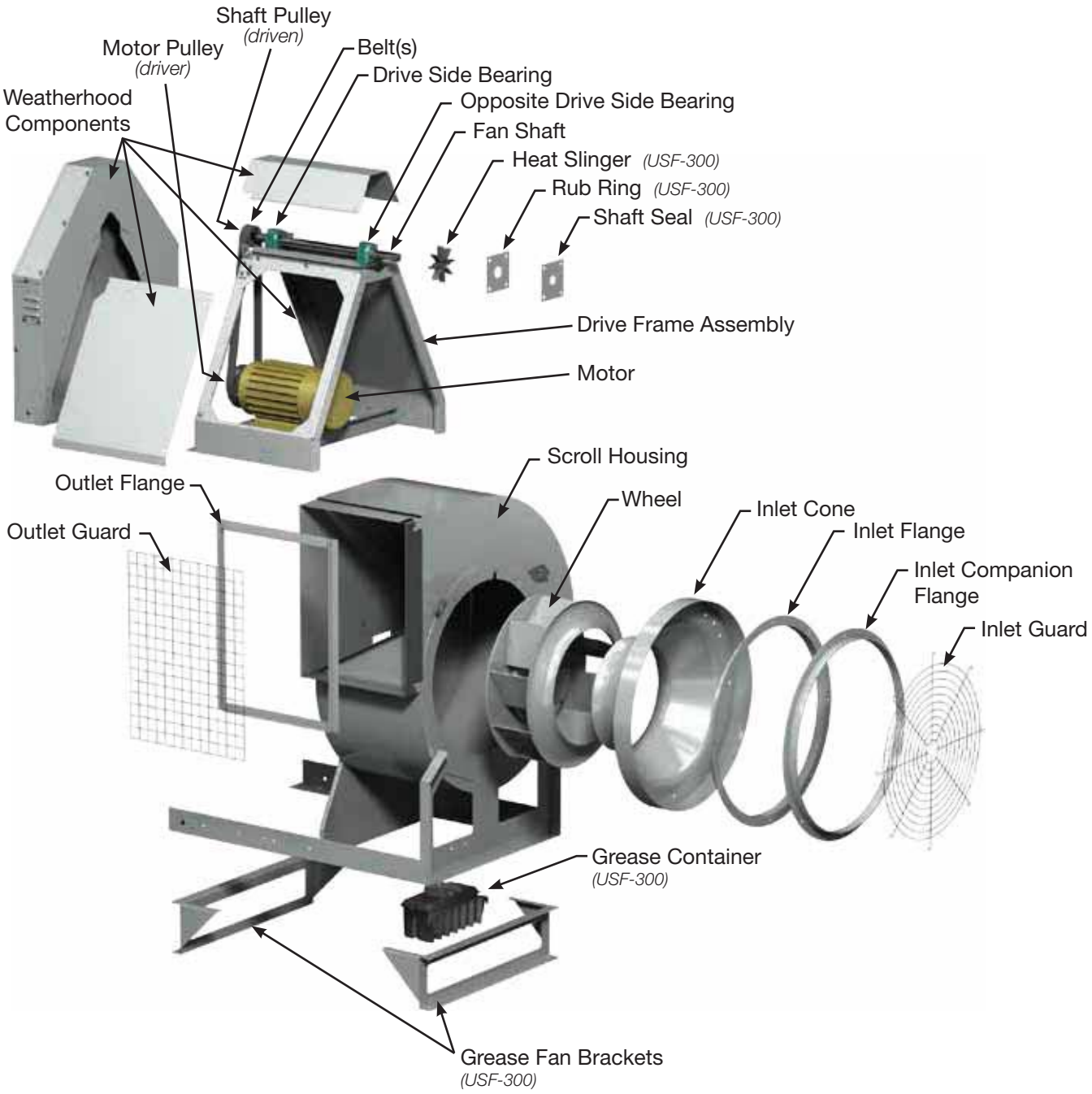
Parts List

Each fan bears a manufacturer's nameplate with model number and serial number embossed. This information will assist the local Greenheck representative and the factory in providing service and replacement parts. Before taking any corrective action, make certain unit is not capable of operation during repairs.

CAUTION
A fan manufactured with an explosion resistant motor does not certify the entire unit to be explosion proof. Refer to UL Listing Mark for the fans approved usage.

CAUTION
La présence d'un moteur antidéflagrant sur un ventilateur ne garantit pas que tout l'appareil est antidéflagrant. Pour connaître les emplois autorisés de l'appareil, voir son marquage de conformité UL.

- **USF-200**
- **USF-300**



- **USF-400**
- **CSW**

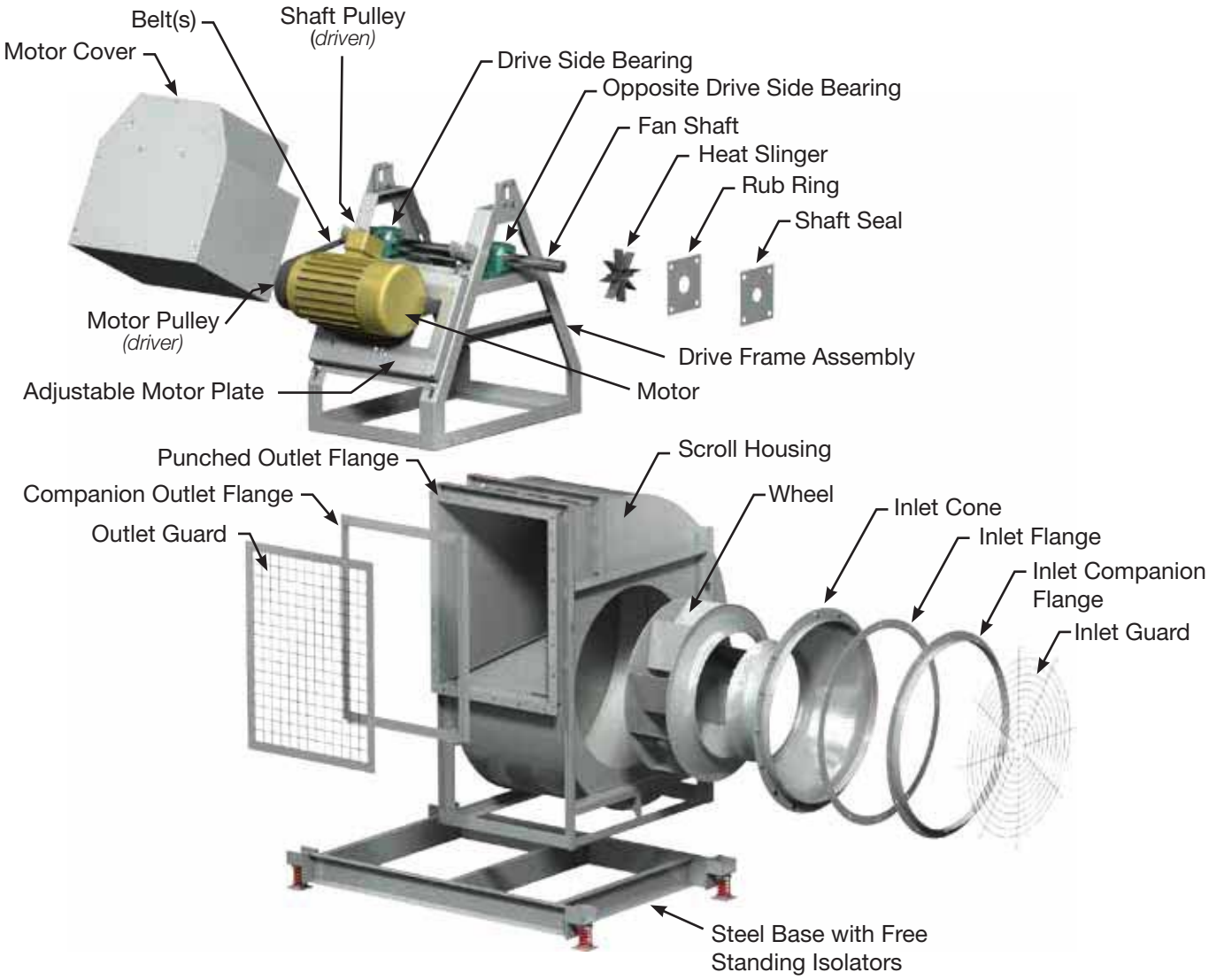


Image shows Arrangement 9. Other arrangements will have variations in motor mounting positions.

Troubleshooting

WARNING

Before taking any corrective action, make certain unit is not capable of operation during repairs.

AVERTISSEMENT

Avant d'entreprendre toute action corrective, s'assurer que l'appareil ne pourra pas fonctionner durant les réparations.

Problem	Cause	Corrective Action
Excessive Noise	Wheel Rubbing Inlet	Adjust wheel and/or inlet cone. Tighten wheel hub or bearing collars on shaft.
	V-Belt Drive	Tighten sheaves on motor/fan shaft. Adjust belt tension. Align sheaves properly (see procedure). Replace worn belts or sheaves.
	Bearings	Replace defective bearing(s). Lubricate bearings. Tighten collars and fasteners.
	Wheel Unbalance	Clean all dirt off wheel. Check wheel balance.
Low CFM	Fan	Check wheel for correct rotation.
	Duct System	Higher pressure than design. Filters need replacement.
High CFM	Fan	Decrease fan speed.
	Duct System	Resize ductwork. Access door, filters, dampers not installed.
Static Pressure Wrong	Duct system has more or less restriction than anticipated	Remove obstructions in system. Use correction factor to adjust for temperature/altitude. Resize ductwork. Clean filters/coils. Change fan speed.*
High Motor Amp Draw	Fan	Check rotation of wheel. Reduce fan speed.
	Duct System	Resize ductwork. Check proper operation of isolation and bypass dampers. Check filters and access doors.
Fan Doesn't Operate	Electrical Supply	Check fuses/circuit breakers. Check for switches turned off or disconnected. Check for correct supply voltage.
	Drive	Check for broken belts. Tighten loose pulleys.
	Motor	Assure motor is correct horsepower and not tripping overload protector.
Overheated Bearing	Lubrication	Check for excessive or insufficient grease in the bearing.
	Mechanical	Replace damaged bearing. Relieve excessive belt tension. Align bearings. Check for bent shaft.
Excessive Vibration	Belts	Adjust tightness of belts. Replacement belts should be a matched set.
	System Unbalance	Check alignment of shaft, motor and pulleys. Adjustable pitch pulleys with motors over 15 hp are especially prone to unbalance. Check wheel balance, rebalance if necessary.

* Always check motor amps and compare to nameplate rating. Excessive fan speed may overload the motor and result in motor failure. Do not exceed the maximum cataloged rpm of the fan.

Maintenance Log

Date _____ Time _____ AM/PM
Notes: _____

Date _____ Time _____ AM/PM
Notes: _____

Date _____ Time _____ AM/PM
Notes: _____

Date _____ Time _____ AM/PM
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Date _____ Time _____ AM/PM
Notes: _____

Our Commitment

As a result of our commitment to continuous improvement, Greenheck reserves the right to change specifications without notice.

Specific Greenheck product warranties are located on greenheck.com within the product area tabs and in the Library under Warranties.

AMCA Publication 410-96, Safety Practices for Users and Installers of Industrial and Commercial Fans, provides additional safety information. This publication can be obtained from AMCA International, Inc. at www.amca.org.

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Building Value in Air.

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Installation, Operation and Maintenance Manual

Please read and save these instructions for future reference. Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage!

Model CUE Direct Drive

Model CUE is a direct drive upblast centrifugal exhaust fan. These fans are specifically designed for roof mounted application. Performance capabilities range up to 6,400 cfm *(10,874 m^3/hr)* and up to 3 in. wg (747 Pa) of static pressure. The maximum continuous operating temperature for fan sizes 098-200 is 400°F *(204°C)* and for fan sizes 060-095 is 160°F *(71°C)*. CUE fans are available in fourteen sizes with nominal wheel diameter ranging from 9 to 20 inches *(229 to 508 mm)* (060 - 200 unit sizes). Each fan shall bear a permanently affixed manufacturers engraved metal nameplate containing the model number and individual serial number.

Model CUBE Belt Drive

Model CUBE is a belt drive upblast centrifugal exhaust fan. These fans are specifically designed for roof mounted applications. Performance capabilities range up to 30,000 cfm *(50,970 m^3/hr)* and up to 5.0 in. wg *(1240 Pa)* of static pressure. The maximum continuous operating temperature is 400°F *(204°C)*. CUBE fans are available in fourteen sizes with nominal wheel diameter ranging from 9 to 48 inches *(229 to 1219 mm*) (098 - 480 unit sizes). Each fan shall bear a permanently affixed manufacturers engraved metal nameplate containing the model number and individual serial number.

General Safety Information

Only qualified personnel should install this fan. Personnel should have a clear understanding of these instructions and should be aware of general safety precautions. Improper installation can result in electric shock, possible injury due to coming in contact with moving parts, as well as other potential hazards. Other considerations may be required if high winds or seismic activity are present. If more information is needed, contact a licensed professional engineer before moving forward.

DANGER
Always disconnect, lock and tag power source before installing or servicing. Failure to disconnect power source can result in fire, shock or serious injury.
CAUTION
When servicing the fan, motor may be hot enough to cause pain or injury. Allow motor to cool before servicing.
CAUTION
Precaution should be taken in explosive atmospheres.

1. Follow all local electrical and safety codes, as well as the National Electrical Code (NEC) and the National Fire Protection Agency (NFPA), where applicable. Follow the Canadian Electrical Code (CEC) in Canada.
2. The rotation of the wheel is critical. It must be free to rotate without striking or rubbing any stationary objects.
3. Motor must be securely and adequately grounded.
4. Do not spin fan wheel faster than max cataloged fan RPM. Adjustments to fan speed significantly affects motor load. If the fan RPM is changed, the motor current should be checked to make sure it is not exceeding the motor nameplate amps.
5. Do not allow the power cable to kink or come in contact with oil, grease, hot surfaces or chemicals. Replace cord immediately if damaged.
6. Verify that the power source is compatible with the equipment.
7. Never open access doors to a duct while the fan is running.

Receiving

Upon receiving the product, check the bill of lading to ensure all items were received. Inspect each crate for shipping damage before accepting delivery. All damage should be noted on all the copies of the bill of lading and a claim should be filed with the carrier. Any physical damage to the unit after acceptance is not the responsibility of Manufacturer.

Unpacking

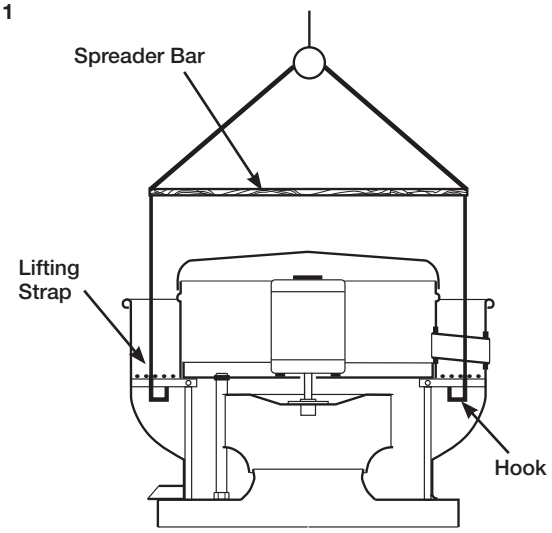
Verify that all required parts and the correct quantity of each item have been received. If any items are missing, report shortages to your local representative to arrange for obtaining missing parts. Sometimes it is not possible that all items for the unit be shipped together due to availability of transportation and truck space. Confirmation of shipment(s) must be limited to only items on the bill of lading.

Handling

CUE Direct Drive

Lift unit on to the roof utilizing hooks under the horizontal supports. Evenly space the hooks using a minimum of four lifting straps. Use a spreader bar to ensure the straps do not come in contact with the unit (see figure 1).

Fig. 1



CAUTION

Do not lift by the fan hood. Avoid lifting fans in a way that will bend or distort fan parts. Never pass slings or timbers through the venturi of fan. Fans with special coatings or paints must be protected in handling to prevent damage.

Fig. 2

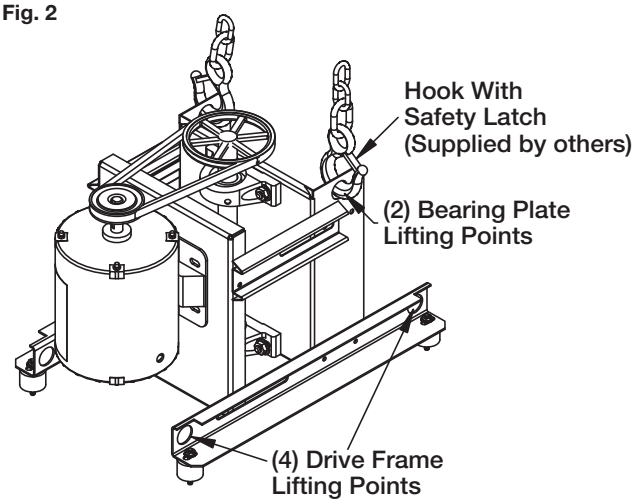
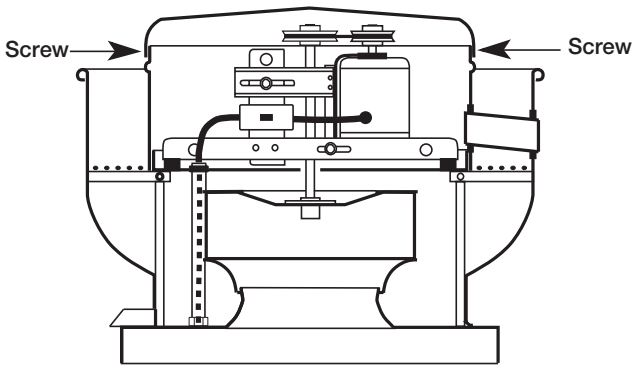


Fig. 3



CUBE Belt Drive

When lifting the unit onto the roof, use either the four lifting points on the drive frame or the two lifting points on the bearing plate if present (see figure 2 for lifting points). Access to the drive frame is accomplished by removing the screws pointed out in figure 3. The cover can then be removed and placed on a flat surface in an area protected from strong winds.

When CUE/CUBE unit is on the roof, move fan to desired location using lifting points and fasten securely through mounting holes in base. Shims may be necessary depending upon roofing material thickness.

The motor amperage and voltage ratings must be checked for compatibility to supply voltage prior to final electrical connection. For CUE/CUBE installations, the electrical supply should be routed through the conduit chase located between the curb cap and the bottom of the motor compartment or through the motor cooling tube. Wiring must conform to local and national codes.

Storage

Fans are protected against damage during shipment. If the unit cannot be installed and operated immediately, precautions need to be taken to prevent deterioration of the unit during storage. The user assumes responsibility of the fan and accessories while in storage. The manufacturer will not be responsible for damage during storage. These suggestions are provided solely as a convenience to the user.

Indoor

The ideal environment for the storage of fans and accessories is indoors, above grade, in a low humidity atmosphere which is sealed to prevent the entry of blowing dust, rain or snow. Temperatures should be evenly maintained between 30° to 110°F *(-1° to 43°C)* (wide temperature swings may cause condensation and "sweating" of metal parts). All accessories must be stored indoors in a clean, dry atmosphere. Remove any accumulations of dirt, water, ice or snow and wipe dry before moving to indoor storage. To avoid "sweating" of metal parts allow cold parts to reach room temperature. To dry parts and packages, use a portable electric heater to get rid of any moisture buildup. Leave coverings loose to permit air circulation and to allow for periodic inspection.

The unit should be stored at least 3½ in. *(89 mm)* off the floor on wooden blocks covered with moisture proof paper or polyethylene sheathing. Aisles between parts and along all walls should be provided to permit air circulation and space for inspection.

Outdoor

Fans designed for outdoor applications may be stored outdoors, if absolutely necessary. Roads or aisles for portable cranes and hauling equipment are needed.

The fan should be placed on a level surface to prevent water from leaking into the fan. The fan should be elevated on an adequate number of wooden blocks so that it is above water and snow levels and has enough blocking to prevent it from settling into soft ground. Locate parts far enough apart to permit air circulation, sunlight and space for periodic inspection. To minimize water accumulation, place all fan parts on blocking supports so that rain water will run off.

Do not cover parts with plastic film or tarps as these cause condensation of moisture from the air passing through heating and cooling cycles.

Fan wheels should be blocked to prevent spinning caused by strong winds.

Inspection and Maintenance During Storage

While in storage, inspect fans once per month. Keep a record of inspection and maintenance performed.

If moisture or dirt accumulations are found on parts, the source should be located and eliminated. At each inspection, rotate the wheel by hand ten to fifteen revolutions to distribute lubricant on motor. If paint deterioration begins, consideration should be given to touch-up or repainting. Fans with special coatings may require special techniques for touch-up or repair.

Machined parts coated with rust preventive should be restored to good condition promptly if signs of rust occur. Immediately remove the original rust preventive coating with petroleum solvent and clean with lint-free cloths. Polish any remaining rust from surface with crocus cloth or fine emery paper and oil. Do not destroy the continuity of the surfaces. Thoroughly wipe clean with Tectyl® 506 (Ashland Inc.) or the equivalent. For hard to reach internal surfaces or for occasional use, consider using Tectyl® 511M Rust Preventive, WD-40® or the equivalent.

Removing From Storage

As fans are removed from storage to be installed in their final location, they should be protected and maintained in a similar fashion until the fan equipment goes into operation.

WARNING

Installation, troubleshooting and parts replacement is to be performed only by qualified personnel. Consult and follow all applicable national, state and local codes. They will supercede this document.

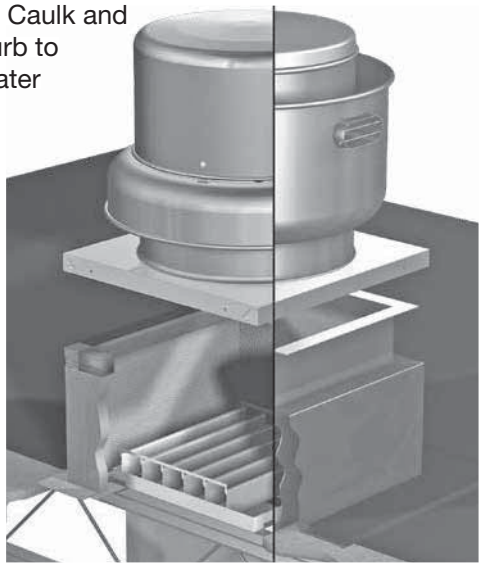
WARNING

Disconnect power before installing or servicing.

Installation

Typical Roof Mounting Installation

1. On the roof surface, cut an appropriate sized hole and follow manufacturer's instructions on curb installation. Caulk and flash the curb to ensure a water tight seal.



Roof Curb Installation

2. If unit is equipped with a backdraft damper, it should be installed now.
3. Remove motor cover. Access to the motor compartment is accomplished by removing the screws as shown in figure 3.
4. For CUBE Belt Drive fans only. On the drive frame use the lifting lugs to lift and place the unit on top of roof curb. (Refer to figure 2 on page 2).
5. Secure fan to curb using a minimum of eight lag screws, metal screws or other suitable fasteners. Shims may be required depending upon curb installation and roofing material.
6. Verify power line wiring is de-energized before connecting fan motor to power source.
7. Connect power supply wiring to the motor as indicated on the motor nameplate or terminal box cover. Check the power source for compatibility with the requirements of your equipment.
8. Check fan wheel for free rotation, re-center if necessary.
9. Check all fasteners for tightness.
10. Mount and wire safety disconnect switch under motor cover. Wire control switches at ground level, refer to figure 4.

Typical Wiring Diagram

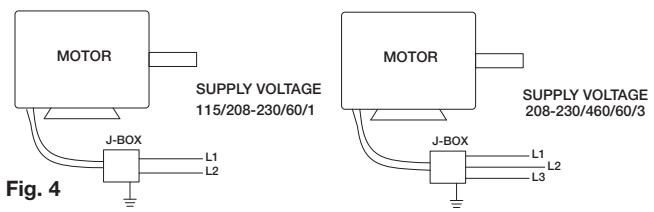


Fig. 4

11. Replace motor cover.
12. For restaurant and UL Listed for smoke evacuation applications, the electrical supply must enter the motor compartment through the breather tube. For other non-flammable applications the electrical supply can be routed through the conduit chase between the curb cap and the bottom of the motor compartment.

IMPORTANT

c UL us LISTED

Power Ventilator 565L

ELECTRICAL - If fan motor is NOT thermally protected, remote overload protection must be installed having adequate rating as to voltage, frequency, horsepower, and full load current per phase. Where connected to a circuit protected by fuses, use time delay fuses. For supply connection use wires rated for at least 194˚F (90˚C).

INSTALLATION - When connecting electrical power to this fan, do not restrict motor movement for possible future belt or wheel adjustment.

CAUTION - Mount with the lowest moving part at least 8 ft (2.5m) above floor or grade level. Not required on roof mounted ventilators or duct mounted ventilators provided with belt guards.

CUE - Direct Drive

Model	Curb Cap	Damper	Roof Opening	*Approx. Weight
CUE 060, 065, 070, 075	17 *(432)*	8 *(203)*	10½ *(267)*	26 *(12)*
CUE 080, 085, 090	19 *(483)*	10 *(254)*	12½ *(318)*	33 *(15)*
CUE 095	19 *(483)*	10 *(254)*	12½ *(318)*	36 *(16)*
CUE 098, 099, 101, 121, 131	19 *(483)*	12 *(305)*	14½ *(368)*	67 *(30)*
CUE 141, 161	22 *(559)*	16 *(406)*	18½ *(470)*	85 *(39)*
CUE 180-200	30 *(762)*	18 *(457)*	20½ *(521)*	142 *(64)*

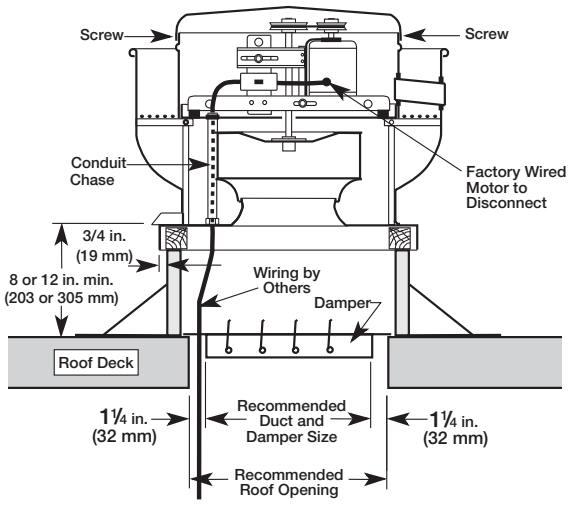
CUBE - Belt Drive

Model	Curb Cap	Shaft Bearings	Damper	Roof Opening	*Approx. Weight
CUBE 098, 099, 101, 101HP, 121, 131	19 *(483)*	½ *(19)*	12 *(305)*	14½ *(368)*	66 *(30)*
CUBE 141, 141HP, 161, 161HP, 161XP	22 *(559)*	½ *(19)*	16 *(406)*	18½ *(470)*	87 *(39)*
CUBE 180	30 *(762)*	¾ *(19)*	18 *(457)*	20½ *(521)*	126 *(57)*
CUBE 180HP	30 *(762)*	1 *(25)*	18 *(457)*	20½ *(521)*	126 *(57)*
CUBE 200	30 *(762)*	¾ *(19)*	18 *(457)*	20½ *(521)*	142 *(64)*
CUBE 200HP	30 *(762)*	1 *(25)*	18 *(457)*	20½ *(521)*	142 *(64)*
CUBE 220, 220HP	34 *(864)*	1 *(25)*	24 *(610)*	26½ *(673)*	174 *(79)*
CUBE 240, 240HP, 240XP	34 *(864)*	1 *(25)*	24 *(610)*	26½ *(673)*	175 *(79)*
CUBE 300, 300HP, 300XP	40 *(1016)*	1 *(25)*	30 *(762)*	32½ *(826)*	313 *(142)*
CUBE 360, 360HP, 360XP	46 *(1168)*	1¼ *(32)*	36 *(914)*	38½ *(978)*	440 *(200)*
CUBE 420	52 *(1321)*	1¼ *(32)*	42 *(1067)*	44½ *(1130)*	578 *(262)*
CUBE 480	58 *(1473)*	1½ *(38)*	48 *(1219)*	50½ *(1283)*	675 *(306)*

- *All dimensions are in inches (millimeters). *Approximate weight shown in lbs. (kg.) is the largest cataloged Open Drip Proof motor.*
- *The roof curb should be 1½ in. (38 mm) less than the curb cap to allow for roofing and flashing.*

General Ventilation Installation

Fig. 5 - Typical Roof Mounting Installation



Kitchen Roof Mounting Installation

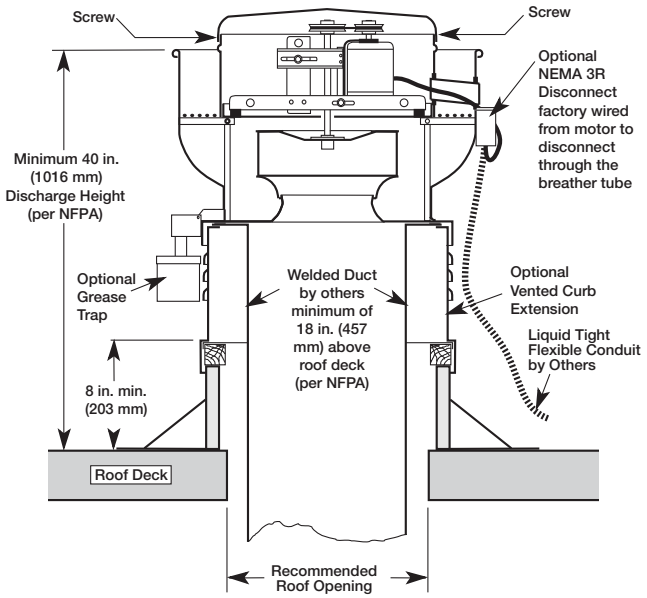
1. The size of the duct must be equal or larger than inlet opening.
2. Secure the fan to curb at all four corners using a minimum eight anchor bolts, lag screws or other suitable fasteners.
3. Area codes may require a continuous weld between duct and inlet.
4. To comply with NFPA 96 the fan discharge has to be a minimum 40 in. *(1016 mm)* above the roof surface and a minimum of 10 ft. *(3048 mm)* from any building air intake.
5. Ductwork to an upblast discharge exhaust fan is constructed of carbon steel not less than 16 MSG *(1.6 mm)* and extend a minimum of 18 in. *(457 mm)* above the roof surface.
6. Ensure that a minimum of 500 ft/min of air velocity through the fan is maintained per NFPA 96, clause 8.2.1.1, 2008 edition and UL 762, Issue #5, December 19, 2003, clause 6.2.
7. The following accessories may be required by NFPA-96 depending upon installation; Grease Trap, Hinge Kit or Hinged Base, Clean-out Port, and Vented Curb.

WARNING

Minimum duct velocities must be maintained in kitchen exhaust applications. If a speed controller is used, ensure compliance with all applicable codes.

Commercial Kitchen Installation

Fig. 6 - Typical Roof Mounting Installation



IMPORTANT

c UL us LISTED

Power Ventilator Restaurant Exhaust Appliances 13G3 Maximum Operating Temperature 400˚F

ELECTRICAL - If fan motor is NOT thermally protected, remote overload protection must be installed having adequate rating as to voltage, frequency, horsepower, and full load current per phase. Where connected to a circuit protected by fuses, use time delay fuses. For supply connection use wires rated for at least 194˚F (90˚C).

INSTALLATION - When connecting electrical power to this fan, do not restrict motor movement for possible future belt or wheel adjustment.

Must be installed in accordance with the requirements of MFPA 96 or must have minimum clearances of zero inches to non-combustibles, 3 inches to limited combustibles, 18 inches to combustibles.

CAUTION - Mount with the lowest moving part at least 8 ft (2.5m) above floor or grade level. Not required on roof mounted ventilators or duct mounted ventilators provided with belt guards.

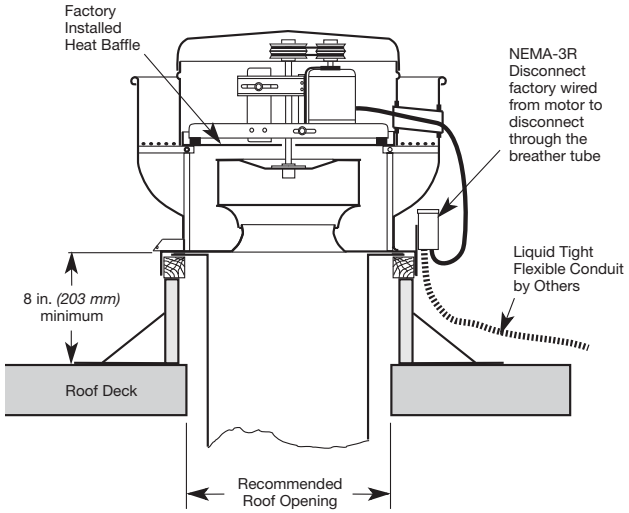
Electric Connection Emergency Smoke Control

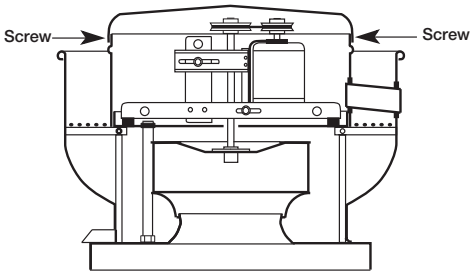
The motor's amperage and voltage rating must be checked for compatibility to the supply voltage prior to final electrical connection. Also, the motor itself cannot have thermal overload.

For emergency smoke removal application, the electrical supply must enter the motor compartment through the breather tube. Disconnect must be mounted outside the fans motor compartment. Consult local code authorities for your specific requirements. Shown below is the UL Listed label that the fan will bear.

IMPORTANT	
c UL us LISTED Power Ventilator For Smoke Control Systems 76Y9	**ELECTRICAL** - If fan motor is NOT thermally protected, remote overload protection must be installed having adequate rating as to voltage, frequency, horsepower, and full load current per phase. Where connected to a circuit protected by fuses, use time delay fuses. For supply connection use wires rated for at least 194°F (90°C). **INSTALLATION** - When connecting electrical power to this fan, do not restrict motor movement for possible future belt or wheel adjustment. **CAUTION** - Mount with the lowest moving part at least 8 ft (2.5m) above floor or grade level. Not required on roof mounted ventilators or duct mounted ventilators provided with belt guards.

Recommended Emergency Smoke Control Installation





For belt drive units in emergency smoke removal installations, the electrical supply must be kept out of the airstream. They may also require an isolated power supply so that if power is cut to the building in the event of a fire, the fan will continue to operate. Check the local and national electrical codes for emergency smoke removal fans.

Grease Trap Installation

Polypropylene trap designed to collect grease residue to avoid drainage onto roof surface. Follow all local codes, as well as the National Fire Protection Agency (NFPA) where applicable.

NFPA 96: Upblast fans shall have a drain directed to a readily accessible and visible grease receptacle not to exceed 1 gal. (3.8L)

Refer to Document #476370 - Grease Trap installation Installation, Operation and Maintenance Manual for parts listing and specific instructions.

Grease Trap Maintenance

Regular inspection of grease trap is recommended. Depending on the amount of grease discharged through the fan, the grease trap should be changed accordingly to ensure proper operation.

- Check grease absorber (if included) every month. Replace grease absorber after every cleaning and/ or as needed between cleanings.
- Replacement grease absorbers (P/N 476084) can be ordered from your local Representative.

Hinged Base

NFPA 96: A hinged base is required on upblast fans and in conjunction with grease trap accessory.

Refer to Document #462865 - Hinge Kit Installation, Operation and Maintenance Manual for parts listing and specific instructions.

Pre-Starting Checks

1. Check all fasteners and set screws for tightness. The wheel should rotate freely and be aligned as shown in figure 7.
2. Wheel position is preset and the unit is test run at the factory. Movement may occur during shipment and realignment may be necessary.

   CUE unit - Centering height alignment can be accomplished by loosening the set screws in the wheel and moving the wheel to the desired position.

   CUBE unit - Centering can be accomplished by loosening the bolts holding the drive frame to the shock mounts and repositioning the drive frame.

   CUBE unit - Wheel and inlet cone overlap can be adjusted by loosening the set screws in the wheel and moving the wheel to the desired position.
3. Check wheel rotation (viewing from the shaft side) by momentarily energizing the unit. Rotation should correspond to the rotation decal on the unit, see figure 8. If wheel rotation is incorrect, reverse two of the wiring leads or check motor wiring for single phase.

Wheel Overlap and Gap Dimensions

Model	G - Overlap in (mm)	H - Gap in (mm)
CUE 060-095	–	3/32 *(2)*
CUE 098-161	1/4 *(6)*	–
CUE 180-200	1/2 *(13)*	–
CUBE 098	–	3/32 *(2)*
CUBE 099-161	1/4 *(6)*	–
CUBE 180-300	1/2 *(13)*	–
CUBE 360-480	3/4 *(19)*	–

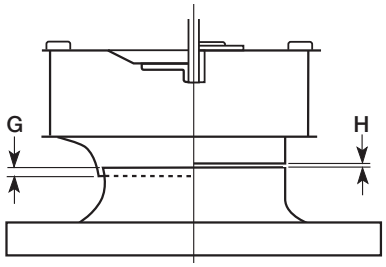


Fig. 7

Wheel Rotation

All CUE Models
All CUBE Models

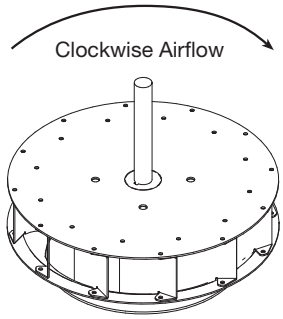


Fig. 8

WARNING

Correct direction of wheel rotation is critical. Reversed rotation will result in poor air performance, motor overloading and possible burnout.

Model CUBE

Pre-Starting Belt Tension Checks

4. Always loosen tension enough to install belts without stretching, see figure 9.

Belts

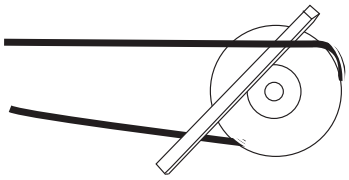
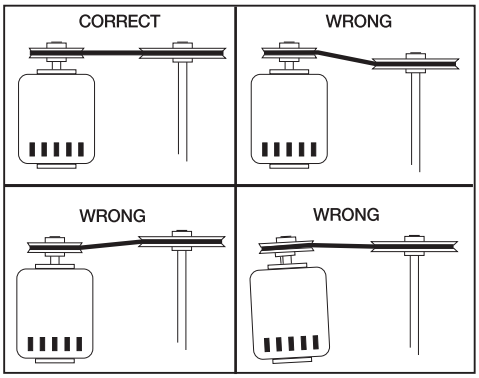


Fig. 9

Do not force belt(s). Forcing the belt(s) will break the cords and cause belt failure

5. For units with two groove pulleys, adjust so the tension is equal in both belts.
6. If adjustments are made, it is very important to check the pulleys for proper alignment. Misaligned pulleys lead to excessive belt wear vibration, noise and power loss, see figure 10.

Fig. 10



WARNING

The fan has been checked for mechanical noises at the factory prior to shipment. If mechanical noise should develop, suggested corrective actions are offered in the Troubleshooting section.

IMPORTANT

Over tightening will cause excessive bearing wear and noise. Too little tension will cause slippage at startup and uneven wear.

7. Belt tension can be adjusted by loosening four fasteners on the drive frame, see figure 11. The motor plate slides on the slotted adjusting arms and drive frame angles in the same manner.

Fasteners

*(4) *Fasteners*

**Identical fasteners on opposing side must also be loosened.*

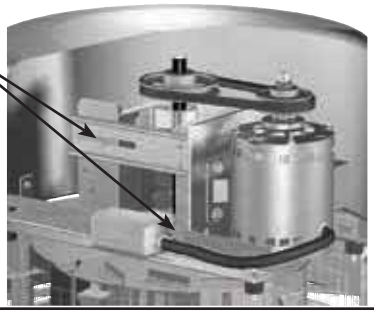


Fig. 11

8a. Sizes 071-161: Belts should be tensioned just enough to prevent slippage at full load.
Note: Belts should have a slight bow on the slack side while running at full load (see figure 12a).

8b. Sizes 180-540: Belt tension should be adjusted to allow 1/64 in. *(0.397 mm)* of deflection per inch of belt span. For example, a 15 in. *(381 mm)* belt span should have 15/64 in. *(0.234 mm)* (or about 1⁄4 in. *(6 mm)*) of deflection with moderate thumb pressure at mid-point between pulleys (see figure 12b).

Deflection

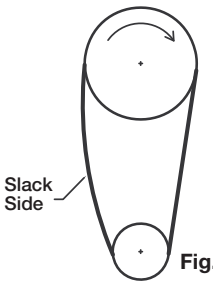


Fig. 12a

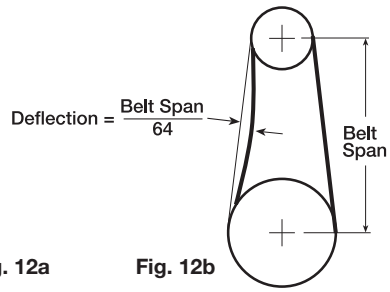


Fig. 12b

9. The adjustable motor pulley is factory set for the RPM specified. Speed can be increased by closing or decreased by opening the adjustable motor pulley.
10. Any increase in speed represents a substantial increase in the horsepower required by the unit.
11. Motor amperage should always be checked to avoid serious damage to the motor when speed is varied.

Operation: CUE / CUBE

1. Before starting up or operating fan, check all fasteners for tightness. In particular, check the setscrews in wheel hub (and pulleys, if applicable).
2. While in the OFF position or before connecting the fan to power, turn the fan wheel by hand to be sure it is not striking the venturi or any obstacle.
3. Start the fan and shut it off immediately to check rotation of the wheel with directional arrow in the motor compartment, see figure 8.
4. When the fan is started, observe the operation and check for any unusual noises.
5. With the system in full operation and all ductwork attached, measure current input to the motor and compare with the nameplate rating to determine if the motor is operating under safe load conditions.
6. Keep inlets and approaches to fan clean and free from obstruction.

IMPORTANT

Adjust (tighten) belt tension after the first 24-48 hours of operation.

Inspection: CUE / CUBE

Inspection of the fan should be conducted at the first 30 minute and 24 hour intervals of satisfactory operation.

30 Minute Interval

Inspect bolts, setscrews and motor mounting bolts. Adjust and tighten as necessary.

24 Hour Interval

Check all internal components. On CUBE unit only, inspect belt alignment and tension. Adjust and tighten as necessary.

Maintenance: CUE / CUBE

Installation and maintenance are to be performed only by qualified personnel who are familiar with local codes and regulations and who are experienced with this type of equipment.

Motor maintenance is generally limited to cleaning and lubrication (where applicable). Cleaning should be limited to exterior surfaces only. Removing dust buildup on motor housing ensures proper motor cooling.

Greasing of motors is only intended when fittings are provided. Many fractional horsepower motors are permanently lubricated and should not be lubricated after installation. Motors supplied with grease fittings should be greased in accordance with manufacturers' recommendations. Where motor temperatures do not exceed 104°F *(40°C)*, the grease should be replaced after 2,000 hours of running time as a general rule.

Wheels require very little attention when moving clean air. Occasionally, oil and dust may accumulate causing imbalance. When this occurs the wheel and housing should be cleaned to ensure smooth and safe operation.

All fasteners should be checked for tightness each time maintenance checks are performed prior to restarting unit.

A proper maintenance program will help these units deliver years of dependable service.

WARNING

Always disconnect, lock and tag power source before servicing. Failure to disconnect power source can result in fire, shock or serious injury.

CAUTION

Uneven cleaning of the wheel will produce an out of balance condition that will cause vibration in the fan.

WARNING

This unit should be made non-functional when cleaning the wheel or housing (fuses removed, disconnect locked off).

Belt/Bearing Maintenance CUBE Unit

1. Belts tend to stretch after a period of time. They should be checked periodically for wear and tightness. When replacing belts, use the same type as supplied with the unit.
2. Matched belts should always be used on units with multi-groove pulleys.
3. For belt replacement, loosen the tensioning device enough to allow removal of the belt by hand.
4. Once installed, adjust belts as shown in "Pre-Starting Checks."
5. Shaft bearings can be classified in two groups: relubricating and non-relubricating. All non-relubricating bearings on standard Model CUBE fans are factory lubricated and require no further lubrication under normal use (between -20° to 180°F *(-29° to 82°C)* in a relatively clean environment).
6. On CUBE belt driven fans, the standard cast pillow block bearings are factory lubricated and are provided with external grease fittings. Annual lubrication is recommended, or more frequently if needed, see Table 2. Do not over-grease. Use only one or two shots of lubricant with a hand gun. Maximum hand gun rating is 40 psi. Rotate bearings during lubrication where good safety practice permits. Caution should be employed to prevent over packing or contamination. Grease fittings should be wiped clean. Extreme care should be used around moving parts.
7. Grease should be pumped in very slowly until a slight bead forms around the seal. A high grade lithium base grease should be used.
8. When installing restaurant exhaust applications follow NFPA 70 for cleaning fans.
9. Grease containers must be emptied at regular intervals to prevent overflow.
10. To ensure tightness, check pulley setscrews. Proper keys must be in keyways.
11. Fan RPM should not be readjusted. Only use pulleys of identical size and type when replacing pulleys.
12. During the first few months of operation check bearing set screws periodically to ensure tightness.
13. If unit is to be left idle for an extended period, remove belts and store in a cool, dry place to avoid premature belt failure.

Recommended Relubrication Frequency in Months

NOTE: If unusual environment conditions exist (extreme temperature, moisture or contaminants) more frequent lubrication is required.

A good quality lithium base grease, conforming to NLGI Grade 2 consistency, such as those listed here may be used.

Table 2: Suggested Fan Bearing Greasing Intervals

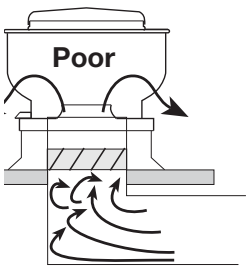
Interval (months)	Type of Service
1 to 3	Heavy duty in dirty, dusty locations; high ambient temperatures; moisture laden atmosphere; vibration.
3 to 6	12 to 24 hours per day, heavy duty, or if moisture is present
6 to 12	8 to 16 hours per day in clean, relatively dry atmosphere
12 to 18	Infrequent operation or light duty in clean atmosphere

Table 3: Grease Manufacturers

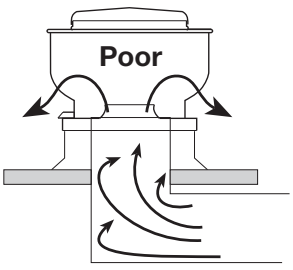
Manufacturer	Grease (NLGI #2)
U.S. Electric Motors	Grease No. 83343
Chevron U.S.A. Inc	Chevron SRI Grease #2
Mobil Oil Corporation	Mobilith
	Mobil 532
Texaco, Inc.	Premium BRB #2
	Texaco Multifak #2
Amoco Oil Co.	Rykon Premium #2
Exxon	Unirex N2
Shell	B Shell Alvania #2

Fan Inlet Connections

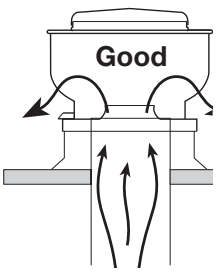
In order to assure proper fan performance, caution must be exercised in fan placement and connection to the ventilation system. Obstructions, transitions, poorly designed elbows, improperly selected dampers, etc, can cause reduced performance, excessive noise and increased mechanical stress. For performance to be as published, the system must provide uniform and stable airflow into the fan.



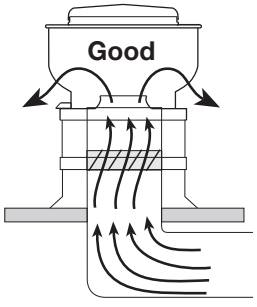
Dampers must open fully. Use motorized dampers in low airflow applications to reduce losses.



Avoid sharp turns or entrance conditions which cause uneven flow. Use turning vanes in elbows to reduce adverse effects.

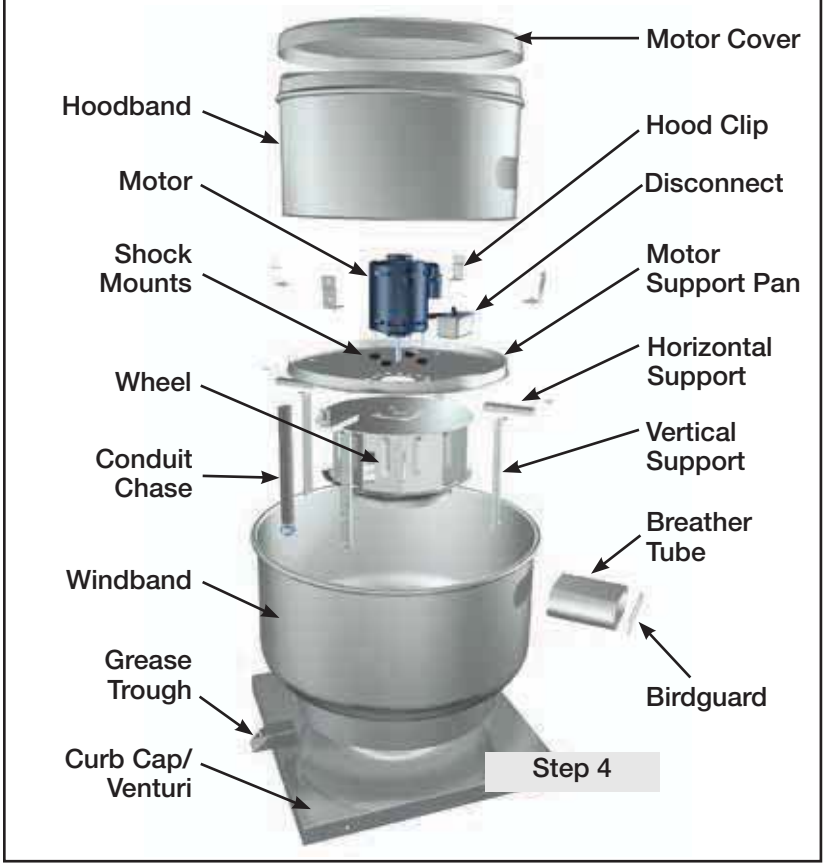


Provide uniform airflow at fan inlet to assure optimum performance.

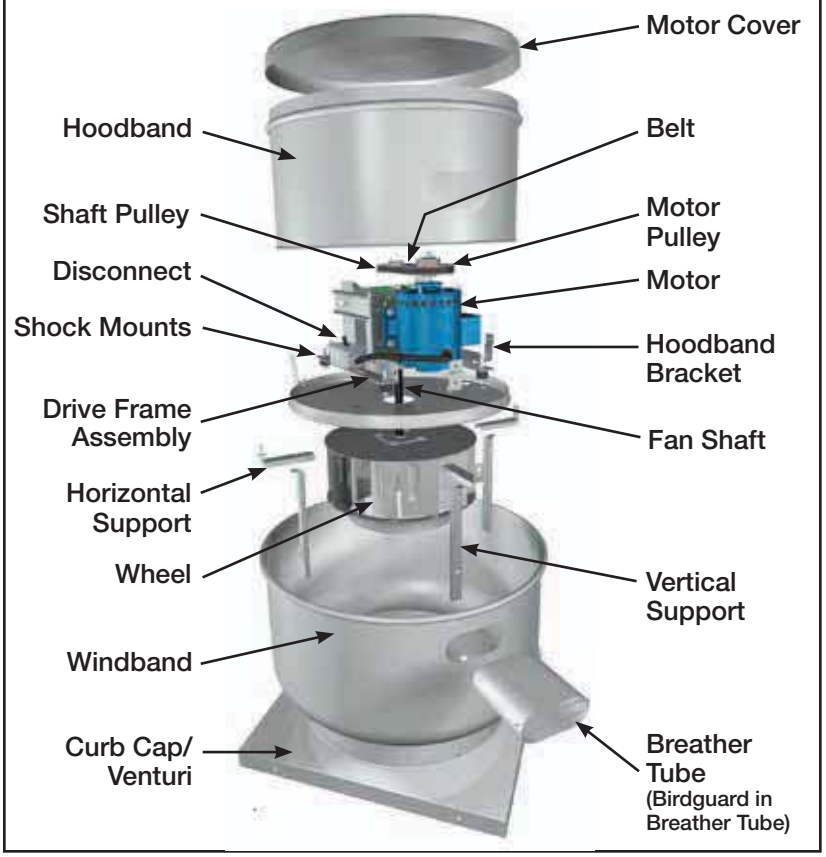


Provide uniform airflow at fan inlet and through the damper to assure optimum performance. The curb cap should be three wheel diameters from the radius. Use turning vanes in duct when possible.

CUE Direct Drive Centrifugal Roof Exhaust Fan



CUBE Belt Drive Centrifugal Roof Exhaust Fan



Parts List

NOTE

Each fan bears a manufacturer's nameplate with model number and serial number embossed. This information will assist the local representative and the factory in providing service and replacement parts. Before taking any corrective action, make certain unit is not capable of operation during repairs.

CAUTION

A fan manufactured with an explosion resistant motor does not certify the entire unit to be explosion proof.

Note:
For replacement, the windband, vertical supports, drain trough and curb cap/venturi come as one complete assembly.

Troubleshooting

WARNING: Before taking any corrective action, make certain unit is not capable of operation during repairs.

PROBLEM	CAUSE	CORRECTIVE ACTION
Excessive noise or vibration	Wheel rubbing inlet	Adjust wheel and/or inlet cone. Tighten wheel hub or bearing collars on shaft.
	V-belt drive	Tighten pulleys on motor/fan shaft. Adjust belt tension. Align pulleys properly, see page 7/figure 9-10. Replace worn belts or pulleys.
	Bearings	Replace defective bearing(s). Lubricate bearings. Tighten collars and fasteners.
	Wheel unbalance	Clean all dirt off wheel. Check wheel balance, rebalance in place if necessary.
	Bad bearings	Replace.
	Belts too tight or too loose	Adjust tension, see figure 12a-b.
	Wheel improperly aligned and rubbing	Center wheel on inlet, see figure 7.
	Loose drive or motor pulleys	Align and tighten. See “Pre-Starting Checks”, see page 7-8.
	Foreign objects in wheel or housing	Remove objects, check for damage or unbalance.
	Fan base not securely anchored	Secure properly.
	Motor hood loose and rattling	Tighten fasteners to secure the motor hood.
	Defective or loose motor bearings	Replace motor with same frame size, RPM-HP
High horsepower	Fan	Check rotation of wheel, see figure 8. Reduce fan speed.
	Duct system	Resize ductwork. Check proper operation of face and bypass dampers. Check filters and access doors.
Fan does not operate	Electrical supply	Check fuses/circuit breakers. Check for switches off. Check for correct supply voltage.
	Drive	Check for broken belts. Tighten loose pulleys or belts.
	Motor	Assure motor is correct horsepower and not tripping overload protector.
Motor overloads or overheats	Lubrication	Check for excessive or insufficient grease in the bearing.
	Mechanical	Replace damaged bearing. Relieve excessive belt tension. Align bearings. Check for bent shaft.
	Belt slippage	Adjust tension or replace bad belts, see page 7-8.
	Over/Under line voltage	Contact power company.
	Incorrect wheel rotation	Check motor wiring. See figure 8.
	Wheel RPM too high	Check drives or slow down fan by opening variable pitch pulley on motor shaft.
	Undersized motor	Check motor ratings with catalog speed and air capacity chart.
	Motor wired incorrectly	Check motor wiring to wiring diagram located on fan motor.
Reduced airflow	System resistance too high	Check system: Proper operation of backdraft or control dampers, obstruction in ductwork, clean dirty filters.
	Unit running backwards	Correct as shown in figure 8.
	Excessive dirt buildup on wheels	Clean wheel.
	Improper wheel alignment	Center wheel on inlets, see Pre-Starting checks and figure 7.
	Dampers closed	Inspect and repair.
	Blocked duct/clogged filter	Clean or replace.
	Belt slippage	Replace and adjust tension.
	Speed too slow	Check for correct drives.

Our Commitment

As a result of our commitment to continuous improvement, Greenheck reserves the right to change specifications without notice.

Specific Greenheck product warranties are located on greenheck.com within the product area tabs and in the Library under Warranties.

Greenheck's Centrifugal Upblast and Sidewall Exhaust catalog provides additional information describing the equipment, fan performance, available accessories, and specification data.

AMCA Publication 410-96, Safety Practices for Users and Installers of Industrial and Commercial Fans, provides additional safety information. This publication can be obtained from AMCA International, Inc. at www.amca.org.

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PN 471558

Downblast Centrifugal Roof Exhaust Fans

Installation, Operation and Maintenance Manual

Please read and save these instructions. Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage! Retain instructions for future reference.

Model G Direct Drive

Model G is a direct drive downblast centrifugal exhaust fan. These fans are specifically designed for roof mounted applications exhausting relatively clean air. Performance capabilities range up to 4,300 cfm *(7,305 m^3/hr)* and up to 1 in. wg *(249 Pa)* of static pressure. The maximum continuous operating temperature is 180°F *(82ºC)*. G models are available in 27 sizes with nominal wheel diameter ranging from 8 to 24 inches *(203 to 610 mm)* (060 - 243 unit sizes). Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number. All fans are UL/cUL listed Standard 705.

Model GB Belt Drive

GB Model Fans are belt drive downblast centrifugal exhaust fans. These fans are specifically designed for roof mounted applications exhausting relatively clean air. Performance capabilities range up to 44,700 cfm *(75,950 m^3/hr)* and up to 2.5 in. wg *(623 Pa)* of static pressure. The maximum continuous operating temperature is 180°F *(82ºC)*. GB models are available in twenty sizes with nominal wheel diameters ranging from 11 to 54 inches *(279 to 1372 mm)* (071-540 unit sizes). Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number. All fans are UL/cUL listed Standard 705.

General Safety Information

Only qualified personnel should install this fan. Personnel should have a clear understanding of these instructions and should be aware of general safety precautions. Improper installation can result in electric shock, possible injury due to coming in contact with moving parts, as well as other potential hazards. Other considerations may be required if high winds or seismic activity are present. If more information is needed, contact a licensed professional engineer before moving forward.

DANGER
Always disconnect, lock and tag power source before installing or servicing. Failure to disconnect power source can result in fire, shock or serious injury.
CAUTION
When servicing the fan, motor may be hot enough to cause pain or injury. Allow motor to cool before servicing.
CAUTION
Precaution should be taken in explosive atmospheres.

1. Follow all local electrical and safety codes, as well as the National Electrical Code (NEC) and the National Fire Protection Agency (NFPA), where applicable. Follow the Canadian Electric Code (CEC) in Canada.
2. The rotation of the wheel is critical. It must be free to rotate without striking or rubbing any stationary objects.
3. Motor must be securely and adequately grounded.
4. Do not spin fan wheel faster than max cataloged fan RPM. Adjustments to fan speed significantly affects motor load. If the fan RPM is changed, the motor current should be checked to make sure it is not exceeding the motor nameplate amps.
5. Do not allow the power cable to kink or come in contact with oil, grease, hot surfaces or chemicals. Replace cord immediately if damaged.
6. Verify that the power source is compatible with the equipment.
7. Never open access doors to a duct while the fan is running.

Receiving

Upon receiving the product, check to make sure all items are accounted for by referencing the bill of lading to ensure all items were received. Inspect each crate for shipping damage before accepting delivery. Notify the carrier if any damage is noticed. The carrier will make notification on the delivery receipt acknowledging any damage to the product. All damage should be noted on all the copies of the bill of lading which is countersigned by the delivering carrier. A Carrier Inspection Report should be filled out by the carrier upon arrival and reported to the Traffic Department. If damaged upon arrival, file a claim with carrier. Any physical damage to the unit after acceptance is not the responsibility of Greenheck Fan Corporation.

Unpacking

Verify that all required parts and the correct quantity of each item have been received. If any items are missing, report shortages to your local representative to arrange for obtaining missing parts. Sometimes it is not possible that all items for the unit be shipped together due to availability of transportation and truck space. Confirmation of shipment(s) must be limited to only items on the bill of lading.

Handling

G Direct Drive

Lift unit on to the roof utilizing hooks under the lip of the shroud. Evenly space the hooks around the shroud using a minimum of four lifting straps. Use a spreader bar to ensure the straps do not come in contact with the unit (see Figure 1).

Figure 1

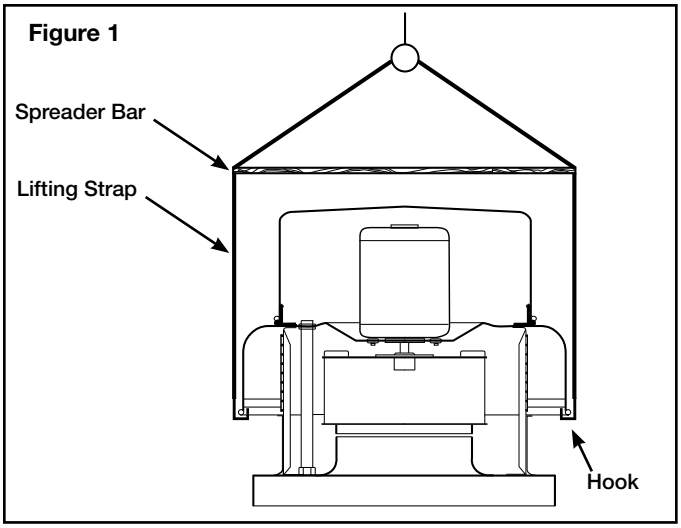


Figure 2

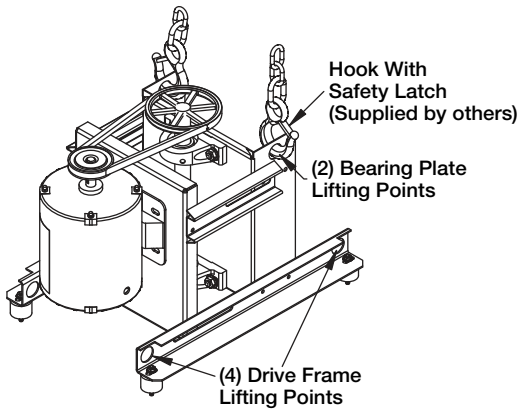
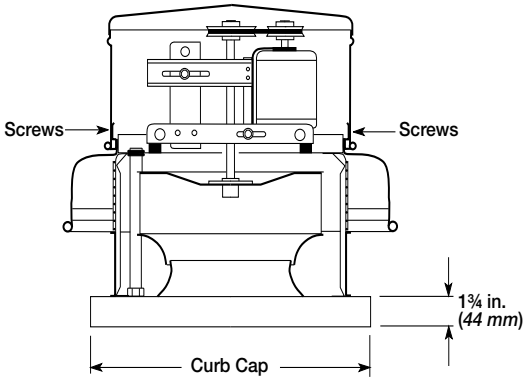


Figure 3



GB Belt Drive

When lifting the unit on to the roof, use either the four lifting points on the drive frame or the two lifting points on the bearing plate if present (see Figure 2 for lifting points). Access to the drive frame is accomplished by removing the screws pointed out in Figure 3. The cover can then be removed and placed on a flat surface in an area protected from strong winds.

When G/GB unit is on the roof, move fan to desired location using lifting points and fasten securely through mounting holes in base. Shims may be necessary depending upon roofing material thickness.

The motor amperage and voltage ratings must be checked for compatibility to supply voltage prior to final electrical connection. For G/GB installations, the electrical supply should be routed through the conduit chase located between the curb cap and the bottom of the motor compartment. Wiring must conform to local and national codes.

Storage

Fans are protected against damage during shipment. If the unit cannot be installed and operated immediately, precautions need to be taken to prevent deterioration of the unit during storage. The user assumes responsibility of the fan and accessories while in storage. The manufacturer will not be responsible for damage during storage. These suggestions are provided solely as a convenience to the user.

Indoor

The ideal environment for the storage of fans and accessories is indoors, above grade, in a low humidity atmosphere which is sealed to prevent the entry of blowing dust, rain or snow. Temperatures should be evenly maintained between 30° to 110°F *(-1° to 43°C)* (wide temperature swings may cause condensation and "sweating" of metal parts). All accessories must be stored indoors in a clean, dry atmosphere.

Remove any accumulations of dirt, water, ice or snow and wipe dry before moving to indoor storage. To avoid "sweating" of metal parts, allow cold parts to reach room temperature. To dry parts and packages, use a portable electric heater to get rid of any moisture buildup. Leave coverings loose to permit air circulation and to allow for periodic inspection.

The unit should be stored at least 3½ inches *(89 mm)* off the floor on wooden blocks covered with moisture proof paper or polyethylene sheathing. Aisles between parts and along all walls should be provided to permit air circulation and space for inspection.

Outdoor

Fans designed for outdoor applications may be stored outdoors, if absolutely necessary. Roads or aisles for portable cranes and hauling equipment are needed.

The fan should be placed on a level surface to prevent water from leaking into the fan. The fan should be elevated on an adequate number of wooden blocks so that it is above water and snow levels and has enough blocking to prevent it from settling into soft ground. Locate parts far enough apart to permit air circulation, sunlight and space for periodic inspection. To minimize water accumulation, place all fan parts on blocking supports so that rain water will run off.

Do not cover parts with plastic film or tarps as these cause condensation of moisture from the air passing through heating and cooling cycles.

Fan wheels should be blocked to prevent spinning caused by strong winds.

Inspection and Maintenance During Storage

While in storage, inspect fans once per month. Keep a record of inspection and maintenance performed.

If moisture or dirt accumulations are found on parts, the source should be located and eliminated. At each inspection, rotate the wheel by hand ten to fifteen revolutions to distribute lubricant on motor. If paint deterioration begins, consideration should be given to touch-up or repainting. Fans with special coatings may require special techniques for touch-up or repair.

Machined parts coated with rust preventive should be restored to good condition promptly if signs of rust occur. Immediately remove the original rust preventive coating with petroleum solvent and clean with lint-free cloths. Polish any remaining rust from surface with crocus cloth or fine emery paper and oil. Do not destroy the continuity of the surfaces. Thoroughly wipe clean with Tectyl® 506 (Ashland Inc.) or the equivalent. For hard to reach internal surfaces or for occasional use, consider using Tectyl® 511M Rust Preventive, WD-40® or the equivalent.

Removing From Storage

As fans are removed from storage to be installed in their final location, they should be protected and maintained in a similar fashion until the fan equipment goes into operation.

WARNING

Installation, troubleshooting and parts replacement is to be performed only by qualified personnel.

WARNING

Disconnect power before installing or servicing.

CAUTION

A fan manufactured with an explosion resistant motor does not certify the entire unit to be explosion proof.

Installation

Typical Roof Mounting Installation

1. On the roof surface, cut an appropriate sized hole and follow manufacturer's instructions on curb installation. Caulk and flash the curb to ensure a water tight seal.
2. If unit is equipped with a backdraft damper, it should be installed now.
3. Remove motor cover. Access to the motor compartment is accomplished by removing the screws as shown in Figure 3.
4. Only on GB Belt Drive fans. On the drive frame use the lifting lugs to lift and place the unit on top of roof curb. (Refer to Figure 2 on page 2).
5. Secure fan to curb using a minimum of eight lag screws, metal screws or the suitable fasteners. Shims may be required depending upon curb installation and roofing material.
   Note: Severe duty applications may require additional fasteners.
6. Verify power line wiring is de-energized before connecting fan motor to power source.
7. Connect power supply wiring to the motor as indicated on the motor nameplate or terminal box cover. Check the power source for compatibility with the requirements of your equipment.
8. Check fan wheel for free rotation, re-center if necessary.
9. Check all fasteners for tightness.
10. Mount and wire safety disconnect switch under motor cover. Wire control switches at ground level, refer to Figure 4.
11. Replace motor cover.

Typical Wiring Diagram

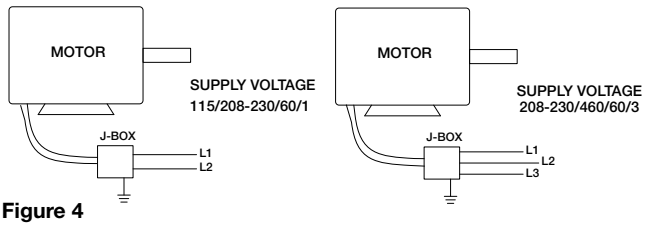


Figure 4

Vari-Green Wiring

For Vari-Green wiring refer to the Vari-Green Motor IOM **PN 473681** for complete wiring and operation instructions.

G - Direct Drive

Model	Curb Cap	Damper	Roof Opening	*Approx. Weight
G 060, 065, 070, 075	17 *(432)*	8 *(203)*	10½ *(267)*	18 *(8)*
G 080, 085, 090, 095	17 *(432)*	10 *(254)*	12½ *(267)*	26 *(12)*
G 97, 98, 99	19 *(483)*	12 *(305)*	14½ *(368)*	57 *(26)*
G 103, 103 HP	19 *(483)*	12 *(305)*	14½ *(368)*	62 *(28)*
G 123	19 *(483)*	12 *(305)*	14½ *(368)*	65 *(30)*
G 133	19 *(483)*	12 *(305)*	14½ *(368)*	66 *(30)*
G 143, 143 HP	22 *(559)*	16 *(406)*	18½ *(470)*	76 *(35)*
G 163, 163 HP	22 *(559)*	16 *(406)*	18½ *(470)*	80 *(36)*
G 183, 183 HP	30 *(762)*	18 *(457)*	20½ *(521)*	119 *(54)*
G 203, 203 HP	*30 (762)*	*18 (457)*	*20½ (521)*	*130 (59)*
G 223/243, 223/243 HP	*34 (864)*	*24 (610)*	*26½ (673)*	*150 (68)*

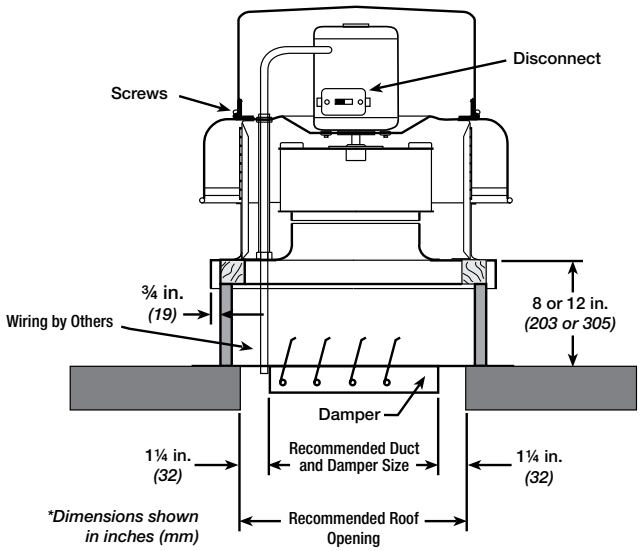
GB - Belt Drive

Model	Curb Cap	Damper	Roof Opening	*Approx. Weight
GB 071, 081, 091	19 *(483)*	12 *(305)*	14½ *(368)*	58 *(26)*
GB 101, 101HP	19 *(483)*	12 *(305)*	14½ *(368)*	63 *(29)*
GB 121	19 *(483)*	12 *(305)*	14½ *(368)*	66 *(30)*
GB 131	19 *(483)*	12 *(305)*	14½ *(368)*	67 *(30)*
GB 141, 141HP	22 *(559)*	16 *(406)*	18½ *(470)*	83 *(38)*
GB 161, 161HP	22 *(559)*	16 *(406)*	18½ *(470)*	89 *(40)*
GB 180, 180HP	30 *(762)*	18 *(457)*	20½ *(521)*	125 *(57)*
GB 200, 200HP	30 *(762)*	18 *(457)*	20½ *(521)*	138 *(63)*
GB 220, 220HP, 240, 240HP	34 *(864)*	24 *(610)*	26½ *(673)*	158 *(72)*
GB 260	40 *(1016)*	30 *(762)*	32½ *(826)*	305 *(138)*
GB 300, 300HP	40 *(1016)*	30 *(762)*	32½ *(826)*	320 *(145)*
GB 330	46 *(1168)*	36 *(914)*	38½ *(978)*	385 *(175)*
GB 360, 360HP	46 *(1168)*	36 *(914)*	38½ *(978)*	403 *(183)*
GB 420	52 *(1321)*	42 *(1067)*	44½ *(1130)*	495 *(225)*
GB 480	52 *(1321)*	48 *(1219)*	50½ *(1283)*	623 *(283)*
GB 500	64 *(1626)*	54 *(1372)*	56½ *(1435)*	687 *(312)*
GB 540	64 *(1626)*	54 *(1372)*	56½ *(1435)*	748 *(339)*

- *All dimensions are in inches (millimeters). *Approximate weight shown in pounds (kilograms) is the largest cataloged Open Drip Proof motor.*
- *The roof curb should be 1½ in. (38 mm) less than the curb cap to allow for roofing and flashing.*

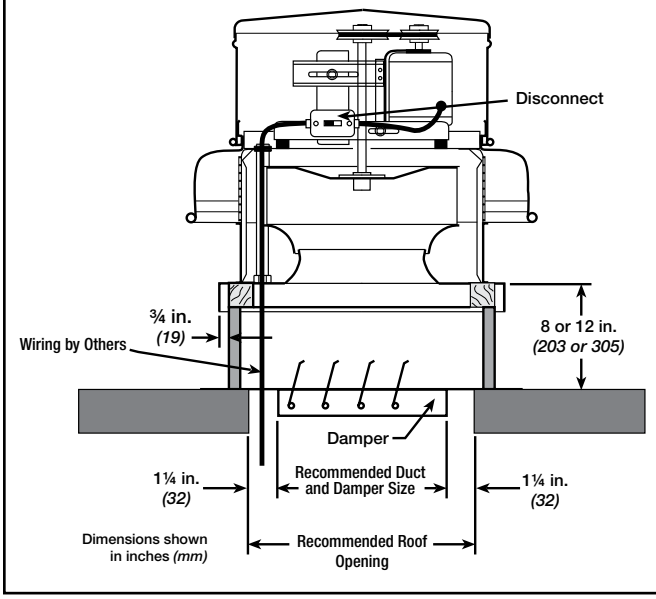
G Direct Drive

Figure 5 - Typical Roof Mounting Installation



GB Belt Drive

Figure 6 - Typical Roof Mounting Installation



Pre-Starting Checks

1. Check all fasteners and set screws for tightness. The wheel should rotate freely and be aligned as shown in Figure 7 below.
2. Wheel position is preset and the unit is test run at the factory. Movement may occur during shipment and realignment may be necessary.
3. Only G unit - Centering height alignment can be accomplished by loosening the set screws in the wheel and moving the wheel to the desired position.
4. Only GB unit - Centering can be accomplished by loosening the bolts holding the drive frame to the shock mounts and repositioning the drive frame.
5. Only GB unit - Wheel and inlet cone overlap can be adjusted by loosening the set screws in the wheel and moving the wheel to the desired position.
6. Only GB unit - Fan RPM should be checked and verified with a tachometer.
7. Check wheel rotation (viewing from the shaft side) by momentarily energizing the unit. Rotation should be clockwise as shown in Figure 8 and correspond to rotation decal on the unit. If wheel rotation is incorrect, reverse two of the wiring leads or check motor wiring for single phase.

Wheel Overlap and Gap Dimensions

Model			G - Overlap in. (mm)	H - Gap in. (mm)
G		060-095	–	3/32 *(2)*
G		97-163	1/4 *(6)*	–
	GB	071-161	1/4 *(6)*	–
G		183-243	3/8 *(10)*	–
	GB	180-240	3/8 *(10)*	–
	GB	260-540	1/2 *(13)*	–

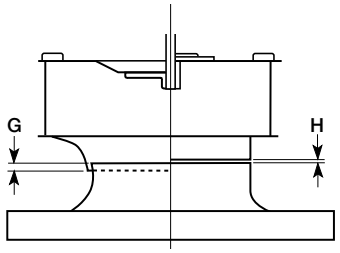


Figure 7

Wheel Rotation

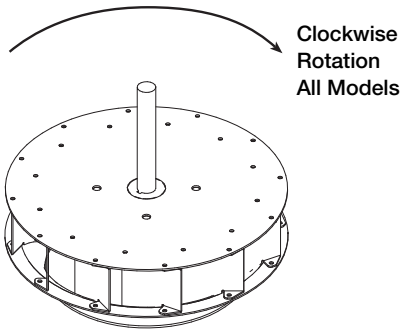


Figure 8

WARNING

Correct direction of wheel rotation is critical. Reversed rotation will result in poor air performance, motor overloading and possible burnout.

WARNING

The fan has been checked for mechanical noises at the factory prior to shipment. If mechanical noise should develop, suggested corrective actions are offered in the Troubleshooting section.

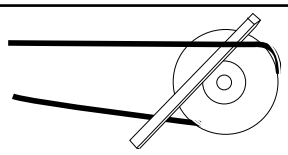
IMPORTANT

Over tightening will cause excessive bearing wear and noise. Too little tension will cause slippage at startup and uneven wear.

Model GB
Pre-Starting Belt Tension Checks

8. Always loosen tension enough to install belts without stretching, see Figure 9.

Belts



Do not force belt(s). Forcing the belt(s) will break the cords and cause belt failure

Figure 9

9. For units with two groove pulleys, adjust so the tension is equal in both belts.
10. If adjustments are made, it is very important to check the pulleys for proper alignment. Misaligned pulleys lead to excessive belt wear vibration, noise and power loss, see Figure 10.

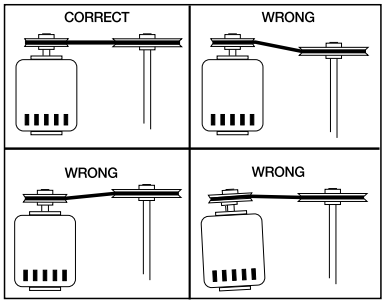


Figure 10

Fasteners

*(4) *Fasteners*

**Identical fasteners on opposing side must also be loosened.*

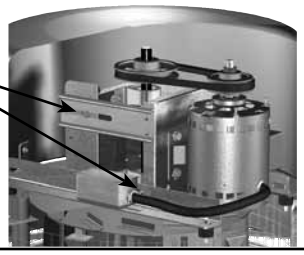


Figure 11

11. Belt tension can be adjusted by loosening four fasteners on the drive frame, see Figure 11. The motor plate slides on the slotted adjusting arms and drive frame angles in the same manner.

12a. Sizes 071-161: Belts should be tensioned just enough to prevent slippage at full load.

Note: Belts should have a slight bow on the slack side while running at full load (see Figure 12a).

Deflection

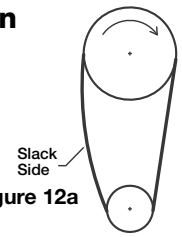


Figure 12a

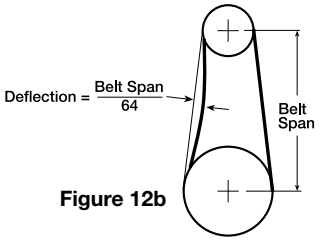


Figure 12b

12b. Sizes 180-540: Belt tension should be adjusted to allow 1/64 in. *(0.397 mm)* of deflection per inch of belt span. For example, a 15 in. *(381 mm)* belt span should have 15/64 in. *(0.234 mm)* (or about 1/4 in. *(6 mm)*) of deflection with moderate thumb pressure at mid-point between pulleys (see Figure 12b).

13. The adjustable motor pulley is factory set for the RPM specified. Speed can be increased by closing or decreased by opening the adjustable motor pulley.
14. Any increase in speed represents a substantial increase in the horsepower required by the unit.
15. Motor amperage should always be checked to avoid serious damage to the motor when speed is varied.

Operation: G / GB

1. Before starting up or operating fan, check all fasteners for tightness. In particular, check the setscrews in wheel hub.
2. While in the OFF position or before connecting the fan to power, turn the fan wheel by hand to be sure it is not striking the venturi or any obstacle.
3. Start the fan and shut it off immediately to check rotation of the wheel with directional arrow in the motor compartment.
4. When the fan is started, observe the operation and check for any unusual noises.
5. With the system in full operation and all ductwork attached, measure current input to the motor and compare with the nameplate rating to determine if the motor is operating under safe load conditions.
6. Keep inlets and approaches to fan clean and free from obstruction.

IMPORTANT

Adjust (tighten) belt tension after the first 24-48 hours of operation.

Inspection

Inspection of the fan should be conducted at the first 30 minute and 24 hour intervals of satisfactory operation.

30 Minute Interval

Inspect bolts, setscrews and motor mounting bolts. Adjust and tighten as necessary.

24 Hour Interval

Check all internal components. On GB unit only, inspect belt alignment and tension. Adjust and tighten as necessary.

Maintenance: G / GB

Installation and maintenance are to be performed only by qualified personnel who are familiar with local codes and regulations and who are experienced with this type of equipment.

Motor maintenance is generally limited to cleaning and lubrication (where applicable). Cleaning should be limited to exterior surfaces only. Removing dust buildup on motor housing ensures proper motor cooling.

WARNING

Always disconnect, lock and tag power source before servicing. Failure to disconnect power source can result in fire, shock or serious injury.

Greasing of motors is only intended when fittings are provided. Many fractional horsepower motors are permanently lubricated and should not be lubricated after installation. Motors supplied with grease fittings should be greased in accordance with manufacturers' recommendations. Where motor temperatures do not exceed 104°F *(40°C)*, the grease should be replaced after 2,000 hours of running time as a general rule.

Wheels require very little attention when moving clean air. Occasionally, oil and dust may accumulate causing imbalance. When this occurs, the wheel and housing should be cleaned to ensure smooth and safe operation.

All fasteners should be checked for tightness each time maintenance checks are performed prior to restarting unit.

A proper maintenance program will help these units deliver years of dependable service.

CAUTION

Uneven cleaning of the wheel will produce an out of balance condition that will cause vibration in the fan.

WARNING

This unit should be made non-functional when cleaning the wheel or housing (fuses removed, disconnect locked off).

Belt/Bearing Maintenance GB Unit

1. Belts tend to stretch after a period of time. They should be checked periodically for wear and tightness. When replacing belts, use the same type as supplied with the unit.
2. Matched belts should always be used on units with multi-groove pulleys.
3. For belt replacement, loosen the tensioning device enough to allow removal of the belt by hand.
4. Once installed, adjust belts as shown in "Pre-Starting Checks."
5. Shaft bearings can be classified in two groups: relubricating and non-relubricating. All non-relubricating bearings on model GB fans are factory lubricated and require no further lubrication under normal use (between -20° to 180°F *(-29° to 82°C)* in a relatively clean environment).
6. On GB belt driven fans, the standard cast pillow block bearings are factory lubricated and are provided with external grease fittings. Annual lubrication is recommended, or more frequently if needed (See Table 2). Do not over-grease. Use only one or two shots of lubricant with a hand gun. Maximum hand gun rating is 40 psi. Rotate bearings during lubrication where good safety practice permits. Caution should be employed to prevent over packing or contamination.
7. Grease fittings should be wiped clean. The unit should be in operation while lubricating. Extreme care should be used around moving parts.
8. Grease should be pumped in very slowly until a slight bead forms around the seal. A high grade lithium base grease should be used. (See Table 3)
9. To ensure tightness, check pulley setscrews. Proper keys must be in keyways.
10. Fan RPM should not be readjusted. Only use pulleys of identical size and type when replacing pulleys.
11. During the first few months of operation, check bearing setscrews periodically to ensure tightness.
12. If unit is to be left idle for an extended period, remove belts and store in a cool, dry place to avoid premature belt failure.

Recommended Relubrication Frequency in Months

NOTE: If unusual environment conditions exist (extreme temperature, moisture or contaminants) more frequent lubrication is required.

A good quality lithium base grease, conforming to NLGI Grade 2 consistency, such as those listed here may be used.

Table 2: Suggested Fan Bearing Greasing Intervals

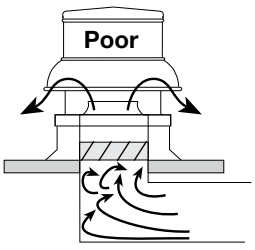
Interval (months)	Type of Service
1 to 3	Heavy duty in dirty, dusty locations; high ambient temperatures; moisture laden atmosphere; vibration.
3 to 6	12 to 24 hours per day, heavy duty, or if moisture is present
6 to 12	8 to 16 hours per day in clean, relatively dry atmosphere
12 to 18	Infrequent operation or light duty in clean atmosphere

Table 3: Grease Manufacturers

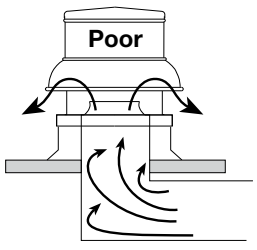
Manufacturer	Grease (NLGI #2)
U.S. Electric Motors	Grease No. 83343
Chevron U.S.A. Inc	Chevron SRI Grease #2
Mobil Oil Corporation	Mobilith
	Mobil 532
Texaco, Inc.	Premium BRB #2
	Texaco Multifak #2
Amoco Oil Co.	Rykon Premium #2
Exxon	Unirex N2
Shell	B Shell Alvania #2

Fan Inlet Connections

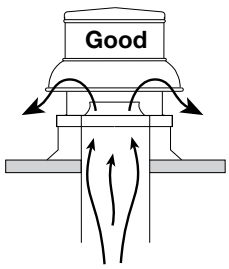
In order to assure proper fan performance, caution must be exercised in fan placement and connection to the ventilation system. Obstructions, transitions, poorly designed elbows, improperly selected dampers, etc. can cause reduced performance, excessive noise and increased mechanical stress. For performance to be as published, the system must provide uniform and stable airflow into the fan.



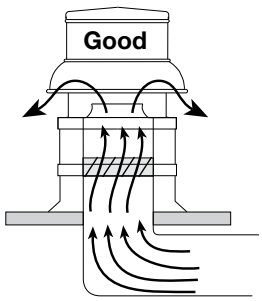
Dampers must open fully. Use motorized dampers in low airflow applications to reduce losses.



Avoid sharp turns or entrance conditions which cause uneven flow. Use turning vanes in elbows to reduce adverse effects.



Provide uniform airflow at fan inlet to assure optimum performance.



Provide uniform airflow at fan inlet and through the damper to assure optimum performance. The curb cap should be three wheel diameters from the radius. Use turning vanes in duct when possible.

Troubleshooting

WARNING: Before taking any corrective action, make certain unit is not capable of operation during repairs.

PROBLEM	CAUSE	CORRECTIVE ACTION
Excessive noise or vibration	Wheel rubbing inlet	Adjust wheel and/or inlet cone. Tighten wheel hub or bearing collars on shaft.
	V-belt drive	Tighten pulleys on motor/fan shaft. Adjust belt tension. Align pulleys properly, see page 6, Figure 9-10. Replace worn belts or pulleys.
	Bearings	Replace defective bearing(s). Lubricate bearings. Tighten collars and fasteners.
	Wheel unbalance	Clean all dirt off wheel. Check wheel balance, rebalance in place if necessary.
	Belts too tight or too loose	Adjust tension, see page 7, Figure 12a-b.
	Wheel improperly aligned and rubbing	Center wheel on inlet, see page 6, Figure 7.
	Loose drive or motor pulleys	Align and tighten. See “Pre-Starting Checks”, see page 6.
	Foreign objects in wheel or housing	Remove objects, check for damage or unbalance.
	Fan base not securely anchored	Secure properly.
	Motor hood loose and rattling	Tighten screws securing motor hood.
	Defective or loose motor bearings	Replace motor with same frame size, RPM-HP.
High horsepower	Fan	Check rotation of wheel, see page 6, Figure 8. Reduce fan speed.
	Duct system	Resize ductwork. Check proper operation of face and bypass dampers. Check filters and access doors.
Fan does not operate	Electrical supply	Check fuses/circuit breakers. Check for switches off. Check for correct supply voltage.
	Drive	Check for broken belts. Tighten loose pulleys.
	Motor	Assure motor is correct horsepower and not tripping overload protector.
Motor overloads or overheats	Lubrication	Check for excessive or insufficient grease in the bearing.
	Mechanical	Replace damaged bearing. Relieve excessive belt tension. Align bearings. Check for bent shaft.
	Belt slippage	Adjust tension or replace bad belts, see page 6-7.
	Over/Under line voltage	Contact power company.
	Incorrect wheel rotation	Check motor wiring (page 4) verify motor is wired for correct rotation.
	Wheel RPM too high	Check drives or slow down fan by opening variable pitch pulley on motor shaft.
	Undersized motor	Check motor ratings with catalog speed and air capacity chart.
	Motor wired incorrectly	Check motor wiring to wiring diagram located on fan motor.
Reduced airflow	System resistance too high	Check system: Proper operation of backdraft or control dampers, obstruction in ductwork, clean dirty filters.
	Unit running backwards	Correct as shown on page 6, Figure 8.
	Excessive dirt buildup on wheels	Clean wheel.
	Improper wheel alignment	Center wheel on inlets, see Pre-Starting checks on page 6, Figure 7.
	Dampers closed	Inspect and repair.
	Blocked duct/clogged filter	Clean or replace.
	Belt slippage	Replace and adjust tension.
	Speed too slow	Check for correct drives.

Maintenance Documentation

Job Information

Job Name:_____
Address: _____
City: _____
State: _____ Zip:_____
Phone: _____
Contact Person:_____

Service Organization: _____
Address:_____
City:_____
State: _____ Zip: _____
Phone: _____
Work Done By: _____

Nameplate Information

Model: _____
Volts:_____ Hertz:_____ Phase:_____
Amps:_____ Mark: _____
Supply hp:_____ Exhaust hp: _____
Serial Number: _____
Model Voltage: _____
Motor Amperage: _____
Fan RPM:_____

Field Start-Up Documentation

Actual Voltage: _____ Hertz:_____ Phase:_____
Actual Amperage: _____
Blower Rotation: _____
Air Volume: Design cfm: _____
Actual cfm:_____
Level of fan (L or H): _____
Fan RPM Range (min.) _____ (max.) _____

Maintenance Log

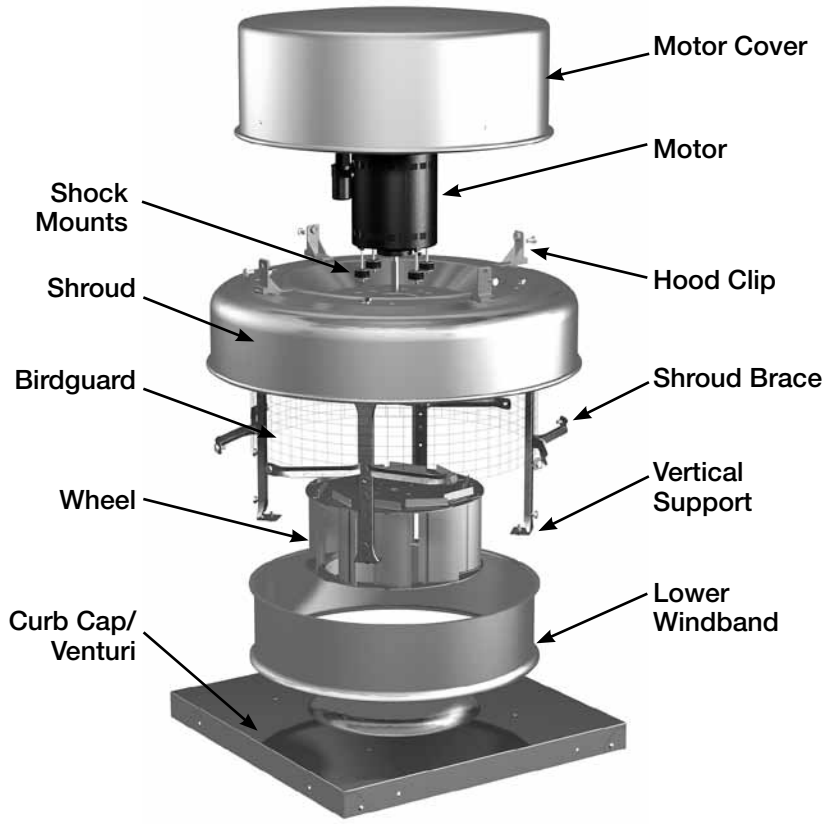
Date	Time	Notes

Parts List

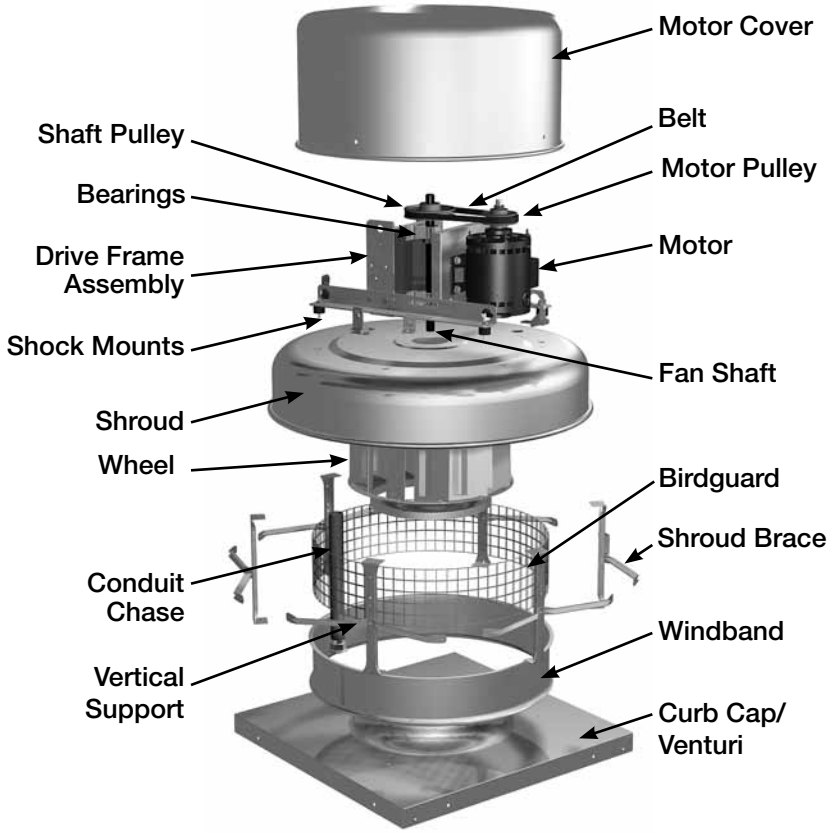
NOTE

Each fan bears a manufacturer's name-plate with model number and serial number embossed. This information will assist the local Greenheck representative and the factory in providing service and replacement parts. Before taking any corrective action, make certain unit is not capable of operation during repairs.

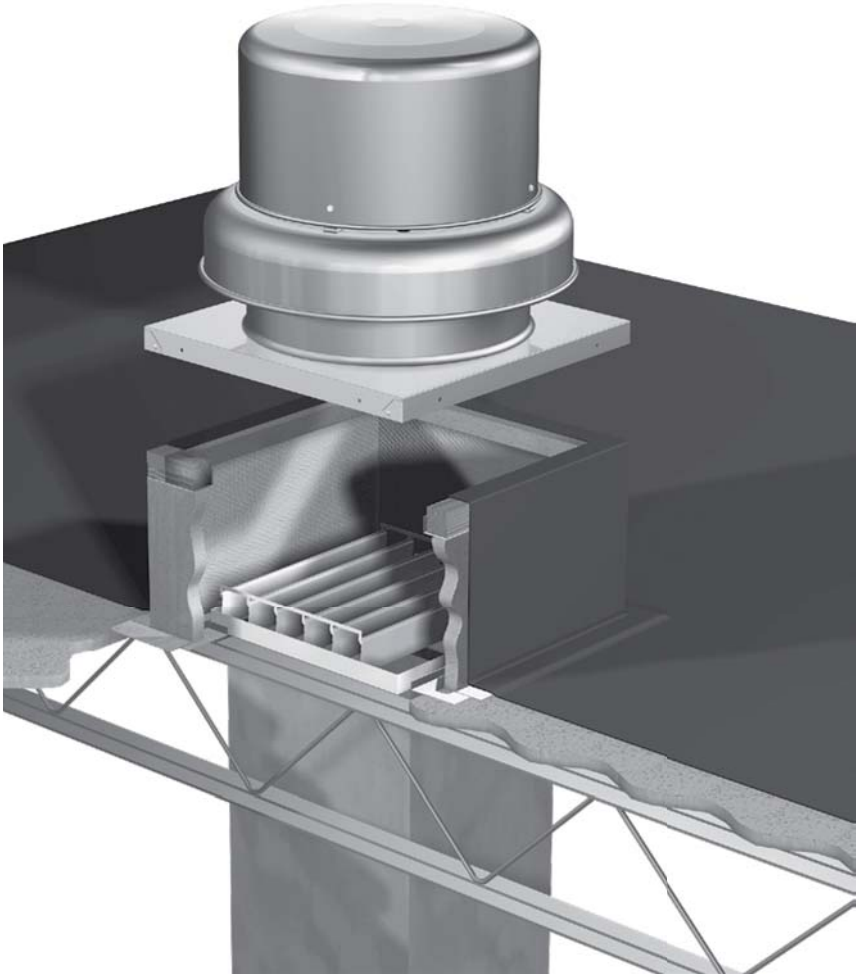
G Direct Drive Centrifugal Roof Exhaust Fan



GB Belt Drive Centrifugal Roof Exhaust Fan



Roof Curb Installation



Warranty

Greenheck warrants this equipment to be free from defects in material and workmanship for a period of one year from the shipment date. Any units or parts which prove defective during the warranty period will be replaced at our option when returned to our factory, transportation prepaid. Motors are warranted by the motor manufacturer for a period of one year. Should motors furnished by Greenheck prove defective during this period, they should be returned to the nearest authorized motor service station. Greenheck will not be responsible for any removal or installation costs.

As a result of our commitment to continuous improvement, Greenheck reserves the right to change specifications without notice.

Greenheck Catalog G/GB provides additional information describing the equipment, fan performance, available accessories, and specification data.

AMCA Publication 410-96, Safety Practices for Users and Installers of Industrial and Commercial Fans, provides additional safety information. This publication can be obtained from AMCA International, Inc. at: www.amca.org.

GREENHECK
Building Value in Air.

Phone: (715) 359-6171 • Fax: (715) 355-2399 • E-mail: gfcinfo@greenheck.com • Website: www.greenheck.com

INSTALLATION INSTRUCTIONS & PARTS LIST

HORIZONTAL STEAM AND HOT WATER UNIT HEATERS

ATTENTION: READ THIS MANUAL AND ALL LABELS ATTACHED TO THE UNIT CAREFULLY BEFORE ATTEMPTING TO INSTALL, OPERATE OR SERVICE THESE UNITS! CHECK UNIT DATA PLATE FOR TYPE OF GAS AND ELECTRICAL SPECIFICATIONS AND MAKE CERTAIN THAT THESE AGREE WITH THOSE AT POINT OF INSTALLATION. RECORD THE UNIT MODEL AND SERIAL No.(s) IN THE SPACE PROVIDED. RETAIN FOR FUTURE REFERENCE.

Model No. _____ Serial No. _____

⚠WARNING Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury or death. Read the installation, operating and maintenance instructions thoroughly before installing or servicing this equipment.

INSTALLER'S RESPONSIBILITY

Installer Please Note: This equipment has been tested and inspected. It has been shipped free from defects from our factory. However, during shipment and installation, problems such as loose wires, leaks or loose fasteners may occur. **It is the installer's responsibility to inspect and correct any problems that may be found.**

RECEIVING INSTRUCTIONS

Inspect shipment immediately when received to determine if any damage has occurred to the unit during shipment. After the unit has been uncrated, check for any visible damage to the unit. Turn fan by hand to determine if damage has occurred. If any damage is found, the consignee should sign the bill of lading indicating such damage and immediately file claim for damage with the transportation company.

MESTEK
260 NORTH ELM ST.
WESTFIELD, MA 01085

MADE IN THE USA

TABLE OF CONTENTS

NOTICE: It is the owner's responsibility to provide any scaffolding or other apparatus required to perform emergency service or annual/periodic maintenance to this equipment.

DESCRIPTION

Horizontal hydronic unit heaters are available in both serpentine and header type units. Serpentine units offer outputs from 8,030 to 35,900 BTU's (2.4 to 10.5 kW) and are ideal for hot water (only) installations with limited clearances. Header type horizontal units range from 18,000 to 360,000 (5.3 to 105.5 kW) and can operate with either hot water or steam. Both units are furnished with totally enclosed motors, with explosion proof motors as optional on header types. The designs are certified by ETL. **Do not alter these units in any way and do not attach any ductwork to the units.** If you have any questions after reading this manual, contact the manufacturer.

Figure 1
Serpentine Type

Figure 2
Header Type

The following terms are used throughout this manual, in addition to ETL requirements, to bring attention to the presence of potential hazards or to important information concerning the product:

⚠ DANGER Indicates an imminently hazardous situation which, if not avoided, will result in death, serious injury or substantial property damage.

⚠ WARNING Indicates an imminently hazardous situation which, if not avoided, could result in death, serious injury or substantial property damage.

⚠ CAUTION Indicates an imminently hazardous situation which, if not avoided, may result in minor injury or property damage.

NOTICE: Used to notify of special instructions on installation, operation or maintenance which are important to equipment but not related to personal injury hazards.

GENERAL SAFETY INFORMATION

⚠ WARNING Failure to comply with the general safety information may result in extensive property damage, severe personal injury or death.

⚠ WARNING Do not alter the unit heater in any way or damage to the unit and/or severe personal injury or death may occur!

⚠ WARNING Disconnect all power supplies before installing or servicing the heater. If the power disconnect is out of sight, lock it in the open position and tag it to prevent unexpected application of power. Failure to do so could result in fatal electric shock, or severe personal injury.

⚠ CAUTION Insure that all power sources conform to the requirements of the unit heater or damage to the unit will result!

Follow installation instructions CAREFULLY to avoid creating unsafe conditions. All external wiring must conform to applicable current local codes, and to the latest edition of the National Electric Code ANSI/NFPA No. 70. In Canada, all external wiring must conform to the Canadian Electric Code, Part 1 CSA Standard C22.1 All wiring should be done and checked by a qualified electrician using copper wire only. All steam and hot water connections should be made and leak-tested by a suitably qualified individual, per instructions in this manual. Also follow procedures listed on the “Unit Equipment Start-Up Sheet” located in this manual.

Make certain that the power source conforms to the electrical requirements of the heater.

⚠ WARNING Do not depend upon a thermostat or other switch as sole means of disconnecting power when installing or servicing heater. Always disconnect power at main circuit breaker as described above. Failure to do so could result in fatal electric shock.

Special attention must be given to any grounding information pertaining to this heater. To prevent the risk of electrocution, the heater must be securely and adequately grounded. This should be accomplished by connecting a grounded conductor between the service panel and the heater. To ensure a proper ground, the grounding means must be tested by a qualified electrician.

Do not insert fingers or foreign objects into the heater or its air moving device. Do not block or tamper with the heater in any manner while in operation or just after it has been turned off, as some parts may be hot enough to cause injury.

To meet ETL and OSHA requirements, units mounted below 8 feet (2.4m) from the floor must be equipped with an OSHA fan guard.

It is good practice to have a shutoff switch on the electrical power lines controlling the heater. Whenever a unit is serviced, shut power off to the unit.

Since these units are installed in most instances higher than 8 feet (2.4m), proper type of ladders or scaffolding should be used, as set up by OSHA requirements (see Notice on page 2).

In industrial plants, professional maintenance crews should service this equipment.

All Horizontal Unit Heaters are shipped fully assembled and may be used for steam or hot water applications. Coils are factory tested at 250 psig (1723.5 kg).

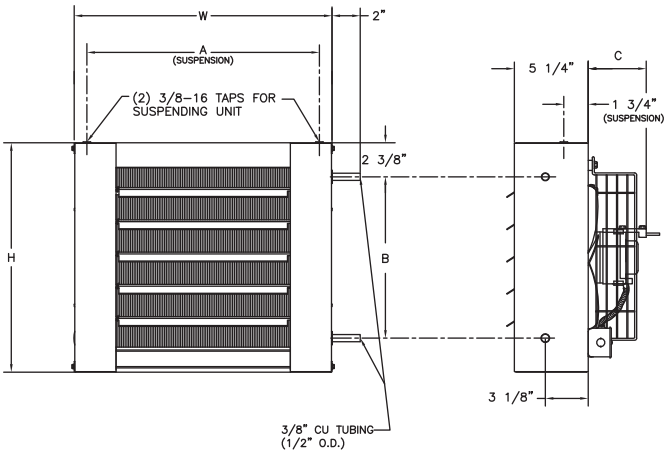
Each unit is packaged individually and marked for proper identification. Use normal care in handling and during installation to prevent damage to the coils fins, fan and casing.

Unless otherwise specified, the following conversions may be used for calculating SI unit measurements:

1 foot = 0.305 m	1 inch water column = 0.249 kPa
1 inch = 25.4 mm	meter/second = FPM ÷ 196.8
1 psig = 6.894 kPa	liter/second = CFM x 0.472
1 pound = 0.453 kg	1000 Btu per hour = 0.293 kW
1 gallon = 3.785 L	1000 Btu/Cu. Ft. = 37.5 MJ/m^3
	1 cubic foot = 0.028 m^3

DIMENSIONAL DATA

Figure 3 – Serpentine Type
Models 108A, 118A, 125A, 136A



NOTE: Motors are totally enclosed, thermally protected, sleeve bearing, with 2"(h) x 4"(w) conduit connection boxes. 3/8-16 nutserts are attached to enclosure for balanced hanging.

Figure 4 – Header Type
Models 18 thru 360

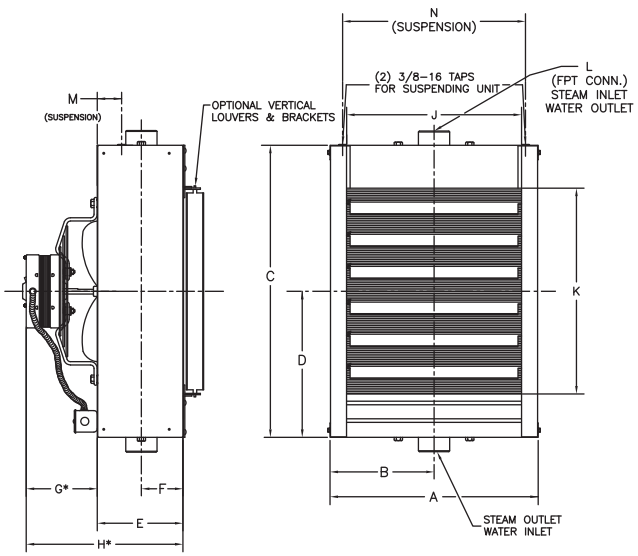


Table 1 – Figure 3 Serpentine Models

MODEL	H inches (mm)	W inches (mm)	A inches (mm)	B inches (mm)	C inches (mm)	NO. OF LOUVERS	NOM. FAN DIAM. inches (mm)	APPROX. SHIP WT. lbs. **(kg)**
108A	16 (406)	18 (457)	16 7/32 (412)	11 1/4 (286)	4 1/4 (108)	5	9 (229)	22 **(10.0)**
118A	16 (406)	18 (457)	16 7/32 (412)	11 1/4 (286)	4 1/4 (108)	5	10 (254)	24 **(10.9)**
125A	16 (406)	18 (457)	16 7/32 (412)	11 1/4 (286)	4 1/4 (108)	5	10 (254)	25 **(11.3)**
136A	18 1/2 (470)	20 1/2 (521)	18 22/32 (475)	13 3/4 (349)	5 11/16 (144)	6	12 (305)	31 **(14.0)**

Table 2 – Figure 4 Header Models

MODEL	A inches (mm)	B inches (mm)	C inches (mm)	D inches (mm)	E inches (mm)	F inches (mm)	G* inches (mm)	H* inches (mm)	J inches (mm)	K inches (mm)	L inches (mm)	M inches (mm)	N inches (mm)	NO. OF LOUVERS	NOM. FAN DIAM. inches (mm)	APPROX. SHIP WT. lbs. **(kg)**
18	14 5/8 (371)	7 5/16 (186)	15 (381)	7 1/2 (191)	6 1/8 (156)	2 15/16 (75)	3 1/4 (83)	9 3/8 (238)	12 1/4 (311)	9 1/2 (241)	1 1/4 (32)	2 1/4 (57)	12 7/8 (327)	4	9 (229)	26 **(11.8)**
24 36	14 5/8 (371)	7 5/16 (186)	18 (457)	9 (229)	6 1/8 (156)	2 15/16 (75)	3 1/4 (83)	9 3/8 (238)	12 1/4 (311)	12 1/2 (318)	1 1/4 (32)	2 1/4 (57)	12 7/8 (327)	5	10 (254)	30 **(13.6)**
48	17 1/8 (435)	8 9/16 (217)	20 1/2 (521)	10 1/4 (260)	5 7/8 (149)	2 15/16 (75)	5 11/16 (144)	11 7/16 (291)	14 3/4 (375)	15 (381)	1 1/4 (32)	1 3/4 (44)	15 3/8 (391)	6	12 (305)	41 **(18.6)**
60	17 1/8 (435)	8 9/16 (217)	20 1/2 (521)	10 1/4 (260)	5 7/8 (149)	2 15/16 (75)	5 1/16 (129)	10 15/16 (278)	14 3/4 (375)	15 (381)	1 1/4 (32)	1 3/4 (44)	15 3/8 (391)	6	12 (305)	41 **(18.6)**
72	18 3/8 (467)	9 3/16 (233)	21 3/4 (552)	10 7/8 (276)	6 (152)	2 15/16 (75)	5 1/16 (129)	11 1/16 (281)	16 (406)	16 1/4 (413)	1 1/4 (32)	1 3/4 (44)	16 5/8 (422)	7	14 (356)	44 **(19.9)**
84	20 7/8 (530)	10 7/16 (265)	24 1/4 (616)	12 1/8 (308)	6 1/8 (156)	2 15/16 (75)	5 11/16 (144)	11 13/16 (300)	18 1/2 (470)	18 3/4 (476)	1 1/4 (32)	1 3/4 (44)	19 1/8 (486)	8	14 (356)	47 **(21.3)**
96 108	19 5/8 (498)	9 13/16 (249)	24 (610)	12 (305)	6 5/16 (160)	3 3/16 (81)	7 1/2 (191)	13 13/16 (351)	17 1/4 (438)	17 1/2 (445)	1 1/2 (38)	1 3/4 (44)	17 7/8 (454)	8	16 (406)	49 **(22.2)**
120	20 7/8 (530)	10 7/16 (265)	25 1/4 (641)	12 5/8 (321)	6 5/16 (160)	3 3/16 (81)	6 11/16 (170)	13 (330)	18 1/2 (470)	18 3/4 (476)	1 1/2 (38)	1 3/4 (44)	19 1/8 (486)	8	18 (457)	59 **(26.7)**
132 144	23 3/8 (594)	11 11/16 (297)	27 3/4 (705)	13 7/8 (352)	6 5/16 (160)	3 3/16 (81)	7 5/8 (194)	14 (356)	21 (533)	21 1/4 (540)	1 1/2 (38)	1 3/4 (44)	21 5/8 (549)	9	18 (457)	74 **(33.5)**
156	23 3/8 (594)	11 11/16 (297)	27 3/4 (705)	13 7/8 (352)	6 5/16 (160)	3 3/16 (81)	7 7/16 (194)	13 3/4 (349)	21 (533)	21 1/4 (540)	1 1/2 (38)	1 3/4 (44)	21 5/8 (549)	9	18 (457)	74 **(33.5)**
180 204	24 5/8 (625)	12 5/16 (313)	29 (737)	14 1/2 (368)	6 3/8 (162)	3 3/16 (81)	7 7/16 (194)	13 3/4 (349)	22 1/4 (565)	22 1/2 (572)	1 1/2 (38)	1 3/4 (44)	22 7/8 (581)	9	18 (457)	90 **(40.8)**
240	27 7/8 (708)	13 15/16 (354)	30 1/4 (768)	15 1/8 (384)	8 1/8 (206)	3 3/16 (81)	5 7/8 (149)	14 (356)	25 1/2 (648)	23 3/4 (603)	2 (51)	1 3/4 (44)	26 1/8 (664)	10	20 (508)	143 **(65)**
280	27 7/8 (708)	13 15/16 (354)	30 1/4 (768)	15 1/8 (384)	8 1/8 (206)	3 3/16 (81)	9 5/8 (244)	17 3/4 (451)	25 1/2 (648)	23 3/4 (603)	2 (51)	1 3/4 (44)	26 1/8 (664)	10	20 (508)	154 **(70)**
300 360	33 3/8 (848)	16 11/16 (424)	37 3/4 (959)	18 7/8 (479)	9 (229)	3 3/16 (81)	9 5/8 (244)	18 5/8 (473)	31 (787)	31 1/4 (794)	2 (51)	1 3/4 (44)	31 5/8 (803)	13	24 (610)	203 **(92)**

* Applies to standard motor with standard fan guard. When optional motors or OSHA fan guards are requested, dimensions will vary according to the substitutions made.

NOTES: 1. OSHA guard standard on all serpentine models and header models 18 thru 48 supplied with 1 phase motors (dimensions shown in tables).
2. Standard motor and standard guard shown.
3. All 3 phase and explosion proof motors are shelf mounted.

STEAM PERFORMANCE DATA

Table 3 - Header Type Models only

Unit Size	Output BTU/ HR* (kW)	Cond. lbs./hr. (kg/hr)	E.D.R. Sq. Ft. (sq. m)	Final Air Deg.°F (Deg. °C)	Motor HP (kW)	RPM	Nominal CFM (m^3/s)	Outlet FPM (m/s)	Nom. Amps @ 115VAC†	Nom. Fan Diam. Inches (mm)
18	18,000 **(5.3)**	18.0 **(8.2)**	75 **(7.0)**	102 **(39)**	16 Watts	1550	395 **(.186)**	395 **(2.007)**	0.80	9 (228.6)
	16,200 **(4.7)**	16.2 **(7.3)**	68 **(6.3)**	105 **(41)**		1350	330 **(.156)**	330 **(1.676)**		9 (228.6)
24	24,000 **(7.0)**	24.5 **(11.1)**	100 **(9.3)**	109 **(43)**	16 Watts	1550	450 **(.212)**	450 **(2.286)**	0.80	10 (254.0)
	21,600 **(6.3)**	22.0 **(10.0)**	90 **(8.4)**	112 **(44)**		1350	380 **(.179)**	380 **(1.930)**		10 (254.0)
36	36,000 **(10.5)**	37.0 **(16.8)**	150 **(13.9)**	119 **(48)**	25 Watts	1550	550 **(.260)**	550 **(2.794)**	1.2	10 (254.0)
	32,400 **(9.5)**	33.0 **(14.9)**	135 **(12.5)**	120 **(49)**		1350	480 **(.227)**	480 **(2.438)**		10 (254.0)
48	48,000 **(14.1)**	49.0 **(22.2)**	200 **(18.6)**	119 **(48)**	1/20 **(.037)**	1000	750 **(.354)**	550 **(2.794)**	1.4	12 (304.8)
	43,200 **(12.7)**	44.0 **(19.9)**	180 **(16.7)**	123 **(51)**		900	630 **(.297)**	460 **(2.337)**		12 (304.8)
60	60,000 **(17.6)**	61.0 **(27.6)**	250 **(23.2)**	121 **(49)**	1/20 **(.037)**	1000	900 **(.425)**	650 **(3.302)**	1.4	12 (304.8)
	54,000 **(15.8)**	55.0 **(24.9)**	225 **(20.9)**	131 **(55)**		900	700 **(.330)**	510 **(2.591)**		12 (304.8)
72	72,000 **(21.1)**	73.0 **(33.1)**	300 **(27.9)**	120 **(49)**	1/20 **(.037)**	1000	1100 **(.519)**	800 **(4.064)**	1.4	14 (355.6)
	64,800 **(19.0)**	66.0 **(29.9)**	270 **(25.1)**	123 **(51)**		900	950 **(.448)**	700 **(3.556)**		14 (355.6)
84	84,000 **(24.6)**	85.0 **(38.5)**	350 **(32.5)**	115 **(46)**	1/12 **(.062)**	1000	1400 **(.661)**	900 **(4.572)**	2.2	14 (355.6)
	75,600 **(22.2)**	76.0 **(34.4)**	315 **(29.3)**	123 **(51)**		900	1100 **(.519)**	750 **(3.810)**		14 (355.6)
96	96,000 **(28.1)**	97.0 **(43.9)**	400 **(37.2)**	123 **(51)**	1/12 **(.062)**	1000	1400 **(.661)**	930 **(4.724)**	2.2	16 (406.4)
	86,400 **(25.3)**	88.0 **(39.9)**	360 **(33.4)**	132 **(56)**		900	1100 **(.519)**	800 **(4.064)**		16 (406.4)
108	108,000 **(31.6)**	110.0 **(49.8)**	450 **(41.8)**	115 **(46)**	1/12 **(.062)**	1000	1800 **(.850)**	1000 **(5.080)**	2.2	16 (406.4)
	97,200 **(28.5)**	98.0 **(44.4)**	405 **(37.6)**	120 **(49)**		900	1500 **(.708)**	900 **(4.572)**		16 (406.4)
120	120,000 **(35.2)**	122.0 **(55.3)**	500 **(46.5)**	118 **(48)**	1/3 **(.249)**	1140	1900 **(.897)**	900 **(4.572)**	4.5	18 (457.2)
132	132,000 **(38.7)**	134.0 **(60.7)**	550 **(51.1)**	121 **(49)**	1/3 **(.249)**	1140	2000 **(.944)**	950 **(4.826)**	4.5	18 (457.2)
144	144,000 **(42.2)**	146.0 **(66.1)**	600 **(55.7)**	120 **(49)**	1/3 **(.249)**	1140	2200 **(1.038)**	1000 **(5.080)**	4.5	18 (457.2)
156	156,000 **(45.7)**	160.0 **(72.5)**	650 **(60.4)**	115 **(46)**	1/3 **(.249)**	1140	2600 **(1.227)**	1150 **(5.842)**	4.5	18 (457.2)
180	180,000 **(52.7)**	190.0 **(86.1)**	770 **(71.5)**	135 **(57)**	1/3 **(.249)**	1140	2200 **(1.038)**	800 **(4.064)**	4.5	18 (457.2)
204	204,000 **(59.8)**	208.0 **(94.2)**	850 **(79.0)**	124 **(51)**	1/3 **(.249)**	1140	2900 **(1.369)**	1000 **(5.080)**	4.5	18 (457.2)
240	240,000 **(70.3)**	244.0 **(110.5)**	1000 **(92.9)**	123 **(51)**	1/3 **(.249)**	1140	3500 **(1.652)**	900 **(4.572)**	4.5	20 (508.0)
280	280,000 **(82.0)**	280.0 **(126.8)**	1100 **(102.2)**	121 **(49)**	1/2 **(.373)**	1100	4200 **(1.982)**	980 **(4.978)**	5.4	20 (508.0)
300	300,000 **(87.9)**	310.0 **(140.4)**	1250 **(116.1)**	117 **(47)**	1/2 **(.373)**	1100	5000 **(2.360)**	700 **(3.556)**	5.4	24 (609.6)
360	360,000 **(105.5)**	366.0 **(165.8)**	1500 **(139.4)**	120 **(49)**	1/2 **(.373)**	1100	5500 **(2.596)**	1000 **(5.080)**	5.4	24 (609.6)

Performance based on 2# steam pressure (13.8 kpa) at heater with air entering @ 60°F (16°C).
For Sound Ratings See Pages 7 & 9.
Use conversion Table on page 3 for all metric conversions.

*** For the lower output, an optional Speed Controller must be ordered.**

† Stated AMP is full load for the standard motors. AMP draw varies by motor manufacturer ± 0.2 AMPS. Please see your unit's motor data plate for exact (FLA) Full Load Amp rating. Additional motor data is shown on page 10.

STEAM CALCULATIONS AND CORRECTION FACTORS

		EXAMPLE: – UNIT SIZE: _____ 24 Steam Pressure ___ 10 PSI Entering Air Temp. __ 40°F
I. CAPACITY A. For 2 lbs. steam, 60° entering air	Read output directly from Table 3, 24,000 BTU/HR. (Ref., Std. 24).	
B. For higher steam pressures and/or E.A.T.'s above or below 60°F	Multiply output from Table 3 by appropriate correction factor from Table 4 (below).	24,000 x 1.29 = 30,960 BTU/HR.
II. FINAL AIR TEMPERATURE A. For 2 lbs. steam, 60° entering air	Read temperature directly from Table 3, 109°F. (Ref., Std. 24).	
B. For capacities calculated in I.B. (above)	$\frac{\text{Output from I.B.}}{1.085 \times \text{CFM from Table 3}}$ + E.A.T. = Final Air Temp.	$\frac{30,960}{1.085 \times 450}$ + 40 = 103.4°F.
III. FINAL AIR VOLUME A. For 2 lbs. steam, 60° entering air	$\frac{460 + \text{Final Air Temp from Table 3}}{530}$ x Nom. CFM from Table 3 = Final Air Volume	$\frac{460+109}{530}$ x 450 = 483 CFM
B. For final air temperatures calculated In II. B. (above)	$\frac{460 + \text{Final Air Temp from II.B.}}{530}$ x Nom. CFM from Table 3 = Final Air Volume	$\frac{460+103.4}{530}$ x 450 = 478 CFM
IV. CONDENSATE PER HOUR A. For 2 lbs. steam, 60° entering air	Read lbs. per hour from Table 3, 24.5 LBS./HR. (Ref., Std. 24).	
B. For capacities calculated in I.B. (above)	$\frac{\text{Output from I.B.}}{\text{Latent Heat From Table 5}}$ = lbs. per hour of condensate	$\frac{30,960}{953}$ = 32.5 LBS./HR.

TABLE 4 — STEAM CORRECTION FACTORS BASED ON 2 PSI (13.8 kPa) STEAM AND 60 Deg. F (16 Deg. C) E.A.T.

ENTERING AIR TEMPERATURE Deg. F (Deg. C)	STEAM PRESSURE (SATURATED) — LBS. PER SQ. IN. (kPa)												
	0 (0)	2 (13.8)	5 (34.5)	10 (68.9)	15 (103.4)	20 (137.9)	30 (206.8)	40 (275.8)	50 (344.7)	75 (517.1)	100 (689.4)	125 (861.8)	150 (1,034.1)
30 -(1)	1.19	1.24	1.29	1.38	1.44	1.50	1.60	1.68	1.70	1.90	2.02	2.11	2.20
40 (4)	1.11	1.16	1.21	1.29	1.34	1.42	1.51	1.60	1.66	1.81	1.93	2.02	2.11
50 (10)	1.03	1.08	1.13	1.21	1.28	1.33	1.43	1.51	1.58	1.72	1.84	1.93	2.02
60 (16)	0.96	1.00	1.05	1.13	1.19	1.25	1.35	1.43	1.50	1.64	1.75	1.84	1.93
70 (21)	0.88	0.93	0.97	1.06	1.12	1.17	1.27	1.35	1.42	1.55	1.66	1.76	1.84
80 (27)	0.81	0.85	0.90	0.98	1.04	1.10	1.19	1.27	1.34	1.47	1.58	1.68	1.76
90 (32)	0.74	0.78	0.83	0.91	0.97	1.02	1.12	1.19	1.26	1.39	1.50	1.59	1.67
100 (38)	0.67	0.71	0.76	0.84	0.89	0.95	1.04	1.12	1.19	1.32	1.42	1.51	1.59

TABLE 5 — PROPERTIES OF SATURATED STEAM

	STEAM PRESSURE IN PSIG (kPa)												
Steam Pressure psi (kPa)	0 (0)	2 (13.8)	5 (34.5)	10 (68.9)	15 (103.4)	20 (137.9)	30 (206.8)	40 (275.8)	50 (344.7)	75 (517.1)	100 (689.4)	125 (891.8)	150 (1,034.1)
Steam Temperature Deg. F (Deg. C)	212 (100)	218.5 (103.6)	227.1 (108.4)	239.4 (115.2)	249.8 (121.0)	258.8 (126.0)	274.0 (134.4)	286.7 (141.5)	297.7 (147.6)	319.9 (159.9)	337.9 (169.9)	352.9 (178.3)	365.9 (185.5)
Latent Heat of Steam Btu/lbm (KJ/Kg)	970 (2256)	966 (2247)	961 (2235)	953 (2217)	946 (2200)	940 (2186)	929 (2161)	920 (2140)	912 (2121)	891 (2072)	881 (2049)	868 (2019)	857 (1993)

HOT WATER PERFORMANCE DATA

Table 6 - Serpentine and Header Type Models

Unit Size	Output BTU/ HR* (kW)	Flow Rate GPM (L/s)	Final Air Deg. °F (Deg. °C)	Prssr. Drop FT./H_2O (m/water)	Motor HP (kW)	RPM	Nominal CFM (m^3/s)	Outlet FPM (m/s)	Nom. Amps @ 115VAC†	Sound Rating
108A	8,030 (2.4)	0.8 (.050)	91 (33)	0.80 (.244)	16 Watts	1550	245 (.116)	250 (1.270)	0.80	II
	6,800 (2.0)		90 (32)			1350	210 (.099)	215 (1.092)		I
118A	18,400 (5.4)	1.9 (.120)	94 (34)	2.20 (.671)	16 Watts	1550	500 (.236)	500 (2.540)	0.80	II
	15,650 (4.6)		96 (36)			1350	420 (.198)	420 (2.134)		I
125A	24,800 (7.3)	2.5 (.158)	102 (39)	2.20 (.671)	25 Watts	1550	580 (.274)	590 (2.997)	1.2	II
	21,230 (6.2)		106 (41)			1350	460 (.217)	450 (2.286)		I
136A	35,900 (10.5)	3.6 (.227)	99 (37)	3.00 (.914)	1/20 (.037)	1000	850 (.401)	550 (2.794)	1.4	II
	32,300 (9.5)		100 (38)			900	750 (.354)	480 (2.438)		I
18	13,050 (3.8)	1.3 (.082)	95 (35)	0.005 (.002)	16 Watts	1550	395 (.186)	395 (2.007)	0.80	II
	11,725 (3.4)		99 (37)			1350	350 (.165)	350 (1.778)		I
24	17,400 (5.1)	1.8 (.114)	96 (36)	0.014 (.004)	16 Watts	1550	450 (.212)	450 (2.286)	0.80	II
	15,600 (4.6)		98 (37)			1350	380 (.179)	380 (1.930)		I
36	26,100 (7.6)	2.7 (.170)	103 (39)	0.09 (.027)	25 Watts	1550	550 (.260)	550 (2.794)	1.2	II
	23,500 (6.9)		103 (39)			1350	480 (.227)	480 (2.438)		I
48	34,800 (10.2)	3.5 (.221)	103 (39)	0.12 (.037)	1/20 (.037)	1000	750 (.354)	550 (2.794)	1.4	II
	31,300 (9.2)		111 (44)			900	630 (.297)	460 (2.337)		I
60	43,600 (12.8)	4.4 (.278)	105 (41)	0.17 (.052)	1/20 (.037)	1000	900 (.425)	650 (3.302)	1.4	II
	39,200 (11.5)		112 (44)			900	700 (.330)	510 (2.591)		I
72	52,300 (15.3)	5.3 (.334)	104 (40)	0.23 (.070)	1/20 (.037)	1000	1100 (.519)	800 (4.064)	1.4	II
	47,000 (13.8)		106 (41)			900	950 (.448)	700 (3.556)		I
84	61,000 (17.9)	6.1 (.385)	100 (38)	0.24 (.073)	1/12 (.062)	1000	1400 (.661)	900 (4.572)	2.2	III
	54,900 (16.1)		106 (41)			900	1100 (.519)	750 (3.810)		II
96	69,700 (20.4)	7.0 (.442)	106 (41)	0.29 (.088)	1/12 (.062)	1000	1400 (.661)	930 (4.724)	2.2	III
	62,700 (18.4)		113 (45)			900	1100 (.519)	800 (4.064)		II
108	78,400 (23.0)	7.9 (.498)	100 (38)	0.36 (.110)	1/12 (.062)	1000	1800 (.850)	1000 (5.080)	2.2	III
	70,500 (20.7)		103 (39)			900	1500 (.708)	900 (4.572)		II
120	87,100 (25.5)	8.8 (.555)	102 (39)	0.39 (.119)	1/3 (.249)	1140	1900 (.897)	900 (4.572)	4.5	III
132	95,800 (28.1)	9.6 (.606)	104 (40)	0.41 (.125)	1/3 (.249)	1140	2000 (.944)	950 (4.826)	4.5	IV
144	104,000 (30.5)	10.4 (.656)	104 (40)	0.43 (.131)	1/3 (.249)	1140	2200 (1.038)	1000 (5.080)	4.5	IV
156	113,000 (33.1)	11.3 (.713)	100 (38)	0.53 (.162)	1/3 (.249)	1140	2600 (1.227)	1150 (5.842)	4.5	IV
180	118,000 (34.6)	11.8 (.744)	110 (43)	0.6 (.183)	1/3 (.249)	1140	2200 (1.038)	800 (4.064)	4.5	III
204	148,000 (43.4)	14.9 (.940)	107 (42)	0.79 (.241)	1/3 (.249)	1140	2900 (1.369)	1000 (5.080)	4.5	IV
240	174,000 (51.0)	17.4 (1.098)	106 (41)	1.06 (.323)	1/3 (.249)	1140	3500 (1.652)	900 (4.572)	4.5	IV
280	209,100 (61.3)	21.0 (1.325)	106 (41)	1.33 (.405)	1/2 (.373)	1100	4200 (1.982)	980 (4.978)	5.4	IV
300	230,000 (67.4)	23.0 (1.451)	102 (39)	2.1 (.640)	1/2 (.373)	1100	5000 (2.360)	700 (3.556)	5.4	IV
360	261,300 (76.6)	26.2 (1.653)	103 (39)	2.1 (.640)	1/2 (.373)	1100	5500 (2.596)	1000 (5.080)	5.4	IV

Performance based on 200°F (93°C) EWT, 60°F (16°C) E.A.T., 20°F (11°C)TD.
For Fan Diameter See Page 4.
Use conversion Table on page 3 for all metric conversions.

*** For the lower output, an optional Speed Controller must be ordered.**

†Stated AMP is full load for standard motors. AMP draw varies by motor manufacturer ± 0.2 AMPS. Please see your unit's motor data plate for exact (FLA) Full Load Amp rating. Additional motor data is shown on page 10.

HOT WATER CALCULATIONS AND CORRECTION FACTORS

		EXAMPLE: – UNIT SIZE: 24 Entering Water Temp. 160°F Entering Air Temp. 40°F Water Temperature Drop 10°F
I. CAPACITY @ 20°TD: A. For 200° EWT, 60° EAT	Read output directly from Table 6, 17,400 BTU/HR (Ref., Std. 24).	
B. For EWT and/or EAT above or below Standard	Multiply output from Table 6 by factor from Table 7 (below).	17,400 x .878 = 15,277 BTU/HR.
II. CAPACITY AT OTHER TD's A. For TD's from 5 to 60°F	Multiply output obtained in IA. or IB. (above) by appropriate factor from Table 8 (below)	IA - 17,400 x 1.15 = 20,010 BTU/HR. – OR – IB - 15,277 x 1.15 = 17,569 BTU/HR.
III. GPM AT OTHER TD's A. For TD's from 5 to 60°F	Multiply GPM of unit for 20° TD, from Table 6 by appropriate factor from Table 8 (below).	1.8 x 2.30 = 4.14 GPM (Applies only to units with Std. 200° EWT, 60° EAT.) For all others calculate using formula – $GPM = \frac{BTU}{500 \times TD}$
IV. CAPACITY AT OTHER RATES OF WATER FLOW	Multiply output from Table 6 by factor from Table 10 (below).	
V. PRESSURE LOSS AT OTHER TD's A. For TD's from 5 to 60°F	Multiply P.D. of unit for 20° TD, from Table 6 by appropriate factor from Table 8 (below).	.014 x 5.00 = .07 Ft. H_2O

TABLE 7 — HOT WATER CONVERSION FACTORS BASED ON 200° (93°C) ENTERING WATER, 60° (16°C) ENTERING AIR AND 20° (11°C) TEMPERATURE DROP

ENTERING AIR TEMPERATURE °F (°C)	ENTERING WATER TEMPERATURE — °F (°C)										
	100° (38)	120° (49)	140° (60)	160° (71)	180° (82)	200° (93)	220° (104)	240° (116)	260° (127)	280° (138)	300° (149)
30 -(1)	0.518	0.666	0.814	0.963	1.120	1.268	1.408	1.555	1.702	1.850	1.997
40 (4)	0.439	0.585	0.731	0.878	1.025	1.172	1.317	1.464	1.609	1.755	1.908
50 (10)	0.361	0.506	0.651	0.796	0.941	1.085	1.231	1.375	1.518	1.663	1.824
60 (16)	0.286	0.429	0.571	0.715	0.857	1.000	1.143	1.286	1.429	1.571	1.717
70 (21)	0.212	0.353	0.494	0.636	0.777	0.918	1.060	1.201	1.342	1.483	1.630
80 (27)	0.140	0.279	0.419	0.558	0.698	0.837	0.977	1.117	1.257	1.397	1.545
90 (32)	0.069	0.207	0.345	0.483	0.621	0.759	0.897	1.035	1.173	1.311	1.462
100 (38)	0.000	0.137	0.273	0.409	0.546	0.682	0.818	0.955	1.094	1.230	1.371

TABLE 8 — HOT WATER OUTPUT, FLOW RATE AND PRESSURE LOSS FACTORS BASED ON STANDARD CONDITIONS OF 200°F (93°C) ENTERING WATER, 60°F (16°C) ENTERING AIR & 20°F (11°C) WATER DROP

USE FACTORS FROM THIS TABLE TO OBTAIN APPROXIMATE RESULTS	TEMPERATURE DROP °F (°C)								
	5 (3)	10 (6)	15 (8)	20 (11)	25 (14)	30 (17)	40 (22)	50 (28)	60 (33)
To obtain output for other Water Temperature Drops, multiply basic output rating by applicable Factor.	1.25	1.15	1.08	1.00	.94	.90	.83	.76	.72
To obtain flow for other Water Temperature Drops, multiply basic rate rating by applicable Factor.*	5.00	2.30	1.44	1.00	.74	.59	.40	.30	.24
To obtain Pressure Loss Feet (Meters) of Water for other temperature Drops, multiply Basic loss at 20°F (11°C) drop by Factor.	10.00	5.00	2.00	1.00	.60	.40	.20	.13	.07

*TABLE 9 — MINIMUM WATER FLOW

MODEL No.	108A	118A	125A	136A	18	24	36	48	60	72	84	96
MINIMUM GPM (L/s)	0.125 (.008)	0.125 (.008)	0.125 (.008)	0.125 (.008)	0.750 (.047)	1.240 (.078)	1.240 (.078)	1.490 (.094)	1.490 (.094)	1.620 (.102)	1.860 (.117)	3.350 (.211)
MODEL No.	108	120	132	144	156	180	204	240	280	300	360	
MINIMUM GPM (L/s)	3.35 (.211)	3.60 (.227)	4.09 (.258)	4.09 (.258)	4.09 (.258)	4.34 (.274)	4.34 (.274)	4.59 (.290)	4.59 (.290)	6.08 (.384)	6.08 (.384)	

*TABLE 10 — HEATING CAPACITY FACTORS FOR VARIOUS RATES OF WATER FLOW

% of Rated Water Flow	25%	50%	75%	100%	125%	150%	175%
Heating Capacity Factor	.80	.89	.96	1.00	1.04	1.07	1.10

TECHNICAL DATA

The performance data listed in Table 6 includes sound ratings. The ratings provide a guide in determining the acceptable degree of loudness in particular occupancy situations.

Certain general rules apply to specific selection of unit heaters with regard to degree of quietness (or loudness);

- The greater the fan diameter, the higher the sound level.
- The higher the motor RPM, the higher the sound level. Note that on most units the lower the speed mode results in lowering the sound rating one increment.
- Selecting a larger number of smaller units generally results in lower overall noise levels than fewer large units.

All horizontal steam and hot water unit heater motors, whether fan guard or shelf-mounted, are isolated from the mechanical mount by resilient isolators. This mounting along with balanced fan blades and excellent overall construction integrity, assures you the utmost in quiet operation.

The following table outlines sound ratings for various applications. The lower the number, the quieter the unit and the lower the sound requirement.

CATEGORY OF AREA	SOUND RATING
Apartment, assembly hall, classrooms churches, courtrooms, executive offices, hospitals, libraries, museums, theatres.	I
Dining rooms, general offices, recreation areas, small retail stores.	II
Restaurants, banks, cafeterias, department stores, public buildings, service stations.	III
Gymnasiums, health clubs, laundromats, supermarkets.	IV
Garages, small machine shops, light manufacturing.	V
Factories, foundries, steel mills.	III - VII*

*Depending on specific use in these facilities, size of operation, etc.

CORRECTIONS WHEN USING GLYCOL SOLUTION IN SYSTEM

		Propylene Glycol
1. Heat transfer @180°F (82°C) with no increase in flow rate	20% solution	.97*
	50% solution	.90*
2. G.P.M. Req'd. @180°F (82°C), 20°F (11°C) Δ t (no correction to pump curve)		1.10%*
3. Pump Head Req'd. @180°F (82°C) w/increase in G.P.M.		1.23%*
4. Specify gravity (water = 1.0)		1.045-1.055*
5. Pounds/Gallons @60°F (16°C) (water = 8.3453 Pound/Gallon)		8.77
6. pH @ 50% by volume		9.5

		Propylene Glycol
7. Freezing Point	55% by volume	-
	50%	-28°F (-33°C)
	40%	-13°F (-25°C)
	30%	+ 4°F (-16°C)
	20%	+17°F (- 8°C)

*Compared to water.

Approximate factors at varying altitudes

Altitude	Factor
Sea level - 1000 ft. (305m)	1.00
1000 ft. - 3000 ft. (915m)	.958
3000 ft. - 5000 ft. (1524m)	.929
5000 ft. - 7000 ft. (2134m)	.900
7000 ft. - 10000 ft. (3048m)	.871

MOTOR DATA

NOTE 1: All motors are constant speed and operate at top speed as indicated in motor data. Models 18 through 108, including 108A, 118A, 125A and 136A can be run at reduced speed with addition of optional variable speed switch. This switch is factory-calibrated for low and high speed ratings, with intermediate speeds infinitely controllable. Models 120 through 360 operate at constant speed as indicated in motor data. All 1/4 H.P. motors are P.S.C.

NOTE 2: Motors under 1/3 H.P. are totally enclosed, frame mounted, 115/1/60 with thermal overload protection and permanently lubricated sleeve bearings with optional speed controller available. 1/3 H.P. (115/1/60) motors are open frame constant speed with thermal over-load protection and ball bearings. 1/3 H.P. (230V) and 1/2 H.P. (230V) motors are open frame constant speed with thermal overload protection and ball bearings.

NOTE 3: 1/3 and 1/2 H.P. motors are available as 230V single and 3 phase in open frame and explosion-proof housings, all available as options. 1/3 and 1/2 H.P. motors operate at single speed only.

NOTE 4: Stated AMP draw is Full Load Amp (FLA). AMP draw varies by motor manufacturer ± 0.2 AMPS. Verify FLA per unit motor data plate.

⚠ CAUTION Select appropriate AMP, MCA, and MOP for the multiple voltage motors. For example, the AMP, MCA, and MOP for Models 360 with a 460 volt Totally Enclosed motor is 1.3, 1.6 and 2.9 respectively.

NOTICE: Also refer to Maintenance section for additional motor data.

Table 11 - TOTALLY ENCLOSED MOTOR TYPE

Unit Model No.	AMP	MCA	MOP	HP	RPM
115/1/60					
18, 24, 108A, 118A	0.8	1	1.8	16W*	1550
136A	1.4	1.8	3.2	1/20*	1000
36, 125A	1.2	1.5	2.7	25W*	1550
48, 60, 72	1.4	1.8	3.2	1/20*	1000
84, 96,108	2.2	2.8	5.0	1/12*	1000
120, 132, 144 156, 180, 204 240	4.5	5.6	10.1	1/3	1140
280, 300, 360	5.4	6.8	12.2	1/2	1100
230/1/60					
18, 24, 108A, 118A	0.4	0.5	0.9	16W	1550
136A	1.4	1.8	3.2	1/20†	1000
36, 125A	0.6	0.8	1.4	25W	1550
48, 60, 72	1.4	1.8	3.2	1/20†	1000
84, 96,108	2.2	2.8	5.0	1/12†	1000
120, 132, 144, 156,180, 204, 240	4.5	5.6	10.1	1/3†	1140
280, 300, 360	5.4	6.8	12.2	1/2†	1100
208-230/460/3/60					
48, 60, 72, 84, 96, 108, 120, 132, 144, 156, 180, 204, 240 280, 300, 360	2.6-2.6/1.3	3.3-3.3/1.6	5.9-5.9/2.9	1/2**	1140

*Optional variable speed switch is available.
**These motors are without thermal overload protection.
†230/1/60 unit has 115/1/60 motor supplied with field installed stepdown transformer.

Table 12 - EXPLOSION PROOF WITH THERMAL OVERLOAD MOTOR TYPE

Unit Model No.	AMP	MCA	MOP	HP	RPM	AMP	MCA	MOP	HP	RPM
	115-230/1/60					**230/460/3/60**				
48, 60, 72, 84, 96, 108, 120, 132	3.7	4.6	8.3	1/6†	1140	—	—	—	—	—
144, 156, 180, 204	5.4	6.8	12.2	1/4†	1140	2.2/1.1	2.8/1.4	5.0/2.5	1/3	1140
240, 280, 300	7.4/3.7	9.3/4.7	16.7/8.3	1/3***	1140	2.2/1.1	2.8/1.4	5.0/2.5	1/3	1140
360	9.6/4.8	12.0/6.0	21.6/10.8	1/2***	1140	2.2/1.1	2.8/1.4	5.0/2.5	1/3	1140

***These motors are 115/230 volts.
†230/1/60 unit has 115/1/60 motor supplied with field installed stepdown transformer.

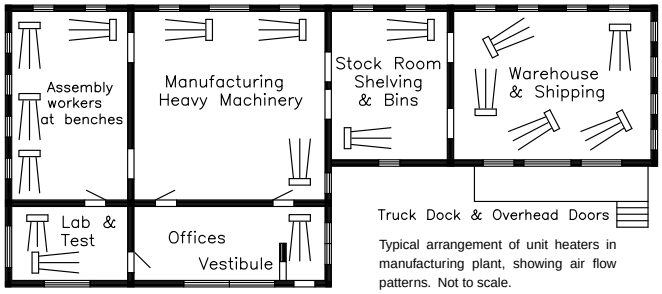
LOCATION

It is assumed that the design engineer has selected, sized, and located in the area to be heated. However, the information given here may be of additional help to the installer. These sketches indicate suggested basic locations for different types of unit heaters.

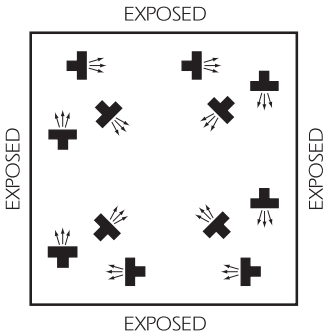
Horizontal unit heaters should be located to give a circulatory motion, preferably in the outer perimeter of the building. The units should be spaced to properly blanket the areas with warm air.

The unit should be suspended from connections provided in the unit by means of rods. The rods should then be attached to solid supports of the building.

Figure 5

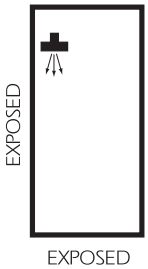


Typical arrangement of unit heaters in manufacturing plant, showing air flow patterns. Not to scale.



A large square area with exposed walls and roof; units are blanketing all exposed surfaces.

A narrow area with two exposed walls either with or without roof exposure.



A small area with exposed walls requiring one unit.

Figure 6
MOUNTING HEIGHT AND APPROX. HEAT THROW
Based on 2 PSI (13.8 kPa) steam pressure and 60°F (16°C) entering air temperature

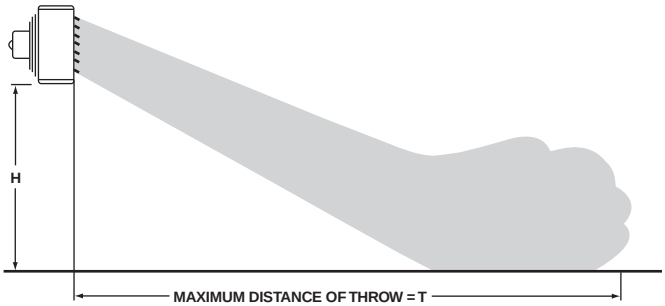


Table 13

Model No.	Maximum Mounting HT. ft (m)	Approx. Max. Throw ft (m)
108A	8 (2.4)	20 (6.1)
118A	8 (2.4)	25 (7.6)
125A	9 (2.7)	29 (8.8)
136A	9 (2.7)	29 (8.8)
18	8 (2.4)	20 (6.1)
24	8 (2.4)	24 (7.3)
36	9 (2.7)	28 (8.5)
48	9 (2.7)	30 (9.1)
60	10 (3.0)	30 (9.1)
72	10 (3.0)	29 (8.8)
84	10 (3.0)	30 (9.1)
96	11 (3.4)	38 (11.6)
108	11 (3.4)	40 (12.2)
120	12 (3.7)	40 (12.2)
132	13 (4.0)	54 (16.5)
144	13 (4.0)	55 (16.8)
156	13 (4.0)	55 (16.8)
180	13 (4.0)	53 (16.2)
204	13 (4.0)	55 (16.8)
240	14 (4.3)	57 (17.4)
280	14 (4.3)	57 (17.4)
300	15 (4.6)	58 (17.7)
360	15 (4.6)	60 (18.3)

INSTALLATION

UNIT MOUNTING

Install unit heaters to meet Occupational Safety and Health Act (OSHA) and ETL requirements. Unit heaters mounted lower than 8 feet (2.4m) from the floor must be equipped with an OSHA fan guard.

NOTICE: Units equipped with the motor mounted to the fan guard require two point suspension. Units equipped with a shelf mounted motor are required to be suspended at four points. Refer to Figures 3 and 4 for two point suspension and refer to Figure 6A for four point suspension.

⚠ CAUTION Unit heaters must be hung level from side to side and from front to back. Failure to do so will result in poor performance and/or premature failure of the unit.

⚠ WARNING Make certain that the lifting methods used to lift the heater and the method of suspension used in the field installation of the heater are capable of uniformly supporting the weight of the heater at all times. Failure to heed this warning may result in property damage or personal injury!

⚠ WARNING Insure that all hardware used in the suspension of each unit heater is more than adequate for the job. Failure to do so may result in extensive property damage, severe personal injury, or death!

⚠ WARNING Make sure that the structure to which the unit heater is to be mounted is capable of safely supporting its weight. Under no circumstances must the water lines or the electrical conduit be used to support the heater; or should any other objects (i.e. ladder, person) lean against the heater water lines or the electrical conduit for support. Failure to heed these warnings may result in property damage, personal injury, or death.

Nutserts are provided at the top of all units for suspension purposes. Support rods should support the total unit weight to assure that no strain is placed on supply and return piping. Provisions for removal of the unit from the suspension rods may be desirable for servicing purposes.

Units must hang level vertically and horizontally.

Provide sufficient clearance around units for maintenance purposes.

Isolators are not required but may be desirable for some applications. Refer to “Dimensional Data” in Tables 1 and 2.

PIPING

To provide proper coil operation, follow all piping recommendations listed in this manual.

See Figures 7 through 11 for proper pipe connections.

Follow standard practices and codes when installing the piping. Provide swing joints for expansion purposes, unions and shut-off valves for servicing purposes and as illustrated in Figures 7 through 11, valves and traps for control purposes. Use 45 degree angle run-offs from all supply and return mains.

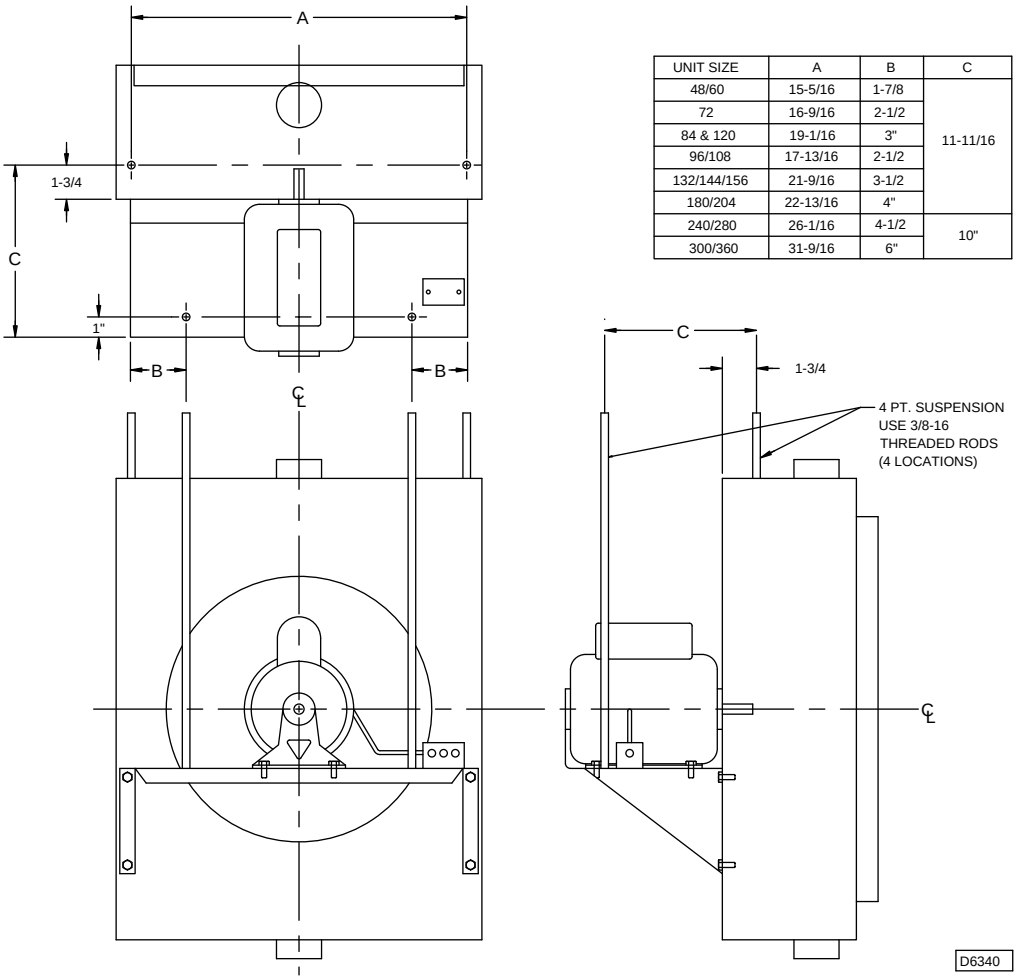
Dirt pockets should be the same pipe size as the return tapping of the unit heater. Also, pipe size in the branch-off should be the same size as the tapping in the traps. Beyond the trap, the return lateral pipe should be increased one size up to the return main.

It is assumed that the design engineer has selected the type of system to be used. The sketches shown are for different types of steam systems or hot water systems. For sizing of piping, traps, filter, etc., consult ASHRAE guides of the manufacturer’s literature on these products.

It is important that the system be kept clean. Care should be exercised that excessive joint materials or foreign substances be kept out of the system.

On steam systems it is recommended that the unit be installed level for proper condensate drainage. Swing joints should be used in piping, and pipes should be pitched down from units so that condensate can drain freely.

Figure 6A
Four Point Suspension - Shelf Mounted Motors Only



UNIT SIZE	A	B	C
48/60	15-5/16	1-7/8	11-11/16
72	16-9/16	2-1/2	
84 & 120	19-1/16	3"	
96/108	17-13/16	2-1/2	
132/144/156	21-9/16	3-1/2	
180/204	22-13/16	4"	
240/280	26-1/16	4-1/2	10"
300/360	31-9/16	6"	

Figure 7
Forced Hot Water

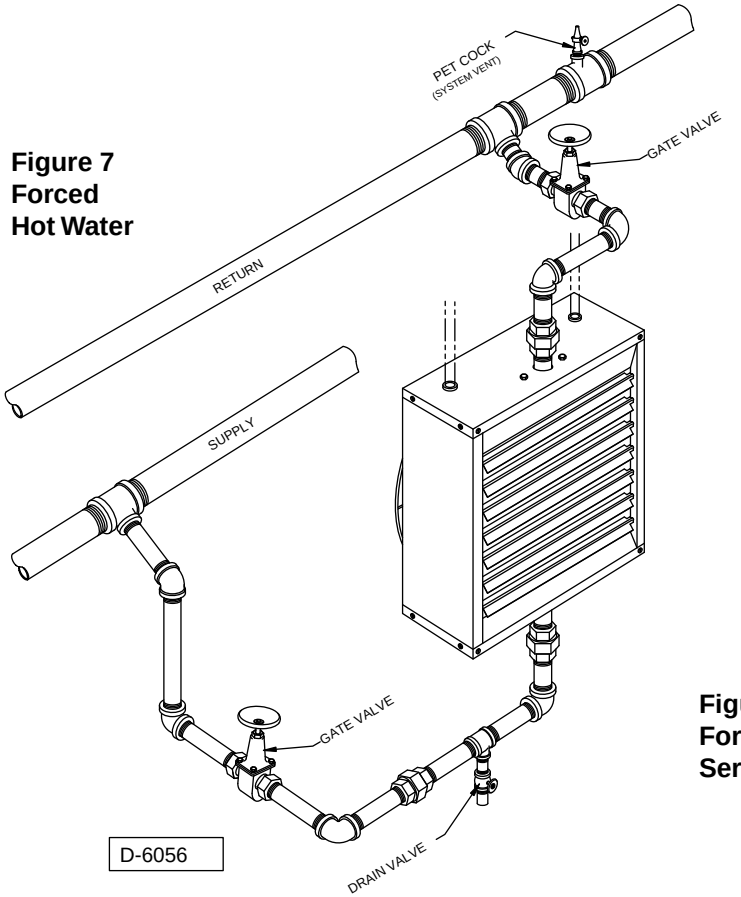


Figure 8
Forced Hot Water Serpentine Unit Only

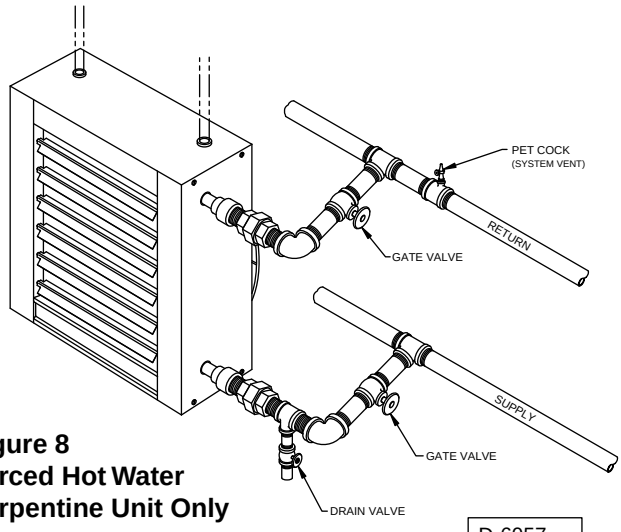


Figure 9
High Pressure Steam

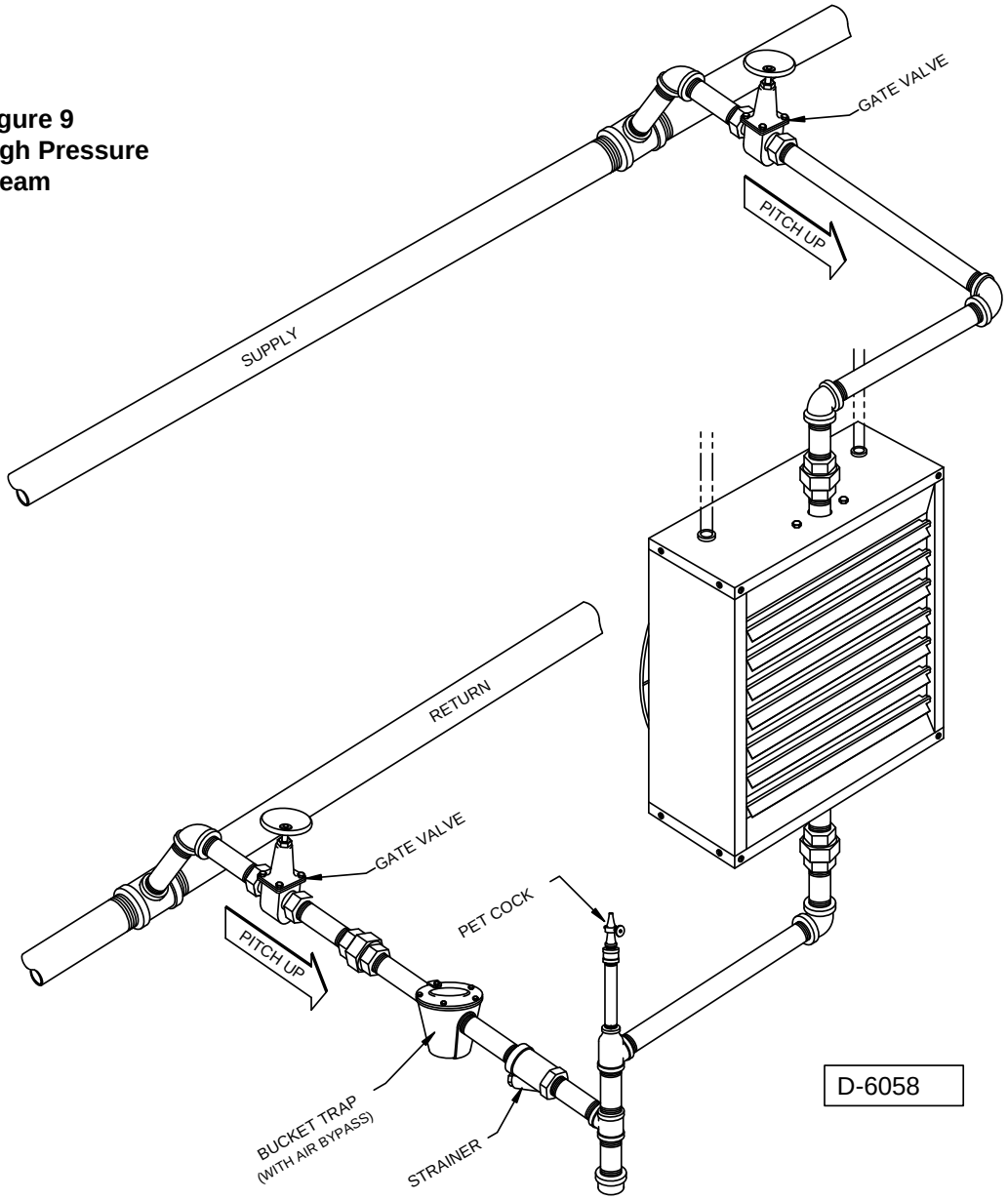


Figure 10
Low Pressure
Steam Gravity

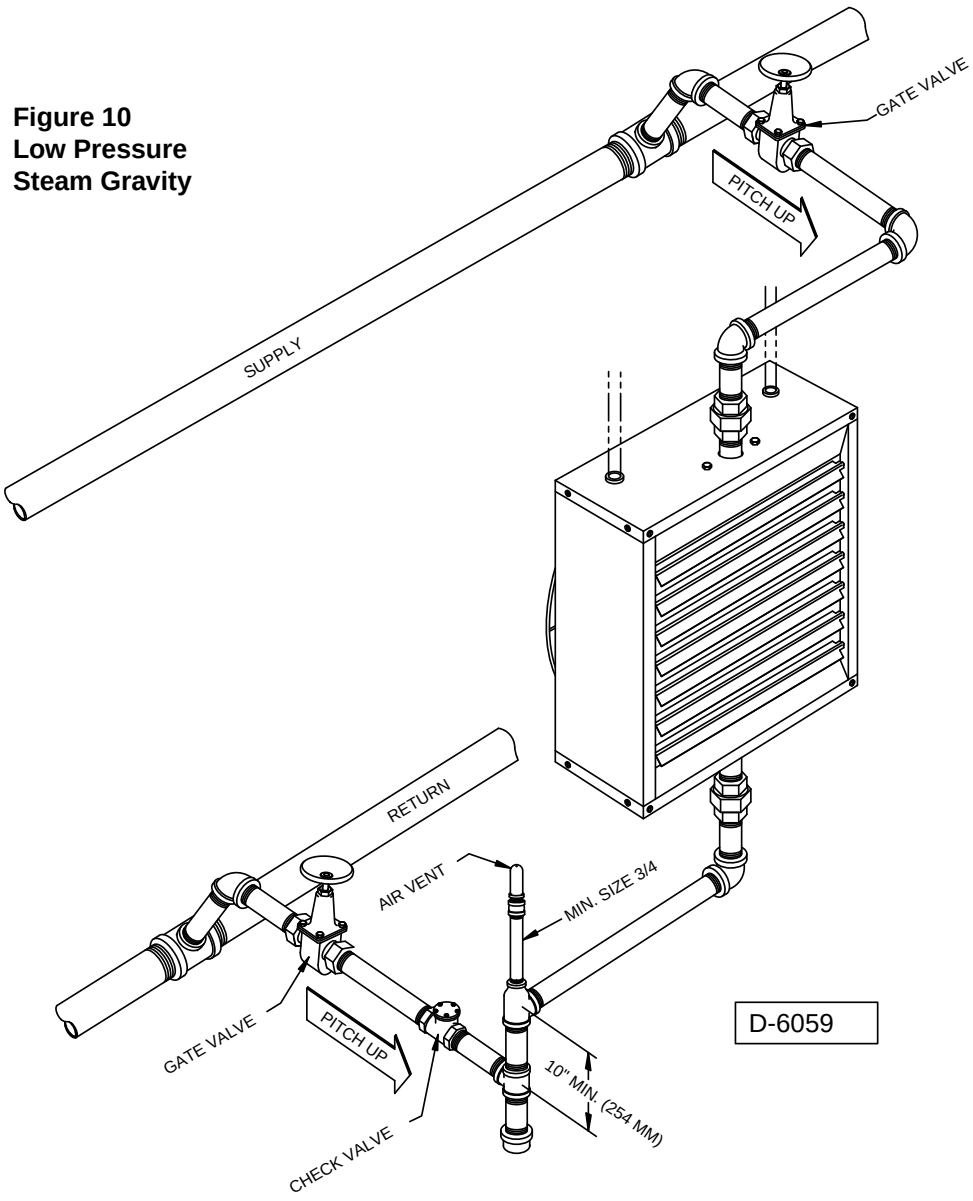
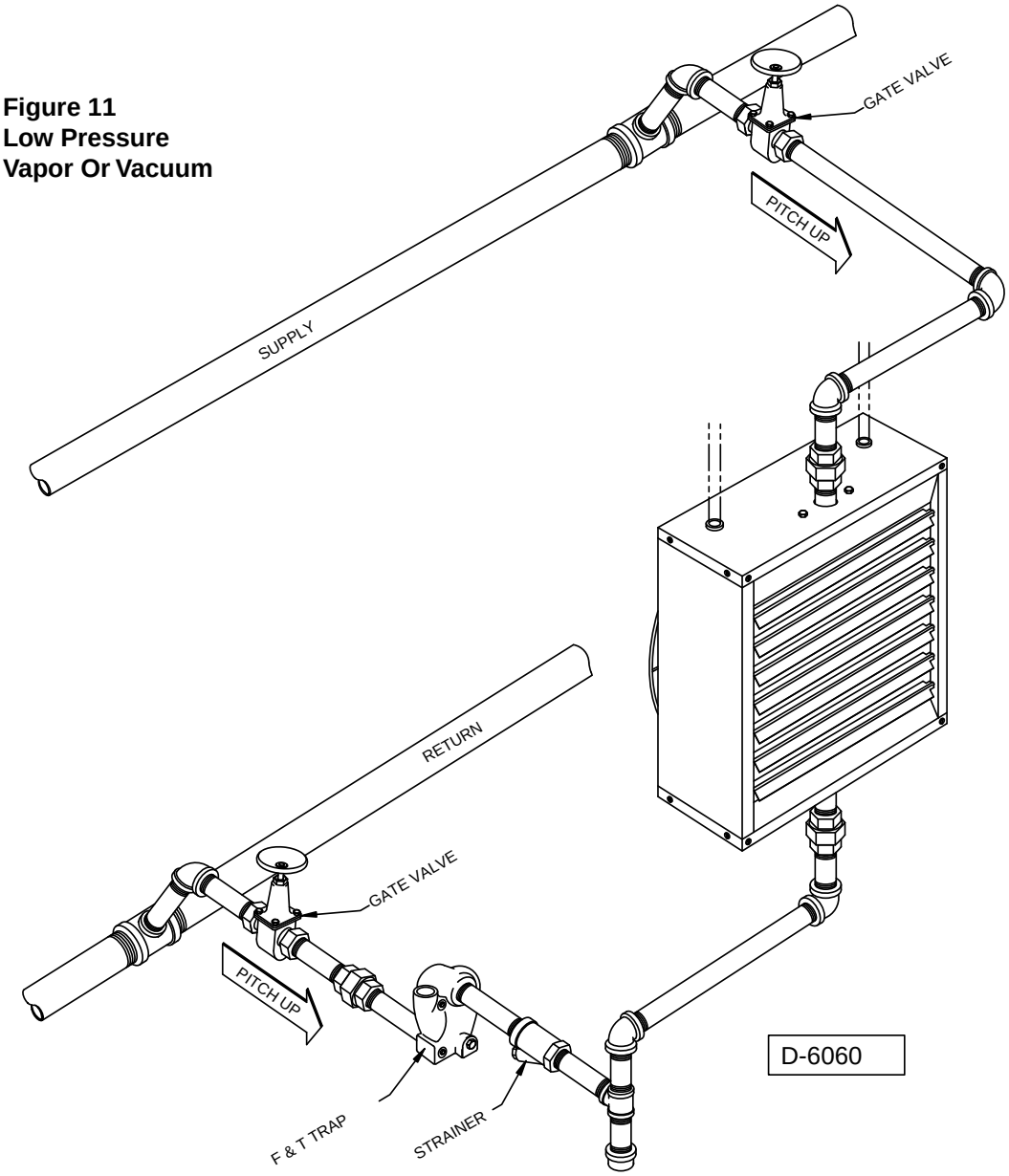


Figure 11
Low Pressure
Vapor Or Vacuum



ELECTRICAL CONNECTIONS

⚠ WARNING

HAZARDOUS VOLTAGE!
DISCONNECT ALL ELECTRIC POWER INCLUDING REMOTE DISCONNECTS BEFORE SERVICING. Failure to disconnect power before servicing can cause severe personal injury or death.

Standard units are shipped for use on 115 volt, 60 hertz single phase electric power. The motor nameplate and electrical rating on the transformer should be checked before energizing the unit heater electrical system. All external wiring must conform to ANSI/NFPA No. 70-2006, National Electrical Code (or the latest edition) and applicable current local codes; in Canada, to the Canadian Electrical Code, Part 1 CSA Standard C22.1.

⚠ CAUTION **Do not use any tools (i.e. screwdriver, pliers, etc.) across the terminals to check for power. Use a voltmeter.**

It is recommended that the electrical power supply to each unit heater be provided by a separate, fused and permanently live electrical circuit. A disconnect switch of suitable electrical rating for each unit heater should be located as close to the controls as possible. Each unit heater must be electrically grounded in accordance with National Electric Code, ANSI/NFPA No. 70-2006 (or the latest edition) or CSA Standard C22.1. Sample wiring connections are depicted in Figures 12 through 22.

OPERATION

Most basic unit heater systems are controlled by a room thermostat. Locate thermostat on inner wall or column so that optimum control can be obtained for that area. Set thermostat for desired temperature.

On steam systems a low limit may be used to prevent fan from blowing cold air unless the heater has steam passing through the coil.

Small hot water systems could have the circulating pump controlled directly by the room thermostat. On large systems, zone valves could be used to control the individual unit heater where constant water circulation is used on the main system.

Horizontal louvers are standard equipment on horizontal unit heaters, vertical louvers are available as an optional accessory.

THERMOSTAT WIRING AND LOCATION

NOTICE: The thermostat must be mounted on a vertical vibration-free surface free from air currents and in accordance with the furnished instructions.

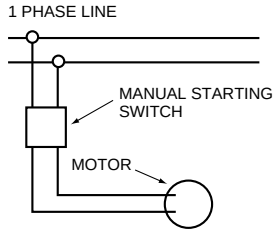
Mount the thermostat approximately 5 feet (1.5 m) above the floor in an area where it will be exposed to a free circulation of average temperature air. Always refer to the thermostat instructions as well as our unit wiring diagram and wire accordingly. Avoid mounting the thermostat in the following locations:

1. Cold areas - Outside walls or areas where drafts may affect the operation of the control.
2. Hot areas - Areas where the sun's rays, radiation, or warm air currents may affect control operation.
3. Dead areas - Areas where air cannot circulate freely, such as behind doors or in corners.

NOTICE: For all wiring connections, refer to the wiring diagram on the motor nameplate (also refer to page 18). Should any original wire supplied with the heater have to be replaced, it must be replaced with wiring material having a temperature rating of at least 105° C.

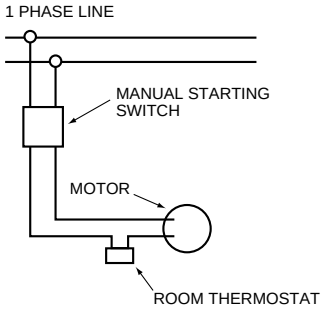
WIRING INSTALLATION

Figure 12



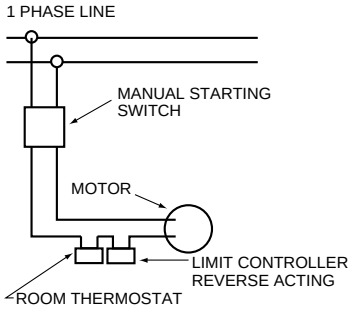
MANUAL CONTROL WITH SINGLE PHASE MOTOR

Figure 13



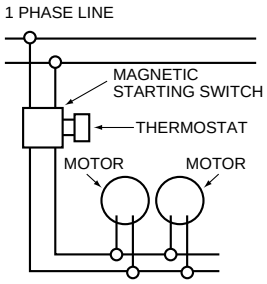
THERMOSTATIC CONTROL WITH MANUAL STARTER

Figure 14



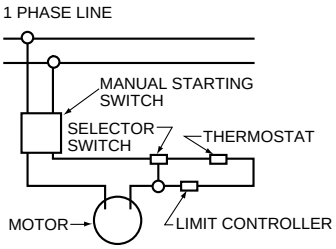
THERMOSTATIC CONTROL WITH REVERSE ACTING CONTROLLER AND MANUAL STARTER

Figure 15



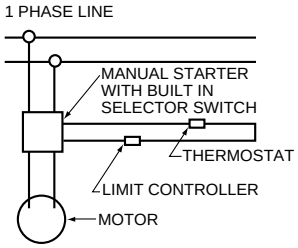
THERMOSTATIC CONTROL USING MAGNETIC STARTER OPERATING SEVERAL UNITS

Figure 16



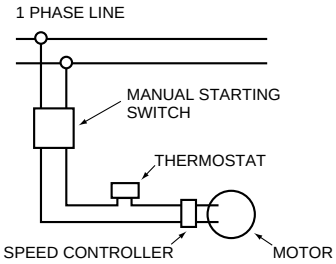
THREE POSITION SELECTOR SWITCH USED FOR EITHER MANUAL OR THERMOSTATIC CONTROL

Figure 17



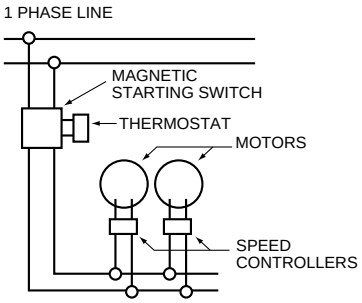
THREE POSITION SELECTOR SWITCH BUILT INTO MAGNETIC STARTER FOR MANUAL OR THERMOSTATIC CONTROL

Figure 18



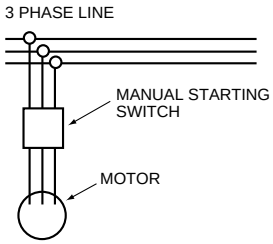
SPEED CONTROLLER WITH MANUAL STARTING SWITCH

Figure 19



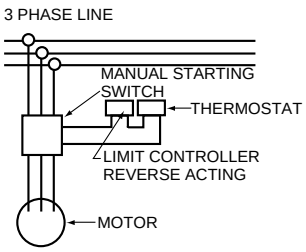
SPEED CONTROLLERS WITH MAGNETIC STARTING SWITCH FOR OPERATING SEVERAL UNITS

Figure 20



MANUAL CONTROL WITH THREE PHASE MOTOR

Figure 21

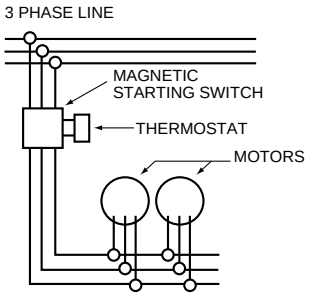


THERMOSTATIC CONTROL WITH LIMIT CONTROLLER FOR THREE PHASE MOTOR

NOTICE

1. **When using a speed controller, always locate the thermostat between the speed controller and the line, not between the motor and the controller.**
2. **For internal wiring and overload protection on all starters, consult the control manufacturer for details.**
3. **When using thermostatic control with a manual starter, be sure that the electrical rating of the thermostat is sufficient to carry the motor current.**

Figure 22



THERMOSTATIC CONTROL OF SEVERAL THREE PHASE UNITS

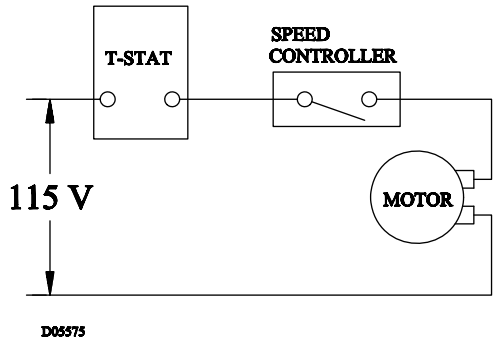
OPTIONS

VARIABLE SPEED CONTROL

115 Volt Only (optional)

The solid state speed controller may be installed at any convenient location and is suitable for surface or flush type mounting. A Standard electrical single or double gang wall box is recommended as in Figure 23.

Figure 23
Wiring Diagram of Speed Control Installation



Installation procedure:

1. Attach the control's leads to the electrical leads in the control box using wire nuts. The speed control is to be wired in series with the motor. See wiring diagram in Figure 23.
2. Make certain wire nuts are tight with no copper wire being exposed.
3. Place wires and wire nuts back into box allowing room for the control to fit in box also.
4. Mount speed control to box using number 6 flathead screws provided.

Setting the control:

1. Turn the control shaft fully clockwise. If the motor is not running at the desired low speed, adjust the trim on the face of the control for low speed setting using a small screwdriver.
2. Rotate the control shaft counter clockwise. The speed will increase smoothly from minimum to maximum and then switch off.
3. Mount face plate with screw provided and attach control knob.

STRAP-ON WATER CONTROL

A SPDT strap-on type hot water control with 100° to 240°F (38 to 116°C) rated at 10 amps at 120V is also available. Control can be used for direct or reverse acting applications as high or low limit.

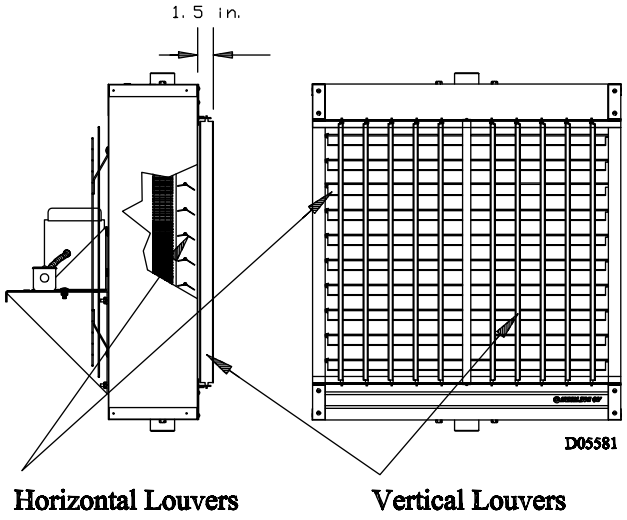
STEAM PRESSURE CONTROL

SPDT switch opens on a rise in pressure. Control is automatically reset, has a range of 0 to 15 PSIG (0 to 103 kPa) and has an adjustable differential. **Other actions, ranges, circuits and manual reset models are available on request.**

HORIZONTAL AND VERTICAL LOUVERS

Horizontal louvers are standard on all models. Vertical louvers are an optional accessory on all models. Vertical louvers are installed on built to order units or shipped loose for field installation.

Figure 24
Horizontal and Vertical Louver Mounting



THERMOSTATS

Line voltage wall thermostats are in stock for immediate shipment. All models are SPST with bimetal thermometer, knob-type set point adjustment, 40 to 90°F (5 to 30°C) range and selector switches. Standard duty models with "off-auto" and "auto-off-fan" and a heavy duty model with "auto-off-fan" switching are available. Other models available on request. Plastic tamperproof one size fits all thermostat guards are also available.

MANUAL STARTERS

Single and three-phase models are available. Standard models are single-speed, toggle-operated, NEMA Type 1 and are surface-mounted.

WALL MOUNTED SPEED CONTROLLERS

Units with standard motors up to Model 108 (115/1/60) can be operated at reduced speeds by addition of optional speed controller. Controller is 5 amps, pre-set at factory for maximum and minimum speeds, with intermediate speeds infinitely controllable. All 1/3, 1/2 HP and 230V motors operate only at rated speed and CFM – See Charts.

NOTICE: When using electrical accessories, always refer to the accessory manufacturer's installation manual for proper use, location and wiring instructions.

MAINTENANCE

PERIODIC SERVICE

⚠WARNING Open all disconnect switches and secure in that position before servicing unit. Failure to do so may result in personal injury or death from electrical shock.

Because of the simple design of the steam and hot water unit heaters, they are nearly maintenance free. However, depending on the environment, simple maintenance practices should be adopted.

Periodically check the finned surfaces and vacuum these as often as necessary to remove any accumulation of lint and dirt. Check fan blades and remove dirt accumulation. If fan blades are not cleaned they tend to become unbalanced.

Most of the motors supplied on the unit heaters have either ball bearings or sleeve bearings and should not require lubrication for long periods of time. It is however advisable that motor maintenance and lubrication recommended by the motor manufacturer be followed.

Check motors for dirt and dust accumulation, and remove any accumulation as often as necessary. Open type motors may overheat if the dirt or dust is not removed from ventilation openings.

⚠CAUTION Allow rotating fans to stop before servicing to avoid serious injury to fingers and hands.

MOTOR LUBRICATION

Sleeve Bearings

Motors with oilers or oil holes are lubricated before shipment with a good grade of electric motor oil. Refill when necessary, with the motor at a stand-still, until oil reaches the proper level.

Use SAE 20W non detergent oil for motors operating in ambient temperatures of 32°F to 100°F (0°C to 38°C). Below 32°F (0°C), SAE 10W non detergent oil will be required.

The frequency of oiling will depend upon operating conditions and length of running time. Inspect the oilers or oil holes when cleaning the unit. If the unit has a fractional horse-power motor, lubricate at least once a year. Under high ambient conditions or constant fan operation, fractional horse-power motors should be lubricated every 90 days. On those motors without oilers or oil holes, follow the instructions given on the motor nameplate.

Ball Bearings

Ball bearing motors are pre-lubricated and normally not equipped with grease fittings. However, motors are equipped with removable grease plugs to allow installation of grease fittings if desired by owner. Motor manufacturers do not recommend or require on the job lubrication of ball bearing motors.

If on the job lubrication is required by the owner, use the following procedure: With the motor at a stand-still, remove the vent and grease plugs. Install grease fitting and add grease sparingly. Remove the old grease from the vent relief chamber. Operate the motor a few minutes before reinstalling the vent plug to allow excess grease to escape. If there is evidence of grease working out around the motor shaft, less grease should be added and the greasing periods lengthened. If grease continues to appear, take the motor to the motor manufacturer's authorized service station for repair.

NOTICE: Consult local motor manufacturer's service facility for information on type of grease and oil to be used.

NOTICE: The heater system should be checked once a year by a qualified technician. All maintenance/ service information should be recorded accordingly on the inspection sheet provided in this manual.

Should maintenance be required, perform the following inspection and service routine:

CLEANING THE UNIT

The unit casing, fan, diffuser and coil should be cleaned thoroughly once a year. Coil heat transfer efficiency depends on cleanliness. The following recommended procedures may be performed when lubricating the motor and cleaning the coil.

1. Wipe all excess lubricant from the motor, fan and casing. Clean the motor thoroughly. A dirty motor will run hot and eventually cause internal damage.
2. Clean the coil:
   a) Loosen the dirt with a brush on the fan side of the coil. Operate the motor allowing the fan to blow the loosened dirt through the unit.
   b) Use high pressure air or steam on the side of the coil away from the fan.

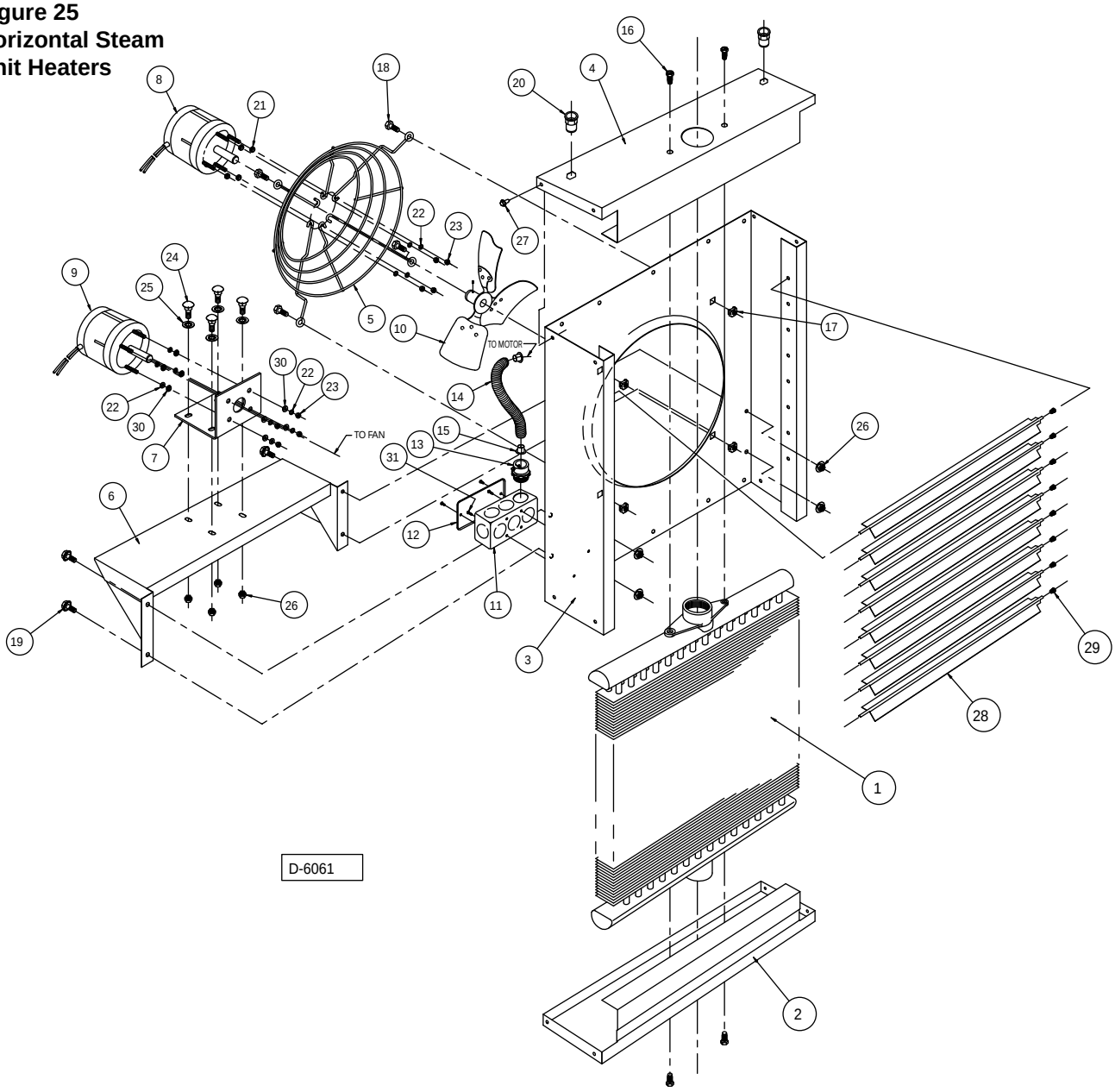
NOTICE: A piece of cheesecloth or a burlap bag may be used to collect the large particles during the cleaning process.

3. Clean the casing, fan blades, fan guard and diffuser using a damp cloth. Any rust spots on the casing should be cleaned and repainted.
4. Tighten the fan guard, motor frame and fan bolts. Check the fan for clearance in the panel orifice and free rotation.

REPLACEMENT PARTS

When ordering replacement parts
Model, Model Type (IE: Standard or Exp. Proof), Size & Item Numbers must be specified
Consult factory for price and availability

Figure 25
Horizontal Steam
Unit Heaters



HORIZONTAL STEAM UNIT HEATER PARTS

1 - Element (1)
2 - Bottom Jacket Panel (1)
3 - Venturi Jacket Panel (1)
4 - Top Jacket Panel (1)
5 - Motor Mount & Fan Guard*
[Std. Unit Shown]
6 - Motor Mounting Bracket
[3 Phase and/or Explosion Proof]*
7 - Motor Mounting Angle
[3 Phase and/or Explosion Proof]* (1)
8 - Motor [Std. Units]*
9 - Motor [3 Phase and/or Explosion Proof]*
10 - Fan (1)
11 - Junction Box (1)
12 - Junction Box Cover (1)
13 - Connector (1)
14 - Conduit, Flex (1)
15 - Anti-Short (2)
16 - Screw (4)
17 - Nut Retainer (4)
18 - Bolt (3) Models 24 & 36,
(4) Models 48/204
19 - Flange Screw
20 - Threaded Inserts
21 - Grommet (4)
22 - Washer, Flat (4)
23 - Nut (4)
24 - Bolt (4)
25 - Washer, Spring Lock (8)
26 - Nut (8)
27 - Screw (2)
28 - Louvers (Horiz)
29 - Cone Spring
30 - Grommet, Stem (4)
31 - Screw (18)

*( ) = Qty Req'd per unit *Select One*

Table 14 - Troubleshooting Guide

SYMPTOMS	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
A. Leaking coil.	1. Frozen coil. 2. Defective coil. 3. Corrosion. 4. Leak in joint.	1. Replace. 2. Replace. 3. Replace 4. Braze joint if joint is exposed where leak has occurred.
B. Poor output on steam.	1. Check for air in coil. 2. Lint on coil fins.	1. Repair or replace thermostatic air vent. 2. Clean coil and fins.
C. Poor output on steam or hot water.	1. No circulation of water through coil. 2. Short cycling of motor. 3. Backward rotating motor.	1. Check circulation pump. Check for blocked tubes. 2. Check voltage and correct. Check for linted coil and clean. Check for defective overload and repair or replace motor. 3. On single phase motor replace motor. On three phase motor, reverse two leads to change rotation.
D. Noisy or vibrating unit.	1. Damaged fan blade. 2. Dirty fan blade.	1. Change fan blade. 2. Clean fan blade.

HOW TO ORDER REPLACEMENT PARTS

Please send the following information to your local representative; If further assistance is needed, contact the manufacturer's customer service department.

- Model number
- Serial Number (if any)
- Part description and Number as shown in the Replacement Parts Catalog.

LIMITED WARRANTY

HORIZONTAL STEAM & HOT WATER UNIT HEATERS

The Manufacturer warrants to the original owner at the original installation site that the Horizontal Steam and Hot Water Unit Heaters (the "Product") will be free from defects in material and workmanship for a period not to exceed one (1) year from startup or eighteen (18) months from date of shipment from the factory, whichever occurs first. If upon examination by the Manufacturer the Product is shown to have a defect in material or workmanship during the warranty period, the Manufacturer will repair or replace, at its option, that part of the Product which is shown to be defective.

This limited warranty does not apply:

(a) if the Product has been subjected to misuse or neglect, has been accidentally or intentionally damaged, has not been installed, maintained or operated in accordance with the furnished written instructions, or has been altered or modified in any way.
(b) to any expenses, including labor or material, incurred during removal or reinstallation of the defective Product or parts thereof.
(c) to any workmanship of the installer of the Product.

This limited warranty is conditional upon:

(a) shipment, to the Manufacturer, of that part of the Product thought to be defective. Goods can only be returned with prior written approval from the Manufacturer. All returns must be freight prepaid.
(b) determination, in the reasonable opinion of the Manufacturer, that there exists a defect in material or workmanship.

Repair or replacement of any part under this Limited Warranty shall not extend the duration of the warranty with respect to such repaired or replaced part beyond the stated warranty period.

THIS LIMITED WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EITHER EXPRESS OR IMPLIED, AND ALL SUCH OTHER WARRANTIES, INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED AND EXCLUDED FROM THIS LIMITED WARRANTY. IN NO EVENT SHALL THE MANUFACTURER BE LIABLE IN ANY WAY FOR ANY CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OF ANY NATURE WHATSOEVER, OR FOR ANY AMOUNTS IN EXCESS OF THE SELLING PRICE OF THE PRODUCT OR ANY PARTS THEREOF FOUND TO BE DEFECTIVE. THIS LIMITED WARRANTY GIVES THE ORIGINAL OWNER OF THE PRODUCT SPECIFIC LEGAL RIGHTS. YOU MAY ALSO HAVE OTHER RIGHTS WHICH MAY VARY BY EACH JURISDICTION.

In the interest of product improvement, we reserve the right to make changes without notice.

EQUIPMENT START-UP

Customer _____ **Job Name & Number** _____

PRE-INSPECTION INFORMATION
With power and water/steam off.

Type of Equipment: Unit Heater

Serial Number _____ Model Number _____

Name Plate Voltage: _____ Name Plate Amperage: _____

Steam Hot Water Rating: _____ BTU @ ____ °F
_____ kw @ ____ °C

- ❒ Are all panels in place?
- ❒ Has the unit suffered any external damage? Damage _____
- ❒ Does the piping and electric wiring appear to be installed in a professional manner?
- ❒ Has the piping and electric been inspected by the local authority having jurisdiction?
- ❒ Is the supply properly sized for the equipment?
- ❒ Were the installation instructions followed when the equipment was installed?
- ❒ Have all field installed controls been installed?
- ❒ Do you understand all the controls on this equipment? **If not, contact your wholesaler or rep. (DO NOT START this equipment unless you fully understand the controls.)**

OPERATION & MAINTENANCE INSTRUCTIONS

Contractor: Eastern Mechanical

Job: ConnCat Culinary Arts

Product: VAV Terminals

T.F. Melia Associates, Inc
9 Progress Drive
Cromwell, CT 06416

Titus Installation Manual

SD-IOM-1.0 6-15-02

Single Duct VAV Terminals

Receiving Inspection

After unpacking the terminal, check it for shipping damage. If any shipping damage is found, report it immediately to the delivering carrier. Store units in a clean, dry location prior to installation.

Caution: Do not use the flow sensor, connecting tubing, or damper shaft linkage as a handle to lift or move assembly. Damage to the flow sensor or controls may result.

Supporting the Assembly

Many basic single duct terminals are light enough to be supported by the duct work itself. Where heavier accessory modules, such as DDC controls, coils, attenuators, or multiple outlets are included, the terminal should be supported directly. Straps screwed directly into the side of the terminal, threaded rod through the opti onal hanger brackets (see Figure 1), or the method prescribed for the rect angular duct on the job specifications may be used.

Important: If equipped with pneumatic controls, the terminal must be mounted right side up. It must be level within + or - 10 degrees of horizontal, both parallel to the air flow and at the right angle of air flow. The control side of the terminal is labeled with an arrow indicating UP. The first letter of the model number (P) indicates pneumatic controls. Most electronic units (A- analog controls and D-digital controls) can be installed in any orientation. Check with the local TITUS representative for verification.

Duct Connections

Slip each inlet duct over the inlet collar of the terminal. Fasten and seal the connection by the method prescri bed by the job specification.

The diameter of the inlet duct "D" in inches must be equal to the listed size of the terminal; e.g. a duct that actually measures 8 inches must be fitted to a size 8 terminal. The inlet collar of the terminal is made 1/8 inch smaller than listed size in order to fit inside the duct (see Figure 1).

Note: Do not insert duct work inside the inlet collar of the assembly. Inlet duct should be installed in accordance with SMACNA guidelines.

The outlet end of the terminal is designed for use with slip and drive duct connections. A rectangular duct the size of the terminal outlet should be attached.

If single-point electronic velocity sensor is used, 3 to 5 inlet duct diameters of straight duct should be provided at the terminal inlet; for specific guidelines, consult the manufacturer's installation material. Sensor(s) may be attached to the inside of control enclosure for protection during shipping. Sensor must be inserted in inlet duct of terminal before operation. Remove any protective plastic devices from tip of sensor before installation.

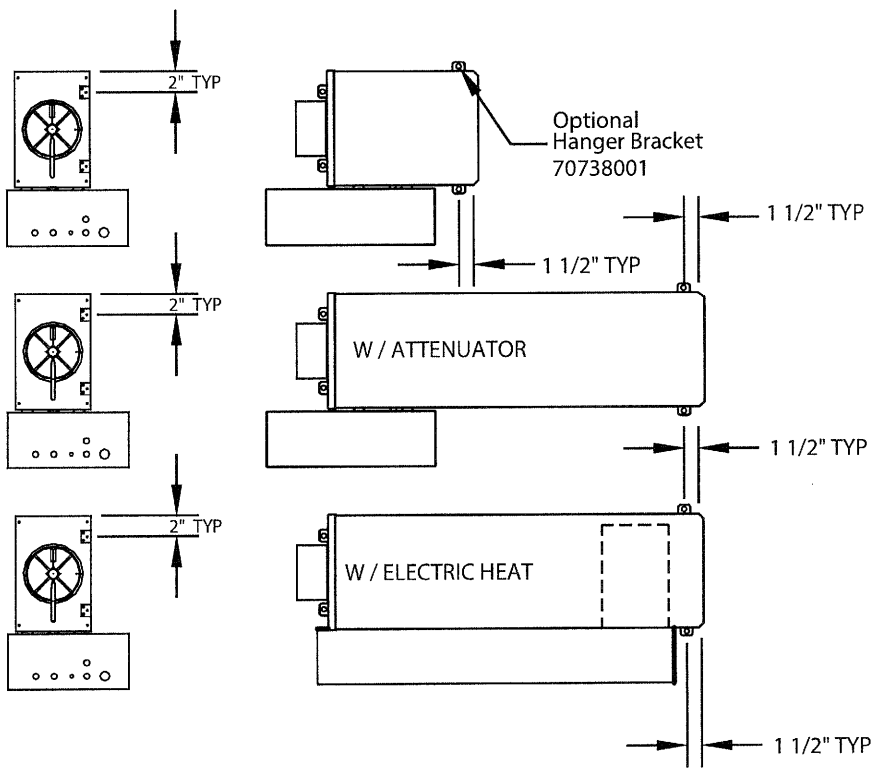


Figure 1. Single Duct Recommended Hanger Bracket Locations

Field Wiring

All field wiring must comply with the local codes and with the National Electrical Code (ANSI/NFPA 70-1981). Electrical, control and piping diagrams are shown on the exterior labeling or on the diagram on the inside of control enclosure cover. All electric heaters if provided by TITUS are balanced by kW per stage. The installing electrician should rotate these heater stages by phase in order to help balance the building electric load.

Control Start-up, Operation

Detailed information regarding power, accessory and communications connections, start-up and operating procedures for the controls provided by TITUS are available from your local TITUS representative. For specific information on controls by other manufacturers, contact that manufacturer's local branch or dealer.

Important: Units with digital controllers may incorporate specific communication addresses based on Building Management Systems Architecture, and original engineering drawings. Installing the terminal in a different location than noted on unit label may result in excessive start-up labor.

Calibration Instructions

For Pneumatic Controls, see PNEU-IOM: Operations Manual for Pneumatic Controls.

For Analog Controls: Titus TA1, see ANA-IOM: Analog Controller Calibration.

For Digital Controls: see control manufacturer's manual

Replacement Parts

Description	Part Number
Primary Damper Assembly	
Size 4-5-6"	31171301
Size 7"	31171302
Size 8"	31171303
Size 9"	31171304
Size 10"	31171305
Size 12"	31171306
Size 14"	31171307
Size 16"	31171308
Damper Shaft Extension	
Short Stub all sizes	70300301
Long Ext. Sz. 4-6, 14, 16	70300302
Long Ext. Sz. 7-12	70300303
Shaft Bearing - All	70324901
Control Tube	
Red Stripe 1/4" O.D.	61510035
Green Stripe 1/4" O.D.	61510234
Red Stripe 3/8" O.D.	61510279
Green Stripe 3/8" O.D.	61510280
Yellow Stripe 1/4" O.D.	61510260
White Stripe 1/4" O.D.	61510261
Blue Stripe 1/4" O.D.	61510262
Tees for sensor taps	
Plastic 1/4"	42150011
Plastic 3/8"	42150020
Plugs for tees	
1/4"	42160081
3/8"	10015601
AeroCross™ Multipoint Velocity Sensors	
Size 4"	3151520001
Size 5"	3151520001
Size 6"	3151520002
Size 7"	3151520003
Size 8"	3151520004
Size 9"	3151520005
Size 10"	3151520006
Size 12"	3151520007
Size 14"	3151520008
Size 16"	3151520009
Size 24" x 16"	3151520009

Titus
Redefine your comfort zone.™

Installation Manual

FB-IOM-1.0 6-18-15

Fan Powered Terminals VAV Terminals

Receiving Inspection

After unpacking the terminal, check it for shipping damage. If any shipping damage is found, report it immediately to the delivering carrier. Store units in a clean dry location and do not stack more than four high.

Also, inspect damper rotation of the unit by rotating the damper by hand to check for free movement, and ensure there is no damage or binding of the damper. If controls are connected to the damper, release the manual clutch (most controls are equipped with this) and rotate the damper by hand. If there is any restriction to the rotation of the damper, contact your Titus rep and inform them of this issue.

Caution: Do not use the inlet collar, damper shaft, flow sensor or air tubing as a handle to lift or move assembly. Damage to the unit or controls may result.

Before installation, remove fan packing and all foreign material from the unit. Check the blower wheel for free rotation.

Supporting the Assembly

Suspend the unit from the building structure in a horizontal plane with the access panels facing downward.

Do not obstruct the access panels with support channels or straps.

One inch long sheet metal screws can be used to penetrate the casing (see Figure 1). Use the support method prescribed for the rectangular duct on the job specifications. Unit may be equipped with optional hanging brackets (see Figure 2). Hanger rod up to 7/16" diameter may be used.

Note: If equipped with pneumatic controls, or unit is parallel fan type (Model TQP or FLP), the terminal must be mounted right side up. It must be level within ±10 degrees of horizontal, both parallel to the air flow and at the right angle of air flow. The control side of the terminal is labeled with an arrow indicating UP.

Duct Connections

Slip each inlet duct over the inlet collar of the terminal. Fasten and seal the connection by the method prescribed by the job specification.

The diameter of the inlet duct "D" in inches must be equal to the listed size of the terminal; e.g. a duct that actually measures 8 inches must be fitted to a size 8 terminal. The inlet collar of the terminal is made 1/8" smaller than listed size in order to fit inside the duct (see Figure 1).

Important: Do not insert duct work inside the inlet collar of the assembly.

Inlet duct should be installed in accordance with SMACNA guidelines. Rectangular discharge opening is designed for flanged duct connections. Fasten and seal by method prescribed in the job specification.

If single-point electronic velocity sensor is used, 3 to 5 inlet duct diameters of straight duct should be provided at the terminal inlet.

Minimum Access

Fan Powered terminals require sufficient clearance to service the fan blower assembly and internal actuator (if so equipped) from the bottom of the unit, low voltage controls from the side of the unit, and line voltage motor controls or electric heat section (if so equipped) from the rear or discharge of the unit.

For bottom access panel removal, 3" minimum vertical clearance below the unit is required, plus sufficient horizontal clearance to slide the access panel clear of the bottom of the unit. Horizontal clearance is dependent on access panel dimensions as indicated on product submittals.

For low voltage control enclosure access, a minimum of 18" is recommended. Specific control enclosure location is indicated on product submittals. Panel for low voltage enclosures are removable (not hinged). For line voltage motor controls or electric heat control access, a minimum of 36" should be provided to allow full opening of hinged access doors. Specific location is indicated on product submittals.

Important: These recommendations do not preclude NEC or local codes that may be applicable, which are the responsibility of the installing contractor.

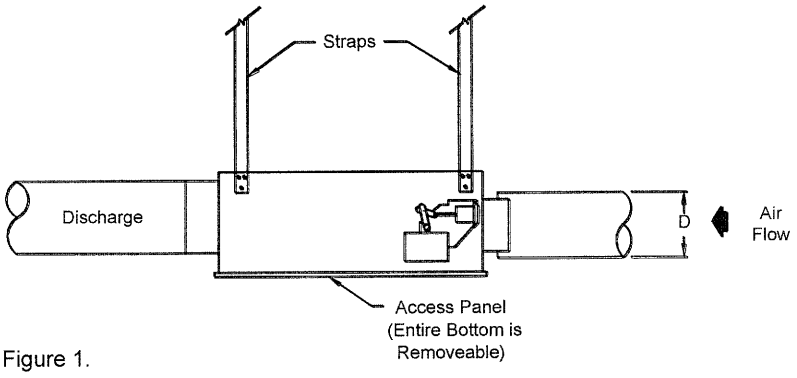


Figure 1.

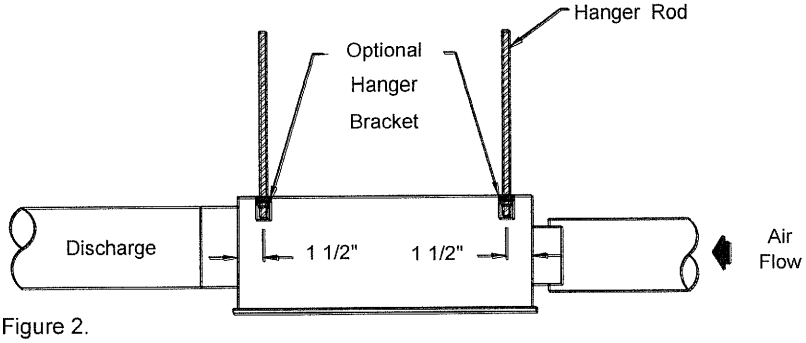


Figure 2.

Field Wiring

All field wiring must comply with the local codes and with the National Electrical Code (ANSI/NFPA 70-1996). Disconnect switches are optional equipment. Electrical, control, and piping diagrams are shown on the exterior labeling or on a diagram on the inside of the control and high voltage enclosure covers. Unless specified otherwise in the order write-up, all units are wired for a single point electrical connection to the fan and optional electrical heater. All electric heaters if provided by TITUS are balanced by kW per stage. The installing electrician should rotate incoming electric service by phase in order to help balance the building electric load.

Caution—Electrical Requirement:

1. Provide a safety disconnect per NEC 424-19, 20 & 21.
2. Disconnect all incoming power before wiring or servicing unit. All disconnect switches on the terminal (if so equipped) should be in OFF position while making power connections.
3. All field wiring must be in accordance with NEC and local code requirements. All units with electric heat should have copper wires for 125% of Nameplate Amperage.
4. Observe wiring diagram and instructions mounted on the unit. 480 V/3 phase units require a 4th (neutral) wire in addition to the full sized ground wire. All units must be grounded as required by NEC 424-14 and 250.

Unit Labeling

Each unit will have two main labels attached to the casing. The FAN UNIT label (Figure 3) lists the Model Number, Supply Voltage requirements, Motor Horsepower, and Overcurrent Protection requirements. The AIR FLOW label (Figure 4) lists the Model Number, Unit Size, Factory Order Number, and Location. The Location (or "Tag") indicates the engineer's planned location for the unit to be installed. There may be other labels attached to the unit, as options or codes may require.

Please read all labels on a typical unit, before beginning installation. If you have any questions, please contact the local TITUS Representative for clarification. Have the key points from the Air Flow label available for reference before calling.

Control Start-up, Operation

Detailed information regarding power, accessory and communications connections, start-up and operating procedures for the TITUS TD-1 controller (digital) or pneumatic and analog controls are available from your local TITUS representative. For specific information on controls by other manufacturers contact that manufacturer's local branch or dealer.

Note: Controllers may incorporate specific communication addresses based on Building Management Systems Architecture, and original engineering drawings. Installing the terminal in a different location than noted on unit label may result in excessive start-up labor.

Primary Air Damper

TFS, TQS and TQP Models:

To replace the damper blade and/or shaft assemblies:

a. Disconnect power before servicing. Remove control enclosure cover to access actuator.
b. Note position of damper shaft, using indicating arrow. Loosen linkage or actuator collar to allow damper to rotate freely.
c. Remove bottom access door to expose damper assembly. Rotate damper to fully closed position, exposing rivets holding damper blade to shafts.
d. Drill out rivets using 1/2" drill, rotate damper to fully open position, and slide damper and/or shaft assemblies out of the duct.
e. Fit new damper and/or shaft assemblies in place, using 1/4-20 screws with lock nuts to replace rivets.
f. Reverse procedure in steps c, b, and a, for assembly. When locking down actuator linkage or collar, position indicating arrow on damper in the same location as before the repair.

FLS and FLP Models:

These units use an opposed blade damper assembly that is not repairable. The entire assembly must be replaced.

Titus — Redefine your comfort zone.™

FAN UNIT

MODEL NO.:	DTFS	CODE:	88-XXXXX-A 2 REV:02			
MOTOR	VOLT:	277	PHASE:	1	HZ	60
	HP:	1/4	FLA(EA)	1.4		
HEAT	VOLT 277	PHASE	1	HZ	60	
	KW	6.0	AMPS	21.66		

MOTOR (S) ARE THERMALLY PROTECTED
MIN. SUPPLY CIRCUIT AMPS: 24 AMP
MAX. FUSE OR OVERCURRENT PROTECTION: 30 AMP
MAX. OUTLET AIR TEMPERATURE: 200F
UNIT DESIGNED TO OPERATE AT NO LESS THAN 0.2 IWG STATIC PRESSURE
ZERO CLEARANCE FROM UNIT, CONNECTED DUCT AND/OR PLENUM TO COMBUSTIBLE MATERIAL

Figure 3. FAN UNIT Label

Titus — Redefine your comfort zone.™

AIR FLOW

MODEL NO.	DTFS	SIZE:	C12
TOTAL CFM:	1100	MIN.CFM:	0
LOCATION:	AH-1		
FACTORY NO:	XXXXX	ITEM:	1
MOTOR:	DL01 L&G		
COIL:	E41-277V KW 6.00		
THST:			
DPR. POSITION:	DL01-FMA L&G		

UP

303155001015

Figure 4. AIR FLOW Label

Standard PSC Motor Fan Flow Adjustment

Note: Before starting fan motor, follow steps 1 and 2.

1. Discharge ductwork should be connected. The minimum recommended discharge static pressure is 0.2" wg. Be sure fan packing is removed from units with fan packing!
2. All foreign materials should be removed from duct system. Filters should be installed where required.
3. Standard PSC motors are shipped from factory at full speed setting. Allow motor to run-in at least 15 minutes before adjusting speed. During initial run-in, check ductwork connections for leaks and repair if necessary. (Do not adjust fan speed down if ductwork is not connected).
4. Unit is equipped with manual fan speed control, mounted on the bottom of the line voltage motor enclosure or electric heat enclosure. Turning the control counterclockwise will reduce the fan speed; clockwise will increase speed.
5. Set the unit to full heating (maximum induction). Adjust and set remote balancing dampers, if present. Adjust the speed control to deliver the required CFM by measuring air quantity at the room outlets.
6. Proceed to primary air adjustment procedure, detailed in control installation information. Fan should be re-adjusted with primary air and ventilation air at maximum setpoint, to insure that no supply air is discharged at the induction port.

ECM Motor Fan Flow Adjustment

Note: Before starting fan motor, follow steps 1 and 2.

1. Discharge ductwork should be connected. The minimum recommended discharge static pressure is 0.2" wg. Be sure fan packing is removed from units with fan packing!
2. All foreign materials should be removed from duct system. Filters should be installed where required.
3. PWM Fan Speed Controller
   a. ECM motors with manual PWM controllers are shipped from factory at design CFM when provided. Otherwise motors are shipped at motor full speed setting.
   b. ECM motors shipped with remote PWM controller require a signal from the DDC controller to control fan speed. **(See page 4 for operating instructions for remote pwm.)**
   c. Allow motor to run-in at least 15 minutes before adjusting speed. During initial run-in, check ductwork connections for leaks and repair if necessary. (Do not adjust fan speed down if ductwork is not connected).
4. ECM unit is equipped with either a manual control or a remote control PWM fan speed controller, mounted on the bottom of the line voltage motor enclosure or electric heat enclosure.
   a. The manual PWM controller has a screwdriver dial adjust pot and an LED readout. The LED display shows the flow index when the screwdriver adjust is turned. The flow index is a number from 0-100 which correlates to a CFM shown in the PWM calibration table. Use the screwdriver adjust to set the CFM of the unit.
   b. Remote PWM controllers require a signal from the DDC controller to control fan speed. An increase in DDC voltage signal from 0-10Vdc correlates linearly to the 0-100 flow index shown in the PWM calibration table. A green lamp continuously flashes to indicate the flow index value. Long flashes represent the tens digit and short flashes represent the units digit of the flow index.
5. Set the unit to full heating (maximum induction). Adjust and set remote balancing dampers, if present. Adjust the speed control to deliver the required CFM by measuring air quantity at the room outlets.
6. Proceed to primary air adjustment procedure, detailed in control installation information. Fan should be re-adjusted with primary air and ventilation air at maximum setpoint, to insure that no supply air is discharged at the induction port.

Maintenance Procedures:
Fan and Motor

Motor is equipped with permanently lubricated bearings. Inspect fan and motor assembly for accumulation of dust and dirt as required by operating environment. Clean as necessary.

If fan motor does not run:

a. Free rotation of blower wheel fan packing removed. Freight or installation damage.
b. Check for proper unit power Disconnects should be ON .Check optional fusing.
c. Check for proper control signal, P/E switch setting, proper air control 24 Vac at fan contactor, coil energized.

If fan motor runs, excessive noise:

a. Clearance problems on blower. All components securely attached.
b. Verify integrity of ductwork. Leaks or loose connections. Rattling diffusers or balancing dampers.
c. Maximum CFM too high, or discharge static pressure too low

If fan motor runs, insufficient air flow:

a. Check for ductwork restrictions. Dirty air filters. Clogged water coils.
b. Re-adjust fan speed control.
c. Discharge static pressure too high.

If repair or replacement is required:
Motor and fan should be removed as an assembly. Disconnect all power before servicing. Remove the hex nuts from the mounting lugs holding the fan assembly to the discharge panel, and lower the assembly. For model TFS, lift the motor / blower assembly to release the tabs from the discharge panel, then lower the assembly. Do not allow assembly to hang from wiring.

If removing motor from blower, first loosen the set screw holding the blower wheel to the motor shaft. Remove the three screws holding motor to the fan housing, and slide motor and fan housing apart.

Reverse the procedure for assembly.

Note: Over tightening motor mounting screws may crush isolation bushings, causing excessive fan noise.

Optional Water Coil Cleaning

In most cases, the supply side of the water coil (optional) can be cleaned by removing the bottom access door and cleaning the coil face through the open space between the motor / blower assembly and the unit casing.

If more space is desired to clean the water coil, the motor / blower assembly may be removed and reinstalled as described above.

Remote PWM Speed Controller

Please note remote PWM shall be set via BMS...any attempt to balance locally will be reset via BMS overide.

The remote PWM controller has a manual adjust potentiometer that allows the user to override the automation signal for 15 minutes, if the automation signal is less than 0.1VDC. This feature, allows heat to be used during construction and achieve air balancing before the automation is installed. However, if the automation is connected and available, automation tools should be used to balance the air.

Steps for Air Balance

Automation Air Balance

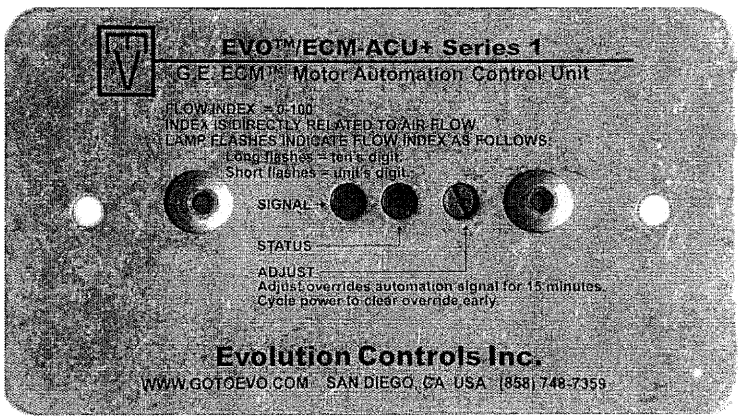
If Automation is already installed, air balance can be achieved using automation tools. Please notice that a control signal less than 0.2Vdc may put the ACU+ into manual override. Avoid setting the automation signal to less than 0.2Vdc. **Caution: turning Adjust locks out the automation signal for 15 minutes**. Cycle power for faster lockout removal.

Manual Air Balance

The ACU+ can be manually adjusted before automation is available. The balancer's manual adjustment has authority until automation is connected.

Air Balancer:

1. Use Adjust to set the air flow. This adjustment will have authority for at least 15 minutes.
2. Read the flashing green light and record the flow index on the air balance report.



Automation Integrator:

1. Set the Signal to 0Vdc to invoke manual override.
2. Record the RPM on the air balance report.
3. Enter the flow index the air balancer entered on the air balance report.
4. Observe the RPM is at or near the RPM observed in step 2.
5. Cycle the motor on/off 5 times. This clears the manual override function unless the "M" jumper is in place.

Replacement Parts List

Description	Part Number
Multipoint Velocity Sensors	
Size 6"	3151520002
Size 8"	3151520004
Size 10"	3151520006
Size 12"	3151520007
Size 14"	3151520008
Size 16"	3151520009
Damper Shaft Extension	
Short Stub All Sizes	70300301
Long Ext. Sz 6,14,16	70300302
Long Ext. Sz 8,10,12	70300303
Shaft Bearing – All	70324901
Primary Damper Assembly (TFS,TQS,TQP)	
Size 6	31171301
Size 8	31171303
Size 10	31171305
Size 12	31171306
Size 14	31171307
Size 16	31171308
Primary Damper Assembly (FLS, FLP)	
Sizes 2, 3	31171303
Size 4 FLS	31462102
Size 4 FLP	31462101
Induced Air Filters	
Model TFS	
B,C 16x14	1026491614
D,E 14x18	1026491418
Model TFS-F Fantom IQ™	
B,C 11x14	1026491114
D,E 18x17	1026491817
Model TQS, TQP	
2,3,4 19x17	1026491917
5,6,7 27x20	1026492720
Model FLS	
2,3,4 10x15	1026491015
Model FLP	
2,4 18x10	1026491810
Filter Bracket Universal	71124401
Filter Clip, Wire	10262701
Control Tube	
Red Stripe .25" O.D.	61510035
Green Stripe .25" O.D.	61510034
Red Stripe .38" O.D.	61510279
Green Stripe .38" O.D.	61510280
Tees for Sensor Taps	
Plastic .25"	42150011
Plastic .38"	42150020

Description	Part Number
Plugs for Tees	
.25" (1/4")	42160081
.38" (3/8")	10015601
Fan Motor Fuse (SC-CL-G 300V)	
1 Amp	10048301
3 Amp	10048501
4 Amp	10048601
6 Amp	10048801
8 Amp	10049001
10 Amp	10049101
12 Amp	10049201
15 Amp	10049301
20 Amp	10105201
Disconnects	
Fan Toggle	10027801
Door Interlock 3P/30A	10329101
Door Interlock 3P/60A	10329201
Door Handle	10329301
Adapter Kits	
Door Interlock 3P/30A	31489601
Door Interlock 3P/60A	31489602
Fan Relays	
1 Pole, 24V Coil	10156901
2 Pole, 24V Coil	10161801
Contactors, Magnetic	
2P/20A, 24V coil	10054401
2P/20A, 120V coil	10054402
2P/20A, 208/240V coil	10054404
2P/20A, 277V coil	10054403
Safety Devices	
Auto Reset Thermal Cutout for Elec. Coils	10052101
Air Flow Switch (AFS)	10269501
AFS Sensor 4" length	10057201
AFS Sensor 6" length	10057202
P.E. Switch, 1 step	10000901
P.E. Switch, 2 step	10199801
P.E. Switch, 3 step	10199802
Control Transformers	
120/24V, 50 VA	10029301
208/240/24V, 50 VA	10057501
277/24V, 50 VA	10006601
Hanger Brackets	
TFS	7247020103
TQS, TQP, FLS, FLP	70738001

Description	Part Number
Fan Speed Controllers (SCR)	
120V	10055301
208/240V	10057601
277V	10053301
Fan Motor Capacitors	
(120V, 208/240V, 277V)	
1/10 Hp Motor 4 MFD	10053001
1/6 Hp Motor 4MFD	10053001
1/4 Hp Motor 5 MFD	10053002
1/3 Hp Motor 10 MFD	10053003
1/2 Hp Motor 10 MFD	10053003
3/4 Hp Motor 20 MFD	10055701
1 Hp Motor 25 MFD	10053004
Mounting Bracket (all)	10054501
ECM Motor Components	
ECM Motor Mounting Assembly Includes: Motor Belly Band, Grommet Set (3), Nut, ¼ - 20 x 1½ Hex Bolt ¼ x ¾, ¼ x ¾ Screw (3), Washers (4)	31372602
PWM (Manual Operation)	15011201
PWM (Remote Operation)	10362701
277V Power Cable, 8 ft.	10320501
277V Power Cable, 5 ft.	10320502
24V Comm. Cable, 8 ft.	10334901
24V Comm. Cable, 5 ft.	10334902
120V Power Cable, 8 ft.	10343501
120V Power Cable, 5 ft.	10343502
Power Filter (1 hp)	10335001
Power Filter (½, 1/3 hp)	10335001

Replacement Parts List (cont.)

Fan Motors & Blowers

Model	Unit Size	HP	120V/1	208/240V/1	277V/1	Blower Assembly
	A	1/10	10051101	10056901	10051102	10192501
TFS, TFS-F	B	1/6	10095302	10150102	10096702	10192402
Left Hand	C	1/4	10051204	10150104	10051203	10045002
Unit	D	1/3	10151205	10151206	10151204	10358002
	E	3/4	10317204	10317205	10317206	10051006
TFS, TFS-F	B	1/6	10095301	10150101	10096701	10192401
Right Hand	C	1/4	10051201	10150103	10051202	10045001
Unit	D	1/3	10151201	10151203	10151202	10358001
	E	3/4	10317201	10317202	10317203	10051005
TQS	2	1/6	10095301	10150101	10096701	10051001
	3	1/4	10051201	10056902	10051202	10044601
	4	1/3	10151201	10151203	10151202	10051003
	5	1/3	10151201	10151203	10151202	10051003
	6	3/4	10051401	10057003	10051402	10051005
	7	1	N/A	31423101	31423102	10311701
TQP	2	1/6	10095301	10150101	10096701	10051001
	3	1/4	10051201	10056902	10051202	10044601
	4	1/3	10151201	10151203	10151202	10044601
	5	1/3	10151201	10151203	10151202	10051003
	6	3/4	10051401	10057003	10051402	10051005
FLS	2	1/6	10095301	10150101	10096701	10045501
	3	1/4	10095303	10150103	10096703	10045001
	4	1/6 (2)	10095301	10150101	10096701	10045002
FLP	2	1/6	10095301	10150101	10096701	10045001
	4	1/4	10095303	10150103	10096703	10045001

Replacement Parts List (cont.)

ECM Fan Motors & Blowers

Model	Unit Size	HP	120V/1	208/240V/1	277V/1	Blower Assembly
TFS w/ECM Motor Left Hand Unit	A	1/3	321014-095	321014-119	321014-093	10192401
	B	1/3	321014-063	321014-111	321014-055	10192402
	C	1/3	321014-064	321014-112	321014-056	10045002
	D	1/2	321014-065	321014-113	321014-057	10358002
	E	3/4	321014-075	321014-114	321014-076	10051006
TFS w/ECM Motor Right Hand Unit	B	1/3	321014-047	321014-103	321014-039	10192401
	C	1/3	321014-048	321014-104	321014-040	10045001
	D	1/2	321014-049	321014-105	321014-041	10358001
	E	3/4	321014-071	321014-106	321014-072	10051005
TFS-F w/ ECM Motor Left Hand Unit	B	1/3	321014-067	321014-115	321014-059	10192402
	C	1/3	321014-068	321014-116	321014-060	10045002
	D	1/2	321014-069	321014-117	321014-061	10358002
	E	3/4	321014-077	321014-118	321014-078	10051006
TFS-F w/ ECM Motor Right Hand Unit	B	1/3	321014-051	321014-107	321014-043	10192401
	C	1/3	321014-052	321014-108	321014-044	10045001
	D	1/2	321014-053	321014-109	321014-045	10358001
	E	3/4	321014-073	321014-110	321014-074	10051005
TQS w/ECM Motor	4	1/2	321014-016	321014-121	321014-001	10051003
	6	1	321014-017	321014-122	321014-002	10051005
TQS w/ UltraLoc w/ ECM Motor	4	1/2	321014-018	321014-123	321014-003	10051003
	6	1	321014-019	321014-124	321014-004	10051005
TQS-IAQ w/ ECM Motor	4	1/2	321014-020	321014-125	321014-005	10051003
	6	1	321014-021	321014-126	321014-006	10051005
TQS-IAQ & UltraLoc w/ ECM Motor	4	1/2	321014-022	321014-127	321014-007	10051003
	6	1	321014-023	321014-128	321014-008	10051005
FLS w/ ECM Motor	3	1/3	321014-028	321014-133	321014-013	10045001
	4CW	1/3	321014-029	321014-134	321014-014	10045002
	4CCW	1/3	321014-030	321014-135	321014-015	10045002
TQP w/ ECM Motor	4	½	321014-036	321014-139	321014-035	10051003
	6	1	321014-038	321014-140	321014-037	10051005

OPERATION & MAINTENANCE INSTRUCTIONS

Contractor: Eastern Mechanical

Job: ConnCat Culinary Arts

Product: Control Dampers

T.F. Melia Associates, Inc
9 Progress Drive
Cromwell, CT 06416

United Enertech

INSTALLATION AND MAINTENANCE INSTRUCTIONS

All Adjustable Louvers and Operating Dampers

BEFORE INSTALLING IN DUCT:

1. If the assembly is provided with un-joined jackshafting that operates more than one section, connect blade jumpers as required or bolt the two jackshafts together, depending on which is provided. Jackshafting may have been repositioned to prevent damage during shipment. If damper operator is to be mounted out of airstream, the jackshaft should extend through the bearing bracket and approximately 6" beyond frame. Secure jackshafting in place with provided clamps.

2. If applicable, link lower and upper jackshafts with the crossover bar through the ball joint on crank arm at each jackshaft. Locate crank arm close to bearing support bracket of jackshaft.

3. Improperly installed dampers and damper sections prevent blades form sealing properly (Fig. 1). Gaps between the blades and frame indicate a damper installed out of flat. Misalignment of the damper or damper sections can cause twist in the frame resulting in blade-to-linkage bind. This overloads the damper actuator or renders it inoperative.

4. We recommend lubricating moving parts with dry graphite.

5. Manual dampers should be run through a full-open to full-close cycle by hand to insure proper operation of the damper.

6. Motorized dampers should be checked by a preliminary attempt to operate with the motor. If binding occurs, disconnect one end of the driving linkage (and note its exact position beforehand) to operate damper manually and check per above. Reconnect linkage and check again.

7. Lift panels into duct (or opening) by its frame, not by any blade or hardware. Final position must be square, straight, plumb, and without twist.

8. Due to shipping and handling, dampers may arrive at the site slightly racked to twisted. Dampers are to be squared and not twisted prior to installation into square duct or sleeves.

9. Damper should be shimmed in the opening to prevent distortion of the frame by the fasteners holding it in place. Dampers with seals should be caulked to prevent leakage between the frame and duct.

10. CHECK DAMPER FOR FREE OPERATION BEFORE INSTALLATION.

MULTIPLE-PANEL DAMPERS:

Multiple-panel dampers will be tagged for ease of assembly.

OPERATORS:

1. An extended shaft kit is supplied if no operator is specified.

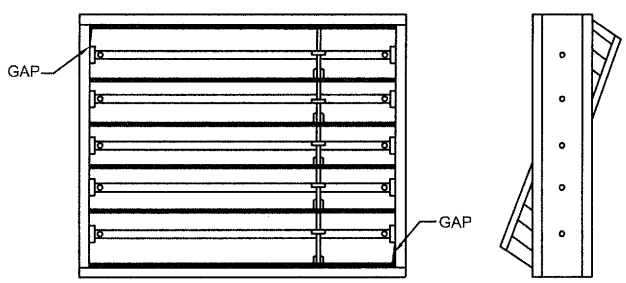
2. Reference specific installation instructions supplied with damper operator for motorized dampers.

MAINTENANCE:

In general this unit must be kept clean and free from foreign matter that may impede normal movement and seating of blades and seals (if applicable). A cleaning schedule should be established and is entirely dependent upon the environment into which the damper is placed. The damper is basically maintenace free with the above exception and regular lubrication and seal inspection as indicated below:

BEARINGS AND LINKAGE PIVOTS: Lubricate with dry graphite as required to provide free movement.

Fig. (1) Dampers Out of Square and Flat



IMPORTANT: Check Often. Use a square.

CAUTION:

Check damper linkage to ensure that blades move freely. Make sure that linkage rods are not bent or damaged. Also check blade brackets for damage. DO NOT INSTALL IF DAMAGED!

NEVER DISCONNECT LINKAGE! If for some reason it is necessary, precision mark the linkage arm where it connects to the actuator and re-connect. If linkage has been disconnected without being marked, power motor to full stroke and push linkage rod to extend louver blades to the full open position and connect and tighten to actuator.

Job Name:	Drawn By: CLJ	Date: 07-19-95	Rev. Date: 4-4-06
Location:			
Architect:			
Engineer:	Rev. No.: 9	Approved By: BGT	Dwg. No.: A-11
Contractor:			

UNITED ENERTECH'S RECOMMENDATIONS FOR PERIODIC INSPECTION, TESTING AND MAINTENANCE OF FIRE, SMOKE, AIR CONTROL AND OTHER LIFE SAFETY DAMPERS

RELATED PRODUCTS:

- All U-E Dampers: F/S, S, FDD, FD, CD, and C (Ceiling Dampers)

INITIALLY

- **Appropriately Commission or Acceptance Test all building systems. Verify and document that all systems operate satisfactorily and perform their appropriate functions per the building's design and that all Fire and Smoke Dampers are properly installed and perform as intended.**

EVERY SIX TO TWELVE MONTHS

- **Cycle Test (open and closed) all motorized Fire and Smoke Dampers**
- **Test all Dedicated Smoke Control Systems**

EVERY TWELVE MONTHS

- **Test all Non Dedicated Smoke Control Systems**
- **Test Operation of All Motorized Air Control Dampers.**

IN FIRST YEAR AND THEN EVERY FOUR YEARS

- **Visually Inspect all Fire Dampers, Ceiling Radiation Dampers, Smoke Dampers, and Combination Fire Smoke Dampers**

- **Manually operate (open and close) all fusible link operated Fire Dampers and Ceiling Radiation Dampers**

No routine preventive maintenance is required unless one of the above periodic inspections or tests identifies the need for maintenance.

INSPECTION, TESTING, AND MAINTENANCE OF FIRE DAMPERS, SMOKE DAMPERS, COMBINATION FIRE SMOKE DAMPERS, CEILING DAMPERS, AND AIR CONTROL DAMPERS

Purpose

Fire Dampers, Smoke Dampers, Combination Fire Smoke Dampers, Ceiling Radiation Dampers, and any other type of Damper that performs a safety function in building's Fire Protection or Life-Safety System must work properly at the appropriate time during a fire or smoke emergency. This could be years after their installation and initial testing. Everyone agrees that periodic inspection, performance testing, and maintenance are required to assure that these dampers function as intended when required in an emergency. A number of codes, standards, regulatory and manufacturer's publications have been issued recommending testing and maintenance intervals as well as testing and maintenance procedures.

The purpose of this document is to bring the more significant of these recommendations together and to provide guidance for a building owner to develop an appropriate periodic and continuing inspection, testing, and maintenance process for all Fire and Life-Safety Related Dampers installed in a building. This document puts more emphasis on life safety equipment, but the air control equipment also needs to be inspected at regular intervals. It is suggested that motor operated dampers be inspected during every other inspection of motorized fire and smoke dampers.

Background

Fire and Smoke Dampers are designed to perform a number of fire and life-safety functions in a building's HVAC and/or Smoke Control System. Generally, Fire and Ceiling Radiation Dampers are designed to close and prevent the spread of fire through an opening in a fire resistive barrier. Smoke and Combination Fire Smoke Dampers generally operate to prevent the spread of smoke by closing to stop airflow, opening to exhaust smoke, or by opening or closing to create pressure differences, which contain or control the spread of smoke.

Underwriters Laboratories (UL) has developed and maintains standards for the testing, qualification, and appropriate labeling of Fire Dampers (UL 555), Smoke and Combination Fire Smoke Dampers (UL555S) and Ceiling Radiation Dampers (UL555C). Manufacturers of these dampers, who have complied with these UL requirements, offer appropriately tested, qualified, and labeled dampers for installation where required in HVAC and Engineered Smoke Control Systems.

Building Codes and several NFPA and ASHRAE Standards identify where Fire and Smoke Dampers are required to be installed in a building's HVAC and/or Smoke Control System. Architects and Design Engineers usually incorporate Code required dampers in their building designs but also may incorporate additional requirements depending on a building's specific purpose and intended function. Most building codes allow architects and engineers to demonstrate that a designed system will provide all needed fire and life-safety functions even though it may not include all code mandated features (such as dampers).

Commissioning or Acceptance Testing

The term **Commissioning** is used to define a process in which all aspects of a new building are started, run, checked out, and shown to be operating as intended by the building's design. Insuring that a building's mechanical systems, its HVAC System, and any Smoke Control or other Life-Safety related systems operate properly (including all Fire and Life-Safety Related Dampers), **and documenting their proper operation** is the aim of the Commissioning process. This process is also called **Acceptance Testing.** ASHRAE and NFPA have developed guidelines and procedures for Acceptance Testing or Commissioning of HVAC, Smoke Control, and other Fire Life Safety Related Systems.

Commissioning a building establishes a point for the beginning of a periodic testing and maintenance program for Fire and Life-Safety Related Dampers. If a building has not been appropriately commissioned, all systems including all dampers must be demonstrated to be operating properly before beginning a continuing testing and maintenance program. It is also extremely important that proper operation of all systems and components be documented to establish a point from which to begin any damper testing and maintenance program. ASHRAE and NFPA recommendations for appropriate documentation should be followed.

Continuous Inspection, Testing, and Maintenance

Fire Life-Safety Related Dampers that are properly applied, equipped with the appropriate UL Labels, appropriately installed, and demonstrated to function as intended through a building commissioning process should require no specific preventive maintenance. The procedures hereinafter discussed are intended to insure that nothing interferes with a damper's proper operation and to identify and eliminate a number of potential situations, which could so interfere.

Generally there are two distinctly separate types of Fire and Smoke Dampers:

- **Fusible Link Operated Dampers:** Fire Dampers and Ceiling Radiation Dampers usually are held in an open position by a fusible link, which is designed to melt at a certain temperature allowing gravity or a spring to close the damper. These dampers then remain closed until reopened manually requiring a new fusible link to be installed. Some of these dampers incorporate a latch to hold them in the closed position, others do not.
- **Motor Operated Dampers:** Smoke Dampers and Combination Fire Smoke Dampers are most often, motor operated. An electric or pneumatic actuator is incorporated as part of the damper assembly. This actuator, responding to control signals from devices such as a high temperature thermostat, a smoke detector, a building's Fire Control Command Center, a sprinkler water flow switch, or possibly other such devices, will position the damper open or closed allowing it to execute its appropriate function during periods of normal or emergency operation.

Cycle Test Each Motor Operated Damper at Least Once Every Six to Twelve Months

All Smoke and Combination Fire Smoke Dampers equipped with electric or pneumatic actuators should be cycled open and closed on a regular periodic basis. This may occur in normal system operation if systems are regularly shut down (i.e. daily or weekly) and if the motorized fire and smoke dampers are arranged to shut or cycle when their corresponding system is shut down.

In any event, a procedure should be established to **cycle all motorized fire and smoke dampers a minimum of one time every six months to one year**. This will verify that each damper is operational and prevent the remote possibility that a damper actuator, continuously actuated for long periods of time, looses its ability to close when appropriately signaled to do so.

This six to twelve months check of all motorized fire and smoke dampers should be accomplished, wherever possible, by simulating an actual fire emergency. Operation of dampers with remote positioning indication can be verified by observing the remote position indication. In the absence of any remote damper position indication, the damper actuator (and damper where appropriate) shall be observed, as it is cycled open or closed. As all damper and actuator manufacturers require this periodic testing, appropriate records should be maintained documenting that each damper has been cycle tested a minimum of once every six months.

Testing of Smoke Control Systems

NFPA 92A (Standard for Smoke Control Systems Utilizing Barriers and Pressure Differences) mandates the following:

- The smoke control system shall be operated for each control sequence in the current design criteria.

- Operation of the correct outputs for each given input shall be verified.
- Where standby power is provided, tests shall also be conducted under standby power.
- **Dedicated Systems should be tested semi annually.**
- **Non Dedicated Systems should be tested at least annually.**

Dedicated Systems are Smoke Control Systems that have no function other than providing smoke control, such as a Stairwell Pressurization System. The previously discussed requirement for every six month (semi annual) cycle testing of all motor operated fire smoke dampers should be a part of the semi annual testing of any Dedicated Smoke Control System.

Non Dedicated Systems are Smoke Control Systems that utilize part or all of a building's HVAC system to perform smoke control functions during a fire emergency, such as a zoned smoke control system. Motorized Fire and Smoke Dampers that are part of any Non Dedicated Smoke Control System must be cycle tested every six months. If these systems are only tested on an annual basis, provisions must also be made to cycle test all associated motorized fire smoke dampers on a six month or semi annual basis.

Inspect all Fusible Link Operated Dampers at One Year After Installation and at Least Every Three Years After

Unlike Motor Operated Dampers, Fusible Link Operated Dampers cannot be cycled open and closed without accessing the damper and manually removing and reinstalling the fusible link. As this is an extremely time consuming process, and because this introduces the possibility the fusible link may be reinstalled improperly, actual cycling (open and closed) of fusible link operated dampers is recommended at first year anniversary and every three years after.

NFPA 90A – 2002 (Standard for the Installation of Air-Conditioning and Ventilating Systems)

- **Recommends:** Each damper should be examined every 2 years ensuring that it is not rusted or blocked, giving attention to hinges and other moving parts. It is recommended that dampers operate with normal system airflow to ensure that they close and are not held open by the airstream. Care should be exercised to ensure that such tests are performed safely and do not cause system damage.

- **Requires:** The following maintenance be performed on fusible link operated dampers at least every 4 years:
    1. Fusible links (where applicable) shall be removed.
    2. All dampers shall be operated to verify that they close fully.
    3. The latch, if provided, shall be checked.
    4. Moving parts shall be lubricated as necessary

  UE recommends any obstructions, dirt build up, and any rust or corrosion be removed using mild solvents or detergents. If needed, damper tracks and blade hinges may be lubricated with a dry lubricant such as Silicone Spray or TFE Dry Lube. **Never use a petroleum based lubricant as it will attract dust and eventually impede a damper's operation.**

  During any inspection and testing of fusible link operated dampers, UE recommends the following:
    1. Caution is advised when a fusible link is tripped or suddenly released. Gravity or spring operated dampers may slam closed causing an abrupt interruption of airflow. As this could cause damage to ductwork, consideration should be given to conducting these tests without system airflow.
    2. When removing the fusible link to check damper operation, be sure to keep fingers, hands, and any other body parts out of the blade travel path to prevent injury.

3. Check closure springs. If defective, contact damper manufacturer for replacement procedures.

Note: Some fire dampers (especially spring operated fire dampers) may, because of their size and/or location, be difficult or in some cases impossible to manually open and close. In these instances, a thorough inspection should be made to insure that nothing would prohibit the damper from closing. This should include verifying that the damper has been installed squarely and free from racking or twisting and that blade channels are free of all obstructions.

Additional Testing, Maintenance, and Inspection Recommendations from UE

The preceding procedures are strongly endorsed by AMCA (the Fire and Smoke Damper Manufacturer's Trade Association) along with the following additional recommendations:

Conduct a Recommissioning or Acceptance Testing Program after any renovation or remodeling project

Any remodeling, reconstruction, or other changes to a building, even those that do not appear to affect a building's HVAC or Smoke Control System, can introduce dirt or debris into the system. Dirt or debris is likely to interfere with proper damper operation. Repeating the original Acceptance Tests or Commissioning Procedure is recommended to insure proper operation of all systems and components, including Fire and Smoke Dampers. In any event, appropriate steps must be taken to make certain any remodeling or reconstruction has not adversely affected any Fire Protection or Life-Safety System.

All Fire Smoke and Life Safety Related Dampers should be inspected every two years

Previously stated recommendations call for the cycle testing of all motor operated dampers every six to twelve months, the operational testing of smoke control systems every six to twelve months, and the physical inspection of all fusible link operated dampers every three years. No periodic preventive maintenance is required unless a periodic inspection or test reveals a specific need.

As cycle testing of motor operated dampers does not always require a visual inspection of the damper (operation can often be verified by remote indication), the additional requirement of visually inspecting motor operated dampers every two years is recommended. As part of the inspection procedure UE recommends the following:

- Remove any obstructions, dirt, rust, corrosion, or other observed conditions that could impede proper damper operation. Clean damper blades and other moving parts if necessary. Use of mild detergent or solvents is recommended for any required cleaning.
- Check linkage between actuator and damper and tighten or adjust if necessary.
- Cause the actuator to operate the damper open and closed. Operation should be smooth and positive throughout entire stroke. Verify that damper blades close and open completely.
- If necessary lubricate linkage, bearings, and other moveable parts using a dry lubricant such as silicone spray or TFE Dry Lube to ensure smooth operation. **Never use a petroleum based lubricant as it will attract dust and eventually impede a damper's operation**.
- In regards to dampers that use thermostats on them for their heat response device, the thermostat does not require any general maintenance other than removal of any debris collected on it.

What If a Fire Smoke Damper Actuator Fails to Operate Properly?

Actuators supplied as an integral part of any UL Labeled Fire Smoke Damper are intended to operate properly throughout the expected design life of the system; however premature failures will occasionally occur. If, during any period test or inspection, a fire smoke damper actuator fails to operate properly, the following steps should be taken to insure that the actuator, itself, is inoperable:

- Verify that appropriate power (voltage or pneumatic air pressure) is being supplied to the actuator.
- Determine what condition and specific control signal (from a thermostat, smoke detector, etc.) are required to cause a damper's operation. Verify that the appropriate control signal is being generated. If this is impractical, disconnect any system wiring or piping and provide the appropriate voltages and signals from a separate reliable source. If the actuator fails to operate, it should be replaced.

Any field replacement of a fire smoke damper actuator should follow the damper manufacturer's specific instructions for this procedure. Fire smoke dampers and their installed actuators are tested and qualified as a unit by UL. The actuators themselves must also meet specific requirements developed by UL and each damper manufacturer. UE recommends that any actuators requiring field replacement be obtained from the damper manufacturer who originally supplied the dampers, along with a detailed procedure for appropriate field replacement. Use of a similar actuator obtained through local distribution channels may not provide all appropriate and required features.

Appropriately Record all Periodic Inspections, Tests, and any Maintenance Performed on any Dampers

An appropriate record or log page should be established for each Fire or Life Safety related damper installed in a building. It is suggested that this record page include the damper's type, manufacturer, make or model number, ratings, date installed, date of commissioning and or acceptance, location (including system or portion of system it is serving), and a listing of recommended periodic inspections and testing. Space should also be provided to record observations made during periodic inspection and testing as well as any corrective actions taken. Any replacement of actuator or other parts or damper components should be recorded for future reference.

The actual format of any log or record sheet can vary to suit a particular building's needs. Development of an appropriate digital format is encouraged, as this would facilitate sorting by systems or other means to aid in organizing and conducting the periodic inspection process.

Reference List of Publications Related to Periodic Inspection, Testing and Maintenance of Fire and Smoke Dampers

Published by the National Fire Protection Association:

- NFPA 90 A Installation of Air Conditioning and Ventilating Systems
- NFPA 92 A Standard for Smoke Control Systems Using Barriers and Pressure Differences
- NFPA 92 B Guide for Smoke Management Systems in Malls, Atria, and Large Areas

Published by the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE)

- ASHRAE Guideline 5-1994 Commissioning of Smoke Management Systems
- ASHRAE Guideline 1-1996 The HVAC Commissioning Process

Published by Underwriter's Laboratories

- UL 555 Standard for Fire Dampers
- UL 555S Standard for Smoke Dampers
- UL 555C Standard for Ceiling Dampers
- Marking and Application Guide – Dampers for Fire Barrier and Smoke Applications & Ceiling Dampers

Johns Manville

Microlite® XG™

Formaldehyde-free™ Fiber Glass Duct Wrap Insulation

Description

Microlite XG Formaldehyde-free™ duct wrap insulation is a white, lightweight, highly resilient, blanket-type thermal insulation. The insulation blanket is manufactured from rotary-process fiber glass bonded with a special thermosetting acrylic resin.

Available Forms

Microlite XG Formaldehyde-free™ insulation is available in a variety of densities, thicknesses and roll lengths. It is supplied with an FSK (foil-scrim-kraft) vapor barrier facing to meet installed performance requirements, with a 2" (51 mm) stapling tab.

Uses

Microlite XG is recommended as thermal insulation for the exterior of HVAC systems or other spaces or surfaces where temperature control is required.

Facing Information

FSK Aluminum Foil
Reinforced with fiber glass scrim laminated to UL rated kraft.
Permeance: 0.02 perms*

**Per ASTM E96, Procedure A for facing material prior to lamination. After lamination, permeance values may be higher.*

General Properties

Temperature (max.) – ASTM C411	250°F (121°C)
Water vapor sorption – ASTM C1104	<5% by weight
Corrosivity with steel – ASTM C665	Does not accelerate
Fungi resistance – ASTM C1338	Does not breed or promote

Standard Thicknesses and Packaging

	100' Roll (31 m)	75' Roll (23 m)	50' Roll (15 m)
Type	Thickness, in (mm)		
75	1½ (38)	2, 2⅓ (51, 58)	3 (76)
100	1½ (38)	2 (51)	–
150	–	1½ (38)	2 (51)

Note: Additional thicknesses, widths and other lengths available on special order. Contact Regional Sales Office for availability.

Surface Burning Characteristics

Microlite XG meets the Surface Burning Characteristics and Limited Combustibility of the following standards:

Standard/Test Method
- ASTM E84
- UL 723
- NFPA 90A and 90B
- UL Guide No. 40 U8.3. Card R3711
- CAN/ULC S102-1188

Maximum Flame Spread Index	25
Maximum Smoke Developed Index	50

Notes: Faced materials are tested as composite products (insulation, adhesive and facing). UL labels supplied on packages when requested on order.

Specification Compliance

ASTM C1290	Type 75, 100 & 150
ASTM C553*	
Type II	Type 75, 100 & 150
Type III	Type 150

**For faced material: 250°F (121°C) maximum temperature.*

ASTM C1136s†	
Type II	FSK Facing

†Replaces HH-B-100B, Type II.

Canada: CGSB 51-GP-11M
NYC MEA 40-75-M

Green Building Certifications

Recycled Content	SCS Certified
ES 1350	Meets Requirements
ENERGY STAR®	Yes
LEED® Credits LEED®-NC	See JM.com/buildgreen, JM LEED® Credit Guide (HIG-1231)

SCS CERTIFIED INDOOR ADVANTAGE GOLD
PLUS FORMALDEHYDE FREE
SCIENTIFIC CERTIFICATION SYSTEMS
SCS-IAQ-02088

SCS CERTIFIED Minimum 25% Recycled Content
5% Pre-consumer
20% Post-consumer
SCIENTIFIC CERTIFICATION SYSTEMS
SCS-MC-01073

JM Certified Formaldehyde-free™ Fiber Glass Insulation

JM certified Formaldehyde-free™ fiber glass insulation offers superior thermal and acoustical performance—and it improves indoor air quality because it's made without formaldehyde. Why is that important? Because the U.S. Environmental Protection Agency (U.S. EPA) recommends limiting exposure to formaldehyde as much as possible, and the California Air Resources Board, a division of the California EPA, recommends that builders and architects use building materials and insulation made without formaldehyde.

Microlite® XG™

Formaldehyde-free™ Fiber Glass Duct Wrap Insulation

Application Recommendations

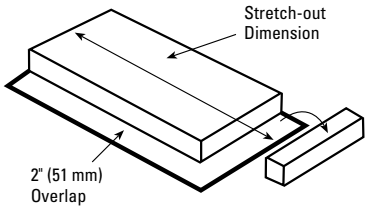
The R-value will vary depending upon how much the insulation is compressed during installation. To obtain the published installed R-values, the insulation stretch-out should be determined using the following table:

Duct Wrap Stretch-outs

Labeled Thick. (in)	Installed Compressed Thickness (in)	Round	Square	Rectangular
1	0.75	P+ 7.0"	P+ 6.0"	P+ 5.0"
1½	1.125	P+ 9.5"	P+ 8.0"	P+ 7.0"
2	1.50	P+ 12.0"	P+ 10.0"	P+ 8.0"
2⅓	1.75	P+ 13.0"	P+ 11.0"	P+ 8.5"
3	2.25	P+ 17.0"	P+ 14.5"	P+11.5"

Stretch-outs include 2" (51 mm) for overlap. P = perimeter of duct to be insulated.

Prepare overlap by removing approximately 2" (51 mm) of insulation from facing.



Before applying duct wrap, sheet metal duct shall be clean, dry and tightly sealed at all joints and seams.

Wrap insulation around duct with facing to the outside so the 2" (51 mm) flap completely overlaps facing and insulation at the other end of stretch-out. Insulation shall be snugly butted.

Secure seams with outward clinching staples placed approximately 6" (152 mm) on center. If required, seal seam with pressure-sensitive tape designed for use with duct insulation. Insulation on the underside of ducts spanning 24" (610 mm) or greater shall be secured with mechanical fasteners and speed clips spaced approximately 18" (457 mm) on center. Fasteners should be cut off flush after the speed clips are installed, and when required, sealed with the same tape as specified above.

Adjacent sections of duct wrap insulation shall be snugly butted with the circumferential 2" (51 mm) tape flap overlapping and secured as recommended for the longitudinal seam. When a vapor seal is required, two coats of vapor retarder mastic reinforced with one layer of 4" (102 mm) wide, open-weave glass fabric may be used in lieu of pressure-sensitive tape.

Guide Specifications

Insulation for Metal Ducts. All ducts shall be insulated on the outside with a Formaldehyde-free™, flexible glass fiber blanket. Microlite XG Formaldehyde-free™ fiber glass duct wrap insulation should have a minimum installed R-value* of _____, and a Type_____ facing. Insulation shall be furnished with a factory-applied facing with a composite UL FHC rating of 25/50.

**The minimum insulation installed R-value should be determined in accordance to the duct operating and ambient conditions.*

Thermal Conductivity (ASTM C518)

Type	k* Compressed Thickness Btu•in/(hr•ft²•°F)	k* Compressed Thickness W/m•°C	k Labeled Thickness Btu•in/(hr•ft²•°F)	k Labeled Thickness W/m•°C
75	0.27	0.039	0.29	0.042
100	0.25	0.036	0.27	0.039
150	0.24	0.035	0.25	0.036

Conductivity at 75°F (24°C) mean temperature.
**Tested with material thickness compressed 25%.*

Installed R-values

Type	Labeled Thickness in	Labeled Thickness mm	Installed "R"† (hr•ft²•°F)/Btu	Installed "R"† m²•°C/W	Out-of-Package "R" (hr•ft²•°F)/Btu	Out-of-Package "R" m²•°C/W
75	1½	38	4.2	0.74	5.2	0.92
	2	51	5.6	0.99	6.9	1.22
	2⅓	58	6.5	1.15	8.0	1.41
	3	76	8.3	1.46	10.3	1.81
100	1½	38	4.5	0.79	5.6	0.99
	2	51	6.0	1.06	7.4	1.30
150	1½	38	4.7	0.83	6.0	1.06
	2	51	6.3	1.11	8.0	1.41

†Installed R-value calculated with a material thickness compressed to a maximum of 25% following recommended duct wrap stretch-outs.

Johns Manville

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Fax: (419) 784-7866

Western Region and Canada
P.O. Box 5108
Denver, CO 80217
(800) 368-4431
Fax: (303) 978-4661

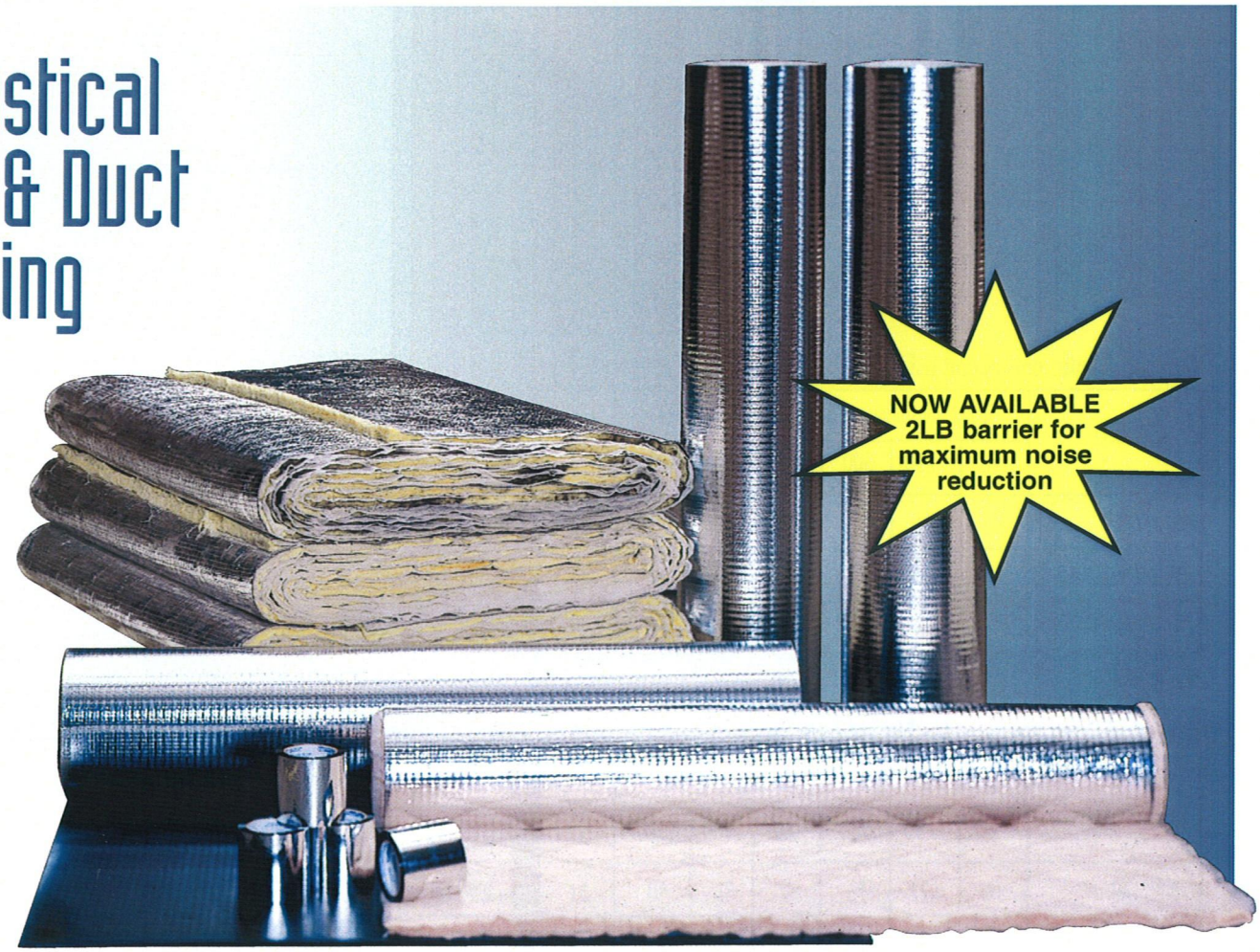
The physical and chemical properties of the Microlite® XG™ listed herein represent typical, average values obtained in accordance with accepted test methods and are subject to normal manufacturing variations. They are supplied as a technical service and are subject to change without notice. Numerical flame spread and smoke developed ratings are not intended to reflect hazards presented by these or any other materials under actual fire conditions. Check with the Regional Sales Office nearest you to ensure current information. **All Johns Manville products are sold subject to Johns Manville's standard Terms and Conditions, including Limited Warranty and Limitation of Remedy. For a copy of the Johns Manville standard Terms and Conditions, Limited Warranty and Limitation of Remedy, and information on other Johns Manville thermal insulation and systems, call (800) 654-3103.**

AHS-331 06/10 (Replaces 02/10)

Industrial
NOISE CONTROL PRODUCTS

Bulletin
SS-105

Acoustical Pipe & Duct Lagging



Sound Seal's Industrial Division Lag Series, which is designed to offer significant reduction of radiated noise, consists of a loaded vinyl noise barrier with a scrim reinforced aluminum foil facing on one side. The LAG barrier is available in two weights and in combination with a nominal 1" thick or 2" thick quilted fiberglass decoupler. In addition to readily accepting a matching lag tape for quick and easy installation, the foil facing offers excellent corrosion resistance, high strength and excellent conformability. The quilt decouples the loaded vinyl barrier from the noise-emitting surface achieving optimum noise reductions. The one-step installation of the decoupler, barrier and protective jacket offers substantially lower installation costs. This composite combination is also designed to provide thermal insulation to reduce energy consumption.

Products in the LAG series are commonly used for wrapping:

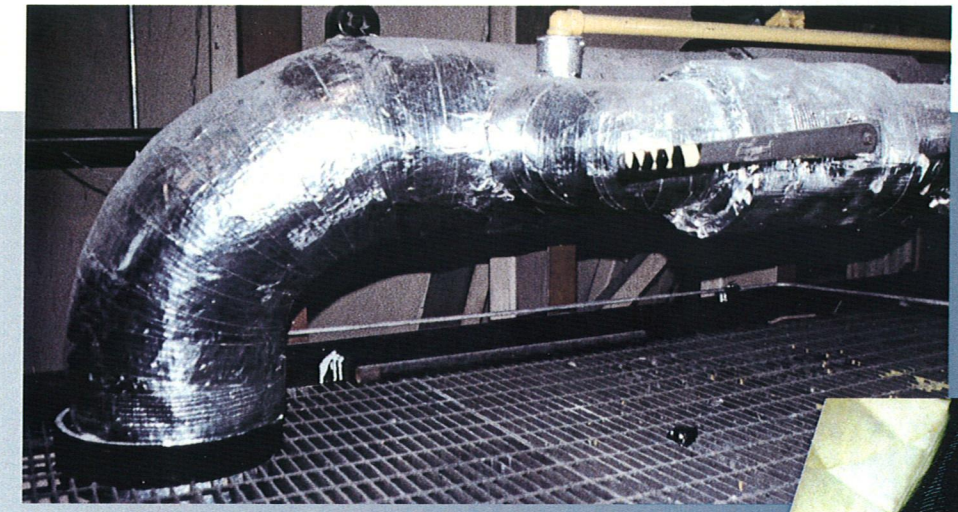
- Noisy iron, steel, and plastic pipe
- Ducts
- VAV units
- Heat exchangers
- Fans
- Mechanical rooms

FEATURES:

- Up to 20 decibel reduction
- STC ratings to 34
- Easy to cut and install
- Accepts matching lag tape
- Quilted fiberglass decouplers available
- Available in a Class A flammability rated composite
- Passes UL-94, FMVSS 302
- High and low temperature applications
- Convenient 54" x 30' roll size

SOUND SEAL®

Acoustical Pipe & Duct Lagging



B-10 LAG/QFA-3 Acoustical Pipe Lagging

LAG Tape
4"x200' rolls

Acoustical Data: one-pound psf based lag products

Product	Sound Transmission Loss (dB) Frequency (Hz)						STC
	125	250	500	1000	2000	4000	
B-10 LAG	15	18	22	27	32	37	27
B-10 LAG/QFA-3	18	18	23	30	39	46	29
B-10 LAG/QFA-9	19	20	23	33	44	53	30

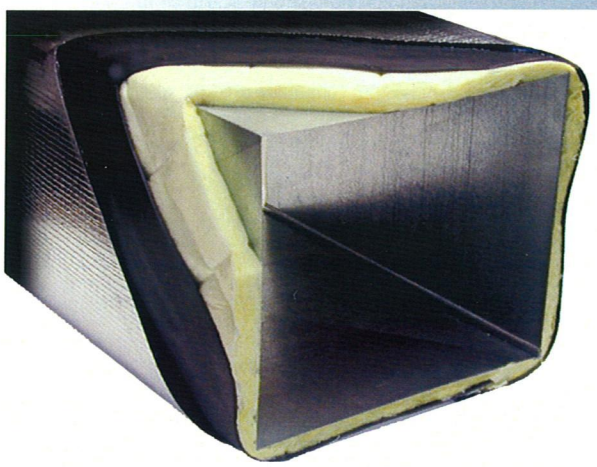
Per ASTM: E90

Acoustical Data: two-pound psf based lag products

Product	Sound Transmission Loss (dB) Frequency (Hz)						STC
	125	250	500	1000	2000	4000	
B-20 LAG	16	22	26	32	35	40	31
B-20 LAG/QFA-3	20	23	28	37	48	56	32
B-20 LAG/QFA-9	21	24	29	41	54	68	34

Physical Properties of Components:

Product	Weight	Thickness	Service temperature	"R" Factor
B-10 LAG	1lb.PSF	.090"	-10° to 180°F	1.0
B-20 LAG	2lb.PSF	.23"	-10° to 180°F	1.0
QFA-3	.2lb.PSF	1"Nom	-20° to 350°F	4.0
QFA-9	.4lb.PSF	2"Nom	-20° to 350°F	8.0



B-10 LAG/QFA-3 is a multi-layered acoustical lagging designed to reduce noise that radiates thru the walls of ductwork or piping. Cutaway view shows the quilted fiberglass decoupler, the loaded vinyl noise barrier and the outer reinforced foil jacket.

Distributed By:

SOUND SEAL®

50 H. P. Almgren Drive
Agawam, MA 01001
TEL: 413.789.1770
FAX: 413.789.2248
e-mail: sales@soundseal.com
www.soundseal.com

Johns Manville

Micro-Lok® *HP*

High-Performance Fiber Glass Pipe Insulation

DESCRIPTION

Micro-Lok *HP* Fiber Glass Pipe Insulation is a high-performance insulation made from rotary glass fibers bonded with a thermosetting resin and produced in 36" (0.92 m) lengths. Micro-Lok *HP* insulation is used to insulate standard iron pipe and copper tubing. The 3' (0.92 m) sections are available plain or with a factory-applied vapor-barrier jacket. The all-service (ASJ) vapor-retarder jacket includes a longitudinal, self-sealing closure lap. The jacket system is adhered to each fiber glass section using a specially formulated adhesive to ensure jacket securement. Latex paint may be applied to the Micro-Lok *HP* jacket after installation.

The factory-installed tape system permits installation at ambient temperatures down to 20°F (-7°C) and will not soften or separate when exposed to high ambient temperatures and humidity.

USES

Micro-Lok *HP* fiber glass pipe insulation is suitable for installation over hot, cold, concealed and exposed piping systems with operating temperatures up to 850°F (454°C). Weather-protective jacketing is required for outdoor applications. Pipes operating below ambient temperatures require all joints to be sealed with the factory-applied, self-seal lap and butt strips.

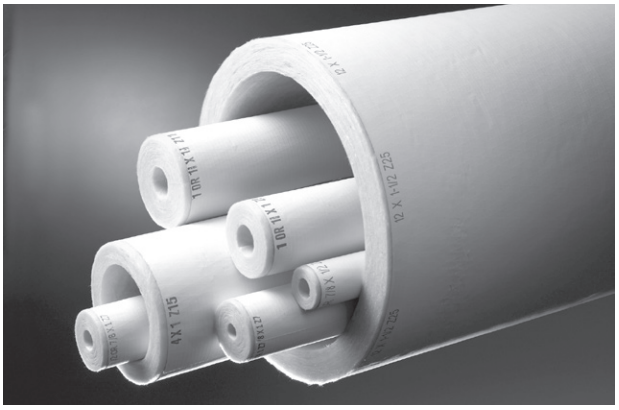
PHYSICAL PROPERTIES

Service Temp. Range (ASTM C411)	0°F to 850°F (-18°C to 454°C)
Moisture Sorption	<5% by weight
Alkalinity	<0.6% expressed as Na_2O
Corrosivity (ASTM C665)	Does not accelerate
Capillarity	Negligible (after 24 hours)
Shrinkage (ASTM C356)	None
Microbial Growth (ASTM C1338)	Does not promote microbial growth
Surface Burning Characteristics	Composite FHC 25/50 per ASTM E84, NFPA 255, CAN/ULC S102-M88
Limited Combustibility	NFPA 90A and 90B
Jacketing	ASTM C1136 (Type I)
Water Vapor Permeance (ASTM E96 – Procedure A)	0.02 perms max.
Burst Strength (ASTM D774)	50 Beach Units (1.5 Joules min.)
Tensile Strength (ASTM D828)	45 lbs./in. (7.9N/mm) width min. (MD) 30 lbs./in. (5.23N/mm) width min. (CD)

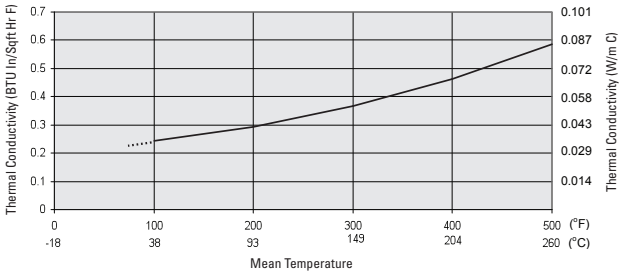
Operating Temperature Limits: 0°F to 850°F (-18°C to 454°C)

SPECIFICATION COMPLIANCE

- ASTM C547 Type I (Replaces HH-I-558B, Form D, Type III, Class 12, Class 13 up to 850°F [454°C])
- ASTM C585 – Dimension Standard
- ASTM C1136 (Jacketing) (Replaces HH-B-100B, Type I & II)
- MIL-I-22344D
- NRC 1.36, ASTM C795, MIL-I-24244C
- Coast Guard/IMO Approved 164.109/56/0 (plain, unjacketed only – excluding ⅞ x ½ [22 mm x 13 mm], ½ x ½ [13 mm x 13 mm])
- New York City MEA # 330-85-M
- California Bureau of Home Furnishings and Thermal Insulation – Registry Number CA-T040 (CO)
- Firestop Assemblies: Meets requirement for jacketed fiber glass pipe insulation product density at or above 3.5 pcf.



THERMAL CONDUCTIVITY ("K")



MEAN TEMPERATURE	K	K(SI)
75˚F (24˚C)	0.23	0.034
100˚F (38˚C)	0.24	0.035
200˚F (93˚C)	0.28	0.040
300˚F (149˚C)	0.34	0.049
400˚F (204˚C)	0.44	0.063
500˚F (260˚C)	0.55	0.079

GREEN BUILDING ATTRIBUTES

Manufacturing Location	Defiance, Ohio (43512)	
Recycled Content	36%	
Volatile Organic Compounds (ASTM D5116) (Analysis ASTM D6196 & ASTM D5197)	Total	0.15 g/l
Fiber Glass Pipe Insulation	Formaldehyde	0.009 ppm
	Aldehydes	0.009 ppm
Volatile Organic Compounds (Calculated)	Total	<49 g/l
Self-Sealing Lap & Butt Strips		

GREEN BUILDING CERTIFICATIONS

GREENGUARD®	
• Indoor Air Quality	Certified
• Children and Schools	Certified
LEED® Credits	
LEED-NC	See JM.com/buildgreen JM LEED Credit Guide (HIG-1231)

GREENGUARD® Certified products have been screened for more than 10,000 volatile organic compounds (VOCs) and meet stringent standards for low chemical emissions based on established criteria from key public health agencies.

GREENGUARD Children & Schools Indoor Air Quality Certified

Micro-Lok® *HP*

High-Performance Fiber Glass Pipe Insulation

SIZE AVAILABILITY

Insulation Thickness		Iron Pipe Size Range		Copper Tubing Size Range	
in.	mm	in.	mm	in.	mm
½	13	½–6	13–152	⅝–4⅛[§]	16–105
1	25	½–24	13–610	⅝–6⅛	16–156
1½	38	½–24	13–610	⅝–6⅛	16–156
2	51	½–24	13–610	1⅛–6⅛	29–156
2½	64	1–24	25–610	1⅜–6⅛	35–156
3	76	1–24	25–610	1⅜–6⅛	35–156
3½	89	1½–24[*]	38–610	–	–
4	102	3–24[**]	76–610	–	–
4½	114	3–24[†]	76–610	–	–
5	127	3–20[††]	76–508	–	–

Notes:

[*] *2½" and 23" IPS not available in this insulation thickness.*

[**] *22" and 23" IPS not available in this insulation thickness.*

[†] *21", 22" and 23" IPS not available in this insulation thickness.*

[††] *19" IPS not available in this insulation thickness.*

[§] *3⅝" CTS not available in this insulation thickness.*

QUALIFICATIONS FOR USE

A sufficient thickness of insulation must be used to keep the maximum surface temperature of Micro-Lok *HP* insulation below 150°F (66°C). In addition, at operating temperatures above 500°F (260°C), Micro-Lok *HP* pipe insulation must be applied in a thickness ranging from 2" (51 mm) minimum to 6" (152 mm) maximum.

During initial heat-up to operating temperatures above 350°F (177°C), an acrid odor and some smoke may be given off as the organic binders used in the fiber glass pipe insulation begin to decompose. When this occurs, caution should be exercised to ventilate the area well. This loss of binder does not directly affect the thermal performance of the pipe insulation, but the compressive strength and resiliency of the product are reduced. For applications with excessive physical abuse or vibration at high temperatures, consult your local Insulation Systems Market Development Manager for alternate material recommendations.

CHILLED WATER SYSTEMS

For chilled water systems, see Chilled Water InsulSpec™ – 3-Part Specification, CI-239.

APPLICATION RECOMMENDATIONS*

MICRO-LOK *HP* PIPE INSULATION AND BUTT STRIPS

1. Do not apply Micro-Lok *HP* insulation if air temperature is below 20°F (-7°C) or above 130°F (54°C) due to the effect of temperature on tape performance. We recommend stapling when application falls outside this temperature range.

When stapling, we recommend mastic be applied over staples to prevent moisture penetration.

2. If stored below 20°F (-7°C) or above 130°F (54°C), insulation cartons should stand within the recommended temperature range for 24 hours prior to application.

3. Once release paper is removed, both adhesive and lap must be kept free of dirt and water, and the lap sealed immediately.

4. When adhered, the lap and butt strips must be pressurized by rubbing firmly with a plastic squeegee or the back of a knife blade to ensure positive closure.

**For complete application recommendations and installation instructions, see CI-245 brochure.*

Johns Manville

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Fax: (419) 784-7866

Western Region & Canada
P.O. Box 5108
Denver, CO 80217
(800) 368-4431
Fax: (303) 978-4661

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CI-228 10/13 (Replaces 2/13)

JMCOM130140A

H-BLOCK PIPE SUPPORT INSULATION

icafittings.com

ASTM E84 25/50 APPROVED!

NEW HIGHER TEMPERATURE LIMIT!

DESCRIPTION

ICA H-Block is a 18# density molded fiberglass which is light amber in color. H-Block was designed to be utilized as a superior pipe support system and to prevent crushing and bottoming-out of the surrounding insulation. H-Block enhances the thermal and vibration control properties of the entire insulation system.

APPLICATION

ICA H-Block is designed for all types of piping systems operating at temperatures between -120° F. to +650° F. H-Block sizes will accommodate pipe sizes from ½" to 24" IPS, and insulation thicknesses from ½" to 4". For higher insulation thicknesses or other specialized sizes or applications, please contact ICA or your local distributor.

ADVANTAGES

ICA H-Block is available in a wide range of standard sizes. These basic sizes have been chosen to help you plan and install pipe support insulation for many types and sizes of piping systems. Because H-Block is continuously produced and stocked in these sizes, you can forget about ordering problems, long manufacturing lead times, and tying-up valuable inventory space.

In the field, H-Block is easy to handle and simple to install.

ICA H-Block is superior to a wood block application. It is incombustible; and immune to rot, corrosion, odors, insects, and oxidation. H-Block resists aging and thermal shock, and its compressive strength is unaffected by water, oils, gasoline, or common solvents.

FOR CUSTOMER SERVICE AND ORDER PLACEMENT CALL 610-377-4120

ICA H-BLOCK CUSTOMERS

The ICA H-Block is a 18# density fiberglass pipe support with widths of 1", 1 1/2", 2", 2 1/2" and 3". The block lengths are 6", 9", 12" and 14". When calculated and installed correctly, they provide adequate support and prevent crushing of the surrounding pipe insulation. The saddles being used must be long enough to provide full support of the blocks.

The following chart demonstrated how to figure the load factor of the blocks as described on the H-Block Technical Data Sheet.

If your calculations fall within these conditions, the blocks will provide adequate support for your system.

PIPE SIZE	WIDTH OF BLOCK	LENGTH OF HANGER & BLOCK	BLOCK REQUIRED	MAX. SUPPORT AT 5% DEFLECTION FORMULA: AXBXCX30^{PSI}	MAX. SUPPORT AT 10% DEFLECTION FORMULA: AXBXCX80^{PSI}
Up to 5"	1 1/2" 1 1/2" 1 1/2"	12" 18" 24"	1 1 1	18 sq. in 540# - 30 PSI 810# - 27 PSI 1080#	1440# - 80 PSI 2160# - 72 PSI 2880#
6" to 8"	1 1/2" 1 1/2" 1 1/2"	12" 18" 24"	2 2 2	1080# 1620# 2160#	2880# 4320# 5760#
10" to 12"	1 1/2" 1 1/2" 1 1/2"	12" 18" 24"	3 3 3	1620# 2430# 3240#	4320# 6480# 8640#
14" to 16"	1 1/2" 1 1/2" 1 1/2"	12" 18" 24"	4 4 4	2160# 3240# 4320#	5760# 8640# 11520#
18" to 24"	1 1/2" 1 1/2" 1 1/2"	12" 18" 24"	5 5 5	2700# 4050# 5400#	7200# 10800# 14400#

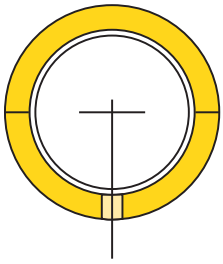
NOTE: For 18" H-Block use two 9" H-Blocks. For 24" H-Block use two 12" H-Blocks.

H-BLOCK PIPE SUPPORT INSULATION

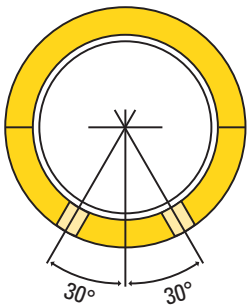
CUSTOM MOLDERS OF THERMAL ACOUSTICAL INSULATION

"Our unique molding process makes us different & better."

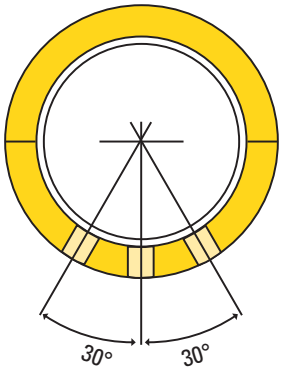
H-Block Recommendation Location: (not to scale)



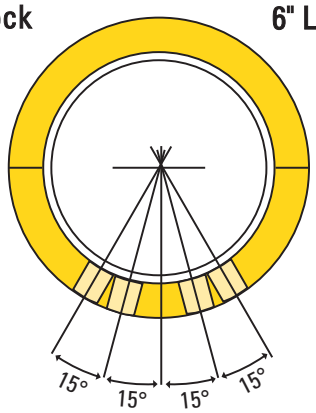
Up to 5" Pipe
6" Long Block



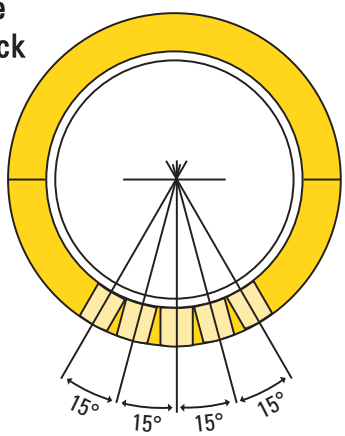
6" - 8" Pipe
6" Long Block



10" - 12" Pipe
9" Long Block



14" - 16" Pipe
12" Long Block

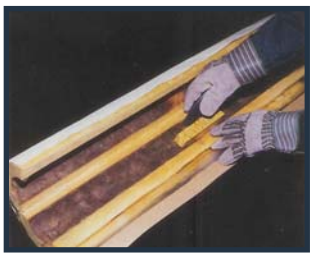


18" - 24" Pipe
14" Long Block

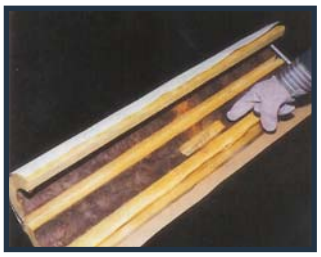
INSTALLATION:

ICA H-Block is placed between the bottom of the pipe to be supported and the metal shield. On pipe sizes above 5" IPS, H-Block should be oriented along the bottom 60° arc of the system. The thickness of the H-Block should be the same thickness as the insulation system. H-Block can be applied with minimum effort and simple tools by removing a "block section" from the pipe insulation, then replacing this section with a heavy density H-Block. Each H-Block is marked to identify which side is placed against the pipe.

1. Remove "block section" from pipe insulation



2. Replace this section of pipe insulation with H-Block



PHYSICAL PROPERTIES:

Service temperatures	-120° F. to +650° F.
Density	18 lb. cu./ft.
Moisture absorption	0.2% by volume, 96 hrs. at 120° F. 96% RH
Corrosion	Does not cause or accelerate corrosion
Safety	Non-combustible
Shrinkage	None. Dimensionally stable.
Alkalinity	Ph9
Thermal Conductivity	K = .30 (stable, non-deteriorating)
Compressive strength	nominal 5% deflection at 30^{PSI} nominal 10% deflection at 80^{PSI}
ASTM E84 25/50	10 flame spread index 10 smoke development

Our technical staff is ready to assist you!

For more data or free samples call us at 610-377-6100
or email us at service@icafittings.com.

icafittings.com

Johns Manville

Zeston® 2000 PVC

Insulated Fitting Covers and Jacketing

Description

Zeston 2000 fitting covers are designed to insulate and to provide a protective covering for pipe fittings. The fitting covers are supplied with Hi-Lo® Temp Formaldehyde-free™ fiber glass insulation inserts from the factory. Zeston PVC jacketing provides a protective covering for insulated or bare pipes. Zeston 2000 PVC fitting covers and jacketing are manufactured from high-impact, gloss white, UV-resistant polyvinyl chloride, which provides a simple, quickly installed system.

Available Shapes and Sizes

Fitting Covers. Zeston 2000 Series PVC fitting covers are available for the following: 45° and 90° (0.8 and 1.6 rad.) short- and long-radius elbows, tees, valves flanges, reducers, end caps, soil pipe hubs, traps and mechanical groove-type fittings.

Jacketing. Zeston PVC White and Color jacketing is available in rolls in thicknesses of 10, 15, 20 and 30 mil (0.3, 0.4, 0.5 and 0.8 mm).

Cut & Curled™ Jacketing. Zeston PVC White and Color Cut & Curled jacketing is available in thicknesses of 20 or 30 mil (0.5 mm or 0.8 mm). (30 mil white [0.8 mm] is recommended for outdoor applications.) It is available in factory-cut sizes to fit up to 30" (762 mm) O.D. All sections of Zeston PVC Cut & Curled jacketing are 48" (1,219 mm) in length and are factory curled to fit snugly.

Uses

Zeston 2000 PVC fitting covers and jacketing are ideally suited for indoor or outdoor use on chilled water, hot water, steam and other piping systems in commercial, institutional and industrial applications. The fitting covers, when combined with Zeston PVC jacketing and Perma-Weld® solvent welding adhesive, form a completely sealed system that meets the requirements of the USDA and FDA for applications in food, beverage and pharmaceutical facilities.

Qualifications for Use

General

- Install the Hi-Lo Temp fiber glass insert by wrapping it completely around the pipe fitting without overly compressing it or leaving any voids. Ensure that the insulation insert covers all exposed surfaces. The Zeston PVC fitting cover should then be installed over the pipe fitting and fiber glass insert by securing the throat using either serrated tacks, Perma-Weld adhesive or Zeston Z-Tape.

Hot Systems

- PVC covers must be kept below 150°F (66°C) by use of proper insulation thickness.
- PVC covers should be kept away from contact with and exposure to sources of direct or radiated heat.
- For fittings where operating temperatures exceed 250°F (121°C) or where pipe insulation thickness is greater than 1½" (38 mm), two or more layers of Hi-Lo Temp insulation inserts are required beneath fitting cover.

Cold Systems

- An approved vapor retarder mastic compatible with PVC must be applied between pipe insulation and fitting cover, and on fitting cover throat overlap seam.
- For fittings where operating temperature is below 45°F (7°C) or where the pipe insulation thickness is greater than 1½" (38 mm), two or more layers of Hi-Lo Temp insulation inserts are required beneath fitting cover.

Operating Temperature Limits:
PVC: Up to 150°F (66°C)
Insert: 0°F to 450°F (-18°C to +232°C)
Flame Spread: 25 or less (up to 30 mil [0.8 mm])
Smoke Developed: 50 or less (up to 30 mil [0.8 mm])
Grade: Weatherable
Color: White
Finish: Gloss

Refrigerant Systems and Cold Systems in Severe Ambient Conditions

- Mitered pipe insulation segments, fabricated or premolded insulation shapes may be used in lieu of Hi-Lo Temp insulation inserts.
- An intermediate vapor retarder compatible with PVC is required to completely seal the insulation prior to installing the Zeston 2000 PVC fitting cover. Care should be taken to ensure that the vapor barrier mastic is applied between the pipe insulation and the fitting cover, and on fitting cover throat overlap seam.

Totally Sealed Systems (USDA Approval)

- System requires that 20 or 30 mil (0.5 mm or 0.8 mm) Zeston PVC jacketing is applied to pipe insulation in conjunction with Zeston PVC fitting covers.
- All circumferential and longitudinal seams of jackets and fitting covers should be sealed with Zeston Perma-Weld solvent welding adhesive. Circumferential seams should be a minimum 1" (25 mm) overlap, and longitudinal seams should be 1½" to 2" (38 mm to 51 mm) overlap.
- Upon completion, all seams should visually be checked for seal and touched up, if necessary.
- Slip joints are required periodically between fixed supports and on continuous long runs of straight piping. Slip joints are achieved by increasing circumferential overlap to 8" to 10" (203 mm to 254 mm) and applying a flexible white caulking in the overlap area to maintain a sealed system.

Zeston® 2000 PVC

Insulated Fitting Covers and Jacketing

Physical Properties of Zeston 2000 PVC

Property	Value	ASTM Test Method
Specific Gravity	1.48	D792
Tensile Strength at Yield, psi (kPa)	6,000 (41,370)	D638
Elongation at Yield (MD), %	3.0	D638
Tensile Modulus, psi (kPa)	425,000 (2,930,270)	D638
Flexural Strength, psi (kPa)	11,000 (75,850)	D638 (min. 0.125" [3 mm] thick specimen)
Flexural Modulus, psi (kPa)	430,000 (2,964,750)	D790
Flame Spread (white only)	25 or less (up to 30 mil [0.8 mm])	E84
Smoke Developed (white only)	50 or less (up to 30 mil [0.8 mm])	E84
Electrical Conductance	Non-Conductor	D257
Gardner—SPI Impact, in. lb./mil by Ductile Failure	10 mil (0.3 mm) 1.3 15 mil (0.4 mm) 1.4 20 mil (0.5 mm) 1.5 30 mil (0.8 mm) 1.6	D3679 (4 lb. [1.8 kg] weight; 8 lb. [3.6 kg] for 30 mil [0.8 mm])

Chemical resistance data available on request.

General Properties of Hi-Lo® Temp Formaldehyde-free™ Fiber Glass Insulation Insert

Thermal conductivity	Mean Temperature °F	Mean Temperature °C	"k" Btu•in/(hr•ft²•°F)	"k" W/m•°C
	75	24	.28	.040
	150	66	.34	.049
	300	149	.45	.065
Temperature limits	0°F to 450°F (-18°C to +232°C)			
Sanitary	Odorless. Will not absorb odors. Provides no food for insects or rodents; will not mildew.			
Vibration resistant	Will not settle or separate.			
Fire safety	Meets most requirements of federal, state and local codes. Accepted for commercial, institutional, industrial and residential projects in all parts of U.S. The fiber glass inserts have UL 25/50 rating and are noncombustible per ASTM E136.			

Specification Compliance

USDA, Agriculture Canada
New York City MEA #7-87
ICBO
SBCCI
BOCA
ASTM D1784, Class 16354-C
L-P-535E,* Composition A, Type II, Grade GU
L-P-1035A,* Composition A, Type II, Grade GU
Canada: CGSB 51-GP-53M
CAN/ULC S102-M88

**Impact strength determined by Gardner-SPI test method rather than Izod, since Gardner is more appropriate for PVC sheeting materials.*

Johns Manville

717 17th St.
Denver, CO 80202
(800) 654-3103
specJM.com

CI-55 06/11 (Replaces 10/08)

North American Sales Offices, Insulation Systems

Eastern Region
P.O. Box 158
Defiance, OH 43512
(800) 334-2399
Fax: (419) 784-7866

Western Region and Canada
P.O. Box 5108
Denver, CO 80217
(800) 368-4431
Fax: (303) 978-4661

The physical and chemical properties of Zeston® 2000 PVC Insulated Fitting Covers and Jacketing listed herein represent typical, average values obtained in accordance with accepted test methods and are subject to normal manufacturing variations. They are supplied as a technical service and are subject to change without notice. Numerical flame spread and smoke developed ratings are not intended to reflect hazards presented by these or any other materials under actual fire conditions. Check with the Regional Sales Office nearest you to assure current information. **All Johns Manville products are sold subject to Johns Manville's standard Terms and Conditions, including Limited Warranty and Limitation of Remedy. For a copy of the Johns Manville standard Terms and Conditions, Limited Warranty and Limitation of Remedy and information on other Johns Manville thermal insulation and systems, call (800) 654-3103.**

JMCOM110360

PROTO FITTING COVERS

25/50 RATED
PER ASTM E-84 — LoSMOKE® PVC

PROTO REGULAR PVC

LoSMOKE® PVC JACKETING

SUBMITTAL SHEET

Effective: 01/01/15

Submitted Date: _____

PROTO CORP.
10500 47th Street North
Clearwater, FL 33762-5017
Tel: (727) 573-4665
Fax: (727) 572-6823
Toll Free (800) 875-7768

PVC FITTING COVERS, PRE-MOLDED, INSULATED
WHITE GLOSS FINISH — INDOOR OUTDOOR GRADE

SUBMITTAL SHEET DOES NOT SUPERCEDE WRITTEN SPECIFICATIONS OR OWNER AGREEMENT.

DESCRIPTION

The Proto Fitting Cover System consists of one piece and two piece pre-molded high impact LoSMOKE® PVC fitting covers with fiberglass inserts and accessories, which include elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, white and indoor color jacketing, Protop® Tank End Panels, tack fasteners, tapes and specialty items.

APPLICATIONS

The Proto Fitting Cover System is used to insulate mechanical piping systems at fitting locations and provide a PVC jacketing for straight run piping. Both give a quality appearance and have excellent durability.

FEATURES AND BENEFITS

25/50 Rated. All Proto PVC Fittings are made of LoSMOKE® grade PVC. Roll Jacketing is available in either 25/50 rated or regular PVC Grade (not 25/50 rated). The 25/50 products meet fire and smoke safety requirements of federal, state and local building codes.

Excellent Appearance. Bright high-gloss white coloring adds a distinct quality appearance to the system. The standard line of Proto Fitting Covers are made in LoSMOKE® PVC designed for indoor and outdoor use. Virtually all sizes pass 25/50 when made of LoSMOKE® PVC. Colored PVC is manufactured from a LoSMOKE® formula that is suitable for indoor use only.

Easy To Clean. Due to the smooth, high gloss finish on Proto PVC Fittings, the product cleans easily with soap and water. This makes the system ideal for food and drug facilities.

Low Cost Installation. Significant cost savings vs. conventional cement, molded sections, and mitered sections.

Fast and Easy. At fitting locations, wrap the fiberglass insert around the pipe fitting, apply the Proto PVC Fitting over the insert and tack or tape in place. Do not use tacks where a vapor retarder is applied.

Wide Temperature Range. May be used for mechanical piping systems operating from -20°F to +140°F surface temperature of insulation. Variety: LoSMOKE®, Indoor/Outdoor, Exod®, Exotuff®. Proto products are also available in LoSMOKE® Indoor colors. Exod® is CPVC, GOOD TO 225° F.

Long Lasting. Can be used more than once on retrofit projects, general maintenance.

Excellent Thermal Value. K value of .26 at 75°F (.037 W/m °C at 24°C) of fiberglass insert, mean temperature assures better thermal efficiency than conventional cement fittings.

Resistance To Fungi and Bacteria. (ASTM G 21, ASTM G 22) Does not promote growth of fungi or bacteria.

U.V. Resistant. Can be used on indoor or outdoor applications, for both (White) LoSMOKE® PVC and Regular PVC. Extra thick fitting covers should be used outdoors. (All Std. Proto Fitting covers are made of LoSMOKE® PVC.)

TECHNICAL PHYSICAL PROPERTIES OF PVC LoSMOKE® MATERIALS

Specific Gravity (ASTM D-792) 1.41
Tensile Modulus, PSI (ASTM D-638) . . . . . .361,000 (25,380 kg/cm²)
Tensile Strength, PSI (ASTM D-638) 6,011
Flexural Strength, PSI (ASTM D-790) 9,396
Izod Impact (1/4") ft. lb./in (ASTM D-256) 3.7
Heat Deflection Temp. (ASTM D-648) . . . . . .157°F (70°C)
at 264 PSI (8.95 kg/cm²), °F
VICAT Softening Temp. (ASTM D-1525) . . . . . .198°F (92°C)

Water Vapor Transmission
ASTM E 96-95
70°F & 50% Relative Humidity
.015" thick = .058
.020" thick = .047
.030" thick = .027

Surface Burning Characteristics of All Fitting Covers and Jacketing
LoSMOKE® PVC . . . . . .passes 25/50 ASTM-E 84
Up to .035" Thk.
Puncture Resistance (ASTM D 781) . . .006" thick = 178 Beach Units
.015" thick = 221 Beach Units

FEDERAL SPECIFICATIONS COMPLIANCE—

POLY VINYL CHLORIDE — ASTM 1784-92

LP-1035A Type II Grade GU and Type III

LP-535E Type II Grade GU and Type III

United States Department of Agriculture Authorized
Agriculture Canada Authorized
New York City MEA 243-84-M, Chicago, Los Angeles ASTM C-585-76 (sizes)
Canada CAN/CGSB - 51.53-95

TECHNICAL PROPERTIES OF FIBERGLASS INSERT MATERIAL

Thermal Conductivity (ASTM C 177)

Mean Temperature – HH-I-558 Form B	°F	"k" — BTU in/hr. Ft.2 °F
Type 1 Class B	75° 1(24°C)	.26 (.037 W/m. °C)
	150° 1(66°C)	.33 (.048 W/m. °C)
	250° (121°C)	.44 (.063 W/m. °C)

APPLICATION AND SPECIFICATION GUIDELINES

A. STORAGE

Protect cartons from water damage or other abuse. Proto Fitting Cover cartons are not designed for outside storage.

B. PREPARATION

Proto Fitting Covers should be applied on clean, dry surfaces.

C. APPLICATION

1. **General:** The matching fiberglass insert shall be wrapped completely around the metal fitting leaving no voids. Loose wrappings of twine is helpful in shaping difficult surfaces. The Proto Fitting Cover shall then be applied over the fitting and insert, and the throat secured by either tack fastening or taping.

2. **Cold Pipe:** Fitting systems below ambient temperature must have a continuous vapor retarder or vapor retardant mastic as specified by the engineer. When using Proto PVC Tape, a 2" (51mm) minimum downward overlap is recommended for optimum performance. Care should be taken not to stretch the last 2" (51mm) of Proto PVC Tape, to avoid stretching or creeping.

3. **Hot Pipe:** Insulate as per General Instructions given above. Due to PVC softening point at approximately 159°F (70.6°C), care should be taken to ensure sufficient insulation thicknesses are applied.

Submittal

AEROCEL®

Closed Cell Elastomeric Thermal Insulation for HVAC & R

General

AEROCEL® Tube and Sheet Insulation is a flexible, closed-cell and light weight EPDM* based elastomeric material designed for insulating liquid cooling and heating lines. 3/8", 1/2", 3/4" and 1" wall in popular I.D. sizes up to 6" IPS. The closed-cell structure of Aerocel Pipe Insulation makes it an efficient insulation.

Aerocel is manufactured to consistently provide actual values on these key performance criteria for mechanical system insulation:

Thermal Conductivity: 0.25
Water Vapor Transmission: 0.1
Fire Rating: Will not contribute significantly to fire (simulated end-use testing).

Aerocel Pipe Insulation in 3/8", 1/2", 3/4" and 1" thicknesses has a flame spread rating of 25 or less and a smoke developed rating of 50 or less as tested by ASTM E 84 "Surface Burning Characteristics of Building Materials."

Note: Numerical flammability ratings alone may not define the performance under actual fire conditions. They are provided only for use in the selection of products to meet limits specified.

Key Features

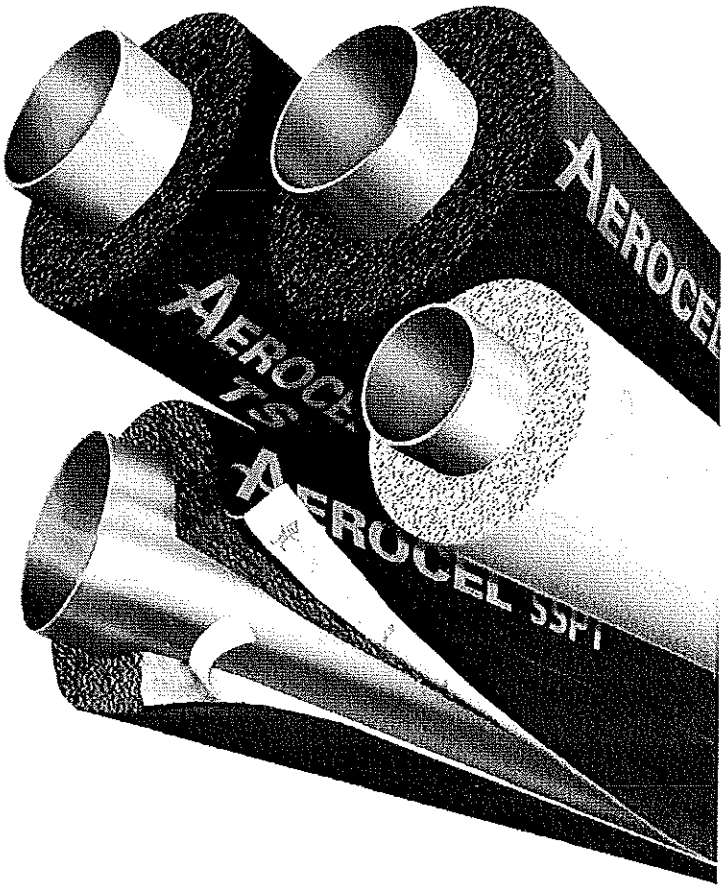
- UV Resistant
- Low thermal conductivity
- Easy to install
- 25/50 rated
- Versatile for heating, AC, refrigeration and plumbing

Uses

AEROCEL® Pipe Insulation is used to retard heat gain and control condensation drip from cold-water plumbing, chilled water, and refrigeration lines. It also efficiently reduces heat flow for hot water plumbing, liquid heating and dual temperature piping. The recommended temperature usage range for Aerocel Pipe Insulation is -70°F to +257°F.

Resistance to Moisture Vapor Flow

The closed-cell structure of Aerocel Insulation effectively retards the flow of moisture vapor, and Aerocel is considered a low transmittance vapor retarder. Aerocel requires no supplemental vapor retarder protection.



Application

AEROCEL® Pipe Insulation in unslit tubular form can be slipped onto piping before it is connected, or it can be slit lengthwise and snapped over piping already connected. Butt joints and seams are to be sealed with contact adhesive; therefore, both surfaces to be joined are coated with adhesive. Aerocel is designed for installation above and below ground, indoors and outdoors. No protective finish is required.

In addition to the specifications listed below, Aerocel also conforms to the following: ASTM C 534, ASTM D 1056, NY City MEA #171-04-M, City of LA RR-8413, UL 181 Section 12 Mold Growth/Humidity, UL 181 Section 17 Air Erosion, UL 94 5 V-0, UL 723, NFPA 90A & 90B, MIL 15280J.

Specifications

PHYSICAL PROPERTIES*		AEROCEL				TEST METHOD**	
CELL STRUCTURE		CLOSED CELL				—	
DENSITY Lbs/ft³ (qm/cm³)		3/6 Lbs/ft³				ASTM D 1667	
THERMAL CONDUCTIVITY BTU.in/ft.²hr. °F	Mean temp.	-40°F (-20°C)	32°F (0°C)	75°F (24°C)	90°F (32°C)	104°F (40°C)	ASTM C177 JIS A 1412
	K-value	0.22	0.23	0.25	0.26	0.27	
SERVICE TEMP ****		-70°F to 257°F -57°C to +125°C				AEROCEL becomes hard at -57°C, but can be used even at -200°C	
U.V. Weather Resistance		Excellent				ASTM G-23	
Ozone Resistance		No cracking				ASTM D 1171	
Water Vapor Permeability		0.10 perm-in (0.15 x 10^{-12})				ASTM C355	
Water Absorption (weight %)		0.2%				ASTM C 209	
Flammability, Smoke Density		Class V O				UL-94	
		25/50				ASTM E84	
		Self extinquishing				ASTM D 635	
Corrossion of copper, stainless		Non corrosive				DIN 1988	
Nitrosamine Contents		Not detected				U.S. FDA	
Flexibility		excellent				—	

AEROCEL® Thickness Recommendation Data

Pipe Size	Line Temp. 60°F (15.5°C)		Line Temp. 50°F (10°C)		Line Temp. 35°F (1.7°C)		Line Temp. 0°F (-18°C)	
	Based on Normal Condition Max. 85°F (29.4°C) 70% RH *							
3/8" ID Thru 3" IPS	1/4"*	Wall	3/8"	Wall	1/2"	Wall	1"	Wall
Over 3" IPS	3/8"*	Sheet	1/2"	Sheet	3/4"	Sheet	1-1/4"	Sheet
	Based on Mild Condition Max. 80°F (26.6°C) 50% RH * *							
3/8" ID Thru 3" IPS	1/4"*	Wall	3/8"	Wall	3/8"	Wall	3/4"	Wall
Over 3" IPS	3/8"*	Sheet	1/2"	Sheet	3/4"	Sheet	3/4"	Sheet
	Based on Severe Condition Max. 90°F (32.2°C) 80% RH * * *							
3/8" ID Thru 3" IPS	1/2"	Wall	3/4"	Wall	1"	Wall	1-1/2"	Wall
Over 3" IPS Thru 10" IPS	3/4"	Sheet	1"	Sheet	1-1/8"	Sheet	1-3/4"	Sheet
Over 10" IPS	3/4"	Sheet	1"	Sheet	1-1/8"	Sheet	2"	Sheet
	Based on Extremely Severe Condition Max. 90°F (32.2°C) 85% RH * * * *							
3/8" ID Thru 3" IPS	3/4"	Wall	1"	Wall	1-1/4"	Wall	2"	Wall
Over 3" IPS Thru 10" IPS	1"	Sheet	1-1/4"	Sheet	1-1/2"	Sheet	2-1/2"	Sheet
Over 10" IPS	1"	Sheet	1-1/4"	Sheet	1-1/2"	Sheet	2-1/2"	Sheet

* Although in some areas of the country, 1/4" and 3/8" wall thicknesses are recommended, Aeroflex USA recommends 1/2" minimum wall thickness for optimum performance

AEROFLEX USA, INC.
9051 EXECUTIVE PARK DRIVE, SUITE 400 • KNOXVILLE, TN 37923
TEL: (865) 690-5740 • FAX: (865) 690-5695 • TOLL FREE: (866) AEROCEL
WEBSITE: www.aeroflexusa.com

Instruction Manual

COMMERCIAL GAS WATER HEATERS

A.O. Smith
500 Tennessee Waltz Parkway
Ashland City, TN 37015
www.hotwater.com

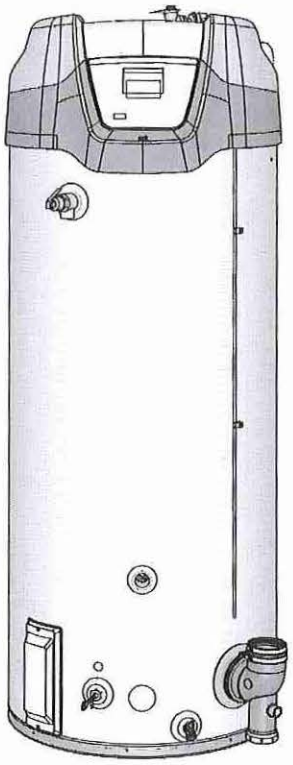
GAS-FIRED UL LISTED
CLASSIFIED UL WATER QUALITY ANSI/NSF-5
ASME HLW
CSA LOW LEAD CONTENT

MODELS
BTH-120(A)/150(A)/199(A)/250(A)
SERIES 200 & 201

INSTALLATION - OPERATION - SERVICE
- MAINTENANCE - LIMITED WARRANTY

AHRI CERTIFIED® www.ahridirectory.org

This model is iCOMM COMPATIBLE. iCOMM For info call 1-888-WATER02



WARNING: If the information in these instructions is not followed exactly, a fire or explosion may result causing property damage, personal injury or death.

— Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

— WHAT TO DO IF YOU SMELL GAS:

- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

— Installation and service must be performed by a qualified installer, service agency or the gas supplier.

Thank you for buying this energy efficient water heater. We appreciate your confidence in our products.

⚠ WARNING

Read and understand this instruction manual and the safety messages herein before installing, operating or servicing this water heater.

Failure to follow these instructions and safety messages could result in death or serious injury.

This manual must remain with the water heater.

PLACE THESE INSTRUCTIONS ADJACENT TO HEATER AND NOTIFY OWNER TO KEEP FOR FUTURE REFERENCE.

PRINTED 0514

327727-000

TABLE OF CONTENTS

SAFE INSTALLATION, USE AND SERVICE

The proper installation, use and servicing of this water heater is extremely important to your safety and the safety of others.

Many safety-related messages and instructions have been provided in this manual and on your own water heater to warn you and others of a potential injury hazard. Read and obey all safety messages and instructions throughout this manual. It is very important that the meaning of each safety message is understood by you and others who install, use, or service this water heater.

	This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER	DANGER indicates an imminently hazardous situation which, if not avoided, will result in injury or death.
WARNING	WARNING indicates a potentially hazardous situation which, if not avoided, could result in injury or death.
CAUTION	CAUTION indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury.
CAUTION	CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, could result in property damage.

All safety messages will generally tell you about the type of hazard, what can happen if you do not follow the safety message, and how to avoid the risk of injury.

The California Safe Drinking Water and Toxic Enforcement Act requires the Governor of California to publish a list of substances known to the State of California to cause cancer, birth defects, or other reproductive harm, and requires businesses to warn of potential exposure to such substances.

This product contains a chemical known to the State of California to cause cancer, birth defects, or other reproductive harm. This water heater can cause low level exposure to some of the substances listed in the Act.

APPROVALS

ASME HLW

CLASSIFIED UL WATER QUALITY

GAS-FIRED UL LISTED

AHRI CERTIFIED® www.ahridirectory.org

SA Low Lead Content

NOTE: ASME construction is optional on the water heaters covered in this manual.

GENERAL SAFETY INFORMATION

PRECAUTIONS

DO NOT USE THIS WATER HEATER IF ANY PART HAS BEEN EXPOSED TO FLOODING OR WATER DAMAGE. Immediately call a qualified service agency to inspect the water heater and to make a determination on what steps should be taken next.

If the unit is exposed to the following, do not operate heater until all corrective steps have been made by a qualified service agency.

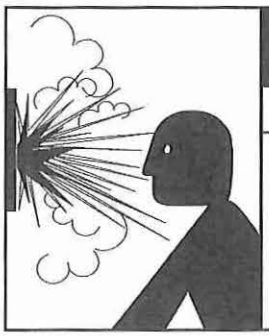
1. External fire.
2. Damage.
3. Firing without water.

GROUNDING INSTRUCTIONS

This water heater must be grounded in accordance with the National Electrical Code and/or local codes. These must be followed in all cases. Failure to ground this water heater properly may also cause erratic control system operation.

This water heater must be connected to a grounded metal, permanent wiring system; or an equipment grounding conductor must be run with the circuit conductors and connected to the equipment grounding terminal or lead on the water heater.

HYDROGEN GAS FLAMMABLE



⚠WARNING

Explosion Hazard

- Flammable hydrogen gases may be present.
- Keep all ignition sources away from faucet when turning on hot water.

Hydrogen gas can be produced in a hot water system served by this water heater that has not been used for a long period of time (generally two weeks or more). Hydrogen gas is extremely flammable. To reduce the risk of injury under these conditions, it is recommended that a hot water faucet served by this water heater be opened for several minutes before using any electrical appliance connected to the hot water system. If hydrogen is present there will probably be an unusual sound such as air escaping through the pipe as the water begins to flow. THERE SHOULD BE NO SMOKING OR OPEN FLAME NEAR THE FAUCET AT THE TIME IT IS OPEN.

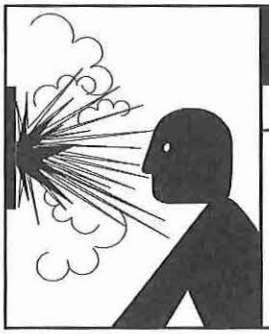
Verify the power to the water heater is turned off before performing any service procedures. The Enable /Disable switch on front panel disables the 24 volt gas valve. Electrical supply must be turned off at circuit breaker serving water heater.

⚠WARNING

Read and understand this instruction manual and the safety messages herein before installing, operating or servicing this water heater.

Failure to follow these instructions and safety messages could result in death or serious injury.

This manual must remain with the water heater.

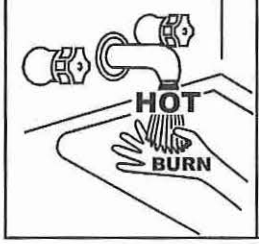


⚠WARNING

Explosion Hazard

- Overheated water can cause water tank explosion.
- Properly sized temperature and pressure relief valve must be installed in the opening provided.

⚠DANGER



Water temperature over 125°F (52°C) can cause severe burns instantly resulting in severe injury or death.

Children, the elderly and the physically or mentally disabled are at highest risk for scald injury.

Feel water before bathing or showering.

Temperature limiting devices such as mixing valves must be installed when required by codes and to ensure safe temperatures at fixtures.

CAUTION

Improper installation, use and service may result in property damage.

- Do not operate water heater if exposed to flooding or water damage.
- Inspect anode rods regularly, replace if damaged.
- Install in location with drainage.
- Fill tank with water before operation.
- Properly sized thermal expansion tanks are required on all closed water systems.

Refer to this manual for installation and service.

GENERAL SAFETY INFORMATION

⚠ WARNING

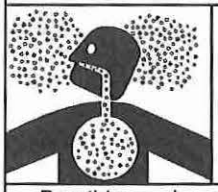
Fire or Explosion Hazard

- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.
- Avoid all ignition sources if you smell gas.
- Do not expose water heater controls to excessive gas pressure.
- Use only the gas shown on the water heater rating label.
- Maintain required clearances to combustibles.
- Keep ignition sources away from faucets after extended periods of non-use.

Read instruction manual before installing, using or servicing water heater.

⚠ WARNING

Breathing Hazard - Carbon Monoxide Gas



- Do not obstruct water heater air intake with insulating blanket.
- Gas and carbon monoxide detectors are available.
- Install water heater in accordance with the instruction manual.

Breathing carbon monoxide can cause brain damage or death. Always read and understand instruction manual.

CAUTION

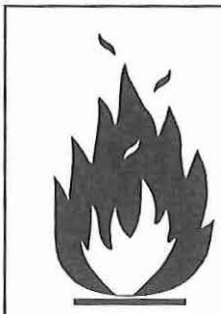
Property Damage Hazard

- All water heaters eventually leak.
- Do not install without adequate drainage.

⚠ WARNING

Electrical Shock Hazard

- Turn off power at the branch circuit breaker serving the water heater before performing any service.
- Label all wires prior to disconnecting when performing service. Wiring errors can cause improper and dangerous operation.
- Verify proper operation after servicing.
- Failure to follow these instructions can result in personal injury or death.

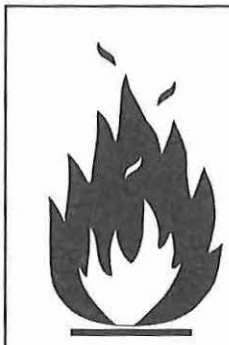


⚠ WARNING

Fire Hazard

For continued protection against risk of fire:

- Do not install water heater on carpeted floor.
- Do not operate water heater if exposed to flooding or water damage.



⚠ WARNING

Fire and Explosion Hazard

- Use joint compound or Teflon tape compatible with propane gas.
- Leak test gas connections before placing water heater in operation.
- Disconnect gas piping at main gas shutoff valve before leak testing heater.
- Install sediment trap in accordance with NFPA 54 or CAN/CSA B149.1.

⚠ WARNING

Fire and Explosion Hazard

- Do not use water heater with any gas other than the gas shown on the rating label.
- Excessive gas pressure to gas valve can cause serious injury or death.
- Turn off gas lines during installation.
- Contact a qualified installer or service agency for installation and service.

⚠ WARNING

Jumping out control circuits or components can result in property damage, personal injury or death.

- Service should only be performed by a qualified service technician using proper test equipment.
- Altering the water heater controls and/or wiring in any way could result in permanent damage to the controls or water heater and is not covered under the limited warranty.

Any bypass or alteration of the water heater controls and/or wiring will result in voiding the appliance warranty.

INTRODUCTION

Thank You for purchasing this water heater. Properly installed and maintained, it should give you years of trouble free service.

ABBREVIATIONS USED

Abbreviations found in this Instruction Manual include :

- ANSI - American National Standards Institute
- ASME - American Society of Mechanical Engineers
- AHRI - Air Conditioning, Heating and Refrigeration Institute
- NEC - National Electrical Code
- NFPA - National Fire Protection Association
- UL - Underwriters Laboratory
- CSA - Canadian Standards Association

QUALIFICATIONS

QUALIFIED INSTALLER OR SERVICE AGENCY

Installation and service of this water heater requires ability equivalent to that of a Qualified Agency (as defined by ANSI below) in the field involved. Installation skills such as plumbing, air supply, venting, gas supply and electrical supply are required in addition to electrical testing skills when performing service.

ANSI Z223.1 2006 Sec. 3.3.83: "Qualified Agency" - "Any individual, firm, corporation or company that either in person or through a representative is engaged in and is responsible for (a) the installation, testing or replacement of gas piping or (b) the connection, installation, testing, repair or servicing of appliances and equipment; that is experienced in such work; that is familiar with all precautions required; and that has complied with all the requirements of the authority having jurisdiction."

If you are not qualified (as defined by ANSI above) and licensed or certified as required by the authority having jurisdiction to perform a given task do not attempt to perform any of the procedures described in this manual. If you do not understand the instructions given in this manual do not attempt to perform any procedures outlined in this manual.

ICOMM™ & BACNET COMPATIBLE

This water heater is compatible with the iCOMM™ remote monitoring system. The iCOMM™ system hardware and monitoring service is purchased separately. It allows users to monitor critical operational, diagnostic and energy usage data from a secure web site.

The iCOMM™ system can automatically notify selected personnel via email and/or cellular phone text messages if operational problems or user defined Alert Conditions occur.

iCOMM™ system hardware is compatible with BACnet compliant supervisory controls and building management systems. For more information call 888-928-3702.

PREPARING FOR THE INSTALLATION

1. Read the entire manual before attempting to install or operate the water heater. Pay close attention to the General Safety Information on page 4 and 5. If you don't follow the safety rules, the water heater may not operate safely. It could cause property damage, injury and/or death.

   This manual contains instructions for the installation, operation, and maintenance of the water heater. It also contains warnings throughout the manual that you must read and be aware of. All warnings and all instructions are essential to the proper operation of the water heater and your safety.

   Detailed installation diagrams are also found in this manual. These diagrams will serve to provide the installer with a reference. It is essential that all venting, water piping, gas piping and wiring be installed as shown.

   Particular attention should be given to the installation of thermometers at the locations indicated in the piping diagrams as these are necessary for checking the operation of the water heater.

   The principal components of the water heater are identified in Features And Components on page 7 in this manual. Use this reference to locate and identify various components on the water heater.

   See the Installation Checklist and Troubleshooting on page 57. By using this checklist the user may be able to make minor operational adjustments and avoid unnecessary service calls. However, service and diagnostic procedures should only be performed by a Qualified Service Agency.

   NOTE: Costs to correct installation errors are not covered under the limited warranty.

2. Be sure to turn off power when working on or near the electrical system of the water heater. Never touch electrical components with wet hands or when standing in water.

3. The installation must conform to all instructions contained in this manual and the local code authority having jurisdiction. These shall be carefully followed in all cases. Authorities having jurisdiction should be consulted before installation begins if there are any questions regarding compliance with local, state or national codes.

   In the absence of local codes, the installation must comply with the current editions of the National Fuel Gas Code, ANSI Z223.1/NFPA 54 and the National Electrical Code, NFPA 70 or CAN/CSA-B149.1, the Natural Gas and Propane Installation Code and CSA C22.1, the Canadian Electrical Code. All documents are available from the Canadian Standards Association, 8501 East Pleasant Valley Road, Cleveland, OH 44131. NFPA documents are also available from the National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269.

4. If after reading this manual you have any questions or do not understand any portion of the instructions, call the toll free number on the back cover of this manual for technical assistance. In order to expedite your request, please have the full Model, Serial and Series number of the water heater you are working with available for the technician. This information is located on the water heater's rating label.

5. Carefully plan the placement of the water heater. Examine the location to ensure that it complies with the requirements in Locating The Water Heater on page 11 and the Rough In Dimensions on page 10.

6. For installation in California this water heater must be braced or anchored to avoid falling or moving during an earthquake. See instructions for correct installation procedures. Instructions may be obtained from California Office of the State Architect, 1102 Q Street, Suite 5100, Sacramento, CA 95811.

7. Massachusetts Code requires this water heater to be installed in accordance with Massachusetts 248-CMR 2.00: State Plumbing Code and 248-CMR 5. See Commonwealth of Massachusetts on page 20.

FEATURES AND COMPONENTS

BASIC OPERATION

The water heaters covered in this manual have a helical coil shaped heat exchanger that is submerged in the storage tank. The water heater's Main Burner is a radial design burner, it is mounted on the top and fires downward through the heat exchanger. This is a forced draft burner; hot burning gases are forced through the heat exchanger under pressure and exit through the exhaust/vent connection located at the bottom of the water heater. See Figure 1 and Figure 2.

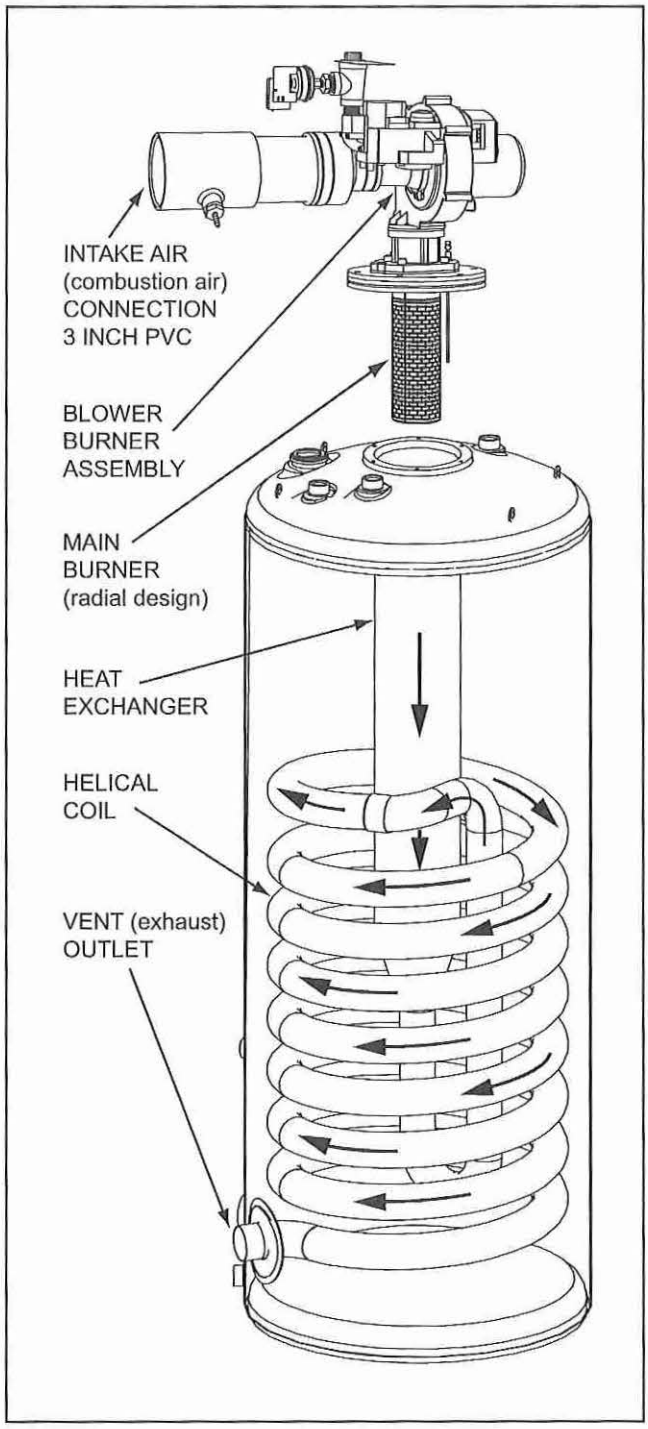


Figure 1

MODULATION

The water heaters covered by this manual are capable of modulating their firing rate. The CCB monitors the water temperature in the tank and regulates the firing rate to achieve the target temperature setpoint. The firing rate is dictated by the hot water draw, proximity to the tank temperature setpoint, and various other temperature limitations. Periodically, when the heater is in modulation mode, the CCB will increase the blower speed for a short period of time to clear out any condensation that has accumulated in the heat exchanger then decreases the blower speed back to the modulating firing rate required to maintain the desired tank temperature setpoint. This ramping up and down of the blower speed is considered normal operation of the water heater.

BLOWER/BURNER ASSEMBLY DETAIL

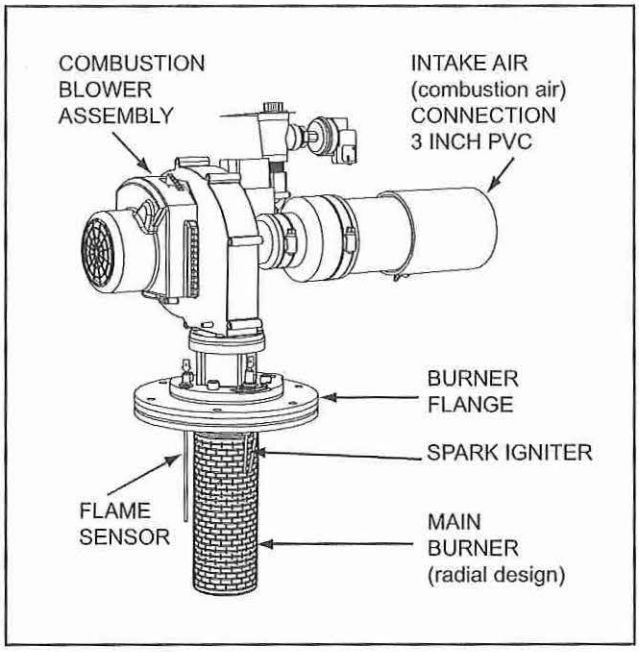


Figure 2

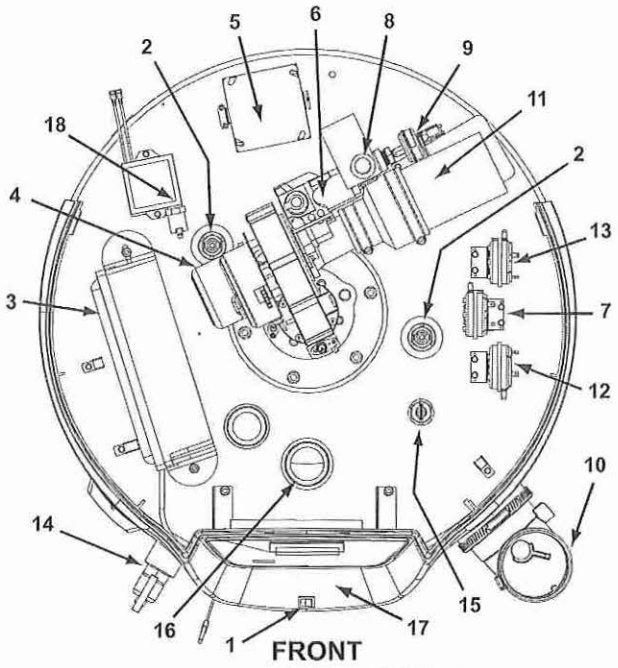
Spark Igniter

The control system energizes the spark ignition control with 120 VAC during the ignition cycle. The spark ignition control then sends a high-voltage current to the spark igniter which in turn ignites the main burner air/gas mixture.

Flame Sensor

The control system also monitors the flame sensor to confirm a flame is present at the Main Burner. If a flame is not verified during the ignition trial period (3-5 seconds) the control system will immediately de-energize the 24 Volt Gas Valve. See the Sequence Of Operation Flow Chart on page 58.

TOP VIEW



TOP VIEW OF ALL MODELS

Figure 3

COMPONENTS (All Models)

IMPORTANT. The Enable/Disable switch listed in this manual is NOT an "on/off" switch and does not disconnect 120 volt power to the CCB and other heater components.

1. Water Heater's Enable/Disable Switch. When in the "Disabled" position the switch removes electrical power from the gas valve and blower so that water heating is disabled. The display, CCB, and other electrical components will still be energized and the display will read "Water Heating Disabled".
2. Powered anode rods. The water heaters covered in this manual are equipped with powered (non sacrificial) anode rods. The BTH 120 has one powered anode, all other models will have two. Protective current is fed by the control system to the titanium electrodes at the end of each anode rod. This current flows through the water to the conductive surfaces inside the storage tank which diminishes the corrosive effect (rusting) of water when it comes in contact with steel.
3. Central Control Board (CCB) enclosure. This enclosure houses the control system's main circuit board, power supply board, power transformer, and configuration key. The CCB regulates water temperature and controls all water heater functions, see Control System Operation on page 45.
4. Combustion Blower Assembly includes, Gas Valve and Venturi gas feed system.
5. 120 VAC junction box. Incoming power supply, ground connections, and other field installed electrical connections are made here. See Power Supply on page 13.
6. Water heater's 24 Volt Gas Valve.
7. Blocked Intake Air switch. Normally closed contacts that open on fall in pressure. This switch is used to insure intake (combustion) air to the water heater is not restricted. The control system monitors this switch and will disable heating operation if its contacts are open during a heating cycle.
8. Supply gas line connection. See the requirements for the Gas Supply Systems on page 13.
9. Low Gas Pressure switch. Normally open contacts that close on a rise in pressure. This switch is used to insure supply gas pressure is above minimum requirements. The control system monitors this switch and will disable heating operation if its contacts are open during a heating cycle. See Gas Pressure Requirements and Table 3 on page 11.
10. Vent connection (exhaust / condensate elbow) - three inch aluminum.
11. Intake air connection - 3 inch PVC.
12. Blocked Exhaust (vent) switch. Normally closed contacts that open on a rise in pressure. This switch is used to insure the Exhaust (vent) piping connected to the water heater is not restricted. The control system monitors this switch and will disable heating operation if its contacts are open during a heating cycle.
13. Blower Prover switch. Normally open contacts that close on a rise in pressure. This switch is used to insure the Combustion Blower is operating properly at blower start-up. The control system monitors this switch and will disable heating operation if its contacts are closed before the Combustion Blower is energized. See Sequence Of Operation on page 57.
14. Temperature-Pressure Relief Valve. See Temperature-Pressure Relief Valve on page 15.
15. Upper Temperature Probe, 1 of 2 temperature probes. The water heater's control system monitors this probe to detect water temperature in the upper portion of the storage tank. The Upper Temperature Probe also houses the ECO (energy cut out) switch. This is a non adjustable high temperature limit switch. The ECO switch contacts are normally closed and will open on a temperature rise. See High Temperature Limit Control (ECO) on page 44.
16. Water outlet connection 1 1/2" NPT.
17. UIM (user interface module). The UIM includes the display circuit board, the control system's LCD display and operational buttons. Used to adjust various user settings and view operational information. See Control System Operation on page 45.
18. Spark Ignition Control. When energized, sends the electrical current to the spark igniter.

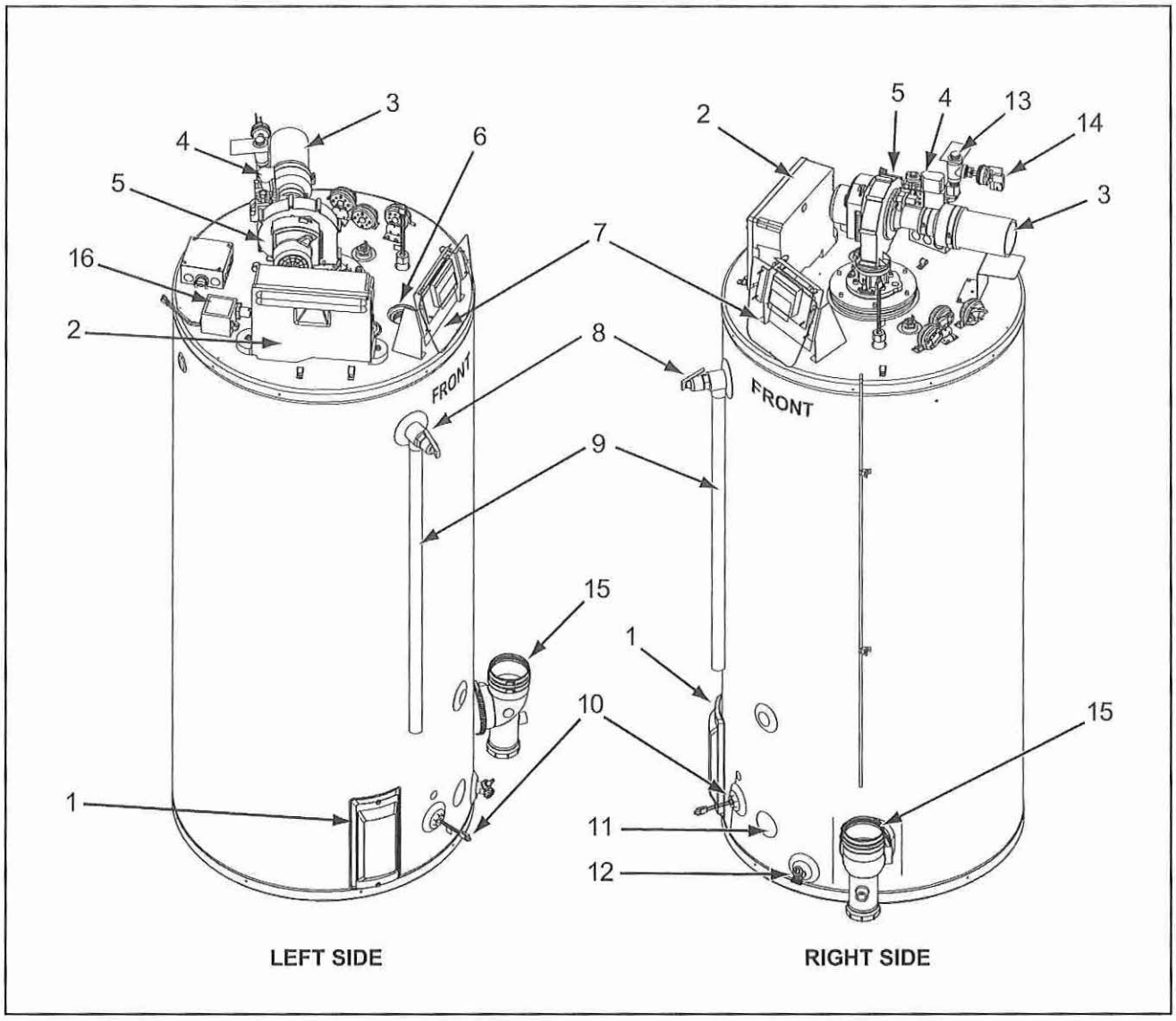


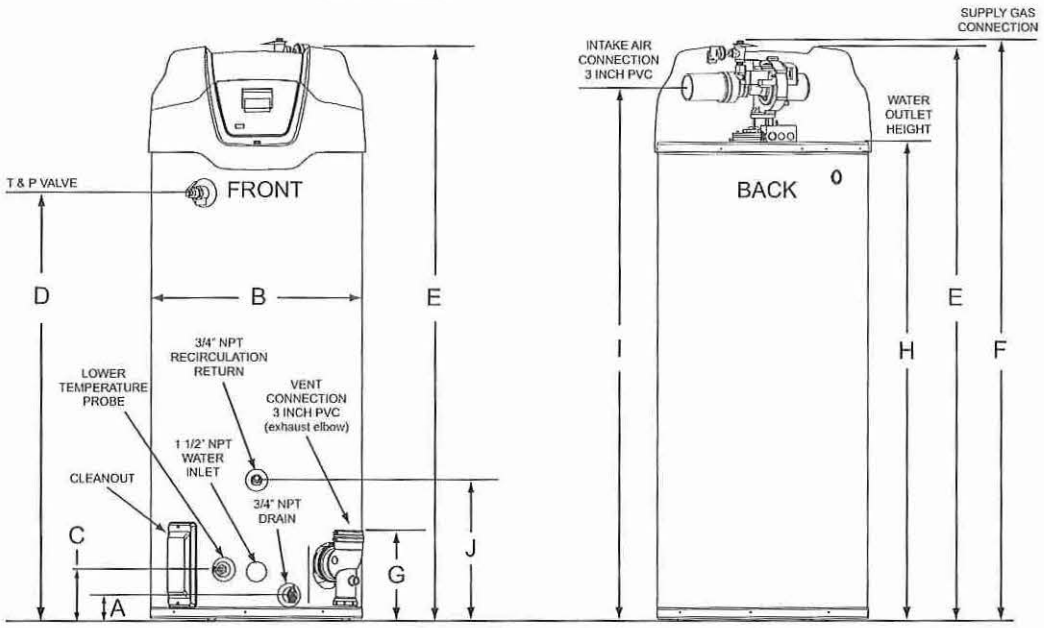
Figure 4

SIDE VIEWS

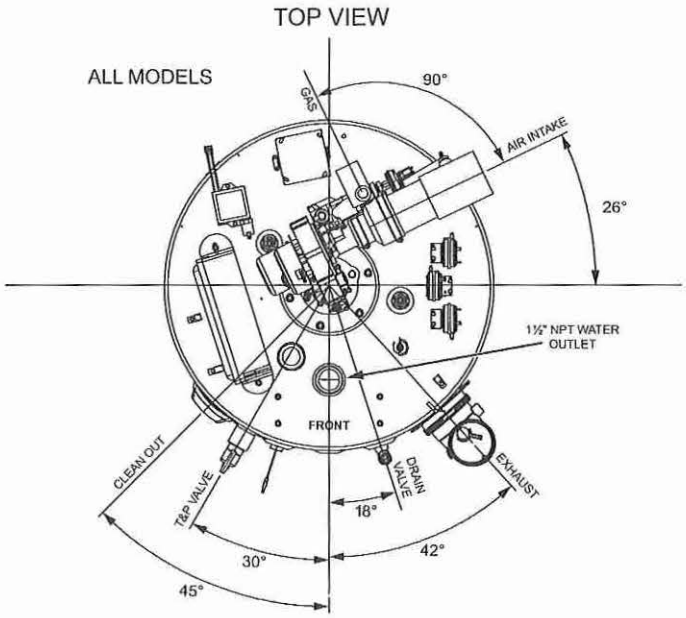
1. Cleanout access panel, covers water heater cleanout opening.
2. CCB enclosure - see item 3 on page 8 for description.
3. Intake air connection - 3 inch PVC.
4. Water heater 24 Volt Gas Valve.
5. Combustion Blower.
6. Water outlet - 1 1/2" NPT connection.
7. UIM (user interface module). The UIM includes the display circuit board, the control system's LCD display and operational buttons. Used to adjust various user settings and view operational information. See Control System Operation on page 45.
8. Temperature-Pressure Relief Valve. See Temperature-Pressure Relief Valve on page 15.
9. Temperature-Pressure Relief Valve discharge pipe - see T&P Valve Discharge Pipe Requirements: on page 15.
10. Lower Temperature Probe, 1 of 2 temperature probes. The water heater's control system monitors this probe to detect water temperature in the lower portion of the storage tank.
11. Water inlet - 1 1/2" NPT connection.
12. Water heater drain valve.
13. Supply gas line connection. See Gas Supply Systems on page 13.
14. Low Gas Pressure switch, see description under beginning on page 8. See Gas Pressure Requirements and Table 3 on page 11.
15. Vent Connection (Exhaust/Condensate Elbow) 3" Aluminum.
16. Spark Ignition Control. When energized, sends the electrical current to the spark igniter.

INSTALLATION CONSIDERATIONS

ROUGH IN DIMENSIONS



These designs comply with the current edition of the American National Standard for Gas Water Heaters, Volume III, ANSI Z21.10.3 / CSA 4.3 as an automatic circulating tank water heater, and automatic storage water heaters.



* Center line of water outlet on top of the water heaters is approximately 7 inches from the front edge of the water heater.

MODEL	DIMENSIONS										SHIP WEIGHT STD	SHIP WEIGHT ASME
	A	B	C	D	E	F	G	H	I	J		
	INCHES/CM	INCHES/CM	INCHES/CM	INCHES/CM	INCHES/CM	INCHES/CM	INCHES/CM	INCHES/CM	INCHES/CM	INCHES/CM	LBS/KG	LBS/KG
BTH 120	3/7.62	27.75/70.5	6.3/16	35/88.9	55.5/141	53.5/135.9	11.25/28.6	42.25/107.32	48.5/123.2	18.25/46.36	460/208	490/220
BTH 150	3/7.62	27.75/70.5	6.3/16	56.38/143.2	76/193.04	75.75/192.4	11.25/28.6	64/162.6	70/177.8	18.25/46.36	523/237	553/251
BTH 199	3/7.62	27.75/70.5	6.3/16	56.38/143.2	76/193.04	75.75/192.4	11.25/28.6	64/162.6	70/177.8	18.25/46.36	523/237	553/251
BTH 250	3/7.62	27.75/70.5	6.3/16	56.38/143.2	76/193.04	75.75/192.4	11.25/28.6	64/162.6	70/177.8	18.25/46.36	523/237	553/251

Figure 5

GAS LINE CONNECTION SIZE

TABLE 1

† MODEL	SERIES	NATURAL GAS	PROPANE GAS
BTH 120	200/201	3/4 "NPT	3/4 "NPT
BTH 150	200/201	3/4 "NPT	3/4 "NPT
BTH 199	200/201	3/4 "NPT	3/4 "NPT
BTH 250	200/201	3/4 "NPT	3/4 "NPT

† Depending on the installed equivalent length, and/or the number of appliances connected, the supply gas line size may have to be increased beyond the minimum required sizes - see Gas Line Sizing on page 40.

STORAGE CAPACITIES

TABLE 2

MODEL	U. S. GALLONS	LITERS
BTH 120	60	227
BTH 150	100	379
BTH 199	100	379
BTH 250	100	379

GAS PRESSURE REQUIREMENTS

TABLE 3

MODEL	MANIFOLD PRESSURE		MINIMUM SUPPLY PRESSURE		MAXIMUM SUPPLY PRESSURE	
	NATURAL GAS	PROPANE GAS	NATURAL GAS	PROPANE GAS	NATURAL GAS	PROPANE GAS
BTH 120	0" W.C. (0 kPa)	0" W.C. (0 kPa)	4.4" W. C. (1.10 kPa)	8.5" W. C. (2.12 kPa)	14" W. C. (3.49 kPa)	14" W. C. (3.49 kPa)
BTH 150	0" W.C. (0 kPa)	0" W.C. (0 kPa)	4.4" W. C. (1.10 kPa)	8.5" W. C. (2.12 kPa)	14" W. C. (3.49 kPa)	14" W. C. (3.49 kPa)
BTH 199	0" W. C. (0 kPa)	0" W. C. (0 kPa)	4.4" W. C. (1.10 kPa)	8.5" W. C. (2.12 kPa)	14" W. C. (3.49 kPa	14" W. C. (3.49 kPa)
BTH 250	0" W. C. (0 kPa)	0" W. C. (0 kPa)	4.4" W. C. (1.10 kPa)	8.5" W. C. (2.12 kPa)	14" W. C. (3.49 kPa)	14" W. C. (3.49 kPa)

RECOVERY CAPACITIES

TABLE 4

						U. S. GALLONS/HR & LITERS/HR AT TEMPERATURE RISE INDICATED											
Model	Type of Gas	Input Btu/hr	Input kW	Thermal Efficiency%	°F / °C	30°F 17°C	40°F 22°C	50°F 28°C	60°F 33°C	70°F 39°C	80°F 44°C	90°F 50°C	100°F 56°C	110°F 61°C	120°F 67°C	130°F 72°C	140°F 78°C
BTH 120	Natural	120,000	35	95	GPH	461	345	276	230	197	173	154	138	126	115	106	99
	Propane				LPH	1743	1308	1046	872	747	654	581	523	475	436	402	374
BTH 150	Natural	150,000	44	98	GPH	594	445	356	297	255	223	198	178	162	148	137	127
	Propane				LPH	2248	1686	1349	1124	963	843	749	674	613	562	519	482
BTH 199	Natural	199,900	58	97	GPH	783	588	470	392	336	294	261	235	214	196	181	168
	Propane				LPH	2965	2224	1779	1483	1271	1112	988	890	809	741	684	635
BTH 250	Natural	250,000	73	96	GPH	970	727	582	485	416	364	323	291	264	242	224	208
	Propane				LPH	3670	2753	2202	1835	1573	1376	1223	1101	1001	918	847	786

LOCATING THE WATER HEATER

Carefully choose a location for the new water heater. The placement is a very important consideration for the safety of the occupants in the building and for the most economical use of the water heater.

CAUTION

Property Damage Hazard

- All water heaters eventually leak.
- Do not install without adequate drainage.

Whether replacing an existing water heater or installing the water heater in a new location observe the following critical points:

1. The water heater must be located indoors.
2. The water heater must not be located in an area where it will be subject to freezing temperatures.
3. Locate the water heater so it is protected and not subject to physical damage by a moving vehicle.
4. Locate the water heater on a level surface.
5. Locate the water heater near a floor drain. The water heater should be located in an area where leakage of the tank or connections will not result in damage to the area adjacent to the water heater or to lower floors of the structure. When such locations cannot be avoided, it is recommended that a metal drain pan, adequately drained, be installed under the water heater.
6. Locate the water heater close to the point of major hot water usage.
7. Locate the water heater close to a 120 VAC power supply. See Power Supply on page 13 for requirements.
8. Locate the water heater where an adequate supply of fresh air for combustion and ventilation can be obtained. See Air Requirements on page 17.
9. Locate the water heater where the vent and intake air piping, when installed, will remain within the maximum equivalent lengths allowed. See Venting Requirements on page 22.
10. Do not locate the water heater where noise (such as the Combustion Blower) during normal operation will be objectionable in adjacent areas.
11. Do not locate the water heater where the subsequent installation of the vent (exhaust) or intake air terminations would be objectionable due to noise at the termination(s). This includes locations close to or across from windows and doors. See Venting Installation on page 21.

⚠WARNING

Fire or Explosion Hazard

- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.
- Avoid all ignition sources if you smell gas.
- Do not expose water heater controls to excessive gas pressure.
- Use only the gas shown on the water heater rating label.
- Maintain required clearances to combustibles.
- Keep ignition sources away from faucets after extended periods of non-use.

Read instruction manual before installing, using or servicing water heater.

There is a risk in using fuel burning appliances such as gas water heaters in rooms, garages or other areas where gasoline, other flammable liquids or engine driven equipment or vehicles are stored, operated or repaired. Flammable vapors are heavy and travel along the floor and may be ignited by the water heater's igniter or Main Burner flames causing fire or explosion.

Flammable items, pressurized containers or any other potential fire hazardous articles must never be placed on or adjacent to the water heater.

CLEARANCE TO COMBUSTIBLE MATERIALS

The water heaters covered in this manual are approved for installation on combustible flooring. The clearance to combustible and non combustible construction materials is 0 inches on the back and sides of the water heater. These water heaters are also approved for installation in an alcove.

When the water heater is installed directly on carpeting, the water heater shall be installed on a metal or wood panel extending beyond the full width and depth of the water heater by at least 3 in (76.2 mm) in any direction or, if the water heater is installed in an alcove or closet, the entire floor shall be covered by the panel. The panel must be strong enough to carry the weight of the heater when full of water.

NOTE: Adequate clearance for servicing should be maintained on all installations. See Service Clearance below.

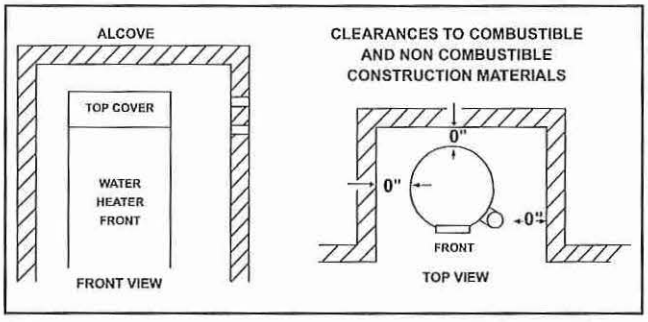


Figure 6

SERVICE CLEARANCE

A service clearance of 24 inches (61 cm) should be maintained from serviceable parts such as the T&P valve, control system components, gas valve, clean out opening, drain valve, the vent connection (exhaust/condensate elbow). Leave as much room as possible above the water heater and near the exhaust elbow for this reason. See Figure 8 on page 16.

INTAKE AIR AND VENT PIPE CLEARANCES

The minimum clearance from combustible materials for the vent (exhaust) and intake air piping shall be 0 inches. Vent or intake air piping passing through a combustible wall or ceiling must be a continuous run (no joints).

EXTENDED VENT TERMINATIONS

The water heaters covered by this manual can be installed using 3 inch pipe for the intake air and/or vent piping up to a maximum of 50 equivalent feet (15.2 m). The intake air and/or vent piping can be extended up to 120 equivalent feet (36.5 m) by installing 4 inch pipe. See the Venting Requirements on page 22.

The water heater ships from the factory with two (2) 3 inch terminations that are 45° PVC elbows with a debris screen installed. When 4 inch intake air or vent pipe is installed, factory supplied 4 inch terminations must be used.

Contact your local distributor or call the parts department phone number listed on the back cover of this manual to order 4 inch termination(s).

OPTIONAL CONCENTRIC & LOW PROFILE TERMINATIONS

The water heaters covered in this manual can be installed in a Direct Vent configuration using optional concentric or Low Profile terminations. See Concentric Termination Installation on page 30 and Low Profile Vent Termination Installation on page 34.

HARD WATER

Where hard water conditions exist, water softening or the threshold type of water treatment is recommended. This will protect the dishwashers, coffee urns, water heaters, water piping and other equipment. See Maintenance on page 63 for sediment and lime scale removal procedures.

CIRCULATION PUMPS

A circulating pump is used when a system requires a circulating loop or there is a storage tank used in conjunction with the water heater. The tank is provided with a 3/4" NPT recirculation loop return connection. See the Water Piping Diagrams beginning on page 69 for installation location of circulating pumps.

See Circulation Pump Wiring Diagrams on page 68 for electrical hookup information. Install in accordance with the current edition of the National Electrical Code, NFPA 70 or the Canadian Electrical Code, CSA C22.1.

Stainless steel circulating pumps are recommended for use with commercial water heaters.

Some circulating pumps are manufactured with sealed bearings and do not require further lubrication. Some circulating pumps must be periodically oiled. Refer to the pump manufacturer's instructions for lubrication requirements.

INSULATION BLANKETS

⚠WARNING

Breathing Hazard - Carbon Monoxide Gas

- Do not obstruct water heater air intake with insulating blanket.
- Gas and carbon monoxide detectors are available.
- Install water heater in accordance with the instruction manual.

Breathing carbon monoxide can cause brain damage or death. Always read and understand instruction manual.

Insulation blankets are available to the general public for external use on gas water heaters but are not necessary with these products. The purpose of an insulation blanket is to reduce the standby heat loss encountered with storage tank heaters. The water heaters covered by this manual meet or exceed the Energy Policy Act standards with respect to insulation and standby heat loss requirements, making an insulation blanket unnecessary.

Should you choose to apply an insulation blanket to this heater, you should follow these instructions. See the Features and Components section of this manual for identification of components mentioned below. Failure to follow these instructions can restrict the air flow required for proper

combustion, potentially resulting in fire, asphyxiation, serious personal injury or death.

- **DO NOT** apply insulation to the top of the water heater, as this will interfere with safe operation of the blower assembly.
- **DO NOT** cover the control system LCD on top of the water heater.
- **DO NOT** cover the Temperature-Pressure Relief Valve.
- **DO NOT** cover the instruction manual. Keep it on the side of the water heater or nearby for future reference.
- **DO** obtain new warning and instruction labels from the manufacturer for placement on the blanket directly over the existing labels.
- **DO** inspect the insulation blanket frequently to make certain it does not sag, thereby obstructing combustion air flow.

INSTALLATION REQUIREMENTS

GAS SUPPLY SYSTEMS

Low pressure building gas supply systems are defined as those systems that cannot under any circumstances exceed 14" W.C. (1/2 PSI Gauge). These systems do not require pressure regulation. Measurements should be taken to insure that gas pressures are stable and fall within the requirements stated on the water heater rating plate. Readings should be taken with all gas burning equipment off (static pressure) and with all gas burning equipment running at maximum rate (dynamic pressure). The gas supply pressure must be stable within 1.5" W.C. from static to dynamic pressure to provide good performance. Pressure drops that exceed 1.5" W.C. may cause rough starting, noisy combustion or nuisance outages. Increases or spikes in static pressure during off cycles may cause failure to ignite or in severe cases damage to appliance gas valves. If your low pressure system does NOT meet these requirements, the installer is responsible for the corrections.

High Pressure building supply systems use pressures that exceed 14" W.C. (1/2 PSI Gauge). These systems must use field supplied regulators to lower the gas pressure to less than 14" W.C. (1/2 PSI Gauge). Water heaters require gas regulators that are properly sized for the water heater input and deliver the rating plate specified pressures. Gas supply systems where pressure exceeds 5 PSI often require multiple regulators to achieve desired pressures. Systems in excess of 5 PSI building pressure should be designed by gas delivery professionals for best performance. Water heaters connected to gas supply systems that exceed 14" W.C. (1/2 PSI Gauge) at any time must be equipped with a gas supply regulator.

All models require a minimum gas supply pressure of 4.4" W.C. for natural gas and 8.5" W.C. for propane gas. The minimum supply pressure is measured while gas is flowing (dynamic pressure). The supply pressure should never fall below 4.4" W.C. for natural gas and 8.5" W.C. for propane gas. The supply pressure should be measured with all gas fired appliances connected to the common main firing at full capacity. If the supply pressure drops more than 1.5" W.C. as gas begins to flow to the water heater then the supply gas system including the gas line and/or the gas regulator may be restricted or undersized. See Supply Gas Regulator section and Gas Piping section of this manual. The gas valve on all models has a maximum gas supply pressure limit of 14" W.C. The maximum supply pressure is measured while gas is not flowing (static pressure).

SUPPLY GAS REGULATOR

The maximum allowable gas supply pressure for this water heater is 14.0 inches W.C. (3.49 kPa) for natural and propane gas. Install a positive lock-up gas pressure regulator in the gas supply line if inlet gas pressure can exceed these pressures at any time.

If a positive lock-up regulator is required follow these instructions:

1. Positive lock-up gas pressure regulators must be rated at or above the input Btu/hr rating of the water heater they supply.
2. Supply gas regulators shall have inlet and outlet connections not less than the minimum supply gas line size for the water heater they supply. See Table 11, page 40.
3. Positive lock-up gas pressure regulator(s) should be installed no closer than 3 feet (1 meter) and no farther than 8 feet (2.4 meters) from the water heater's inlet gas connection.
4. After installing the positive lock-up gas pressure regulator(s) an initial nominal supply pressure setting of 7.0" W.C. while the water heater is operating is recommended and will generally provide good water heater operation. Some addition adjustment maybe required later to maintain a steady gas supply pressure.
5. When installing multiple water heaters in the same gas supply system it is recommended that individual positive lock-up gas pressure regulators be installed at each unit from the supply gas connection on the water heater.

POWER SUPPLY

The water heaters covered in this manual require a 120 VAC, 1Ø (single phase), 60Hz, 15 amp power supply and must also be electrically grounded in accordance with local codes or, in the absence of local codes, with the National Electrical Code, ANSI/NFPA 70 or the Canadian Electrical Code, CSA C22.1.

DEDICATED POWER WIRING AND BREAKERS

Dedicated power supply wires, ground wiring and dedicated circuit breakers often prevent electrical line noise and are required when installing the water heater.

POWER FLUCTUATIONS AND ELECTRICAL NOISE

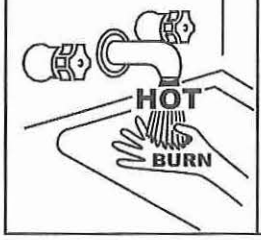
The water heater's control system requires a source of stable clean electricity for proper operation. Connecting the water heater to a branch circuit that is subject to fluctuations in voltage level or electrical line noise such as EMI (electro magnetic interference) or RFI (radio frequency interference) may cause erratic control system operation and malfunction.

A high quality power supply filter/suppressor such as the Kleen Line model SELF/T-10 Series SC-L or equivalent must be installed if the above conditions exist. Call the technical support phone number listed on the back cover of this manual for more information.

NOTE: Malfunctions caused by the power supply and costs to install power supply filters are not covered under the limited warranty.

MIXING VALVES

⚠DANGER



Water temperature over 125°F (52°C) can cause severe burns instantly resulting in severe injury or death.

Children, the elderly and the physically or mentally disabled are at highest risk for scald injury.

Feel water before bathing or showering.

Temperature limiting devices such as mixing valves must be installed when required by codes and to ensure safe temperatures at fixtures.

Water heated to a temperature which will satisfy clothes washing, dish washing, and other sanitizing needs can scald and cause permanent injury upon contact. Short repeated heating cycles caused by small hot water uses can cause temperatures at the point of use to exceed the water heater's temperature setting by up to 20°F (11°C).

Some people are more likely to be permanently injured by hot water than others. These include the elderly, children, the infirm and the physically/mentally disabled. Table 5 shows the approximate time-to-burn relationship for normal adult skin. If anyone using hot water provided by the water heater being installed fits into one of these groups or if there is a local code or state law requiring a certain water temperature at the point of use, then special precautions must be taken.

In addition to using the lowest possible temperature setting that satisfies the demand of the application a Mixing Valve should be installed at the water heater (see Figure 7) or at the hot water taps to further reduce system water temperature.

Mixing valves are available at plumbing supply stores. Consult a Qualified Installer or Service Agency. Follow mixing valve manufacturer's instructions for installation of the valves.

TABLE 5

Water Temperature °F (°C)	Time for 1st Degree Burn (Less Severe Burns)	Time for Permanent Burns 2nd & 3rd Degree (Most Severe Burns)
110 (43)	(normal shower temp.)	
116 (47)	(pain threshold)	
116 (47)	35 minutes	45 minutes
122 (50)	1 minute	5 minutes
131 (55)	5 seconds	25 seconds
140 (60)	2 seconds	5 seconds
149 (65)	1 second	2 seconds
154 (68)	instantaneous	1 second
(U.S. Government Memorandum, C.P.S.C., Peter L. Armstrong, Sept. 15, 1978)		

DISHWASHING MACHINES

All dishwashing machines meeting the National Sanitation Foundation requirements are designed to operate with water flow pressures between 15 and 25 pounds per square inch (103 kPa and 173 kPa). Flow pressures above 25 pounds per square inch (173 kPa), or below 15 pounds per square inch (103 kPa), will result in improperly sanitized dishes. Where pressures are high, a water pressure reducing or flow regulating control valve should be used in the 180°F (82°C) line to the dishwashing machine and should be adjusted to deliver water pressure between these limits.

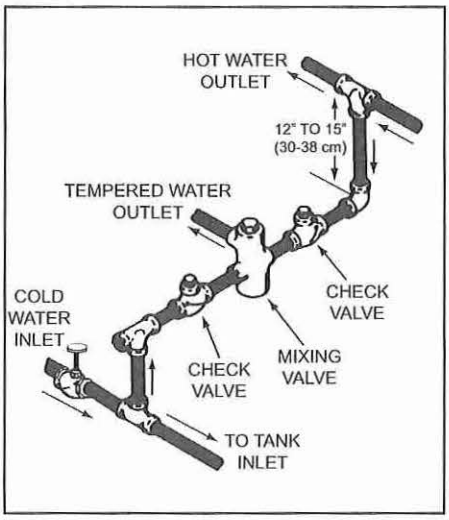


Figure 7

The National Sanitation Foundation also recommends circulation of 180°F (82°C) water. Where this is done, the circulation should be very gentle so that it does not cause any unnecessary turbulence inside the water heater. The circulation should be just enough to provide 180°F (82°C) water at the point of take-off to the dishwashing machine.

Adjust flow by throttling a full port ball valve installed in the circulating line on the outlet side of the pump. Never throttle flow on the suction side of a pump. See the Water Piping Diagrams beginning on page 69.

NOTE: To comply with NSF Standard 5 installation requirements the bottom of the water heater must be sealed to the floor with a silicone based sealant or elevated 6 inches above the floor.

CLOSED WATER SYSTEMS

Water supply systems may, because of code requirements or such conditions as high line pressure, among others, have installed devices such as pressure reducing valves, check valves, and back flow preventers. Devices such as these cause the water system to be a closed system.

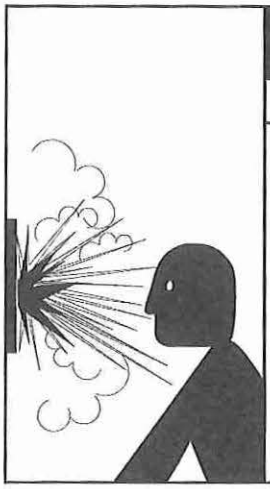
THERMAL EXPANSION

As water is heated, it expands (thermal expansion). In a closed system the volume of water will grow when it is heated. As the volume of water grows there will be a corresponding increase in water pressure due to thermal expansion. Thermal expansion can cause premature tank failure (leakage). This type of failure is not covered under the limited warranty. Thermal expansion can also cause intermittent Temperature-Pressure Relief Valve operation: water discharged from the valve due to excessive pressure build up. This condition is not covered under the limited warranty. The Temperature-Pressure Relief Valve is not intended for the constant relief of thermal expansion.

A properly sized thermal expansion tank must be installed on all closed systems to control the harmful effects of thermal expansion. Contact a local plumbing service agency to have a thermal expansion tank installed.

See Water Line Connections on page 43 and the Water Piping Diagrams beginning on page 69.

TEMPERATURE-PRESSURE RELIEF VALVE



⚠ WARNING

Explosion Hazard

- Temperature-Pressure Relief Valve must comply with ANSI Z21.22-CSA 4.4 and ASME code.
- Properly sized temperature-pressure relief valve must be installed in opening provided.
- Can result in overheating and excessive tank pressure.
- Can cause serious injury or death.

This water heater is provided with a properly rated/sized and certified combination Temperature-Pressure Relief Valve (T&P valve) by the manufacturer. The valve is certified by a nationally recognized testing laboratory that maintains periodic inspection of production of listed equipment of materials as meeting the requirements for Relief Valves for Hot Water Supply Systems, ANSI Z21.22 • CSA 4.4, and the code requirements of ASME.

If replaced, the new T&P valve must meet the requirements of local codes, but not less than a combination Temperature-Pressure Relief Valve rated/sized and certified as indicated in the above paragraph. The new valve must be marked with a maximum set pressure not to exceed the marked hydrostatic working pressure of the water heater (150 psi = 1,035 kPa) and a discharge capacity not less than the water heater Btu/hr or kW input rate as shown on the water heater's model rating label.

NOTE: In addition to the factory installed Temperature-Pressure Relief Valve on the water heater, each remote storage tank that may be installed and piped to a water heating appliance must also have its own properly sized, rated and approved Temperature-Pressure Relief Valve installed. Call the toll free technical support phone number listed on the back cover of this manual for technical assistance in sizing a Temperature-Pressure Relief Valve for remote storage tanks.

For safe operation of the water heater, the Temperature-Pressure Relief Valve must not be removed from its designated opening nor plugged. The Temperature-Pressure Relief Valve must be installed directly into the fitting of the water heater designed for the relief valve. Install discharge piping so that any discharge will exit the pipe within 6 inches (15.2 cm) above an adequate floor drain, or external to the building. In cold climates it is recommended that it be terminated at an adequate drain inside the building. Be certain that no contact is made with any live electrical part. The discharge opening must not be blocked or reduced in size under any circumstances. Excessive length, over 30 feet (9.14 m), or use of more than four elbows can cause restriction and reduce the discharge capacity of the valve.

No valve or other obstruction is to be placed between the Temperature-Pressure Relief Valve and the tank. Do not connect discharge piping directly to the drain unless a 6" (15.2 cm) air gap is provided. To prevent bodily injury, hazard to life, or property damage, the relief valve must be allowed to discharge water in adequate quantities should circumstances demand. If the discharge pipe is not connected to a drain or other suitable means, the water flow may cause property damage.

CAUTION

Water Damage Hazard

- Temperature-Pressure Relief Valve discharge pipe must terminate at adequate drain.

T&P Valve Discharge Pipe Requirements:

- Shall not be smaller in size than the outlet pipe size of the valve, or have any reducing couplings or other restrictions.
- Shall not be plugged or blocked.
- Shall not be exposed to freezing temperatures.
- Shall be of material listed for hot water distribution.
- Shall be installed so as to allow complete drainage of both the Temperature-Pressure Relief Valve and the discharge pipe.
- Must terminate a maximum of six inches above a floor drain or external to the building. In cold climates, it is recommended that the discharge pipe be terminated at an adequate drain inside the building.
- Shall not have any valve or other obstruction between the relief valve and the drain.

⚠ DANGER

- Burn hazard.
- Hot water discharge.
- Keep clear of Temperature-Pressure Relief Valve discharge outlet.

The Temperature-Pressure Relief Valve must be manually operated at least twice a year. Caution should be taken to ensure that (1) no one is in front of or around the outlet of the Temperature-Pressure Relief Valve discharge line, and (2) the water manually discharged will not cause any bodily injury or property damage because the water may be extremely hot. If after manually operating the valve, it fails to completely reset and continues to release water, immediately close the cold water inlet to the water heater, follow the draining instructions in this manual, and replace the Temperature-Pressure Relief Valve with a properly rated/sized new one.

NOTE: The purpose of a Temperature-Pressure Relief Valve is to prevent excessive temperatures and pressures in the storage tank. The T&P valve is not intended for the constant relief of thermal expansion. A properly sized thermal expansion tank must be installed on all closed systems to control thermal expansion, see Closed Water Systems and Thermal Expansion on page 14.

If you do not understand these instructions or have any questions regarding the Temperature-Pressure Relief Valve call the toll free number listed on the back cover of this manual for technical assistance.

CONDENSATE DRAIN

The water heaters covered in this manual are condensing appliances and require a building drain to be located in close proximity to allow the condensate to drain safely.

Condensate drains from the water heater at the exhaust elbow located at the bottom. The field installed condensate drain line must not be elevated above the condensate drain connection on the condensate trap, see Figure 8. If the condensate does not drain properly it will build up in the exhaust (vent) elbow. This will restrict the flow of flue gases and cause the Blocked Exhaust pressure switch to open its contacts. The control system monitors all pressure switches, if the Blocked Exhaust Switch contacts are open the control system will lock out and disable heating operation. The "Blocked Exhaust" Fault message will be displayed on the control system's LCD, see Fault And Alert Conditions beginning on page 60.

The Condensate Cleanout Cap must be on and tight when unit is in operation.

NOTE: If the "Blocked Exhaust " Fault message is ever displayed on the control system LCD, check the condensate drain first and ensure it is not blocked.

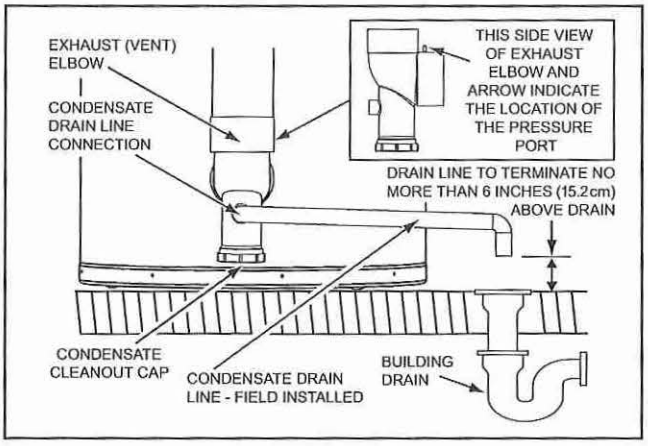
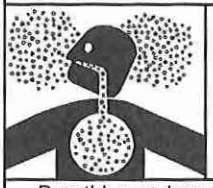


Figure 8

CONDENSATE DRAIN WATER TRAP

⚠WARNING

Breathing Hazard - Carbon Monoxide Gas



- Ensure a functioning water trap is installed in the condensate drain.
- Gas and carbon monoxide detectors are available.
- Install water heater in accordance with the instruction manual.

Breathing carbon monoxide can cause brain damage or death. Always read and understand instruction manual.

DO NOT remove the factory installed exhaust/condensate elbow for any reason, see Figure 8. The water heater's vent pipe is under a slight positive pressure while unit is in operation. The water trap inside of the exhaust/condensate elbow prevents flue gases from escaping into the installed space. See Condensate Drain Installation on page 39.

CONDENSATE PH LEVEL

The condensate drains from the water heater's covered in this manual have PH levels between 4.3 and 5.0. Install a commercially available neutralizing kit if required by local codes.

NOTE: Lower PH levels are acidic. Do not connect a metal drain line, such as copper, to the water heater for this reason. See Condensate Drain Installation on page 39.

COMBUSTIBLE MATERIAL STORAGE

⚠WARNING

Fire or Explosion Hazard

- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.
- Avoid all ignition sources if you smell gas.
- Do not expose water heater controls to excessive gas pressure.
- Use only the gas shown on the water heater rating label.
- Maintain required clearances to combustibles.
- Keep ignition sources away from faucets after extended periods of non-use.

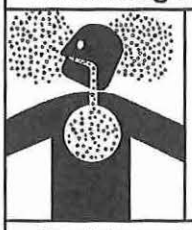
Read instruction manual before installing, using or servicing water heater.

Keep water heater area clear and free of combustible materials, gasoline and other flammable vapors and liquids.

CONTAMINATED AIR

⚠WARNING

Breathing Hazard - Carbon Monoxide Gas



- Install water heater in accordance with the Instruction Manual and NFPA 54 or CAN/CSA-B149.1.
- To avoid injury, combustion and ventilation air must be taken from outdoors.
- Do not place chemical vapor emitting products near water heater.

Breathing carbon monoxide can cause brain damage or death. Always read and understand instruction manual.

Corrosion of the flue ways and vent system may occur if air for combustion contains certain chemical vapors. Such corrosion may result in failure and risk of asphyxiation.

Combustion air that is contaminated can greatly diminish the life span of the water heater and water heater components such as igniters and burners. Propellants of aerosol sprays, beauty shop supplies, water softener chemicals and chemicals used in dry cleaning processes that are present in the combustion, ventilation or ambient air can cause such damage.

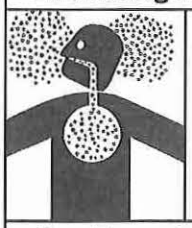
Do not store products of this sort near the water heater. Air which is brought in contact with the water heater should not contain any of these chemicals. If necessary, uncontaminated air should be obtained from remote or outdoor sources. The limited warranty is voided when failure of water heater is due to a corrosive atmosphere. (See limited warranty for complete terms and conditions).

If the water heater will be used in beauty shops, barber shops, cleaning establishments, or self-service laundries with dry cleaning equipment, it is imperative that the water heater(s) be installed in a Direct Vent configuration so that all air for combustion is derived directly from the outdoor atmosphere through a sealed intake air pipe. See Venting Installation on page 21.

AIR REQUIREMENTS

⚠WARNING

Breathing Hazard - Carbon Monoxide Gas



- Install water heater in accordance with the Instruction Manual and NFPA 54 or CAN/CSA-B149.1.
- To avoid injury, combustion and ventilation air must be taken from outdoors.
- Do not place chemical vapor emitting products near water heater.

Breathing carbon monoxide can cause brain damage or death. Always read and understand instruction manual.

For safe operation an adequate supply of fresh uncontaminated air for combustion and ventilation must be provided.

An insufficient supply of air can cause recirculation of combustion products resulting in contamination that may be hazardous to life. Such a condition often will result in a yellow, luminous burner flame, causing sooting of the combustion chamber, burners and flue tubes and creates a risk of asphyxiation.

Do not install the water heater in a confined space unless an adequate supply of air for combustion and ventilation is brought in to that space using the methods described in the Confined Space section that follows.

Never obstruct the flow of ventilation air. If you have any doubts or questions at all, call your gas supplier. Failure to provide the proper amount of combustion air can result in a fire or explosion and cause property damage, serious bodily injury or death.

UNCONFINED SPACE

An Unconfined Space is one whose volume IS NOT LESS THAN 50 cubic feet per 1,000 Btu/hr (4.8 cubic meters per kW) of the total input rating of all appliances installed in the space. Rooms communicating directly with the space, in which the appliances are installed, through openings not furnished with doors, are considered a part of the unconfined space.

Makeup air requirements for the operation of exhaust fans, kitchen ventilation systems, clothes dryers and fireplaces shall also be considered in determining the adequacy of a space to provide combustion, ventilation and dilution air.

UNUSUALLY TIGHT CONSTRUCTION

In unconfined spaces in buildings, infiltration may be adequate to provide air for combustion, ventilation and dilution of flue gases. However, in buildings of unusually tight construction (for example, weather stripping, heavily insulated, caulked, vapor barrier, etc.) additional air must be provided using the methods described in the Confined Space section that follows.

CONFINED SPACE

A Confined Space is one whose volume IS LESS THAN 50 cubic feet per 1,000 Btu/hr (4.8 cm per kW) of the total input rating of all appliances installed in the space.

Openings must be installed to provide fresh air for combustion, ventilation and dilution in confined spaces. The required size for the openings is dependent on the method used to provide fresh air to the confined space AND the total Btu/hr input rating of all appliances installed in the space.

DIRECT VENT APPLIANCES

Appliances installed in a Direct Vent configuration that derive all air for combustion from the outdoor atmosphere through sealed intake air piping are not factored in the total appliance input Btu/hr calculations used to determine the size of openings providing fresh air into confined spaces.

EXHAUST FANS

Where exhaust fans are installed, additional air shall be provided to replace the exhausted air. When an exhaust fan is installed in the same space with a water heater, sufficient openings to provide fresh air must be provided that accommodate the requirements for all appliances in the room and the exhaust fan. Undersized openings will cause air to be drawn into the room through the water heater's vent system causing poor combustion. Sooting, serious damage to the water heater and the risk of fire or explosion may result. It can also create a risk of asphyxiation.

LOUVERS AND GRILLES

The free areas of the fresh air openings in the instructions that follow do not take in to account the presence of louvers, grilles or screens in the openings.

The required size of openings for combustion, ventilation and dilution air shall be based on the "net free area" of each opening. Where the free area through a design of louver or grille or screen is known, it shall be used in calculating the size of opening required to provide the free area specified. Where the louver and grille design and free area are not known, it shall be assumed that wood louvers will have 25% free area and metal louvers and grilles will have 75% free area. Non motorized louvers and grilles shall be fixed in the open position.

FRESH AIR OPENINGS FOR CONFINED SPACES

The following instructions shall be used to calculate the size, number and placement of openings providing fresh air for combustion, ventilation and dilution in confined spaces. The illustrations shown in this section of the manual are a reference for the openings that provide fresh air into confined spaces only. **DO NOT** refer to these illustrations for the purpose of vent installation. See Venting Installation on page 21 for complete venting installation instructions.

OUTDOOR AIR THROUGH TWO OPENINGS

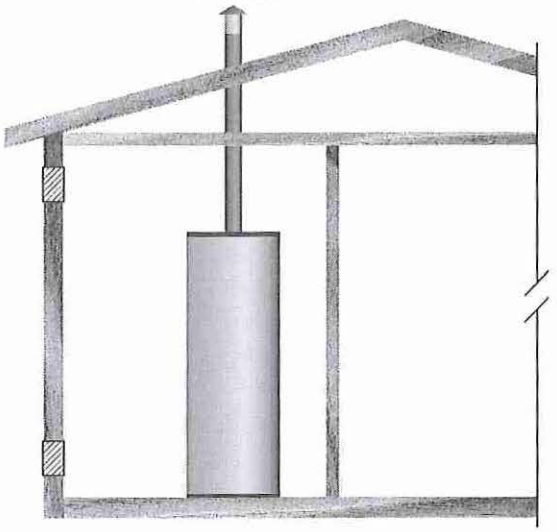


Figure 9

The confined space shall be provided with two permanent openings, one commencing within 12 inches (300 mm) of the top and one commencing within 12 inches (300 mm) of the bottom of the enclosure. The openings shall communicate directly with the outdoors. See Figure 9.

Each opening shall have a minimum free area of 1 square inch per 4,000 Btu/hr (550 mm2 per kW) of the aggregate input rating of all appliances installed in the enclosure. Each opening shall not be less than 100 square inches (645 cm2).

OUTDOOR AIR THROUGH ONE OPENING

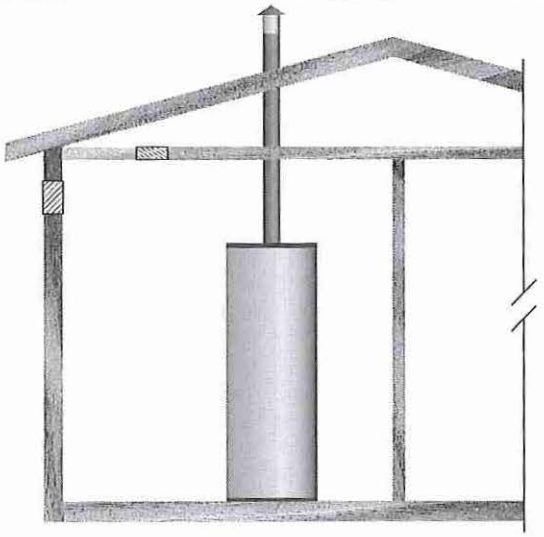


Figure 10

Alternatively a single permanent opening, commencing within 12 inches (300 mm) of the top of the enclosure, shall be provided. See Figure 10. The water heater shall have clearances of at least 1 inch (25 mm) from the sides and back and 6 inches (l50 mm) from the front of the water heater. The opening shall directly communicate with the outdoors or shall communicate through a vertical or horizontal duct to the outdoors or spaces that freely communicate with the outdoors and shall have a minimum free area of the following:

1. 1 square inch per 3000 Btu/hr (733 mm2 per kW) of the total input rating of all appliances located in the enclosure, and
2. Not less than the sum of the areas of all vent connectors in the space.

OUTDOOR AIR THROUGH TWO HORIZONTAL DUCTS

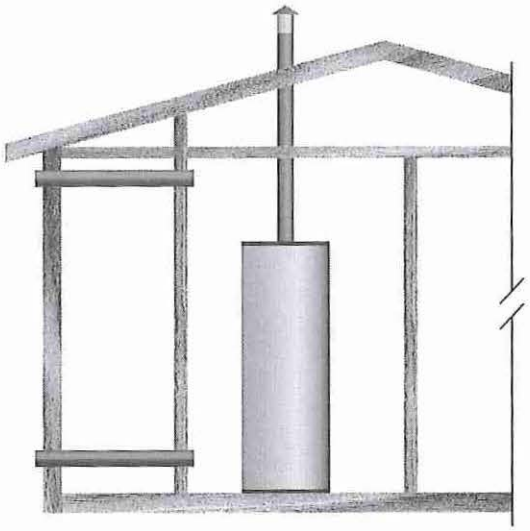


Figure 11

The confined space shall be provided with two permanent horizontal ducts, one commencing within 12 inches (300 mm) of the top and one commencing within 12 inches (300 mm) of the bottom of the enclosure. The horizontal ducts shall communicate directly with the outdoors. See Figure 11.

Each duct opening shall have a minimum free area of 1 square inch per 2,000 Btu/hr (1100 mm2 per kW) of the aggregate input rating of all appliances installed in the enclosure.

When ducts are used, they shall be of the same cross sectional area as the free area of the openings to which they connect. The minimum dimension of rectangular air ducts shall be not less than 3 inches.

OUTDOOR AIR THROUGH TWO VERTICAL DUCTS

The illustrations shown in this section of the manual are a reference for the openings that provide fresh air into confined spaces only.

DO NOT refer to these illustrations for the purpose of vent installation. See Venting Installation on page 21 for complete venting installation instructions.

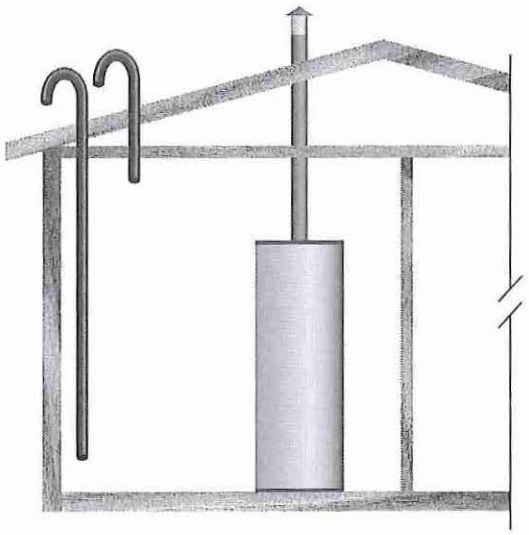


Figure 12

The confined space shall be provided with two permanent vertical ducts, one commencing within 12 inches (300 mm) of the top and one commencing within 12 inches (300 mm) of the bottom of the enclosure. The vertical ducts shall communicate directly with the outdoors. See Figure 12.

Each duct opening shall have a minimum free area of 1 square inch per 4,000 Btu/hr (550 mm2 per kW) of the aggregate input rating of all appliances installed in the enclosure.

When ducts are used, they shall be of the same cross sectional area as the free area of the openings to which they connect. The minimum dimension of rectangular air ducts shall be not less than 3 inches (7.62 cm).

AIR FROM OTHER INDOOR SPACES

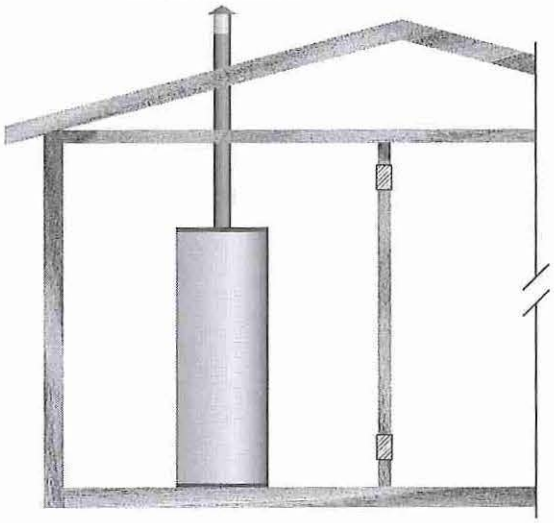


Figure 13

The confined space shall be provided with two permanent openings, one commencing within 12 inches (300 mm) of the top and one commencing within 12 inches (300 mm) of the bottom of the enclosure. See Figure 13.

Each opening shall communicate directly with an additional room(s) of sufficient volume so that the combined volume of all spaces meets the criteria for an Unconfined Space.

Each opening shall have a minimum free area of 1 square inch per 1,000 Btu/hr (2200 mm2 per kW) of the aggregate input rating of all appliances installed in the enclosure. Each opening shall not be less than 100 square inches (645 cm2).

INSTALLATION REQUIREMENTS - COMMONWEALTH OF MASSACHUSETTS

COMMONWEALTH OF MASSACHUSETTS

For all side wall terminated, horizontally vented power vent, direct vent, and power direct vent gas fueled water heaters installed in every dwelling, building or structure used in whole or in part for residential purposes, including those owned or operated by the Commonwealth and where the side wall exhaust vent termination is less than seven (7) feet above finished grade in the area of the venting, including but not limited to decks and porches, the following requirements shall be satisfied:

INSTALLATION OF CARBON MONOXIDE DETECTORS

At the time of installation of the side wall horizontal vented gas fueled equipment, the installing plumber or gasfitter shall observe that a hard wired carbon monoxide detector with an alarm and battery back-up is installed on the floor level where the gas equipment is to be installed. In addition, the installing plumber or gasfitter shall observe that a battery operated or hard wired carbon monoxide detector with an alarm is installed on each additional level of the dwelling, building or structure served by the sidewall horizontal vented gas fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified licensed professionals for the installation of hard wired carbon monoxide detectors.

In the event that the side wall horizontally vented gas fueled equipment is installed in a crawl space or an attic, the hard wired carbon monoxide detector with alarm and battery back-up may be installed on the next adjacent floor level.

In the event that the requirements of this subdivision can not be met at the time of completion of installation, the owner shall have a period of thirty (30) days to comply with the above requirements provided that during said thirty (30) day period, a battery operated carbon monoxide detector with an alarm shall be installed.

APPROVED CARBON MONOXIDE DETECTORS

Each carbon monoxide detector as required in accordance with the above provisions shall comply with NFPA 720 and be ANSI/ UL 2034 listed and CSA certified.

SIGNAGE

A metal or plastic identification plate shall be permanently mounted to the exterior of the building at a minimum height of eight (8) feet above grade directly in line with the exhaust vent terminal for the horizontally vented gas fueled heating appliance or equipment. The sign shall read, in print size no less than one-half (1/2) inch in size, **"GAS VENT DIRECTLY BELOW. KEEP CLEAR OF ALL OBSTRUCTIONS."**

INSPECTION

The state or local gas inspector of the side wall horizontally vented gas fueled equipment shall not approve the installation unless, upon inspection, the inspector observes carbon monoxide detectors and signage installed in accordance with the provisions of 248 CMR 5.08(2)(a) 1 through 4.

EXEMPTIONS

The following equipment is exempt from 248 CMR 5.08(2)(a)1 through 4:

1. The equipment listed in Chapter 10 entitled "Equipment Not Required To Be Vented" in the most current edition of NFPA 54 as adopted by the Board; and
2. Product Approved side wall horizontally vented gas fueled equipment installed in a room or structure separate from the dwelling, building, or structure used in whole or in part for residential purposes.

MANUFACTURER REQUIREMENTS - GAS EQUIPMENT VENTING SYSTEM PROVIDED

When the manufacturer of Product Approved side wall horizontally vented gas equipment provides a venting system design or venting system components with the equipment, the instructions provided by the manufacturer for installation of the equipment and the venting system shall include:

1. Detailed instructions for the installation of the venting system design or the venting system components; and
2. A complete parts list for the venting system design or venting system.

MANUFACTURER REQUIREMENTS - GAS EQUIPMENT VENTING SYSTEM NOT PROVIDED

When the manufacturer of a Product Approved side wall horizontally vented gas fueled equipment does not provide the parts for venting the flue gases, but identifies "special venting systems," the following requirements shall be satisfied by the manufacturer:

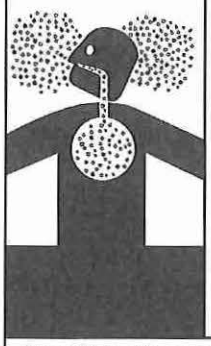
1. The referenced "special venting system" instructions shall be included with the appliance or equipment installation instructions; and
2. The "special venting systems" shall be Product Approved by the Board, and the instructions for that system shall include a parts list and detailed installation instructions.

A copy of all installation instructions for all Product Approved side wall horizontally vented gas fueled equipment, all venting instructions, all parts lists for venting instructions, and/or all venting design instructions shall remain with the appliance or equipment at the completion of the installation.

VENTING INSTALLATION

⚠WARNING

Breathing Hazard - Carbon Monoxide Gas



- Install vent system in accordance with codes.
- Do not operate water heater if exposed to flooding or water damage
- Special consideration must be taken with installations above 10,000 feet (3,048 m) refer to high altitude section of this manual.
- Do not operate if soot buildup.
- Do not obstruct water heater air intake with insulating jacket or blanket.
- Do not place chemical vapor emitting products near water heater.
- Gas and carbon monoxide detectors are available.
- Never operate the heater unless it is vented to the outdoors and has adequate air supply to avoid risks of improper operation, fire, explosion or asphyxiation.
- Analyze the entire vent system to make sure that condensate will not become trapped in a section of vent pipe and therefore reduce the open cross sectional area of the vent.

Breathing carbon monoxide can cause brain damage or death. Always read and understand the instruction manual.

Never operate the water heater unless it is vented to the outdoors.

The instructions in this section of the manual must be followed to avoid choked combustion or recirculation of flue gases. Such conditions cause sooting of the combustion chamber, burners and flue tubes and creates a risk of asphyxiation.

GENERAL VENTING INFORMATION

The water heaters covered in this manual are operationally equivalent to Category IV appliances and may be installed in either a Power Vent or Direct Vent configuration.

APPROVED MATERIALS

Approved vent and intake air pipe materials that may be used in the United States:

- PVC Schedule 40 (ASTM D 2241 / CSA B181.2, ASTM D 1785 / CSA B137.3
- CPVC Schedule 40 (ASTM F-411 / CSA B137.6)
- Polypropylene
- AL29-4C Stainless Steel

Approved vent and intake air pipe materials that must be used in Canada:

- ULC S636 PVC / CPVC
- ULC S636 Polypropylene
- AL29-4C Stainless Steel

CATEGORY IV APPLIANCE

Category IV appliances operate with a positive vent (exhaust) static pressure and with vent gas temperatures low enough to produce condensate in the vent piping.

POWER VENT CONFIGURATION

Power Vent configurations derive all combustion air from the room where they are installed and discharge all flue gases to the outdoor atmosphere through a sealed vent (exhaust) pipe. Power vent configurations have one vent pipe connected to the water heater which can be terminated in a vertical or horizontal arrangement. See Figure 42 and Figure 43 on page 35.

DIRECT VENT CONFIGURATION

Direct Vent configurations derive all combustion air directly from the outdoor atmosphere through a sealed intake air pipe and discharge all flue gases to the outdoor atmosphere through a sealed vent (exhaust) pipe. Direct Vent configurations have two pipes connected to the water heater, one vent pipe and one intake air pipe. Direct Vent configurations can be terminated in one of seven different arrangements. See Figure 44 on page 35 through Figure 50 on page 36.

GENERAL VENTING INSTRUCTIONS

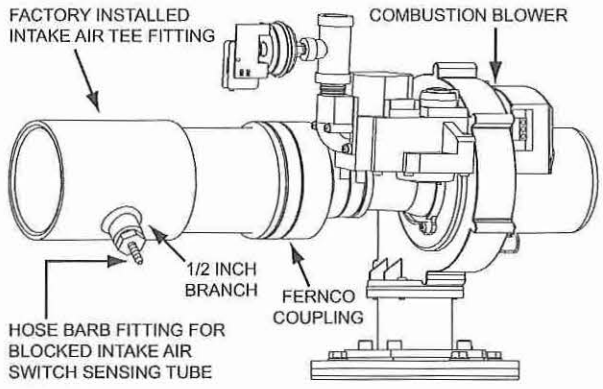
These instructions must be followed on all installations.

1. DO NOT install the water heater in a Power Vent configuration unless there is adequate supply of fresh air, see Air Requirements on page 17. If the installation space does not provide an adequate supply of fresh air the water heater must be installed in a Direct Vent configuration.
2. If the water heater is to be installed in a beauty shop, barber shop, cleaning establishment, a laundry with dry cleaning equipment or any space with contaminated air it is imperative that the water heater(s) be installed in a Direct Vent configuration so that all air for combustion is derived from the outdoor atmosphere.
3. The vent and intake air piping must terminate outdoors.
4. The minimum clearance from combustible materials for the vent (exhaust) and intake air piping shall be 0 inches. Vent piping passing through a combustible wall or ceiling must be a continuous run (no joints).
5. The water heater must be protected from freezing downdrafts during shutdown periods.
6. The vent (exhaust) pipe must not be combined or connected to any other appliance's vent system or chimney.
7. The intake air pipe must not be combined or connected to any other appliance's intake air piping.
8. Locate the water heater where the vent (exhaust) and intake air piping will remain within the maximum equivalent lengths allowed. See Venting Requirements on page 22.
9. Do not install the vent or intake air piping in a manner that will allow water to be trapped in the piping.
10. Vent pipes must be pitched a minimum of a 1/4 inch per foot back to the water heater (to allow drainage of condensate).
11. Do not anchor the vent or intake air pipe directly to framed walls, floors or ceilings unless rubber isolation pipe hangers are used to prevent vibration noise from being transmitted.
12. Use only approved vent/intake air pipe sizes and materials. See Venting Requirements on page 22.
13. Use only factory supplied vent and intake air or concentric terminations. See the Venting Requirements on page 22.
14. Do not locate the vent (exhaust) or intake air terminations where they would be objectionable due to noise at the termination(s). This includes locations close to or across from windows and doors.
15. Direct venting into dead air spaces such as alleys, atriums, and inside corners can cause recirculation of flue gases. Recirculation of flue gases will cause sooting, premature failure of the heat exchanger and icing of the combustion air intake during severe cold weather. To prevent the recirculation of flue gases, maintain as much distance as possible between the intake air and vent terminations.
16. Do not locate the vent termination over a public area where condensate or vapor can cause a nuisance or ice hazard.
17. Ensure the screens in the factory supplied terminations are securely installed to prevent blockage in the vent system.

18. Stress levels in pipe/fittings can be significantly increased by improper installation. If rigid pipe clamps are used to hold the pipe in place, or if the pipe cannot move freely through a wall penetration, the pipe may be stressed, or high thermal stresses may be formed when the pipe heats up and expands. Install accordingly to minimize such stresses.
19. Ensure the intake air connection Tee fitting is oriented properly, see page 22 for instructions.
20. Carefully read the Venting Requirements on page 22 and then proceed to the Venting Installation Sequence on page 23.

INTAKE AIR CONNECTION

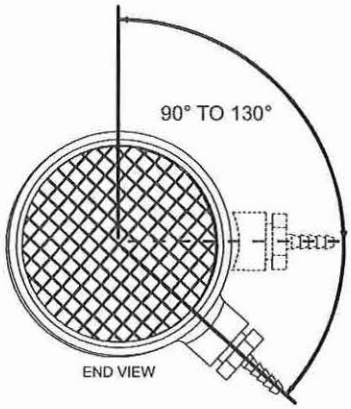
The water heaters covered in this manual are factory equipped with a unique Combustion Blower and intake air connection Tee fitting. The Tee is a 3" x 3" x 1/2" fitting. The intake air connection Tee fitting has a hose barb installed in the 1/2 inch branch to connect the Blocked Intake Air switch sensing tube, see Figure 14.



COMBUSTION BLOWER ASSEMBLY

Figure 14

Ensure the hose barb installed in the Tee fitting **IS NOT** facing down towards the ground (180° - 6 o'clock position) before venting installation begins. The barb fitting must be angled between 90° and no more than 130° as shown in Figure 15. If the barb fitting is facing down, residual condensate that occasionally forms in the intake air pipe can drain into the Blocked Intake Air switch through the attached sensing tube and damage the switch. This condition can also lead to Blocked Intake Air fault conditions and associated control system lock outs.



CORRECT ORIENTATION
INTAKE AIR TEE FITTING

Figure 15

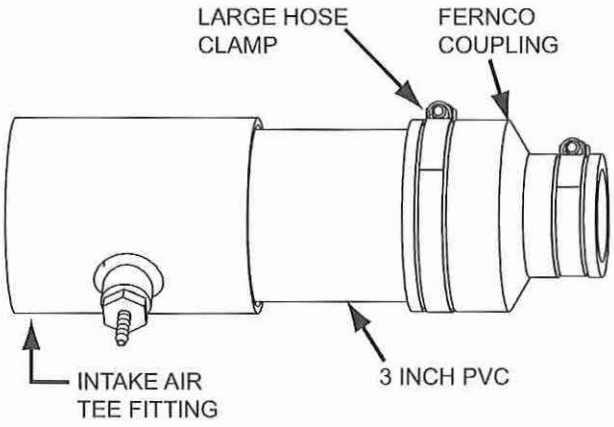
The intake air Tee fitting is factory installed with the 1/2 inch branch and hose barb angled to the right at approximately 130° when viewed from the end, see Figure 15. The Tee fitting's 1/2 inch branch and hose barb must not be angled any lower (towards the ground) than this factory specification. Angling higher, up to a 90° position, will not adversely affect operation and is acceptable.

INSPECT/ADJUST INTAKE AIR TEE FITTING

Inspect the angle of the Tee fitting's 1/2 inch branch and hose barb while viewing from the end of the Tee, see Figure 16. If the angle of the Tee fitting 1/2 inch branch and hose barb is lower than shown, adjustment will be necessary. To adjust the intake air Tee fitting angle follow the steps listed below.

Adjustment Procedure:

21. Ensure the water heater is turned off at the on/off switch on the front of the water heater.
22. Disconnect the Blocked Intake Air switch sensing tube, see Figure 3 on page 8 for location.
23. Loosen the large hose clamp on the Fernco coupling that connects the intake air connection pipe to the Combustion blower, see Figure 16.
24. Adjust the angle of the Tee fitting so that the 1/2 inch branch and hose barb are at the proper angle as shown in Figure 15.
25. Retighten the large hose clamp on the Combustion Blower intake air Fernco coupling,
26. Reconnect the Blocked Intake Air switch sensing tube making sure the sensing tube is securely connected at both ends and is not kinked.



INTAKE AIR CONNECTION PIPE

Figure 16

VENTING REQUIREMENTS

FIELD SUPPLIED FITTINGS

Field supplied fittings should be equivalent to the piping material being installed. Field installed/supplied fittings will add equivalent feet to the vent or intake air piping as indicated below. All field supplied/installed fittings and piping must be factored into the equivalent feet calculations.

- 90° elbows (short or long radius) are equivalent to 5 linear feet (152 cm) of pipe.
- 45° elbows (short or long radius) are equivalent to 2.5 linear feet (76 cm) of pipe.

NOTE: Refer to Tables 9 and 10 on page 29 for the equivalent linear pipe length of AL29-4C® 45° and 90° elbows.

PRIMER AND CEMENT

Tetrahydrofuran (THF) primer should be used to prepare the surfaces of pipe and fittings for solvent welding. If CPVC or ABS pipe and fittings are used, then the proper cement must be used for all joints, including joining the pipe to the factory provided terminations (PVC material). PVC Materials should use ASTM D-2564 Grade Cement; CPVC Materials should use ASTM F-493 Grade Cement and ABS Materials should use ASTM D-2235 Grade Cement.

PIPE SIZE REQUIREMENTS

The water heaters covered in this manual are certified for the use of 3 and 4 inch pipe for the vent (exhaust) and intake air piping. If the installed equivalent length for the intake air or vent piping will be 50 feet (15.2 m) or less, 3 inch pipe must be used. If the installed equivalent length will be more than 50 feet (15.2 m), 4 inch pipe must be used.

NOTE: Install the pipe size required for the installed equivalent length of each pipe independently. IE: If the intake air pipe will be 50 equivalent feet or less and the vent pipe will be more than 50 equivalent feet; the intake air pipe must be installed using 3 inch pipe and the vent must be installed using 4 inch pipe.

MAXIMUM EQUIVALENT LENGTHS

Three Inch Pipe

The water heaters covered in this manual are certified to a maximum length of 3 inch pipe for the exhaust venting arrangement of 50 equivalent feet (15.2 m). The certified maximum length of 3 inch pipe for intake air piping is also 50 equivalent feet (15.2 m). IE: On Direct Vent installations both pipes can be up to 50 equivalent feet (15.2 m).

Four Inch Pipe

The water heaters covered in this manual are certified to a maximum length of 4 inch pipe for the exhaust venting arrangement of 120 equivalent feet (36.5 m). The certified maximum length of 4 inch pipe for intake air piping is also 120 equivalent feet (36.5 m). IE: On Direct Vent installations both pipes can be up to 120 equivalent feet (36.5 m).

MINIMUM EQUIVALENT LENGTHS

Three Inch Pipe

The water heaters covered in this manual are certified to a minimum length of 3 inch pipe for the vent (exhaust) of 7 equivalent feet (2.1 m). There is no minimum equivalent feet requirement for the intake air pipe.

Four Inch Pipe

The water heaters covered in this manual are certified to a minimum length of 4 inch pipe for the vent (exhaust) of 50 equivalent feet (15.2 m). There is no minimum equivalent feet requirement for the intake air pipe.

MAXIMUM NUMBER OF ELBOWS

Three Inch Pipe

The vent pipe may have a maximum of four 90° elbows installed when 3 inch pipe is being used. The intake air pipe may also have a maximum of four 90° elbows installed. IE: in a Direct Vent configuration each pipe can have up to four 90° elbows installed.

NOTE: Refer to Tables 9 and 10 on page 29 for the equivalent linear pipe length of AL29-4C® 45° and 90° elbows.

Four Inch Pipe

The vent pipe may have a maximum of six 90° elbows installed when 4 inch pipe is being used. The intake air pipe may also have a maximum of six 90° elbows installed. IE: in a Direct Vent configuration each pipe can have up to six 90° elbows installed.

FACTORY SUPPLIED FITTINGS

The water heater ships with two (2) factory supplied 3 inch terminations (PVC 45° elbows with debris screen). Factory supplied vent and intake air terminations, concentric, or low profile terminations must be used. Factory supplied terminations and installed fittings (exhaust/condensate elbow and intake air connection) add zero equivalent feet to the vent and intake air piping.

TABLE 6

Number of 90° Elbows Installed	3 Inch Pipe Maximum Feet (Meters)	4 Inch Pipe Maximum Feet (Meters)
One (1)	45 feet (13.7 meters)	115 feet (35.0 meters)
Two (2)	40 feet (12.2 meters)	110 feet (33.5 meters)
Three (3)	35 feet (10.7 meters)	105 feet (32.0 meters)
Four (4)	30 feet (9.1 meters)	100 feet (30.5 meters)
Five (5)	N/A	95 feet (29.0 meters)
Six (6)	N/A	90 feet (27.4 meters)

4 INCH EXTENDED VENT TERMINATIONS

When 4 inch intake air or vent pipe is installed, factory supplied 4 inch terminations must be used. Contact your local distributor or call the parts department (phone number listed on the back cover of this manual) to order 4 inch termination(s).

OPTIONAL CONCENTRIC & LOW PROFILE TERMINATIONS

The water heaters covered by this manual may be installed in a Direct Vent configuration using a 4 inch concentric termination or a 3" or 4" low profile termination.

Concentric and Low Profile terminations must be ordered separately. Contact your local distributor or call the parts department phone number listed on the back cover of this manual to order.

Concentric & Low Profile Vent Termination Part Numbers:

- 4" Concentric Termination # 9006328005
- 3" Low Profile Termination # 9008933005
- 4" Low Profile Termination # 9008934005

VENTING INSTALLATION SEQUENCE

1. Read General Venting Instructions on page 21 and Venting Requirements on page 22 before proceeding. These instructions and requirements must be followed on all installations.
2. Determine whether the water heater will be installed in a Power Vent or Direct Vent configuration and which vent system arrangement will be used for the installation. See the various venting arrangements on pages 35 and 36.
3. Proceed to the applicable instructions:
   - Power Vent Installation on page 23.
   - Direct Vent Installation on page 24.

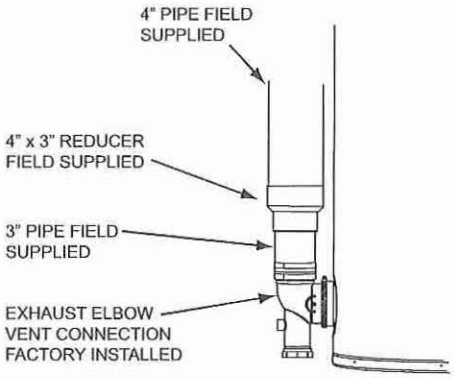
POWER VENT INSTALLATION

1. Read the General Venting Instructions on page 21 and Venting Requirements on page 22 before proceeding. These instructions and requirements must be followed in addition to the instructions below that are specific for Power Vent configurations.
2. Determine which Power Vent arrangement will be used for the installation; vertical or horizontal termination. See Figure 42 and Figure 43 on page 35.
3. Determine the vent pipe size for the installation, see Venting Requirements on page 22.
4. Plan the layout of the vent piping backwards from the termination point outdoors to the water heater. Layout the vent piping to use a minimum of pipe and elbows.
5. Install the termination first.

If the vent piping will terminate vertically, through a roof, see Vertical Termination Installation on page 25.

If the vent piping will terminate horizontally, through a sidewall, see Sidewall Termination Installation on page 27.

6. When installation of the termination is complete install necessary piping and fittings to route the vent piping back to the water heater.
7. The vent pipe must be supported properly to avoid bending or failure. The water heater manufacturer recommends that the vent pipe be supported every 5 feet (152 cm) of vertical run and every 3 feet (91 cm) of horizontal run.
8. Do not install the vent piping in a manner that will allow water to be trapped in the piping.



VENT (EXHAUST) CONNECTION

Figure 17

9. All vent (exhaust) pipes must be pitched a minimum of a 1/4 inch per foot back to the water heater (to allow drainage of condensate).
10. If installing 3 inch vent pipe connect the vent pipe to the exhaust elbow on the water heater.
11. If installing 4 inch pipe transition to 3 inch pipe at the exhaust elbow on the water heater as shown in Figure 17. The field installed 3" pipe between the exhaust elbow and the 4" x 3" reducer coupling should be 18 inches (45 cm) or less in length.

DIRECT VENT INSTALLATION

1. Read the General Venting Instructions on page 21 and Venting Requirements on page 22 before proceeding. These instructions and requirements must be followed in addition to the instructions below that are specific for Direct Vent configurations.
2. Determine which Direct Vent arrangement will be used for the installation. There are seven (7) Direct Vent arrangement options. See Figures 44 through 50.
3. Determine vent and intake air pipe size to be used for the installation; see Venting Requirements on page 22.
4. Plan the layout of the vent and intake air piping backwards from the termination point outdoors to the water heater. Layout the vent and intake air piping to use a minimum of pipe and elbows.
5. Install the terminations first.

   If standard terminations are being used and the intake air or vent piping will terminate vertically, through a roof, see Vertical Termination Installation on page 25.

   If standard terminations are being used and the intake air or vent piping will terminate horizontally, through a sidewall, see Sidewall Termination Installation on page 27.

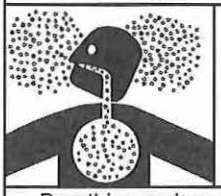
   If a concentric termination(s) will be used see Concentric Termination Installation on page 30.

   If a low-profile termination will be used see Low Profile Termination Installation on page 34.
6. When installation of the termination(s) is complete Install necessary piping and fittings to route the intake air and vent piping back to the water heater.
7. The intake air and vent piping must be supported properly to avoid bending or failure. The water heater manufacturer recommends that the vent and intake air piping be supported every 5 feet (152 cm) of vertical run and every 3 feet (91 cm) of horizontal run.
8. Do not install the vent or intake air piping in a manner that will allow water to be trapped in the piping.
9. A field supplied condensate Tee fitting and drain hose should be installed in the intake air piping near the water heater in colder climates with heavy snow accumulations and in areas that regularly experience high humidity. The drain hose should be routed to an adequate floor drain separate from any other condensate drains. See Figure 20 on page 25.

   NOTE: Snow being pulled into the intake air piping and then melting can lead to excessive amounts of water accumulation and damage water heater components. Warm, humid outdoor air can lead to excessive condensation inside the intake air piping and may also damage water heater components.
10. The intake air and vent (exhaust) piping must be pitched a minimum of a 1/4 inch per foot back to the water heater (to allow drainage of condensate).
11. If installing 3 inch vent pipe connect the vent pipe to the exhaust elbow on the water heater.
12. If installing 4 inch vent pipe transition to 3 inch pipe at the exhaust elbow on the water heater as shown in Figure 17 on page 24. The field installed 3" pipe between the exhaust elbow and the 4" x 3" reducer coupling should be 18 inches (45 cm) or less in length.
13. Ensure the Intake Air Screen on the Intake Air Connection to the water heater is removed before connecting the intake air pipe to the water heater. See Figure 18.

⚠WARNING

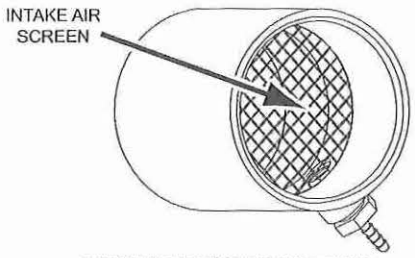
Breathing Hazard - Carbon Monoxide Gas



- Do not obstruct water heater air intake.
- Gas and carbon monoxide detectors are available.
- Install water heater in accordance with the instruction manual.

Breathing carbon monoxide can cause brain damage or death. Always read and understand instruction manual.

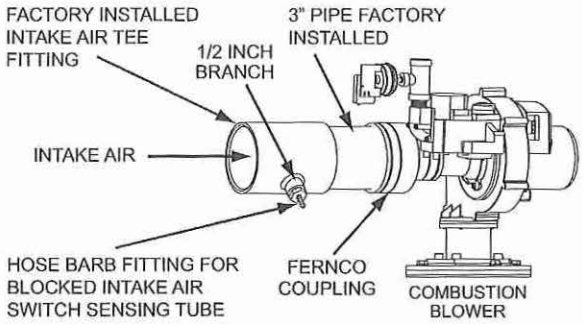
NOTE: Do not leave the screen inside the Intake Air Connection for Direct Vent installations. Once the intake air pipe is installed the screen will be hidden from view and may become clogged with debris over time. This will cause improper combustion and may also lead to Blocked Intake Air fault conditions and associated control system lock outs.



INTAKE AIR SCREEN
(remove for Direct Vent)

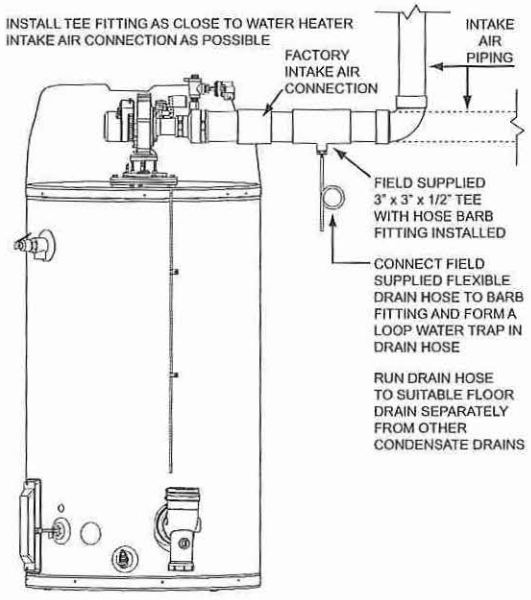
Figure 18

14. If installing 3 inch intake air pipe connect the intake air pipe to the intake air connection on the water heater.
15. If installing 4 inch intake air pipe transition to 3 inch pipe at the intake air connection on the water heater as shown in Figure 19. The field installed 3" pipe between the intake air connection and the 4" x 3" reducer coupling should be 18 inches (45 cm) or less in length.



INTAKE AIR CONNECTION

Figure 19



INTAKE AIR CONDENSATE TEE INSTALLATION

Figure 20

VERTICAL TERMINATION INSTALLATION

1. Determine the location for the termination(s).
2. If installing only the vent (exhaust) piping in a Power Vent configuration vertically through the roof; ensure that all exterior vertical clearance requirements shown in Figure 22 and Figure 23 on page 26 are being maintained. These clearances and those cited by local and national codes must be maintained.

   NOTE: On flat roof installations the vent termination must be a minimum of 24 inches (60 cm) above any parapet, vertical wall or structure within 10 feet (3 m) horizontally. See Figure 23 on page 26.
3. If installing both intake air and vent piping in a Direct Vent configuration vertically through the roof; ensure that all exterior vertical clearance requirements shown in Figure 22 and Figure 23 on page 26 are being maintained. These clearances and those cited by local and national codes must be maintained.

   NOTE: On flat roof installations the intake air and the vent terminations must be a minimum of 24 inches (60 cm) above any parapet, vertical wall or structure within 10 feet (3 m) horizontally. See Figure 23 on page 26.
4. If installing only vent piping in a Power Vent configuration vertically through the roof the following instructions must be followed:

   The vent termination must be oriented facing downward as shown in Figure 22 and Figure 23 on page 26.

   The bottom edge of the vent termination must be a minimum of 12 inches (30 cm), 18 inches (45 cm) in Canada, above the average or expected snow level as shown in Figure 22 on page 26.
5. If installing both intake air and vent piping in a Direct Vent configuration vertically through the roof the following instructions must be followed:

   The intake air and vent pipes must penetrate the same side of the roof as shown in Figure 24 on page 26.

   The intake air and vent terminations must be oriented facing downward and in the same direction as shown in Figure 24 on page 26.

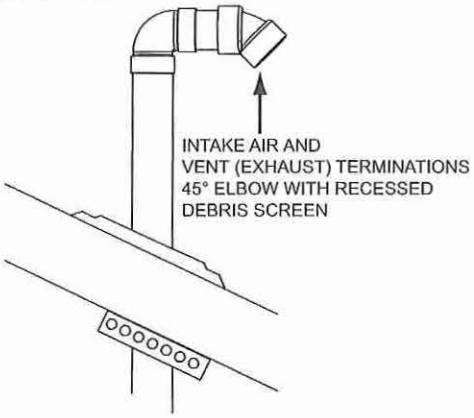
   The intake air and vent terminations must have a minimum separation of 24" (61 cm) measured on center line as shown in Figure 24 on page 26. In colder climates this separation should be increased to at least 48 inches (122 cm).

   The bottom edge of the intake air and vent terminations must be a minimum of 12 inches (30 cm), 18 inches (45 cm) in Canada, above the average or expected snow level as shown in Figure 22 and Figure 24 on page 26.
6. When the intake air and/or vent piping from multiple water heaters will terminate in the same location the vent terminations can be grouped together in close proximity 0 inches/touching. Intake air terminations can also be grouped together in close proximity 0 inches/touching.

   The distance between the closest vent and intake air terminations must be a minimum of 24 inches (61 cm) as shown in Figure 24 on page 26. In colder climates this separation should be increased to at least 48 inches (122 cm).
7. Cut a 4 inch (10 cm) diameter hole for 3 inch pipe or 5 inch (13 cm) diameter hole for 4 inch pipe where the pipe(s) will pass through the roof.

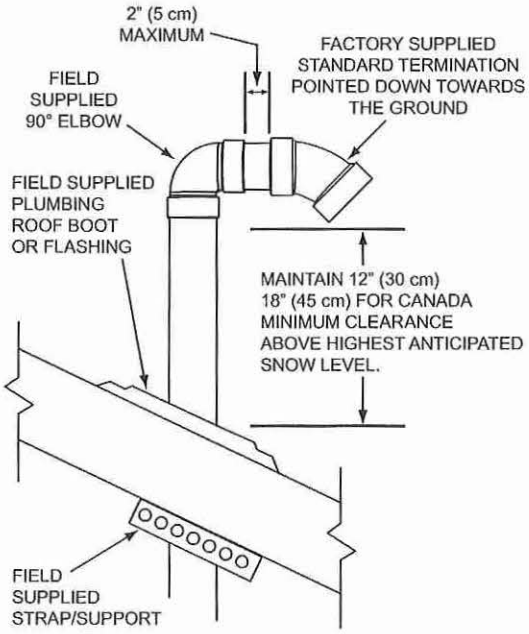
   NOTE: Beware of concealed wiring and piping when cutting through the roof.

8. Suspend the pipe(s) through center of hole using field supplied metal strapping or equivalent support materials as shown in Figure 22 on page 26.
9. Slide a roof boot or equivalent flashing over the pipe and secure roof boot or equivalent flashing to roof and seal around the flashing as shown in Figure 22, Figure 23 and Figure 24 on page 26.
10. Install the factory supplied intake air and/or vent termination(s) using field supplied pipe and one field supplied 90° elbow as shown in Figure 22 on page 26. The short section of pipe that connects between the field supplied 90° elbow and the factory supplied termination must not be excessive in length. The exposed portion of this pipe shall be no more than 2 inches (5 cm), see Figure 22 on page 26.
11. Return to Power Vent Installation on page 23 or Direct Vent Installation on page 24 to complete the installation of the intake air and/or vent piping between the termination(s) and the water heater.



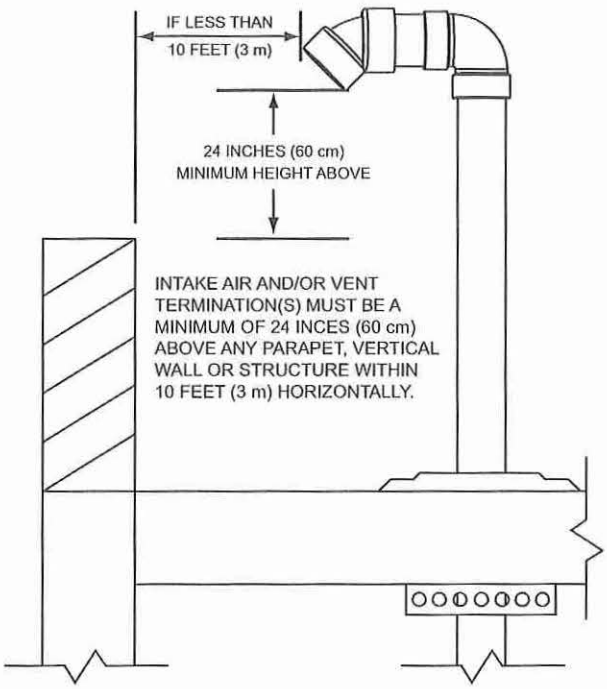
STANDARD FACTORY SUPPLIED TERMINATIONS

Figure 21



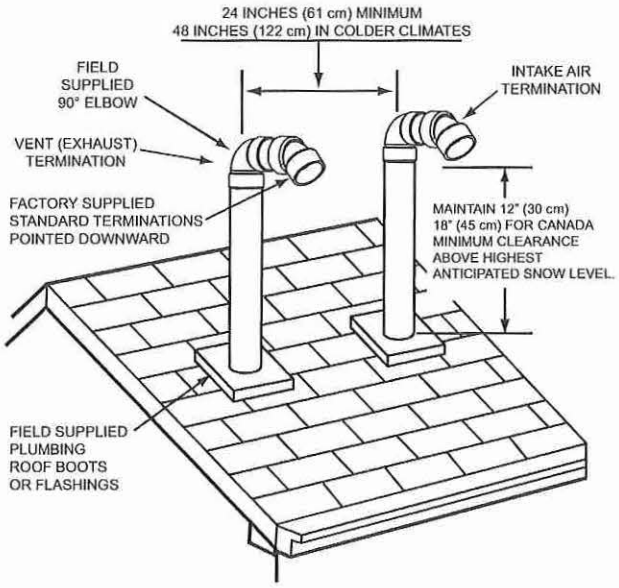
VERTICAL TERMINATION(S) INSTALLATION
INTAKE AIR AND/OR VENT (EXHAUST)

Figure 22



VERTICAL TERMINATION(S) FLAT ROOF CLEARANCE
INTAKE AIR AND/OR VENT (EXHAUST)

Figure 23



VERTICAL TERMINATION - DIRECT VENT
STANDARD TERMINATIONS

Figure 24

SIDEWALL TERMINATION INSTALLATION

12. Determine the location for the termination(s).
13. If installing only vent (exhaust) piping in a Power Vent configuration through a sidewall; ensure that all exterior sidewall clearance requirements for the termination, shown in Figure 51 on page 37, are being maintained. These clearances and those cited by local and national codes must be maintained.
14. If installing both the intake air and the vent piping in a Direct Vent configuration through a sidewall; ensure that all exterior sidewall clearance requirements for the terminations, shown in Figure 52 on page 38, for the vent and the intake air termination are being maintained. These clearances and those cited by local and national codes must be maintained.
15. If installing both an intake air and vent termination in a Direct Vent configuration through a sidewall there must be a minimum of 24 inches (61 cm) separation, measured on vertical center line, between the intake air and vent terminations, see Figure 25.

    NOTE: In colder climates this separation should be increased to at least 48 inches (122 cm) between the intake air and vent termination or any other appliance vent that discharges moisture-laden air such as clothes dryers. This will reduce possibility of frost over from side winds blowing exhaust vapors to the intake air termination and is recommended for Canadian installations.
16. If installing both intake air and vent terminations in a Direct Vent configuration through a sidewall the intake air and vent terminations must be installed at the same elevation measured on horizontal center line - see Figure 25.

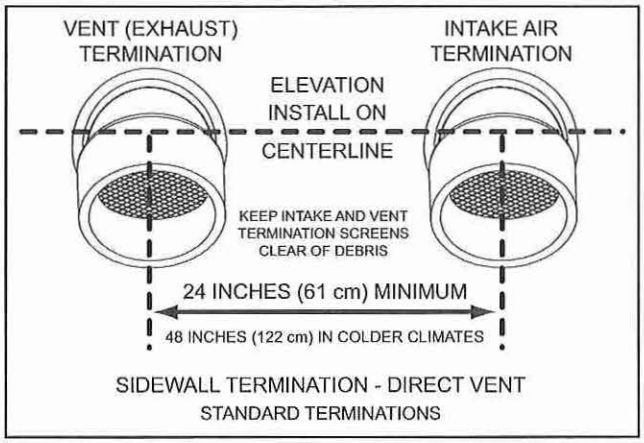


Figure 25

17. When the intake air and/or vent piping from multiple water heaters will terminate at the same location through a sidewall, the vent terminations can be grouped together in close proximity - 0 inches/touching. The intake air terminations can also be grouped together in close proximity - 0 inches/touching.

    However, the distance between the closest vent and intake air terminations must be a minimum of 24 inches (61 cm). In colder climates this separation should be increased to at least 48 inches (122 cm). See Figure 25.
18. Cut a 4 inch (10 cm) diameter hole for 3 inch pipe or 5 inch (13 cm) diameter hole for 4 inch pipe where the pipe(s) will pass through the wall.

    NOTE: Beware of concealed wiring and piping when cutting through the wall.
19. Cut a length(s) of pipe being installed 3.5 inches (8.9 cm) to 9.5 inches (24.1 cm) longer than the wall thickness at the opening. See Figure 26.

    NOTE: Vent Termination – exhaust gases of this water heater are less than 140°F. In cold climates water vapor in the exhaust gases will condense into a cloud of vapor where the vent exits the building. This vapor can gradually discolor exterior building surfaces. The vent termination should be located where this vapor cloud and potential discoloration are not a concern. Extending the exposed vent piping up to a maximum of 6 inches (15.2 cm) from the wall helps vapor from being trapped along a building's face. To avoid this problem, the vent can also be terminated vertically through the roof, see Vertical Termination Installation on page 25.
20. Cement the intake air and/or vent termination to the section(s) of pipe cut to length in the above Step.
21. Slide the included metal wall plate(s) over the pipe(s) to stop against the intake air and/or vent termination. Place some silicone caulking (field supplied) on the back of the wall plate(s) to secure it to the wall.
22. Working from outside, slide the pipe and termination(s) assembled in the above steps through the wall. Ensure the termination(s) is pointed down towards the ground. See Figure 26.

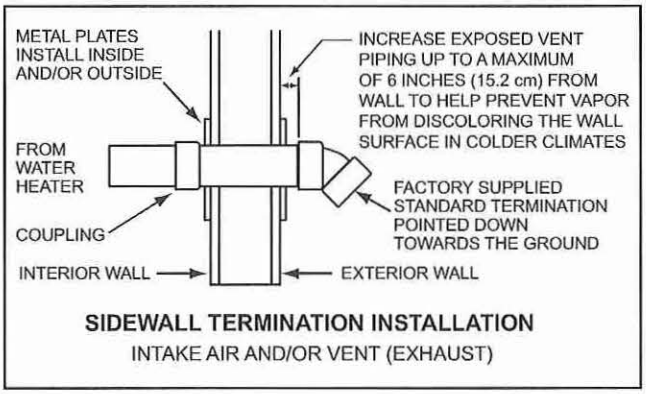


Figure 26

23. Place a bead of silicone caulking (field supplied) around the gap between the installed pipe(s) and the wall. Apply enough to fill the gap between the pipe(s) and wall.
24. Press the wall plate flush against the outside wall.
25. Working from the inside apply enough silicone caulking on the back of the interior wall plate(s) to hold it in place and slide the wall plate over the installed pipe(s).
26. Install a coupling to the end of the pipe(s) inside the building. Before the silicone caulking has time to completely set go outside the building and ensure the termination(s) is still pointing down towards the ground. See Figure 26.
27. Return to Power Vent Installation on page 23 or Direct Vent Installation on page 24 to complete the installation of the intake air and/or vent piping between the termination(s) and the water heater.

POLYPROPYLENE INSTALLATIONS

The water heater has been approved to be installed with Polypropylene vent material as shown in Tables 7 and 8. The approved application of single wall, non-flexible, non-concentric Polypropylene vent material is offered by two specific manufacturers (Centrotherm ECO Systems and DuraVent Polypropylene. These listed products must be installed by following the vent manufacturer's instructions. Refer to Table 6 on Page 23 to determine the maximum pipe length and number of elbows that can be used.

Insulation should not be used on Polypropylene venting materials. The use of insulation will cause increased vent wall temperatures, which could result in vent pipe failure.

Use only the adapters and vent system listed in Tables below. DO NOT mix vent systems of different types or manufacturers. Failure to comply could result in severe personal injury, death, or substantial property damage.

Installations must comply with applicable national, state, and local codes. For Canadian installation, Polypropylene vent must be listed as a ULC-S636 approved system. If Polypropylene vent is not required by your local code, you may use either PVC or CPVC pipes for your water heater that allows non-metallic venting material installations.

Polypropylene vent systems do not use cement to connect the pipe and elbow sections but use a push together gasket seal method. Do not attempt to connect Polypropylene with sealant cement. All vent connections MUST be secured by the vent manufacturer's joint connector. The installer must use a specific vent starter adapter at the flue connection. The adapter is supplied by the vent manufacturer to adapt to its vent system.

In order to be in full compliance with UL 1738 or ULC-S636 and to meet the requirements of the water heater manufacturer, you must use the metal joint connector rings, available from the Polypropylene vent manufacturer, to stiffen the joints of 3" and 4" diameter pipes.

TABLE 7

M & G Duravent PolyPro						
Nominal Pipe Diameter	Flue Outlet Adapter	Adapter Connector	Ring Connector	90 Degree Elbow	Vent Material	Terminal(s)
3"	3PPS-AD	PPS-PAC	3PPS-LB	3PPS-E90B	3PPS	3PPS-E45B for Exhaust; 3PPS-E45B for Intake (Direct Vent only)
4"	4PPS-AD	PPS-PAC	4PPS-LB	4PPS-E90B	4PPS	4PPS-E45B for Exhaust; 4PPS-E45B for Intake (Direct Vent only)

TABLE 8

Centrotherm InnoFlue SW						
Nominal Pipe Diameter	Flue Outlet Adapter	Adapter Connector	Ring Connector	90 Degree Elbow	Vent Material	Terminal(s)
3"	ISAGL 0303	IAFC03	IANS03	ISELL0387	ISVL03	ISELL0345UV for Exhaust; ISELL0345UV for Intake (Direct Vent only)
4"	ISAGL 0404	IAFC04	IANS04	ISELL0487	ISVL04	ISELL0445UV for Exhaust; ISELL0445UV for Intake (Direct Vent only)

AL29-4C® VENT INSTALLATIONS

(AL29-4C® is a registered trademark of Allegheny Technologies, Inc.)

The water heaters covered by this manual are approved to be installed with AL29-4C® stainless steel vent material using parts from the manufacturers listed in Tables 9 and 10 below. These listed systems must be installed using the vent manufacturer's instructions including their listed clearances to combustible and noncombustible materials. Refer to Table 6 on page 23 for the maximum and minimum equivalent linear vent lengths and number of elbows that may be used. However, use Tables 9 and 10 below to find the appropriate equivalent linear vent lengths for the AL29-4C® elbows.

NOTE: The equivalent lengths of the AL29-4C® elbows are different than those from smooth walled plastic vents. Consult Tables 9 and 10 for the correct equivalent linear vent lengths.

Listed vent systems composed of AL29-4C® must not mix parts from the different manufacturers. The joints of these products are sealed by internal gaskets. Do not use any other type of sealant. When assembling these vent systems, follow the vent manufacturer's instructions for cleaning and lubricating the joints, if required. Each section must be locked together using the method supplied by the vent manufacturer.

The water heaters covered by this manual are approved to be installed using the approved vent terminations shown in this manual. This means that, the installer must use the adapter listed in Tables 9 and 10 and a short piece of PVC pipe to complete the end of the vent system with an approved termination. In Canada, the PVC pipe length must be listed to ULC636.

TABLE 9

HeatFab Saf-T Vent AL29-4C® Vent System Parts							
Diameter	**Flue Outlet Adapter**	***Straight Pipe (3' Section)**	**45° Elbow**	**Equivalent Linear Length, 45° Elbow**	**90° Elbow**	**Equivalent Linear length, 90° Elbow**	**Adapter to PVC**
3 inches	9301 PVC	9307	9311	5 feet	9314	10 feet	9353CPVC
4 inches	9401 PVC	9407	9411	5 feet	9414	10 feet	9454CPVC
*Consult vent manufacturer's catalog for other available lengths.							

TABLE 10

Duravent FasNSeal AL29-4C® Vent System Parts							
Diameter	**Flue Outlet Adapter**	**"Straight Pipe (3' Section)**	**45" Elbow**	**Equivalent Linear Length, 45" Elbow**	**90° elbow**	**Equivalent Linear Length, 90- Elbow**	**Adapter to PVC**
3"	810005378	FSVL3603	FSELB4503	5 feet	FSELB9003	10 feet	810009530
4"	810005545	FSVL3604	FSELB4504	5 feet	FSELB9004	10 feet	810009529
*Consult vent manufacturer's catalog for other available lengths.							

CONCENTRIC TERMINATION INSTALLATION

1. Concentric terminations must be ordered separately. BTH 120 - 250 models must use the 4 inch concentric termination; Part Number: 9006328005. Contact your local distributor or call the parts department phone number on the back cover of this manual to order concentric terminations.
2. Determine the location for the termination.

   NOTE: Roof termination is preferred since it is less susceptible to damage, has reduced chances to intake contaminants and vent vapors are less visible.
3. When installing a concentric termination vertically through the roof; ensure that all exterior vertical clearance requirements for the concentric termination, shown in Figure 29 on page 31 are being maintained. These clearances and those cited by local and national codes must be maintained.
4. When installing a concentric termination vertically through a flat roof, the termination's vent cap must be a minimum of 10 feet (3 m) away from any parapet, vertical wall or structure as shown in Figure 27.

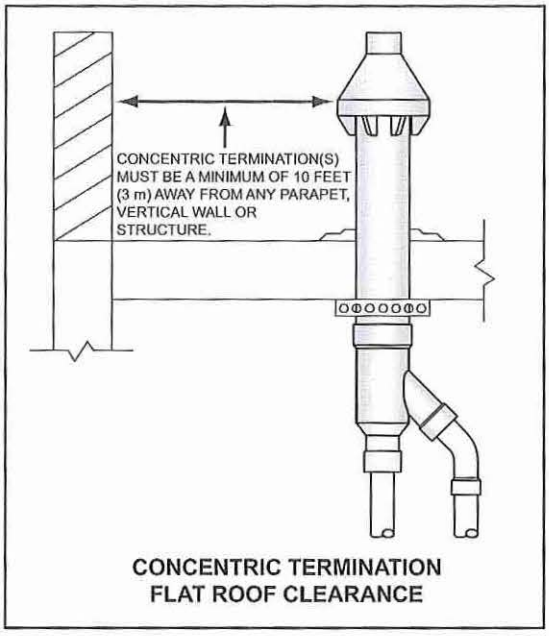


Figure 27

   NOTE: If this required 10 foot (3 m) distance to a parapet, vertical wall or structure cannot be maintained, standard terminations must be used. See Vertical Termination Installation on page 25.
5. When installing a concentric termination through a sidewall; ensure that all exterior sidewall clearance requirements for the termination, shown in Figure 52 on page 38, are being maintained. These clearances and those cited by local and national codes must be maintained.
6. When installing multiple concentric terminations vertically through a roof or horizontally through a sidewall ensure the required clearances between terminations and groupings of multiple terminations are maintained. See pages 32 and 33 for more information.
7. Cut a 5 inch (13 cm) diameter hole for the 4 inch concentric termination where the termination will pass through the wall or roof.

   NOTE: Beware of concealed wiring and piping when cutting through the wall or roof.
8. When installing multiple concentric terminations vertically through the roof in the same location the termination caps for all concentric terminations must be at the same height measured from ground. See Multiple Concentric Termination Arrangements on page 33.
9. Determine if the concentric termination will need to be shortened to accommodate required clearances or to ensure all vent caps are at the same height when installing multiple terminations vertically through the roof in the same location.

   See Figure 28 on page 31 for the minimum lengths allowed for the 4 inch concentric termination.

   Use only SDR-26 pipe to extend the 4 inch concentric termination.

   NOTE: When shortening the length of the termination carefully measure and cut the larger (intake air) pipe first. Cut the same amount of pipe off of the smaller (vent) pipe.

   NOTE: Lengthening of the Concentric Vent Termination is not permitted.
10. Proceed to 4 Inch Concentric Termination Installation on page 31.

4 INCH CONCENTRIC TERMINATION INSTALLATION

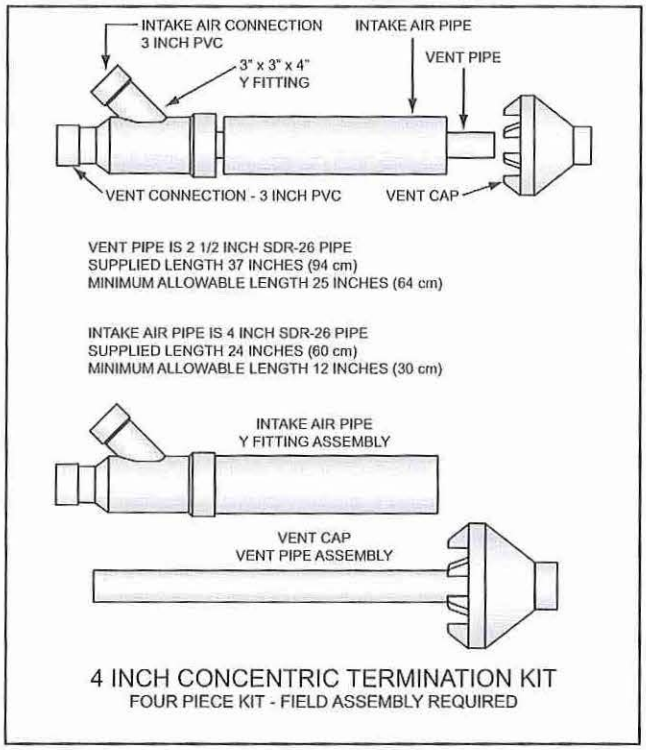


Figure 28

Assemble and install the 4 inch concentric termination. Refer to Figure 28, Figure 29 and Figure 30 for these instructions:

1. Cement the Y fitting to the larger diameter intake air pipe.
2. Slide the intake air pipe and Y fitting assembly from inside the building through the hole cut for the termination in the roof or sidewall. Ensure no foreign materials such as insulation accumulate inside the assembly.
3. Secure the intake air Y fitting assembly using field supplied metal strapping or equivalent support materials.
4. On installations installed through the roof slide a field supplied plumbing boot or roof flashing over the intake air Y fitting assembly and secure it to the roof.
5. Seal around the plumbing boot or roof flashing.
6. Cement the vent cap onto the vent pipe. Alternately a field-supplied stainless steel screw may be used to secure the 2 components together when field disassembly is desired for cleaning. A pilot hole must be drilled for the screw to prevent damage/cracking of the vent cap and/or vent pipe.
7. Install the vent cap/vent pipe assembly into the intake air Y fitting assembly, Ensure small diameter vent pipe is cemented and bottomed in the Y fitting.
8. When installing 3 inch intake air and vent piping connect and cement the pipe directly to the concentric termination. When installing 4 inch intake air and vent pipe - connect the piping to the concentric termination using field supplied 4" x 3" reducer couplings and short sections of 3 inch pipe (18 inches or less) pipe. Cement all fittings and pipe in place.
9. Return to Direct Vent Installation on page 24 to complete the installation of the intake air and vent piping between the concentric termination and the water heater.

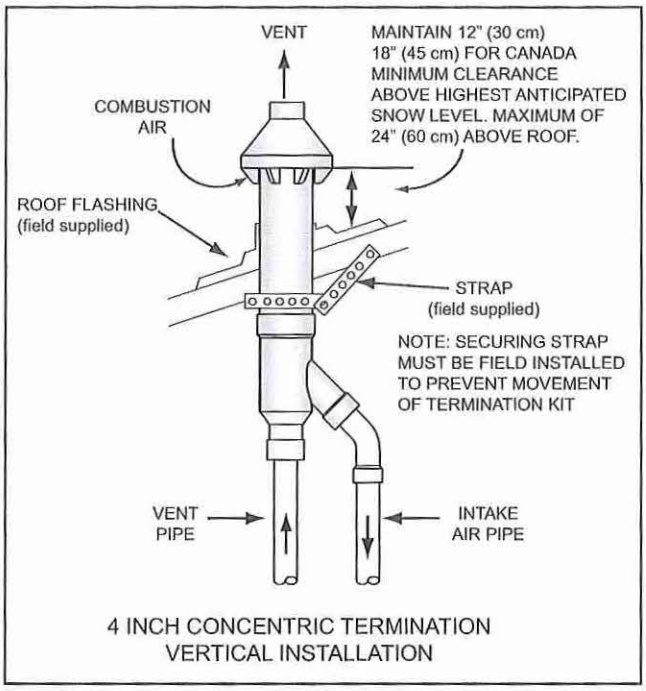


Figure 29

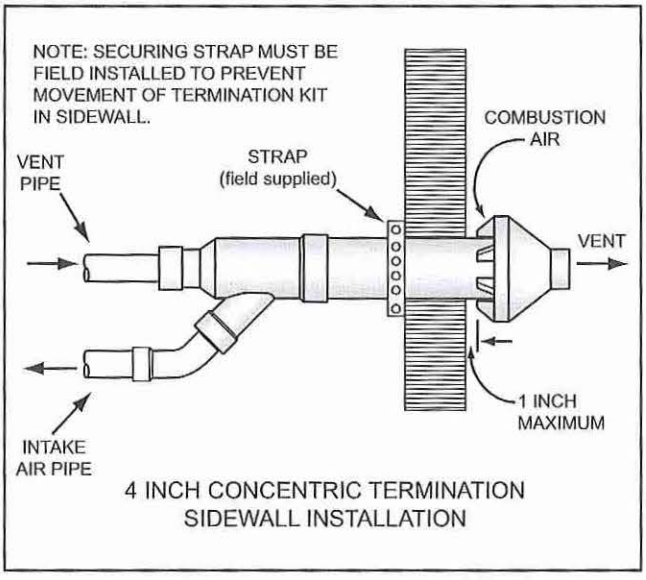


Figure 30

MULTIPLE CONCENTRIC TERMINATION CLEARANCES

When installing multiple concentric terminations vertically through a roof or horizontally through a sidewall ensure the required clearances (separation) between terminations are maintained. Ensure multiple terminations are arranged or grouped as required.

NOTE: These clearances must be maintained to prevent the recirculation of vent (exhaust) gases to the intake air. Clearances are measured between the edges of the concentric termination caps.

When installing multiple concentric terminations through a roof or through a sidewall the clearances shown in Figure 31 must be maintained.

See Multiple Concentric Termination Arrangements on page 33.

Close Proximity & Standard Clearance

1. The clearance between multiple termination caps must be 0 inches (touching) to a maximum of 2 inches (5 cm), dimension A - Figure 31, when installing concentric terminations in close proximity. See Figure 36 on page 33.
2. The clearance between multiple termination caps must be increased to a minimum of 24 inches (61 cm), dimension B - Figure 31, when installation in close proximity (above) is not possible. This is the standard clearance.

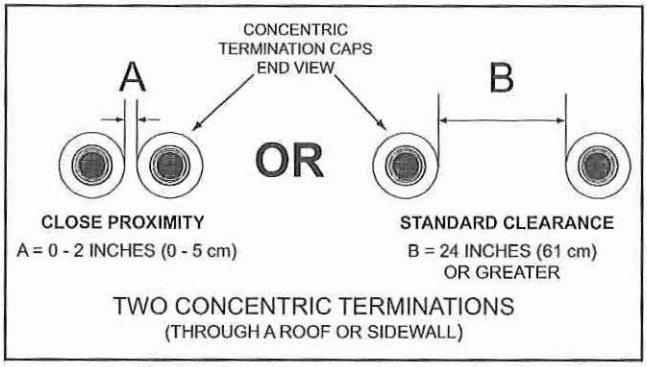


Figure 31

Three Concentric Terminations

1. When installing three concentric terminations through a roof or through a sidewall the third termination may be installed in close proximity as indicated by dimension A in Figure 32.
2. If close proximity installation of the third termination is not possible the third termination may be installed as indicated by dimension B in Figure 32.

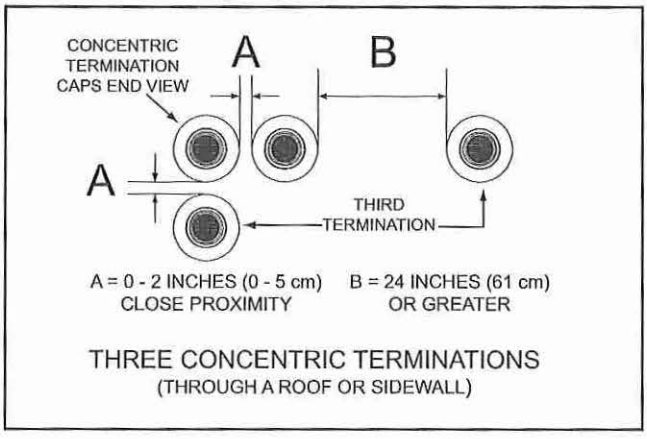


Figure 32

Four Concentric Terminations

1. When installing four concentric terminations through a roof or through a sidewall in close proximity they may be arranged into stacked rows of two as shown in Figure 33 or lateral rows of two as shown in Figure 34.
2. Four is the maximum number of concentric terminations that may be installed in a group where all terminations are in close proximity as shown in Figure 33.

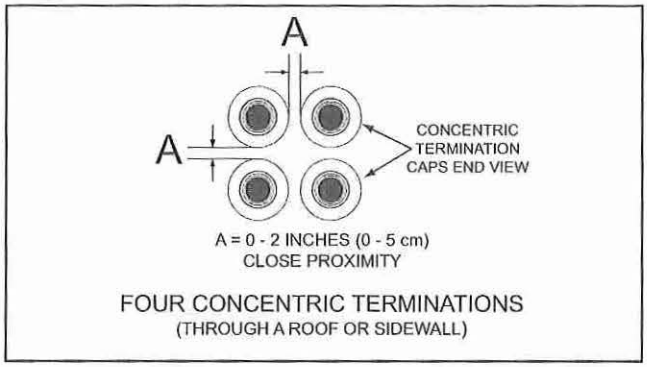


Figure 33

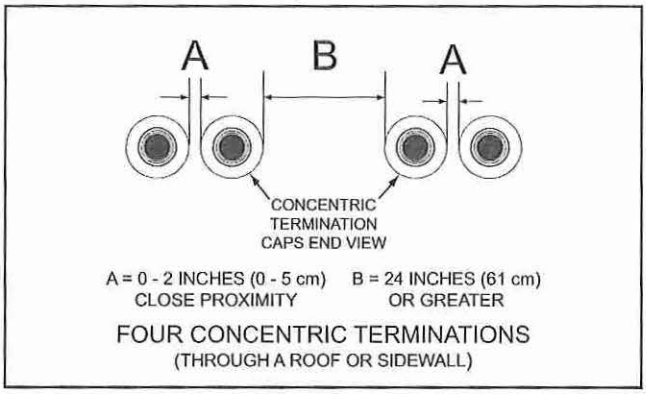


Figure 34

Groups Of Terminations

1. When installing multiple groups of concentric terminations through a roof or through a sidewall in close proximity they can be installed into stacked groups of four as shown in Figure 35. Lateral groups of four as shown in Figure 34 may be a more convenient installation arrangement for multiple groups depending on available space.

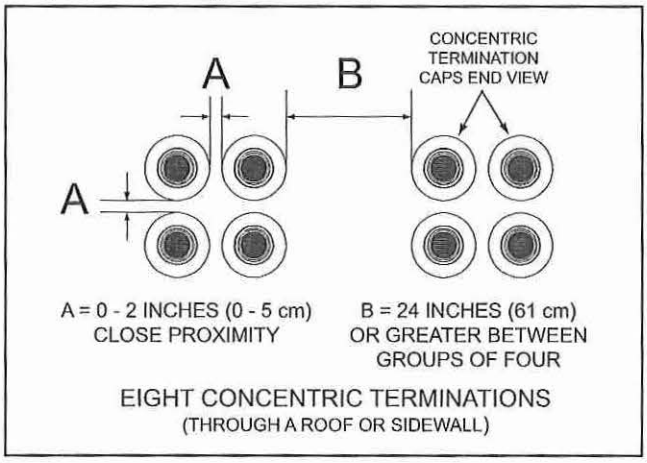


Figure 35

MULTIPLE CONCENTRIC TERMINATION ARRANGEMENTS

The illustrations on this page show some of the installation arrangements for multiple concentric terminations that are allowed.

See Multiple Concentric Termination Clearances on page 32 for detailed information on clearances and additional arrangement options.

NOTE: When multiple concentric terminations are installed through a roof in the same location all termination caps must be at the same height measured from the ground.

Two Concentric Terminations

Two concentric terminations may be installed in close proximity as shown in Figure 36 or with standard clearances when this arrangement is not possible. See Figure 31 on page 32 for detailed information on clearances. See Figure 32 on page 32 when installing three concentric terminations.

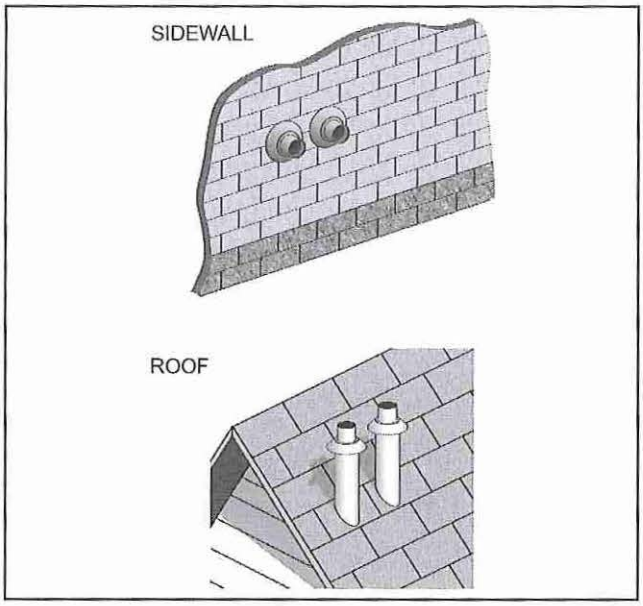


Figure 36

Four Concentric Terminations

Four concentric terminations may be installed in close proximity as shown in Figure 37. See Figure 33 and Figure 34 on page 32 for detailed information on clearances and additional arrangement options.

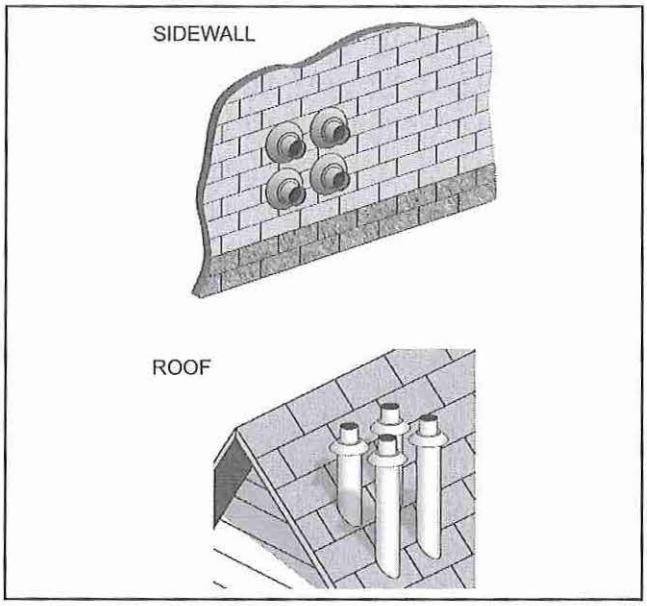


Figure 37

Eight Concentric Terminations

Eight concentric terminations may be installed in two stacked groups of four, in close proximity, as shown in Figure 38. See Figure 35 on page 32 for detailed information on clearances.

Lateral groups of four as shown in Figure 34 on page 32 may be a more convenient installation arrangement for multiple groups depending on available space.

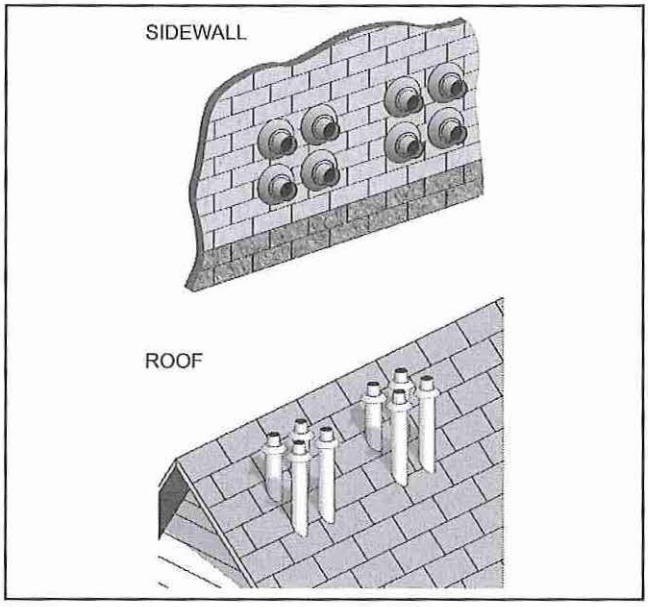


Figure 38

LOW PROFILE VENT INSTALLATION

This water heater is certified for sidewall direct venting with IPEX System 636 Low Profile Vent Kit. Follow instructions below for proper installations.

All termination kits must be located and installed in accordance with locl building code and CSA B149.1 Natural Gas and Propane Installation Code.

1. Once the proper location has been determined, cut 2 holes in the wall large enough to accomodate the pipe. See the Chart at bottom of this page for pipe diameters and distance between hole centers.
2. Slide both the intake and exhaust pipes through the holes. Solvent cement both pipes to the base of the vent termination kit, follow the solvent cementing procedures outlined in the IPEX System 636 Installation Guide, which is available on the web www.ipexinc.com.
3. To fasten the Base to the wall, use the supplied screws and anchors. A 3/16" (5mm) hole, 1-3/16" (30mm) deep, will need to be drilled for the anchors. Locate the anchor hole using the base as a template.
4. Screw the Cap to the Base using the supplied screws.
5. Once the vent termination and pipes are secured, the wall penetrations will need to be sealed from the interior using a PVC-compatible sealant material.
6. All vent pipes and air inlets must terminate at the same height to avoid possibility of severe personal injury, death, or substantial property damage.
7. Operate heater through 1 heat cycle to ensure combustion-air and vent pipes are properly connected to concentric vent termination.

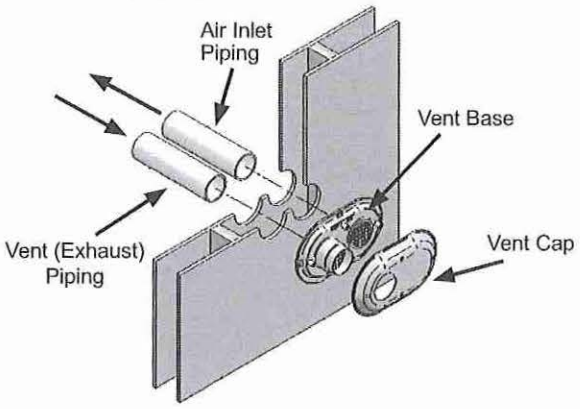


Figure 39

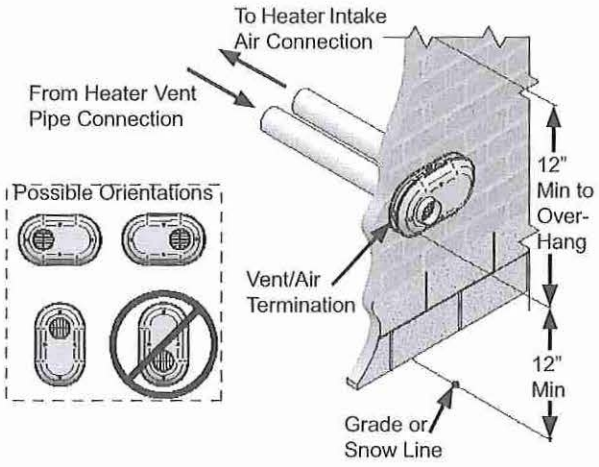


Figure 40

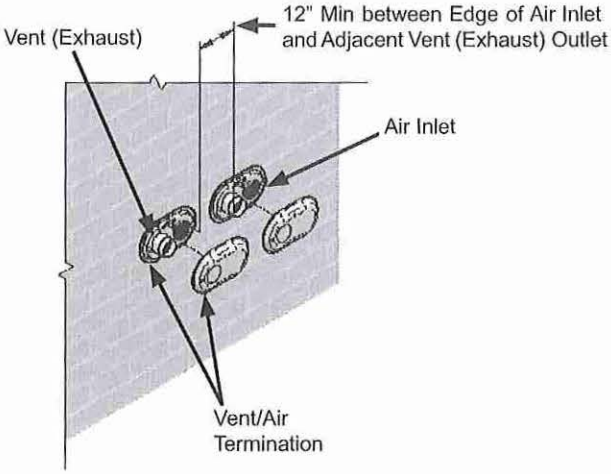


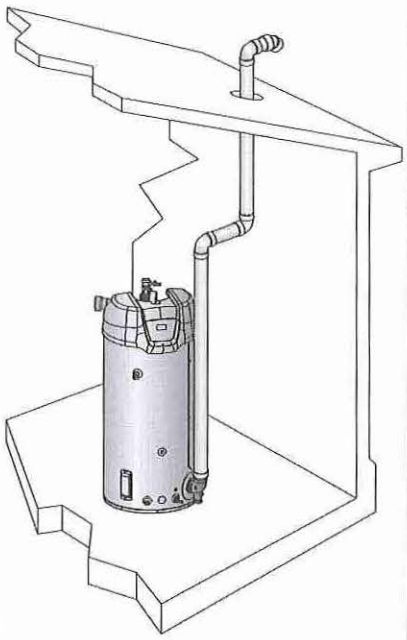
Figure 41

Low Profile Termination Kits - Dimensions and Contents Chart

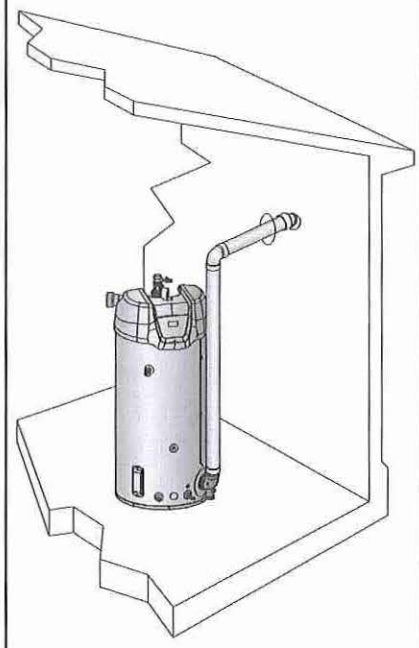
Low Profile Termination Kits - Dimensions				
Kit Number	**IPEX Part Number**	**Description**	**Pipe Outside Diameter**	**Hole Spacing (ctr to ctr)**
9008933005	196985	3" Flush Mount Vent Kit	3.5"	5.63"
9008934005	196986	4" Flush Mount Vent Kit	4.5"	5.63"

Each Kit Contains	
Qty	**Item Description**
1	Base (two holes)
1	Cap (one hole)
8	Stainless Steel Screws
4	Plastic Anchors

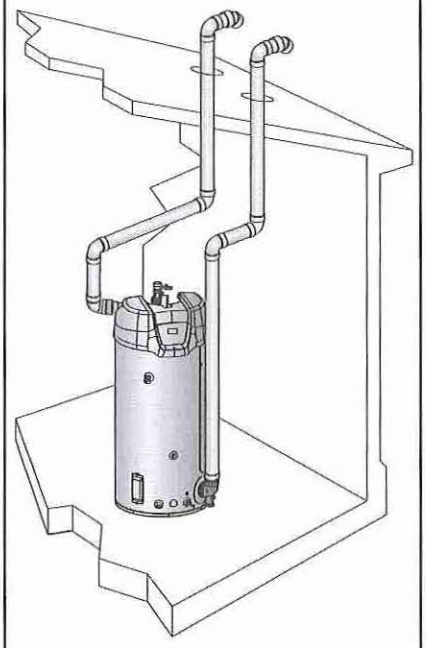
VENTING ARRANGEMENTS



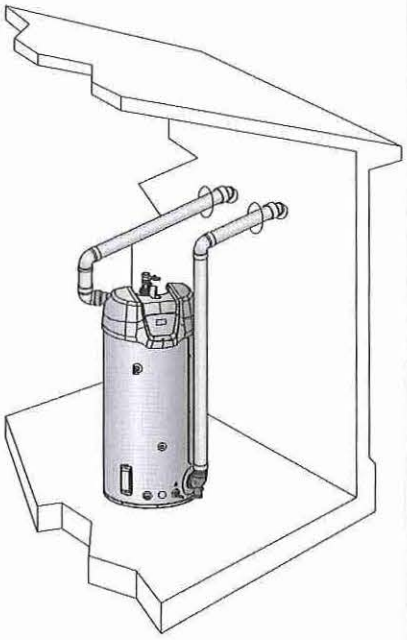
Power Vent Vertical
Figure 42



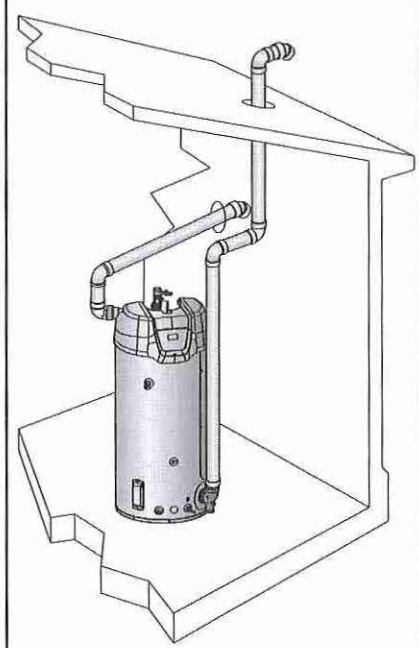
Power Vent Horizontal
Figure 43



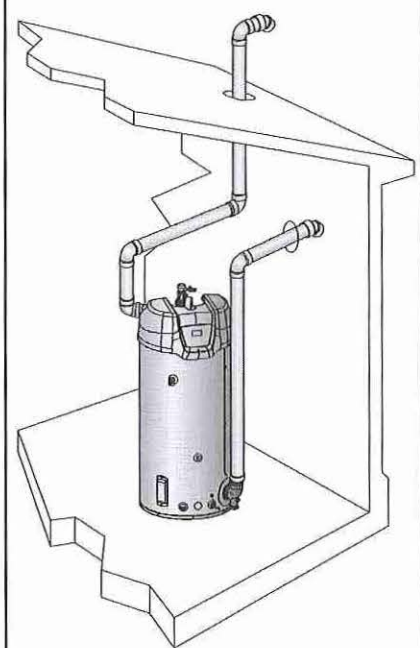
Direct Vent Vertical
Figure 44



Direct Vent Horizontal
Figure 45

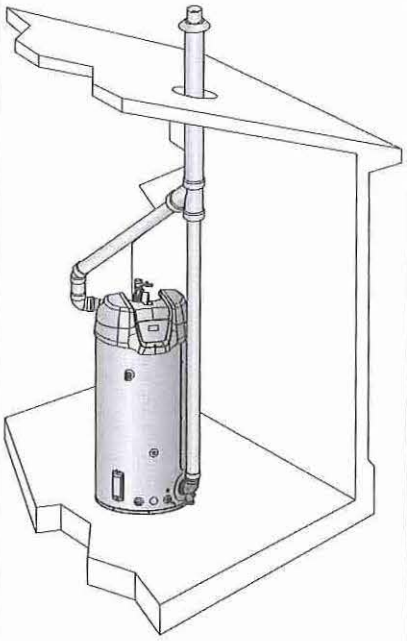


Direct Vent Vertical Vent
Horizontal Intake
Figure 46

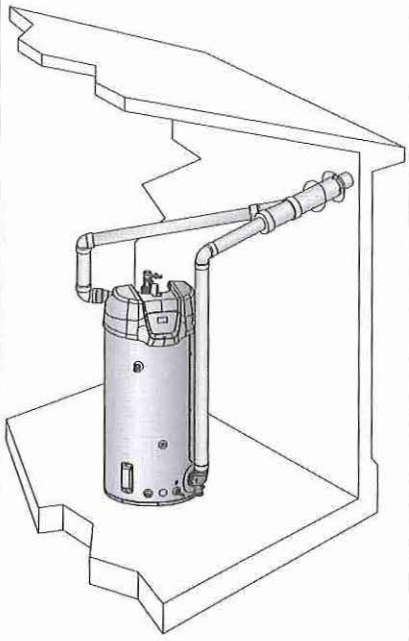


Direct Vent Horizontal Vent
Vertical Intake
Figure 47

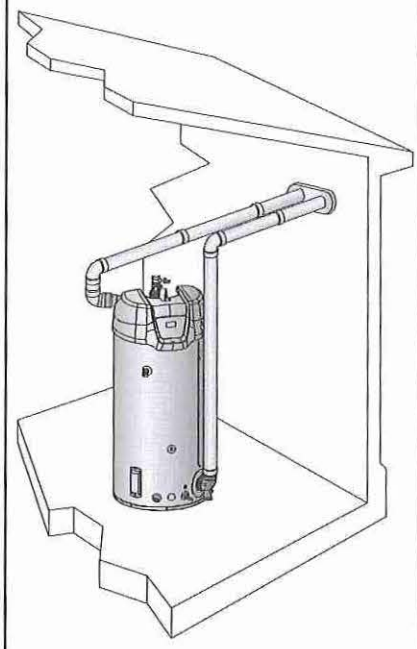
VENTING ARRANGEMENTS



Direct Vent Vertical Concentric
Figure 48



Direct Vent Horizontal Concentric
Figure 49



Direct Vent Horizontal Low Profile
Figure 50

TERMINATION CLEARANCES SIDEWALL POWER VENT

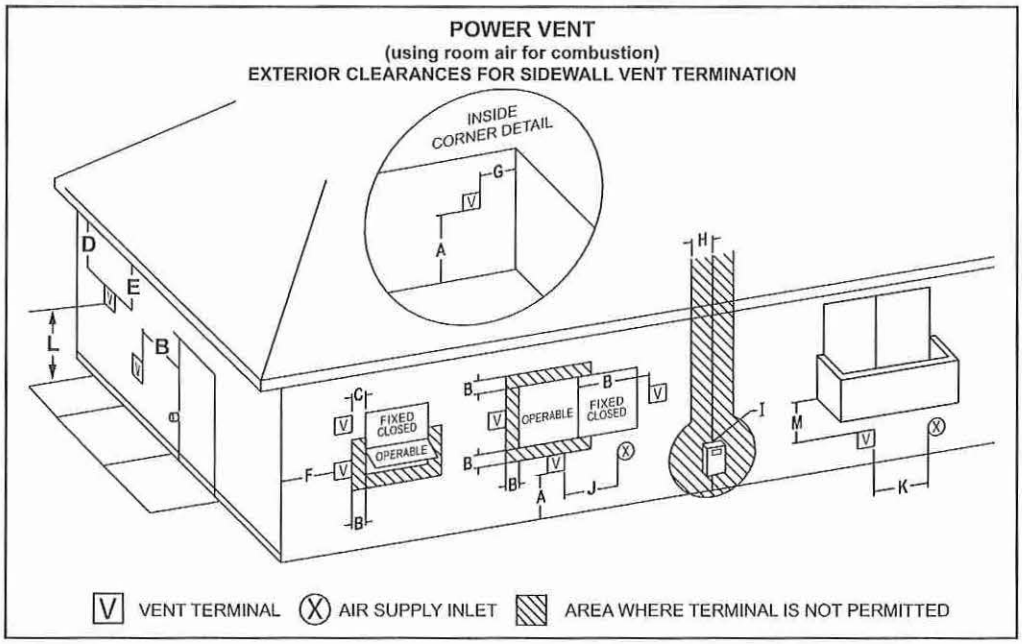


Figure 51

Vent terminal clearances for "Power Vent" installations. Power Vent configurations use room air for combustion.

		CANADIAN INSTALLATIONS [1]	US INSTALLATIONS [2]			CANADIAN INSTALLATIONS [1]	US INSTALLATIONS [2]
A	Clearance above grade, veranda, porch, deck or balcony	12 inches (30 cm)	12 inches (30 cm)	H	Clearance to each side of center line extended above meter/regulator assembly	3 feet (91 cm) within a height 15 feet (4.5 m) above the meter/ regulator assembly	3 feet (91 cm) within a height 15 feet (4.5 m) above the meter/regulator assembly*
B	Clearance to window or door that may be opened	6 inches (15 cm) for appliances up to 10,000 Btu/hr (3 kW), 12 inches (30 cm) for appliances between 10,000 Btu/hr (3 kW) and 100,000 Btu/hr (30 kW), 36 inches (91 cm) for appliances above 100,000 Btu/hr (30 kW)	4 feet (1.2 m) below or to side of opening; 1 foot (30 cm) above opening	I	Clearance to service regulator vent outlet	3 feet (91 cm)	3 feet (91 cm)*
C	Clearance to permanently closed window	12 inches (30 cm)*	12 inches (30 cm)*	J	Clearance to a non mechanical air supply inlet into building or combustion air inlet to any other appliance	6 inches (15 cm) for appliances up to 10,000 Btu/hr (3 kW), 12 inches (30 cm) for appliances between 10,000 Btu/hr (3 kW) and 100,000 Btu/hr (30kW), 36 inches (91cm) for appliances above 100,000 Btu/ hr (30 kW)	4 feet (1.2 m) below or to side of opening; 1 foot (30 cm) above opening.
D	Vertical clearance to ventilated soffit located above the terminal within a horizontal distance of 2 feet (61 cm) from the center line of the terminal	12 inches (30 cm)*	12 inches (30 cm)*	K	Clearance to a mechanical air supply inlet	6 feet (1.83 m)	3 feet (91 cm) above if within 10 feet (3 m) horizontally
E	Clearance to unventilated soffit	12 inches (30 cm)*	12 inches (30 cm)*	L	Clearance above paved sidewalk or paved driveway located on public property	7 feet (2.13 m)†	7 feet (2.13 m)
F	Clearance to outside corner	2 feet (60 cm)*	2 feet (60 cm)*	M	Clearance under veranda, porch, deck, or balcony	12 inches (30 cm) ‡	12 inches (30 cm) ‡
G	Clearance to inside corner	18 inches (45 cm)*	18 inches (45 cm)*				

1 In accordance with the current CSA B149.1, Natural Gas and Propane Installation Code.

2 In accordance with the current ANSI Z223.1/NFPA 54, National Fuel Gas Code.

† A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings. Where it may cause hazardous frost or ice accumulations on adjacent property surfaces.

‡ Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor.

* Clearance in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions.

TERMINATION CLEARANCES SIDEWALL DIRECT VENT

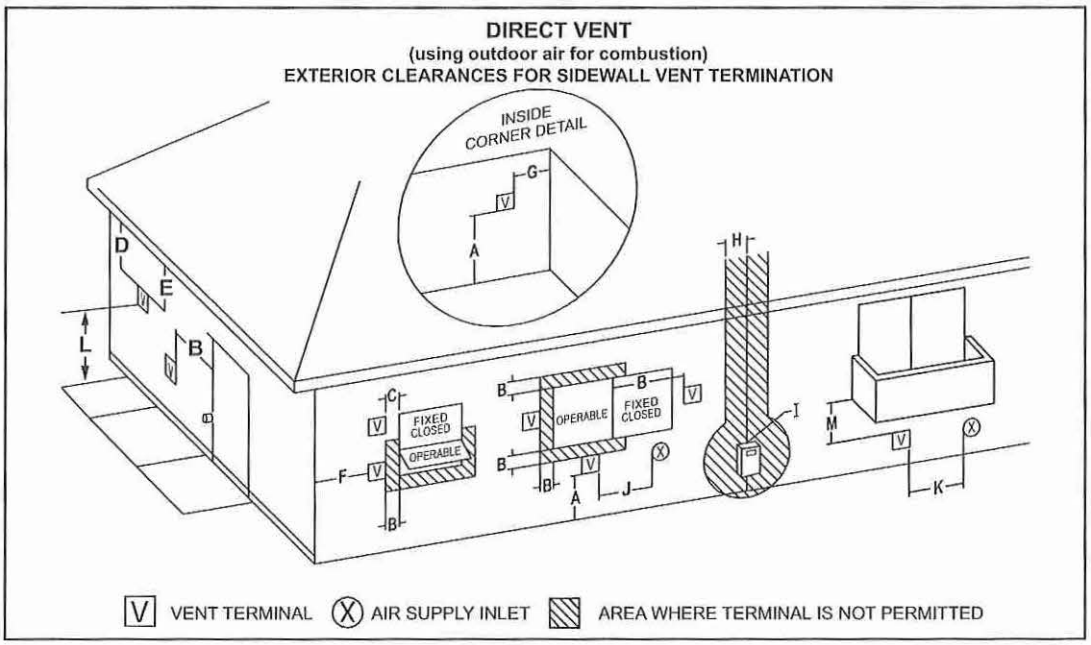


Figure 52

Vent terminal clearances for "Direct Vent" installations. Direct Vent configurations use outdoor air for combustion.

		CANADIAN INSTALLATIONS [1]	US INSTALLATIONS [2]			CANADIAN INSTALLATIONS [1]	US INSTALLATIONS [2]
A	Clearance above grade, veranda, porch, deck or balcony	12 inches (30 cm)	12 inches (30 cm)	H	Clearance to each side of center line extended above meter/regulator assembly	3 feet (91 cm) within a height 15 feet (4.5 m) above the meter/ regulator assembly	3 feet (91 cm) within a height 15 feet (4.5 m) above the meter/regulator assembly*
B	Clearance to window or door that may be opened	6 inches (15 cm) for appliances up to 10,000 Btu/hr (3 kW), 12 inches (30 cm) for appliances between 10,000 Btu/hr (3 kW) and 100,000 Btu/hr (30 kW), 36 inches (91 cm) for appliances above 100,000 Btu/hr (30 kW)	6 inches (15 cm) for appliances up to 10,000 Btu/hr (3 kW), 9 inches (23 cm) for appliances between 10,000 Btu/hr (3 kW) and 50,000 Btu/hr (15 kW), 12 inches (30 cm) for appliances above 50,000 Btu/hr (15 kW)	I	Clearance to service regulator vent outlet	3 feet (91 cm)	3 feet (91 cm)*
C	Clearance to permanently closed window	6 inches (15 cm)*	6 inches (15 cm)*	J	Clearance to a non mechanical air supply inlet into building or combustion air inlet to any other appliance	6 inches (15 cm) for appliances up to 10,000 Btu/hr (3 kW), 12 inches (30 cm) for appliances between 10,000 Btu/hr (3 kW) and 100,000 Btu/hr (30 kW), 36 inches (91 cm) for appliances above 100,000 Btu/ hr (30 kW)	6 inches (15 cm) for appliances up to 10,000 Btu/hr (3 kW), 9 inches (23 cm) for appliances between 10,000 Btu/hr (3 kW) and 50,000 Btu/hr (15 kW), 12 inches (30 cm) for appliances above 50,000 Btu/hr (15 kW)
D	Vertical clearance to ventilated soffit located above the terminal within a horizontal distance of 2 feet (61 cm) from the center line of the terminal	12 inches (30 cm)*	12 inches (30 cm)*	K	Clearance to a mechanical air supply inlet	6 feet (1.83 m)	3 feet (91 cm) above if within 10 feet (3 m) horizontally
E	Clearance to unventilated soffit	12 inches (30 cm)*	12 inches (30 cm)*	L	Clearance above paved sidewalk or paved driveway located on public property	7 feet (2.13 m)†	7 feet (2.13 m)†*
F	Clearance to outside corner	2 feet (60 cm)*	2 feet (60 cm)*	M	Clearance under veranda, porch, deck, or balcony	12 inches (30 cm) ‡	12 inches (30 cm) ‡*
G	Clearance to inside corner	18 inches (45 cm)*	18 inches (45 cm)*				

1 In accordance with the current CSA B149.1, Natural Gas and Propane Installation Code.

2 In accordance with the current ANSI Z223.1/NFPA 54, National Fuel Gas Code.

† A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings. Where it may cause hazardous frost or ice accumulations on adjacent property surfaces.

‡ Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor.

* Clearance in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions.

WATER HEATER INSTALLATION

CONDENSATE DRAIN INSTALLATION

Installation must conform with these instructions and local building codes.

Field supplied materials required for installation include:

- Approved PVC cement and PVC primer.
- 1/2 inch PVC pipe - minimum length to equal the distance between the water heater and a suitable building drain.
- 1/2 inch PVC fittings (elbows, couplings, and adapters) necessary to install a condensate drain line between the Exhaust/Condensate Elbow Assembly and a suitable building drain.
- Floor mounted standoffs to brace the drain line.

INSTALLATION NOTES

1. The condensate drains from the water heater's covered by this instruction have PH levels between 4.3 and 5.0. Install a commercially available neutralizing kit if required by local codes. Lower PH levels are acidic. Do not connect a metal condensate drain line, such as copper pipe, to the water heater for this reason.
2. The field installed condensate drain line must not be less than 1/2 inch PVC in size.
3. **DO NOT** remove, modify or alter the factory condensate trap.

INSTALLATION INSTRUCTIONS

1. Ensure the water heater's on/off switch is in the "off" position.
2. Install a 1/2 inch PVC condensate drain line between condensate drain connection on the Exhaust/Condensate Elbow and a suitable building drain, see Figure 53.
3. Terminate the condensate drain piping with an elbow above the drain. Ensure that any discharge will exit the condensate drain line no more than 6 inches (15.2 cm) above a suitable building drain, or external to the building, see Figure 53.

   NOTE: In cold climates it is recommended the condensate drain be terminated at a suitable drain inside the building.
4. Ensure the condensate drain line is not elevated above the condensate drain connection on the Exhaust/Condensate Elbow, see Figure 53.
5. Brace the condensate drain line with floor mounted standoffs every three feet.
6. Ensure the condensate drains freely during start up, see Start Up on page 53.

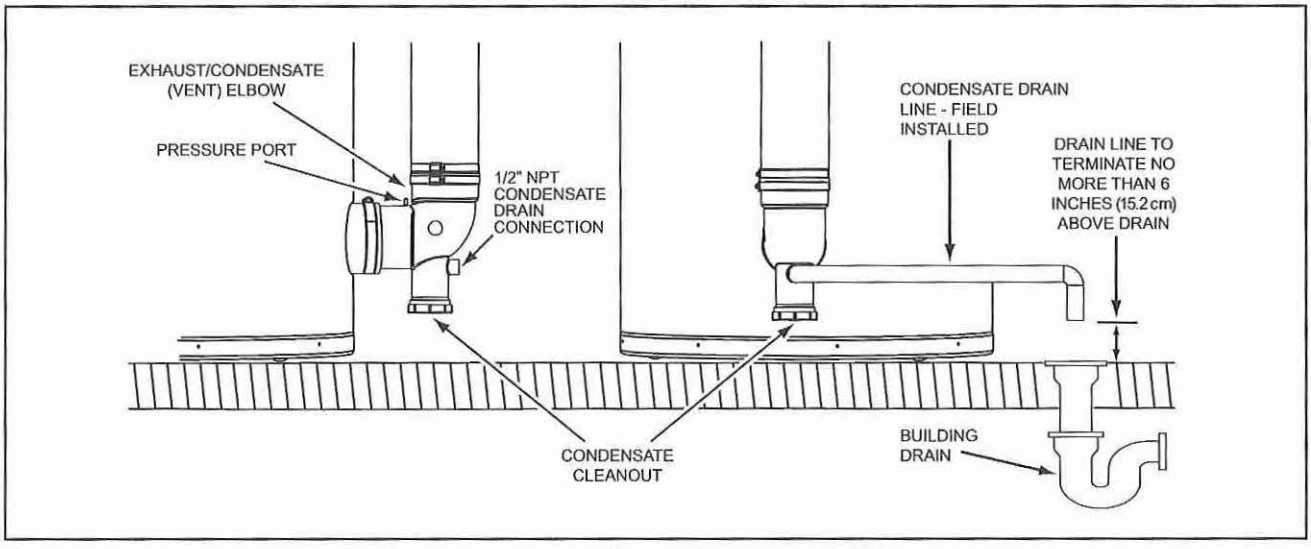


Figure 53

SUPPLY GAS LINE INSTALLATION

Contact your local gas utility company to ensure that adequate gas service is available and to review applicable installation codes for your area.

Be sure that the gas meter has sufficient capacity to supply the rated gas input of the water heater as well as the requirements of all other gas fired equipment supplied by the meter. If the gas meter is undersized, the gas company will have to install a properly sized gas meter.

Make sure gas supplied is same type listed on the water heater's rating label.

The water heaters covered in this manual are not intended for operation at higher than 14.0" W. C. (2.62 kPa) for natural gas and 14.0" W. C. (3.49 kPa) for propane gas supply pressure, see Table 3 on page 11. The water heaters covered in this manual require supply gas regulators to maintain required supply gas pressure. Exposure to higher gas supply pressure may cause damage to the gas controls which could result in fire or explosion. If overpressure has occurred such as through improper testing of gas lines or malfunction of the supply system the water heater's gas valve must be checked for safe operation by a Qualified Service Agency.

Ensure supply regulator vent lines and the safety vent valves are protected against blockage. These are components of the gas supply system, not the water heater. Vent blockage may occur during ice storms.

It is important to guard against gas valve fouling from contaminants in the gas ways. Such fouling may cause improper operation, fire or explosion. If copper supply lines are used they must be internally tinned and certified for gas service.

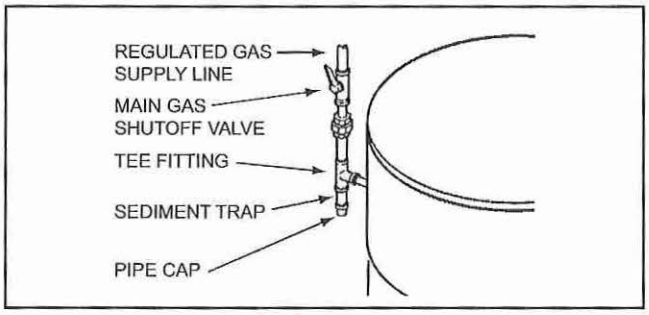


Figure 54

Ensure all gas pipe is clean on the inside before installation. To trap any dirt or foreign material in the gas supply line a sediment trap must be installed as shown in Figure 54. The sediment trap must be readily accessible and not subject to freezing conditions. Install in accordance with the recommendations of the local gas utility company.

GAS LINE SIZING

Depending on the developed equivalent length and/or the number of appliances connected to a common main, the size of supply gas lines may have to be increased.

Size the supply/main gas line(s) in accordance with Table 11 or Table 12. The values given in Table 11 and Table 12 are for straight lengths of iron pipe at 0.5" W. C. (125 Pa) pressure drop, which is considered normal for low pressure systems. Note that fittings such as elbows and tees will add to the pipe pressure drop.

Schedule 40 Steel or Wrought Iron Pipe is the preferred material for the gas line of this water heater. It is imperative to follow the sizing recommendations in the latest version of the National Fuel Gas Code if Corrugated Stainless Steel Tubing (CSST) is used as the gas line for this water heater.

SUPPLY GAS LINE SIZING U. S. UNITS

TABLE 11

LENGTH IN FEET	NORMAL IRON PIPE SIZES (INCHES) INPUT IN THOUSANDS BTU/HR					
	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
10	175	360	680	1400	2100	3960
20	120	250	485	950	1460	2750
30	97	200	375	770	1180	2200
40	82	170	320	660	990	1900
50	73	151	285	580	900	1680
60	66	138	260	530	810	1520
70	61	125	240	490	750	1400
80	57	118	220	460	690	1300
90	53	110	205	430	650	1220
100	50	103	195	400	620	1150
125	44	93	175	360	550	1020
150	40	84	160	325	500	950
175	37	77	145	300	460	850
200	35	72	135	280	430	800

SUPPLY GAS LINE SIZING METRIC UNITS

TABLE 12

LENGTH IN METERS	NORMAL IRON PIPE SIZES (INCHES) INPUT IN kW					
	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
3.0	51	105	199	410	615	1160
6.1	35	73	142	278	428	805
9.1	28	59	110	225	346	644
12.2	24	50	94	193	290	556
15.2	21	44	83	170	264	492
18.3	19	40	76	155	237	445
21.3	18	37	70	143	220	410
24.4	17	35	64	135	202	381
27.4	16	32	60	126	190	357
30.5	15	30	57	117	182	337
38.1	13	27	51	105	161	299
45.7	12	25	47	95	146	278
53.3	11	23	42	88	135	249
61.0	10	21	40	82	126	234

GAS LINE CONNECTION

1. The water heaters covered by this manual are shipped from the factory with 3/4 inch supply gas connections. The supply gas line must not be smaller than 3/4 inch. Connect the supply gas line to the water heater's 24 Volt Gas Valve in accordance with all applicable local and national code requirements.
2. Depending on the developed equivalent length and/or the number of appliances connected to a common main, the size of the supply gas line may have to be increased, see Gas Line Sizing on page 40. If the supply gas line must be re-sized larger to accommodate increased supply gas line lengths or multiple appliances use reducer couplings and short pipe nipples to increase the supply gas line.

   NOTE: Make the transition to the larger supply gas line as close to the supply gas connection as possible.
3. Apply thread sealing compounds (pipe dope/Teflon tape) sparingly and only to the male threads of the pipe joints. Do not apply sealing compound to the first two threads. Use pipe dope or Teflon tape marked as being resistant to the action of liquid petroleum (LP/propane) gases.

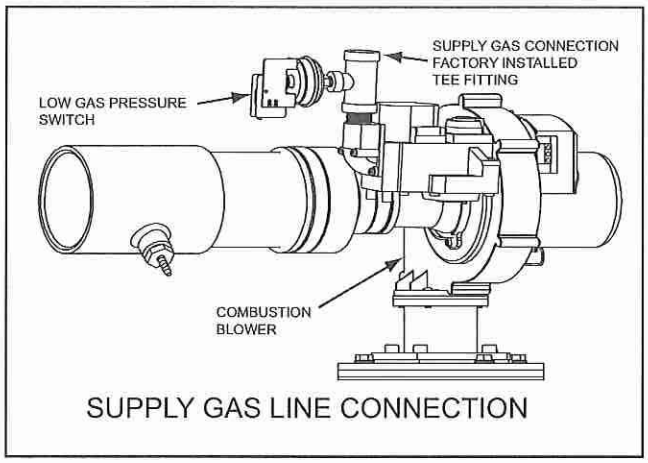
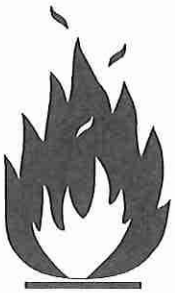


Figure 55

4. Use only a smooth jaw adjustable wrench as a back up on the body of the 24 Volt Gas Valve when tightening the first pipe nipple into the body of the valve. **DO NOT** use a standard pipe wrench (Stillson wrench) with metal tooth jaws as this may permanently damage the valve.
5. Use a standard pipe wrench (Stillson wrench) as a back up on the first pipe nipple installed above when connecting other fittings and pipe in the supply gas line to prevent the 24 Volt Gas Valve on the water heater from twisting during installation.
6. To prevent damage, care must be taken not to apply too much torque when connecting the supply gas line to the water heater.
7. Install a sediment trap as shown in Figure 54 on page 40.
8. Install a Main Gas Shutoff valve in the supply gas line as shown in Figure 54 on page 40.

NOTE: Should overheating occur or the gas supply fail to shut off, turn off the Main Gas Shutoff valve to the water heater.

GAS LINE LEAK TESTING



⚠WARNING

Fire and Explosion Hazard

- Use joint compound or Teflon tape compatible with propane gas.
- Leak test gas connections before placing water heater in operation.
- Disconnect gas piping at main gas shutoff valve before leak testing heater.
- Install sediment trap in accordance with NFPA 54 or CAN/CSA B149.1.

Any time work is done on the gas supply system perform a leak test to avoid the possibility of fire or explosion.

1. For test pressures exceeding 1/2 psi (3.45 kPa) disconnect the water heater and its Main Gas Shutoff Valve from the gas supply piping system during testing, see Figure 54 on page 40. The gas supply line must be capped when disconnected from the water heater.
2. For test pressures of 1/2 psi (3.45 kpa) or less, the water heater need not be disconnected, but must be isolated from the supply gas line by closing the Main Gas Shutoff Valve during testing.
3. Paint all supply gas line joints and connections upstream of the water heater with a rich soap and water solution to test for leaks. Bubbles indicate a gas leak. Do not use matches, candles, flame or other sources of ignition for this purpose.
4. Repair any leaks before placing the water heater in operation.

PURGING

Gas line purging is required with new piping or systems.

Purging should be performed per the current edition of NFPA 54 the National Fuel Gas Code or CAN/CSA B149.1 Natural Gas and Propane Installation Code.

ELECTRICAL WIRING

All electrical work must be installed in accordance with the National Electrical Code, ANSI/NFPA 70 or the Canadian Electrical Code, CSA C22.1 and local requirements.

When installed, the water heater must be electrically grounded in accordance with local codes or, in the absence of local codes, with the National Electrical Code, ANSI/NFPA 70 or the Canadian Electrical Code, CSA C22.1.

If any of the original wire as supplied with the water heater must be replaced, it must be replaced with 105°C rated wiring or its equivalent, except in the burner housing. In this case 200°C rated wire must be used.

POWER SUPPLY CONNECTIONS

Read the requirements for the Power Supply on page 13 before connecting power.

The 120 VAC hot wire from the power supply must connect to the black jumper wire or the "L1" terminal block location in the junction box and the 120 VAC neutral wire must connect to the white jumper wire or the "Neutral" terminal block location in the junction box for correct polarity. See Figure 56.

Power supply connections must be made as follows:

1. Ensure the power supply is turned off at the breaker or disconnect switch.
2. Remove the junction box cover. See Figure 3 on page 8 for junction box location.
3. Connect the 120VAC hot wire from the power supply to the black jumper wire or the terminal block location marked "L1" inside of the junction box located on top of the water heater. If the black jumper wire is used make the connection inside of the junction box with a properly sized wire nut and wrap electrical tape around the wire nut and wire end. See junction box Figure 56 and wiring diagram Figure 67 on page 67.

   NOTE: If electrical connection is made directly to terminal block remove black jumper wire before making connection.
4. Connect the 120VAC neutral wire from the power supply to the white jumper wire or the terminal block location marked "Neutral" inside of the junction box located on top of the water heater. If the white jumper wire is used, make the connection inside of the junction box with a properly sized wire nut and wrap electrical tape around the wire nut and wire end. See junction box Figure 56 and wiring diagram Figure 67 on page 67.

   NOTE: If electrical connection is made directly to terminal block remove white jumper wire before making connection.
5. Connect the ground wire from the power supply to the grounding lug inside the junction box. See junction box Figure 56 and Wiring Diagram Figure 67 on page 67.
6. Replace junction box cover when connections are complete.

NOTE: Do not apply power to the water heater before installation is complete and the water heater is filled with water.

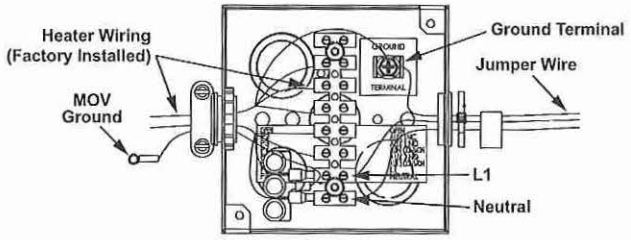


Figure 56

ENABLE / DISABLE CIRCUIT (For Building Management Systems)

The water heaters covered in this manual are equipped with an enable/disable circuit for use with field supplied external supervisory controls such as time clocks or Building Management Systems. The enable/disable circuit may be used to disable heating operation during periods when the building is unoccupied or there is no demand for hotwater.

To use the enable/disable circuit it must first be activated by selecting the "Use External Enable" from the UIM. Field supplied wiring is then installed between the water heater's CCB and a set of "dry contacts" (no voltage or load) on the field supplied external control.

NOTE: The water heater's enable/disable circuit is a switching circuit only: Do not apply external voltage or connect any load (IE: relay coil) to this circuit. This will damage the CCB circuit board and is not covered under the limited warranty.

CONNECTING AN EXTERNAL SUPERVISORY CONTROL

The enable/disable circuit is accessed from the CCB's J17 plug inside the CCB enclosure; see Figure 3 on page 8 to locate the CCB enclosure. Install field wiring to the enable/disable circuit:

1. Turn off power at the water heater's enable/disable switch and the breaker that supplies power to the water heater.
2. Locate the CCB enclosure.
3. Carefully remove the Temperature Probe connectors and CCB enclosure cover.
4. Locate pins 1 and 2 on the CCB J17 plug. See Figure 66 on page 66.
5. Connect the two field supplied control wires to pins 1 and 2 on the CCB J17 plug.
6. Thread the control wires out of the CCB enclosure with the other wiring and carefully replace the CCB enclosure cover. Ensure all wiring is routed through the intended area provided for strain relief. Ensure no wiring is being pinched.
7. Reinstall the CCB enclosure cover.
8. Route the control wires inside the junction box on the top of the water heater; see Figure 3 on page 8 to locate the junction box. Use an available knock-out to route the wires inside the junction box.
9. Install field supplied control wiring and conduit as required by national and local codes between the water heater's junction box and the external supervisory control. Connect the wiring from the external control to the control wires inside the junction box using wire nuts and electrical tape.
10. Connect the control wiring to a set of dry contacts on the external control. Follow the control manufacturer's instructions for making connections.
11. Restore power to the water heater.
12. From the water heaters UIM "Heater Information Screen" select "Use External Enable" and change to "Yes". See Figure 3 on page 8 to locate the UIM.

NOTE: Whenever the external control opens the set of dry contacts used, water heating operation will be disabled. Whenever the external control closes the set of dry contacts used, water heating operation will be enabled. A diagonal line and circle appears over the thermometer icon on the UIM when water heating operation is disabled. See the Status Icons descriptions in Table 14 on page 46.

NOTE: Ensure the water heater is protected from freezing temperatures when water heating operation is disabled. Damage to the water heater caused by freezing temperatures is not covered under the limited warranty.

WATER LINE CONNECTIONS

The water piping installation must conform to these instructions and to all local and national code authority having jurisdiction. Good practice requires that all heavy piping be supported.

Read and observe all requirements in the following sections before installation of the water piping begins:

1. Mixing Valves on page 14.
2. Dishwashing Machines on page 14.
3. Temperature-Pressure Relief Valve on page 15.
4. Closed Systems and Thermal Expansion on page 14.
5. For multiple water heater installations see Water Piping Diagrams beginning on page 69.

WATER PIPING DIAGRAMS

This manual provides detailed water piping diagrams for typical methods of application for the water heaters, see Water Piping Diagrams beginning 69.

The water heater may be installed by itself, or with a separate storage tank. When used with a separate storage tank, the circulation may be either by gravity or by means of a circulating pump. When a circulating pump is used, it is important to note that the flow rate should be slow so that there will be a minimum of turbulence inside the water heater storage tank.

Adjust flow by throttling a full port ball valve installed in the circulating line on the outlet side of the pump. Never throttle flow on the suction side of a pump. See the Water Piping Diagrams beginning on page 69.

NOTE: In addition to the factory installed Temperature-Pressure Relief Valve (T&P valve) on the water heater, each remote storage tank that may be installed and piped to a water heating appliance must also have its own properly sized, rated and approved Temperature-Pressure Relief Valve installed.

Call the toll free technical support phone number listed on the back cover of this manual for further assistance in sizing a T&P valve for remote storage tanks.

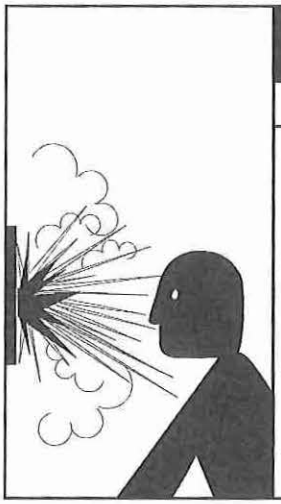
THERMOMETERS (NOT SUPPLIED)

Thermometers are installed in the water piping system as a means of detecting the temperature of the hot water supply at critical points in the system. Field supplied thermometers should be obtained and installed. See Water Piping Diagrams on page 69.

WATER (POTABLE) HEATING AND SPACE HEATING

1. All water piping components connected to the water heater that are for space heating applications shall be suitable for use with potable water.
2. Toxic chemicals, such as those used for boiler treatment, must NEVER be introduced into this system.
3. The water heaters covered in this manual may never be connected to any existing heating system or component(s) previously used with non-potable water heating appliance.
4. When the system requires water for space heating that exceed safe temperatures at domestic water fixtures a mixing valve must be installed, see Mixing Valves on page 14.
5. These water heaters cannot be used in space heating applications only.

T&P VALVE DISCHARGE PIPE



⚠ WARNING

Explosion Hazard

- Temperature-Pressure Relief Valve must comply with ANSI Z21.22-CSA 4.4 and ASME code.
- Properly sized temperature-pressure relief valve must be installed in opening provided.
- Can result in overheating and excessive tank pressure.
- Can cause serious injury or death.

This water heater is provided with a properly rated/sized and certified combination temperature - pressure (T&P) relief valve by the manufacturer. See Temperature-Pressure Relief Valve on page 15 for information on replacement and other requirements.

CAUTION

Water Damage Hazard

- Temperature-Pressure Relief Valve discharge pipe must terminate at adequate drain.

Install a discharge pipe between the T&P valve discharge opening and a suitable floor drain. Do not connect discharge piping directly to the drain unless a 6" (15.2 cm) air gap is provided. To prevent bodily injury, hazard to life, or property damage, the relief valve must be allowed to discharge water in adequate quantities should circumstances demand. If the discharge pipe is not connected to a drain or other suitable means, the water flow may cause property damage.

T&P Valve Discharge Pipe Requirements:

- Shall not be smaller in size than the outlet pipe size of the valve, or have any reducing couplings or other restrictions.
- Shall not be plugged or blocked.
- Shall not be exposed to freezing temperatures.
- Shall be of material listed for hot water distribution.
- Shall be installed so as to allow complete drainage of both the Temperature-Pressure Relief Valve and the discharge pipe.
- Must terminate a maximum of six inches above a floor drain or external to the building. In cold climates, it is recommended that the discharge pipe be terminated at an adequate drain inside the building.
- Shall not have any valve or other obstruction between the relief valve and the drain.

TEMPERATURE REGULATION

HIGH TEMPERATURE LIMIT CONTROL (ECO)

This water heater is equipped with an ECO (energy cut out) non adjustable high temperature limit switch. The ECO is a normally closed switch that opens (activates) on a rise in temperature.

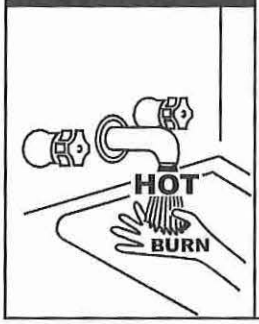
The ECO is located inside the Upper Temperature Probe (two red wires), see pages 8 and 9 for location. The ECO switch contacts will open when the water temperature reaches approximately 202°F (94°C) and close at approximately 140°F (49°C).

If the ECO activates (contacts open) due to abnormally high water temperatures in the storage tank the control system will immediately de-energize the 24 Volt Gas Valve and end the current heating cycle. The control system will "lock out" disabling further heating operation. The control system will display the "Energy Cut Out (ECO)" Fault message on the LCD screen. It is important that a Qualified Service Agent be contacted to determine the reason for the ECO activation before resetting the ECO. Once the reason has been determined and corrected the ECO can be reset as follows:

Should the ECO activate, the water temperature must drop below 140°F (49°C) before the control system can be reset. Once the water temperature has cooled below this point the power supply to the water heater must be turned off and on again to reset the control system.

THERMOSTAT CONTROL

⚠ DANGER



Water temperature over 125°F (52°C) can cause severe burns instantly resulting in severe injury or death.

Children, the elderly and the physically or mentally disabled are at highest risk for scald injury.

Feel water before bathing or showering.

Temperature limiting devices such as mixing valves must be installed when required by codes and to ensure safe temperatures at fixtures.

Hot water temperatures required for automatic dishwasher and laundry use can cause scald burns resulting in serious personal injury and/or death. Table 13 shows the approximate time-to-burn relationship for normal adult skin.

The temperature at which injury occurs varies with the person's age and duration of exposure. The slower response time of children, the elderly or disabled persons increases the hazards to them. If anyone using hot water provided by the water heater being installed fits into one of these groups or if there is a local code or state law requiring a certain water temperature at the point of use, then special precautions must be taken.

In addition to using the lowest possible temperature setting that satisfies the demand of the application a mixing valve can be installed at the water heater (see Figure 7 on page 14) or at the hot water taps to further reduce system water temperature.

Never allow small children to use a hot water tap or draw their own bath water. Never leave a child or disabled person unattended in a bathtub or shower.

The water heater should be located in an area where the general public does not have access to set temperatures.

Setting the Operating Set Point at 120°F (49°C) will reduce the risk of scalds. Some States require settings at specific lower temperatures.

TABLE 13

Water Temperature °F (°C)	Time for 1st Degree Burn (Less Severe Burns)	Time for Permanent Burns 2nd & 3rd Degree (Most Severe Burns)
110 (43)	(normal shower temp.)	
116 (47)	(pain threshold)	
116 (47)	35 minutes	45 minutes
122 (50)	1 minute	5 minutes
131 (55)	5 seconds	25 seconds
140 (60)	2 seconds	5 seconds
149 (65)	1 second	2 seconds
154 (68)	instantaneous	1 second
(U.S. Government Memorandum, C.P.S.C., Peter L. Armstrong, Sept. 15, 1978)		

The water heaters covered in this manual are equipped with an electronic control system to regulate water temperature inside the storage tank. The control system senses temperature from two factory installed temperature probes, one installed in the top of the storage tank and one installed near the bottom, See Top Views on page 8 and Figure 4 on page 9 for location.

The "Operating Set Point" is adjusted to regulate water temperature inside the storage tank. This is an adjustable user setting in the control system's "Temperatures Menu." This and all control system menus are accessed through the UIM (user interface module) located on the front of the water heater, see Figure 57.

The Operating Set Point is adjustable from 90°F (42°C) to 180°F (82°C). The factory setting is 120°F (49°C). See Operating Set Point And Differential Adjustment on page 48 for instructions on how to adjust the Operating Set Point and other user settings.

Set the Operating Set Point at the lowest setting which produces an acceptable hot water supply. This will always provide the most energy efficient operation.

MODULATION

The water heaters covered by this manual are capable of modulating their firing rate. The CCB monitors the water temperature in the tank and regulates the firing rate to achieve the target temperature setpoint. The firing rate is dictated by the hot water draw, proximity to the tank temperature setpoint, and various other temperature limitations. Periodically, when the heater is in modulation mode, the CCB will increase the blower speed for a short period of time to clear out any condensation that has accumulated in the heat exchanger then decreases the blower speed back to the modulating firing rate required to maintain the desired tank temperature setpoint. This ramping up and down of the blower speed is considered normal operation of the water heater.

HIGH TEMPERATURE APPLICATIONS

Higher operating temperatures cause more wear on all water heaters and will decrease the life span of the water heater. Consider installing a small booster water heater for high temperature applications, such as commercial dishwashers, to raise the outlet temperature from the larger primary water heater to the desired point of use temperature.

Contact your local distributor or call the technical support phone number listed on the back cover of this manual for further technical assistance.

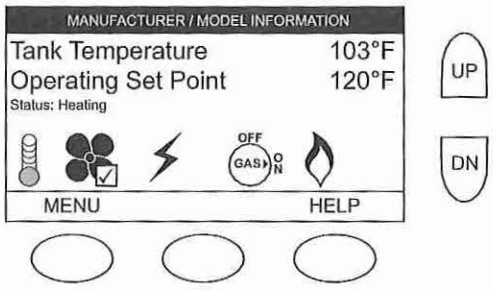


Figure 57

CONTROL SYSTEM OPERATION

OVERVIEW

The water heaters covered in this manual are equipped with an electronic control system that regulates water temperature inside the storage tank. Heating cycles and ignition are managed by the control system. The ECO (energy cut out), flame sensor, pressure switches and temperature probes are monitored by the control system. The Combustion Blower, Spark Ignition Control, 24 Volt Gas Valve and anode rods are all powered by the control system.

The main components of the control system are a UIM (user interface module) and a CCB (central control board). The UIM is located on the top front side of the water heater. The CCB is mounted on top of the water heater inside a protective enclosure. See Features And Components on page 7 for location of these and all water heater components.

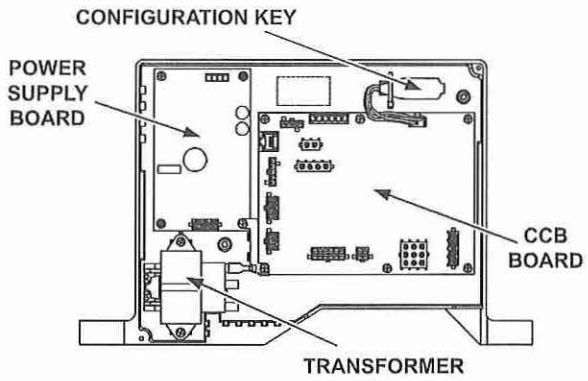


Figure 58

CONTROL SYSTEM NAVIGATION

All operational information and user settings are displayed and accessed from the UIM. The UIM houses the control system's LCD (liquid crystal display) and five snap acting (momentary) user input buttons; an up, down and three (3) multi functional operational buttons below the LCD, see Figure 59.

User Input Buttons

- The up and down buttons are used to navigate menus and adjust user settings.
- The operational buttons are used to enter/exit menus, select menu items, activate adjustment modes and confirm or cancel new user settings. The operational buttons are multifunctional, their current function is defined by the text that appears directly above each button on the LCD screen.

THE DESKTOP SCREEN

During normal operation the control system will display the "Desktop" screen on the LCD which is the default screen. The control system will return to the Desktop screen when there are no active Fault or Alert conditions or when there has been no user input for several minutes.

- Manufacturer and water heater model information is displayed in Title Bar at the top of the Desktop screen. Menu titles are displayed in the Title Bar when navigating the control system menus.
- The first temperature shown on the Desktop screen, Tank Temperature, is the temperature of the water inside the water heater's storage tank.
- The second temperature shown on the Desktop screen is the Operating Set Point. The Operating Set Point is the temperature at which the control system will maintain the water inside the storage tank.
- Beneath the Operating Set Point is the "Status" line. The Status line shows the current operational state of the control system in real time, see Table 15 on page 47 for a description of the various operational states.
- The Desktop screen also displays animated "Status Icons" to convey operational information, see Table 14 on page 46 for descriptions of the Status Icons.

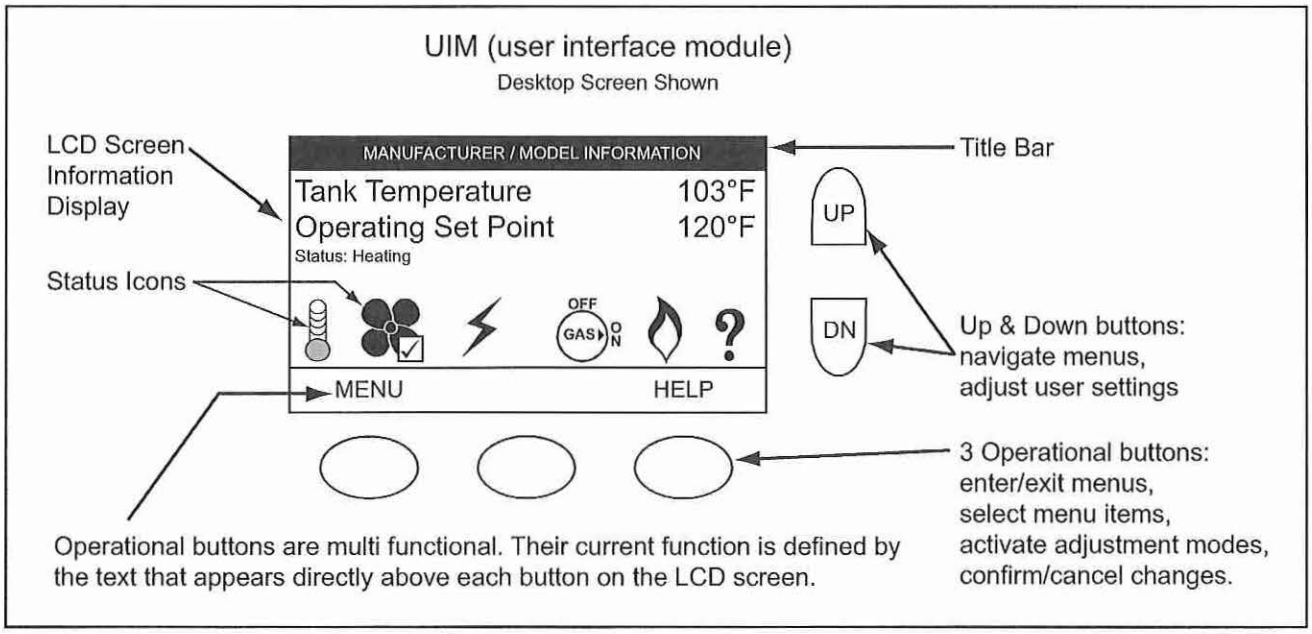


Figure 59

STATUS ICONS

The Status Icons are displayed on the Desktop screen and convey operational and diagnostic information. The icons are described in the table below. See Figure 59 on page 45 and the Sequence Of Operation on page 57.

TABLE 14

Icon	Description
	Water temperature in the tank has fallen. Shaded area of the animated thermometer icon will rise and fall in response to water temperature in the storage tank as sensed from the Upper and Lower Temperature Probes. See beginning on page 8 and Figure 4 on page 9 for location of Temperature Probes.
	Water temperature in the tank has reached the Operating Set Point. The control system enters the Standby mode.
	The control is unable to initiate a heating cycle. This will happen whenever a Fault condition is detected by the control system or when the Enable/Disable switch on front panel or Building Management system Enable/Disable circuit is an open circuit. Display will read "Status: Water Heating Disabled". For more information see Enable/Disable Circuit on page 42.
	The Combustion Blower is being energized.
	The Blower Prover pressure switch contacts have closed. The check mark icon is visual confirmation of contact closure. See beginning on page 8 for Blower Prover Switch location.
	The Spark Igniter is being energized. See Figure 2 on page 7 for Spark Igniter location.
	The 24 Volt Gas Valve is being energized.
	The control system has sensed flame at the Main Burner from the flame sensor. See the Sequence Of Operation Flow Chart on page 58 and Figure 2 on page 7.
	The control system has declared a Fault condition and must be inspected/serviced by a Qualified Service Agent. Fault message details can be viewed in the Current Fault menu. Heating operation is disabled (lock out) until the condition that caused the Fault is corrected. Power to the water heater must be cycled off and on at the breaker to reset the control system. **NOTE:** Cycling power will not reset the control system if the condition that caused the Fault has not been corrected.
	The control system has declared an Alert condition and must be inspected/serviced by a Qualified Service Agent. The water heater will continue to operate during an Alert condition.

OPERATING STATES

The current operational state of the water heater is displayed on the Desktop screen as the "Status." The common operational states are described in the table below. See Figure 59 on page 45 and the Sequence Of Operation on page 57.

TABLE 15

State	Description
Standby	The water heater is not in an active heating cycle. IE: the Tank Temperature is at or above the Operating Set Point.
Input Verification	The control system is conducting a diagnostic check at the beginning of a heating cycle.
Water Heating Disabled	A Fault condition is detected by the control or when the Enable/Disable switch on front panel or the Building Management system Enable/Disable is an open circuit.
Pre-Purge	The Combustion Blower is energized to flush residual flue gases from the combustion chamber prior to ignition.
Spark Igniter Energized	The Spark Igniter is energized.
Ignition Activation	The 24 Volt Gas Valve is energized and opens to allow fuel gas to flow to the Main Burner.
Ignition Verification	The control system is monitoring the flame sensor for the required minimum flame sensing current. See the Sequence Of Operation on page 57 for minimum flame sensing current (DC micro amps) information.
Inter-Purge	The Combustion Blower is energized to flush residual fuel gas from the combustion chamber after a failed ignition attempt.
Heating	Ignition was successful, flame sensing current has been established. The water in the storage tank is being heated.
Post-Purge	The Combustion Blower is energized to flush residual flue gases from the combustion chamber at the end of a heating cycle.
Fault	The control system has detected a Fault condition. Heating operation is disabled until the Fault condition is corrected. Power to the water heater must be cycled off and on at the breaker to reset the control system. **NOTE:** Cycling power will not reset the control system if the condition that caused the Fault has not been corrected.

CONTROL SYSTEM MENUS

From the Desktop screen pressing the Operational directly below "Menu" on the LCD will display the "Main Menu" this is where all control system menus are located. The table below describes the control system menus.

TABLE 16

Menu	Description
Temperatures	Most commonly accessed menu. Contains the Operating Set Point and Differential user settings.
Heater Status	This menus displays the current state of all pressure switches and the ECO (open/closed). The on/off status of the Combustion Blower, gas valve, Spark Igniter, flame sensor and other monitored water heater components are displayed in this menu.
Display Settings	Temperature units (°F or °C), the LCD appearance (brightness/contrast) and backlight delay user adjustable settings are located in this menu.
Heater Information	Elapsed time of operation, total heating cycle time, heating cycle count, heating on time along with UIM and CCB software revisions can be viewed in this menu.
Current Fault	Displays any current Alert or Fault messages.
Fault History	This control system menu retains a list of the last nine (9) Fault and Alert messages with a time stamp. The newest event will replace the oldest. Faults will clear after 30 days.
Fault Occurrence	This control system menu retains a running total of how many times each Fault condition has occurred since the water heater was first installed. The data does not clear and cannot be reset.
Restore Factory Defaults	This control system feature allows the user to restore control system user settings to their factory default settings. Display Settings preferences ARE NOT changed when factory defaults are restored.
Help Screens	Text based operational and user information explaining how to change user settings, navigate the control system menus and icon descriptions.

USER SETTINGS & CONTROL SYSTEM MENUS

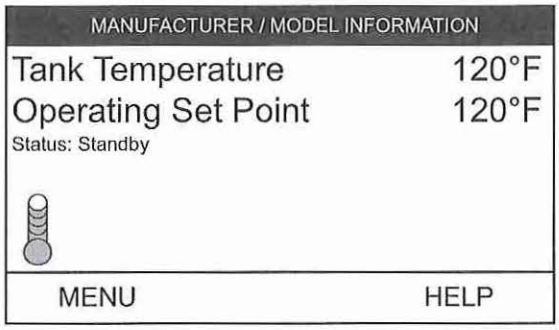
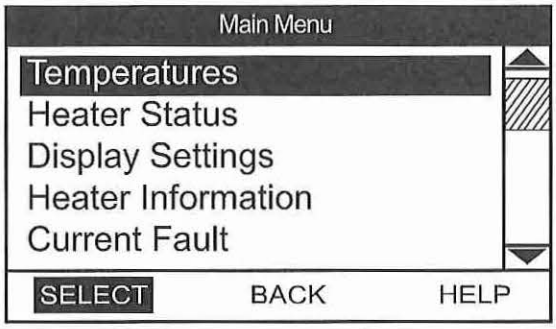
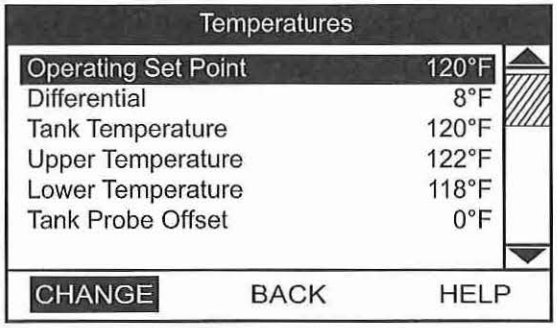
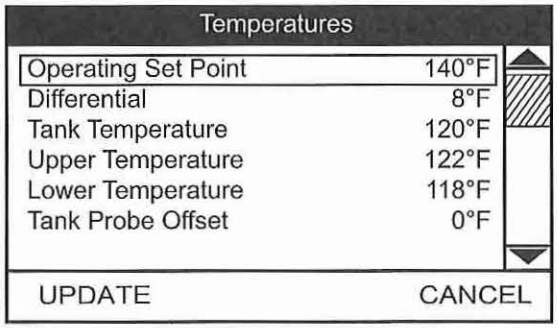
TEMPERATURES MENU

Operating Set Point And Differential Adjustment

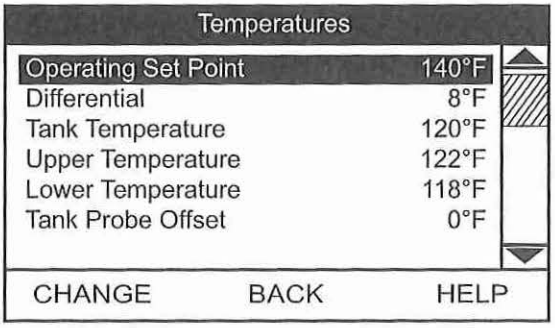
The Operating Set Point is adjustable from 90°F (42°C) to 180°F (82°C). The factory setting is 120°F (49°C). The Differential is adjustable from 2° to 20°. The factory setting is 8°. These user settings are accessed from the Temperatures menu. The following instructions will explain how to adjust these settings and navigate the control system menus.

When the water temperature sensed by the control system from the two (upper and lower) Temperature Probes reaches the Operating Set Point the control system will end the heating cycle. A heating cycle will be activated again when the sensed water temperature drops below the Operating Set Point minus the Differential setting.

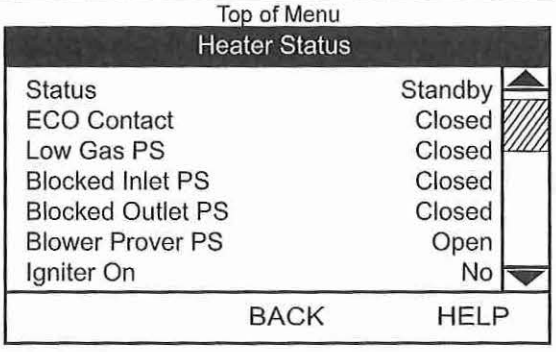
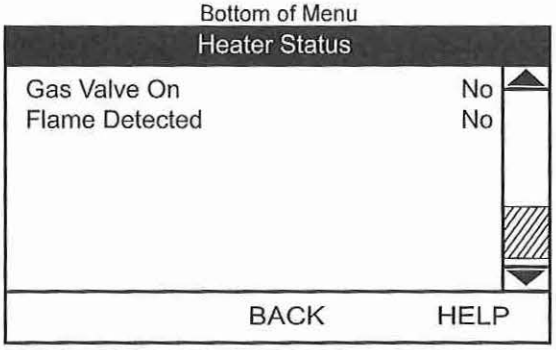
NOTE: Lower Differential settings may cause excessive heating cycles (short-cycling) which can cause premature failure of heater components. Set the Differential at the highest setting which produces an acceptable hot water supply. Set the Operating Set Point to the lowest setting which produces an acceptable hot water supply for most efficient use.

DESCRIPTION/ACTION	DISPLAY
From the Desktop screen, press the Operational Button under MENU. The "Main Menu" screen will be displayed.	
The Main Menu is where all control system menus are listed, see Table 16 on page 47 for a complete list and description of control system menus. Use the Up and Down Buttons to view all control system menus from the Main Menu. With Temperatures menu selected (highlighted in black) in the Main Menu screen, press the Operational Button under "SELECT" to enter the Temperatures menu. If the Temperatures menu is not selected use the Up and Down Buttons to select this menu item.	
With the Operating Set Point selected in the Temperatures menu, press the Operational Button underneath "CHANGE" to activate the adjustment mode for this menu item. If Operating Set Point is not selected use the Up and Down Buttons to select this menu item. **NOTE:** Higher Temperature settings increase wear and operating costs. Set the Operating Set Point to the lowest setting which produces an acceptable hot water supply. This will always provide the most energy efficient operation and longer life.	
With the adjustment mode for the Operating Set Point activated the selection bar will change from a black fill to a black outline. Use the Up and Down Buttons to change the current setting. Press the Operational Button under "UPDATE" to save the new setting. Press the Operational Button under "CANCEL" to discard changes and return to the previously saved setting. **NOTE:** Use this same procedure to change the Differential setting and other adjustable user settings in the control system menus.	

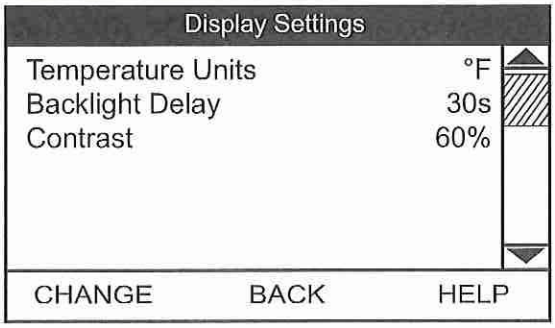
TEMPERATURES MENU (CONT)

DESCRIPTION/ACTION	DISPLAY
• **Differential** - Adjustable user setting that changes the tank temperature differential with a range of 2° to 20°F. The factory setting is 8°F. • **Tank Temperature** - non adjustable - control system sensed temperature (averaged from upper and lower temperature probes). • **Upper Temperature** - non adjustable - control system sensed temperature from the Upper Temperature Probe. • **Lower Temperature** - non adjustable - control system sensed temperature from the Lower Temperature Probe. • **Tank Probe Offset** - adjustable user setting, range -5° to +5° (factory setting 0°). **NOTE:** These settings should only be used if the hot water supply temperature varies greatly from the Operating Set Point setting. The Tank Probe Offset is used to calibrate control system temperature sensing. This can improve the precision of temperature control in the storage tank and at points of use. This feature can also be used to compensate for building recirculation loops (hot water returning to the storage tank) that may cause the heating cycles to terminate prematurely. Example: If the current sensed temperature from a temperature probe is 120°F (49°C) and the Offset setting is adjusted to a value other than 0°, the control system would calibrate or "offset" the sensed temperature from the probe and the averaged tank temperature. Heating cycles would be activated and deactivated based on the calibrated (offset) temperature. A -5° setting results in +5° hotter water. These settings are adjusted in the same way described for Operating Set Point And Differential Adjustment on page 48.	

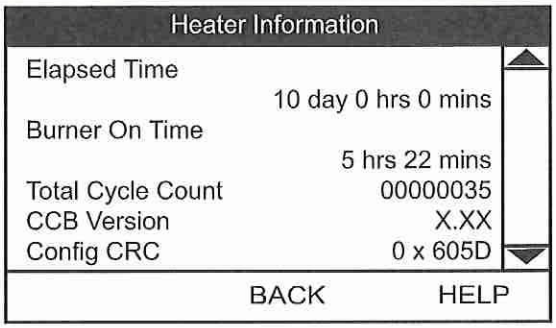
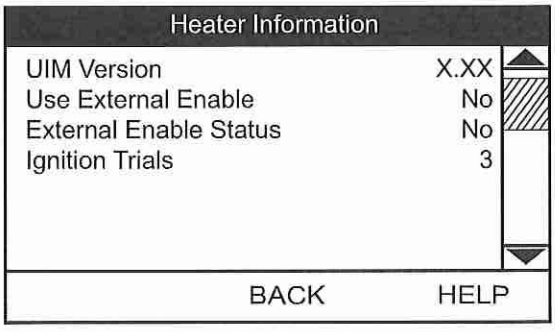
HEATER STATUS MENU

DESCRIPTION/ACTION	DISPLAY
Select Heater Status from the Main Menu and press the Operational Button under "SELECT" to enter this menu. This menu contains non adjustable operational information. Use the Up & Down Buttons to navigate the menu. • **Status** - displays the current Operating State, see Table 15 on page 47. • **ECO Contact**, **Low Gas PS**, **Blocked Inlet PS**, **Blocked Outlet PS**, **Blower Prover PS** - displays the current state of the switch contacts; open or closed. • **Igniter On**, **Gas Valve On** - displays whether or not the control system is currently energizing these water heater components; yes = energized, no = de-energized. • **Flame Detected** - displays whether or not the control system has detected Main Burner flame during ignition from the flame sensor.	Top of Menu  Bottom of Menu 

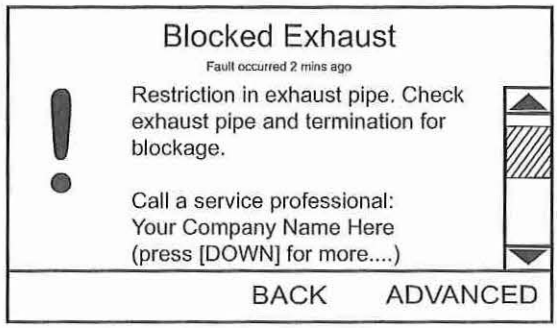
DISPLAY SETTINGS

DESCRIPTION/ACTION	DISPLAY
Select Display Settings from the Main Menu and press the Operational Button under "SELECT" to enter this menu. This menu contains adjustable display options for viewing information on the UIM's LCD screen. Use the Up & Down Buttons to navigate the menu. • **Temperature Units** - Adjustable user setting that changes temperature units display to Celsius °C or Fahrenheit °F. • **Backlight Delay** - Adjustable user setting that determines how long the UIM's LCD backlight remains illuminated after a key has been pressed. Available settings are; Always Off, 10, 30 or 60 seconds and Always On. • **Contrast** - Adjustable user setting to adjust the UIM's LCD screen contrast between text and background. **NOTE:** These settings are adjusted in the same way described for the Operating Set Point And Differential Adjustment on page 48.	

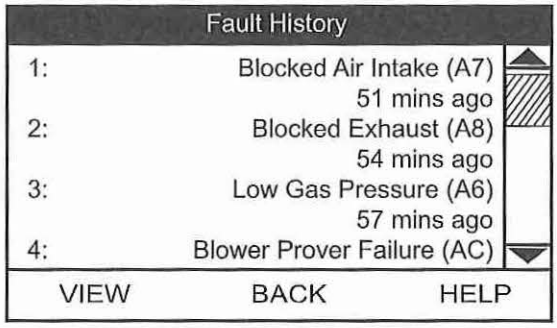
HEATER INFORMATION

DESCRIPTION/ACTION	DISPLAY
Select Heater Information from the Main Menu and press the Operational Button under "SELECT" to enter this menu. This menu contains non adjustable operational information. • **Elapsed Time** - Total accumulated time the control system (water heater) has been energized. • **Burner On Time** - Total accumulated time the control system has been in the heating operating state; burner run time. • **Total Cycle Count** - Total accumulated count of heating cycles. • **CCB Version** - Software version for central control board. • **Config CRC** - Verifies the configuration key matches the CCB programming. • **UIM Version** - Software version for user interface module. • **Use External Enable** - Enables/Disables the external enable circuit. • **External Enable Status** - Displays whether or not the external enable circuit has been activated. • **Ignition Trials** - Displays the number of ignition trials allowed. **NOTE:** Historical data is stored in the configuration key. If this "key" is replaced during servicing the historical data will be lost. The data stored in the new configuration key will no longer reflect the entire history of the water heater. The Elapsed Time, Burner On Time and Cycle Count indicate age, usage and wear. If the Cycle Count per day is high (divide cycle count by days to determine cycles per day) or the cycle duration is short (determine burner on time total minutes, divide burner on time total minutes by cycle count) consider rasing the Differential setting to avoid short cycling and excessive component wear, see Operating Set Point And Differential Adjustment on page 48. This historical data can also be used to assist facilities managers in forecasting planned replacement of equipment to help avoid lengthy and costly hot water supply interruptions.	 **Bottom of Menu** 

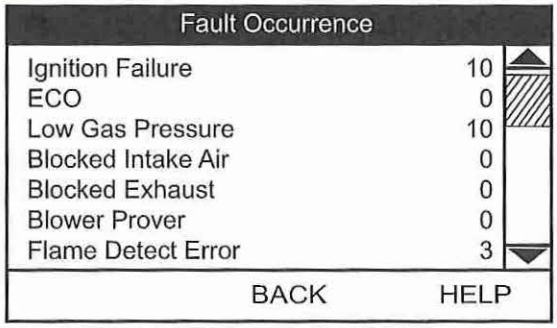
CURRENT FAULT

DESCRIPTION/ACTION	DISPLAY
Select Current Fault from the Main Menu and press the Operational Button under "SELECT" to enter this menu. This menu contains non adjustable operational information. Use the Up & Down Buttons to navigate the menu. This menu contains the current Fault or Alert error message. The time the Fault or Alert message occurred appears directly below. A brief description of what causes the particular Fault or Alert condition appears below that. Pressing the Operational Button under "ADVANCED" will give more detailed service information and a list of possible causes for the Fault or Alert condition. See Fault And Alert Messages on page 61 for more detailed information and diagnostic procedures. If there is no Fault or Alert condition active this menu will not contain any information, "(none)" will be shown next to Current Fault in the Main menu.	

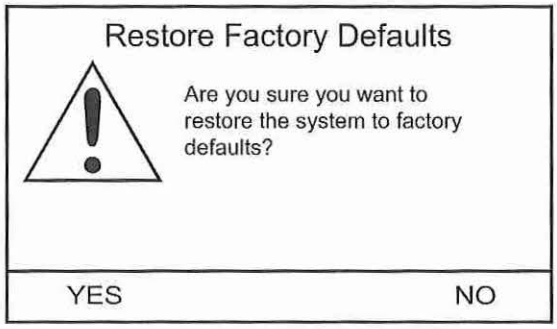
FAULT HISTORY

DESCRIPTION/ACTION	DISPLAY
Select Fault History from the Main Menu and press the Operational Button under "SELECT" to enter this menu. This menu contains non adjustable operational information. Use the Up & Down Buttons to navigate the menu. This menu contains a list of the last nine (9) Fault and Alert messages with a time stamp. The newest event will replace the oldest. Press the Operational Button under "VIEW" to view details for each Fault or Alert message stored.	

FAULT OCCURRENCE

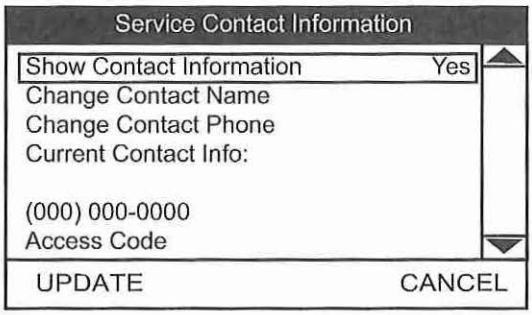
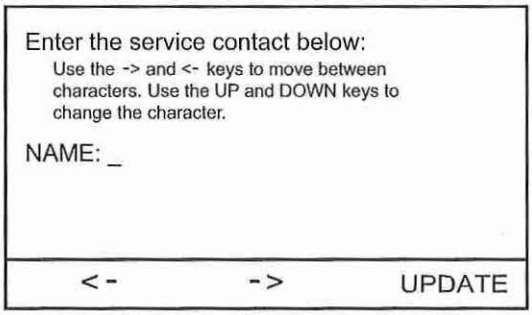
DESCRIPTION/ACTION	DISPLAY
Select Fault Occurrence from the Main Menu and press the Operational Button under "SELECT" to enter this menu. This menu contains non adjustable operational information. Use the Up & Down Buttons to navigate the menu. This menu contains a running total of how many times each Fault condition has occurred since the water heater was first installed. **NOTE:** Historical data is stored in the configuration key. If this "key" is replaced during servicing the historical data will be lost. The data stored in the new configuration key will no longer reflect the entire history of the water heater.	

RESTORE FACTORY DEFAULTS

DESCRIPTION/ACTION	DISPLAY
Select Restore Factory Defaults from the Main Menu and press the Operational Button under "SELECT" to enter this menu. To restore the adjustable user settings to their factory default settings press the Operational Button underneath "YES." The display will show text confirming the factory default settings have been restored. Press the Operational Button underneath "BACK" to exit the Restore Factory Defaults menu.	

SERVICE CONTACT INFORMATION

The control system has a discrete menu that Installing contractors and/or service agents can access to enter contact information for their customers. This contact information will be displayed with all Fault and Alert messages.

DESCRIPTION/ACTION	DISPLAY
From the Desktop Screen (see Figure 59 on page 45) press and hold down the middle (unmarked) Operational Button for 30 seconds and then release it. This will launch a discrete menu where personalized contact information can be entered. Using the UP and DOWN buttons select (highlighted in black) the "Show Contact Information" menu item. Press the Operational Button under "CHANGE" to activate the adjustment mode for this parameter.	
With the adjustment mode for "Show Contact Information" activated the selection bar will change from a black fill to a black outline. Use the Up and Down Buttons to change the setting from "No" to "Yes" and press the Operational Button underneath "UPDATE" to save the new setting. **NOTE:** The Access Code at the bottom of the Service Contact Information screen is for manufacturing engineering purposes only. There are no user settings or information accessed through this menu item.	
Using the UP and DOWN buttons select (highlighted in black) the "Change Contact Name" menu item. Press the Operational Button under "SELECT" to open the Change Contact Name menu.	
Follow the on screen instructions to enter your name or the name of your company. There is a maximum of 20 character spaces for this purpose. When finished press the Operational Button "UPDATE" to save the new Contact Name. The control system will return to the discrete menu.	
Using the UP and DOWN buttons select (highlighted in black) the "Change Contact Phone" menu item and press the Operational Button under "SELECT". Follow the on screen instructions to enter a new Contact Phone number and press the Operational Button under "UPDATE" to save the new phone number. When the new Contact Name and Contact Phone number have both been updated, press the Operational Button under "BACK" to return to the Desktop screen.	

START UP

PRIOR TO START UP

Installation and start up of this water heater requires abilities and skills equivalent to that of a licensed tradesman in the field involved, see Qualifications on page 6.

Do not place the water heater in operation if any part has been exposed to flooding or water damage. Immediately call a qualified service technician to inspect the water heater and to replace any part of the control system and any gas control which has been under water.

Light the water heater in accordance with the Lighting and Operation Instruction label on the water heater and in this manual beginning on page 54.

The water heaters covered by this manual are equipped with an electronic control system (see page 45) which automatically sequences the Combustion Blower, pre and post purging of the combustion chamber, the spark generator, the 24 Volt Gas Valve, Main Burner ignition, and flame sensing. The control system will lock out after three unsuccessful ignition attempts.

Before attempting start up, thoroughly study and familiarize yourself with the exact Sequence Of Operation, see the written Sequence Of Operation on page 57 and the Sequence Of Operation Flow Chart on page 58.

Be certain that the water heater is full of water, that air is purged from the gas and water lines and that there are no leaks in the gas and water lines. Ensure all inlet water valves are open.

FILLING THE WATER HEATER

Follow these steps to fill the water heater prior to start up.

1. Close the heater drain valve.
2. Open a nearby hot water faucet to permit air in system to escape.
3. Fully open the cold water inlet valve allowing the piping and water heater to fill with water.
4. Close the hot water faucet opened in Step 2 as water starts to flow.

INITIAL START UP

REQUIRED TEST EQUIPMENT

- Two U-tube manometers, recommended ranges; 0-14" W.C. (0-3.5 kPa) and 0-35" W.C. (0-8.7 kPa) or pressure gauges.
- Two digital manometers can be used in place of U-tube manometers or pressure gauges. Recommended ranges; -14.00 to +14.00" W.C. (0-3.5 kPa) resolution 0.01" W.C. and 0-35" W.C. (0-8.7 kPa) resolution 0.10" W.C.

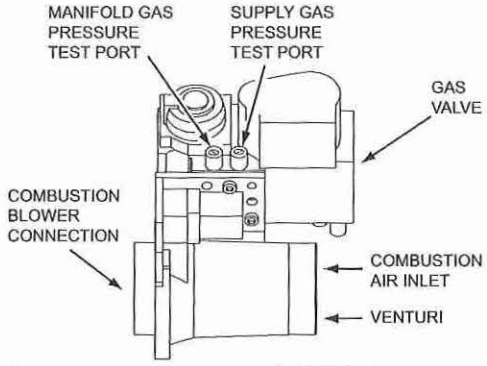
NOTE: All test equipment must be acclimated to ambient temperature before calibration and use.

PREPARATION

1. Using the control system menus, change the Operating Set Point to the lowest temperature setting, see Operating Set Point And Differential Adjustment on page 48.
2. Turn the water heater's enable/disable switch to the "disabled" position.
3. Close the Main Gas Shut Off Valve, see Figure 54 on page 40.
4. Wait five (5) minutes for any residual gas to clear.
5. Connect one manometer (higher range) to an available test port for the supply gas pressure to the water heater:

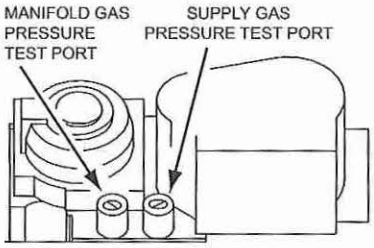
   On the water heaters covered by this manual there are test ports for supply and manifold gas pressure readings on the gas valve. Using a small flat tip pocket screw driver - open the needle valve inside the supply gas pressure test port one full turn only; turn the needle valve screw counter-clockwise to open the valve. Slide the manometer sensing tube over the top of the test port, see Figure 60 and Figure 61.
6. Connect one manometer (lower range) to an available test port for manifold gas pressure to the Main Burner:

   Using a small flat tip pocket screw driver - open the needle valve inside the manifold gas pressure test port one full turn only; turn the needle valve screw counter-clockwise to open the valve. Slide the manometer sensing tube over the top of the test port, see Figure 60 and Figure 61.
7. Open the Main Gas Shutoff Valve.
8. Measure and record the supply gas pressure, this is a "static" supply gas pressure reading; while the water heater is not firing. Adjust supply gas pressure as necessary, see Supply Gas Pressure Adjustment on page 55.



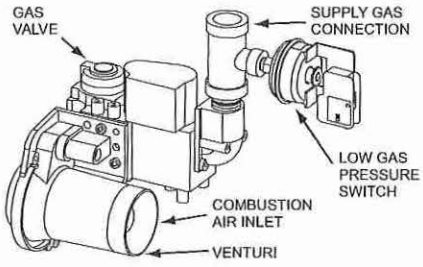
GAS VALVE / VENTURI ASSEMBLY TOP VIEW

Figure 60



GAS VALVE TOP DETAIL VIEW

Figure 61



GAS VALVE / VENTURI ASSEMBLY SIDE VIEW

Figure 62

LIGHTING THE WATER HEATER

LIGHTING & OPERATION LABELS

The instruction label below is affixed to the water heater's covered by this manual at the factory and must be followed when lighting and operating the water heater.

FOR YOUR SAFETY READ BEFORE LIGHTING

WARNING: If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

FLAMMABLE

BEFORE OPERATING: ENTIRE SYSTEM MUST BE FILLED WITH WATER AND AIR PURGED FROM ALL LINES.

A. This appliance does not have a pilot. It is equipped with an ignition device which automatically lights the burner. **Do not try to light the burner by hand.**

B. BEFORE OPERATING smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.

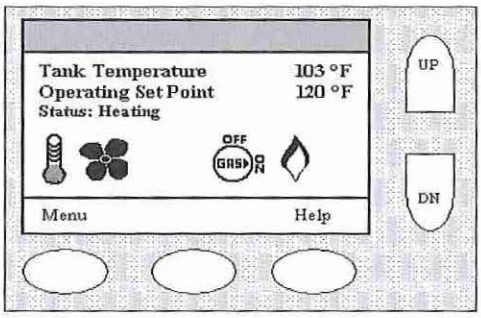
WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electric switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

C .Use only your hand to push in the control buttons. Never use tools. If the control buttons will not push in, don't try to repair them, call a qualified service technician. Force or attempted repair may result in a fire or explosion.

D. Do not use this appliance if any part has been under water. Immediately contact a qualified installer or service agency to replace a flooded water heater. Do not attempt to repair the unit. It must be replaced!

OPERATING INSTRUCTIONS



ENABLE/DISABLE SWITCH

1. STOP! Read the safety information above on this label.
2. Set the Enable/Disable switch on the control panel to the Enable position.
3. Set the thermostat to the lowest setting.
4. Set the Enable/Disable switch on the control panel to the Disable position.
5. This appliance is equipped with a device which automatically lights the burner. **DO NOT TRY TO LIGHT THE BURNER BY HAND.**
6. Wait five (5) minutes to clear out any gas. If you then smell gas, STOP! Follow "B" in the safety information above on this label. If you don't smell gas, go to the next step.
7. Turn on all electrical power to the appliance.
8. Set the Enable/Disable switch on the control panel to the Enable position.
9. Set the thermostat to the desired setting.

CAUTION: Hotter water increases the risk of scald injury. Consult the instruction manual before changing temperature.

10. If the appliance will not operate, follow the instructions "TO TURN OFF GAS TO APPLIANCE" and call your technician or gas supplier.

WARNING: TURN OFF ALL ELECTRIC POWER BEFORE SERVICING.

TO TURN OFF GAS TO APPLIANCE

1. Set the thermostat to the lowest setting.
2. Set the Enable/Disable switch on the control panel to the Disable position.
3. Turn off all electrical power to the appliance if service is to be performed.

SUPPLY GAS PRESSURE ADJUSTMENT

Supply gas pressure shall be measured while the water heater is not firing (static pressure) AND while the water heater is firing at full capacity (dynamic pressure).

If the supply gas pressure to the water heater is not between the required minimum and maximum values given in Table 3 on page 11 adjust the supply gas regulator as necessary. Adjust the supply gas regulator(s) per the regulator manufacturer's instructions to achieve the required "static" and "dynamic" supply gas pressure.

Multiple Water Heater Installations:

In multiple water heater installations or in installations where the installed water heater(s) share a common gas supply main with other gas fired appliances; the supply gas pressures shall be measured at each water heater with all gas fired appliances connected to a common main firing at full capacity.

On multiple water heater installations the supply gas line regulators shall be adjusted to provide gas pressure to each water heater within the minimum and maximum supply pressure requirements listed in Table 3 on page 11 with all gas fired appliances connected to a common gas main firing at full capacity.

NOTE: A pressure drop of more than 1.5" W. C. (0.37 kPa) when the Main Burner ignites is an indication of an inadequate supply of gas and can lead to ignition failure, rough starts and/or rough operation. If a drop of more than 1.5" W. C. (0.37 kPa) in supply gas pressure occurs when the Main Burner ignites, ensure the supply gas lines and regulator(s) are properly sized and installed. See the requirements for Supply Gas Regulator and Gas Supply Systems on page 13. See Supply Gas Line Installation on page 40 and Supply Gas Regulator on page 13. Ensure all requirements and installation instructions are maintained.

MANIFOLD GAS PRESSURE

The manifold pressure is non adjustable. The manifold gas pressure is factory set and cannot be field adjusted. If the manifold gas pressure readings taken on these models is off by more than ± 0.3" W. C. from the listed values in Table 3 on page 11 call the technical support phone number listed on the back cover of this manual for further assistance.

CHECKING THE FIRING RATE

If firing rate adjustment is required follow these instructions to determine the actual firing rate of the water heater:

NOTE: The heaters covered by this manual are capable of modulating their firing rate. The firing rate should be checked with the heater operating at it's full firing rate.

1. Ensure there are no other gas fired appliances connected to the gas meter firing during this test.
2. Contact the gas supplier to determine the heating value, in Btu per cubic foot, of the gas supply.
3. Connect a manometer to the supply gas pressure tap. Follow the instructions for Initial Start Up on page 53.
4. Start the water heater and ensure it is firing.
5. Check the supply gas pressure, refer to Table 3 on page 11 for correct pressure.
6. Locate the gas meter serving the water heater.
7. Time how long (in seconds) it takes for one cubic foot of gas to be used while the water heater is firing with a stop watch.
8. Use the formula below to "clock" the gas meter and determine the actual firing rate of the water heater based on the heating value (Btu per cubic foot) of the gas supply:

$$\frac{3600}{T} \times H = \text{Btu/hr}$$

Example:

$$\frac{3600}{12.6} \times 1050 = 300{,}000 \text{ Btu/hr (87.9 kW)}$$

- 3600 = seconds in one hour.
- T = time, in seconds, to burn one cubic foot of gas.
- H = heating value of gas in Btu per cubic foot.
- Btu/hr = actual firing rate of the water heater.

  NOTE: 1050 Btu per cubic foot is a standard value for natural gas. Standard propane gas Btu content is 2500 Btu per cubic foot. Btu values may change in certain areas and at high elevations. Check with the local gas utility company.

TO TURN OFF GAS

1. Change the Operating Set Point to the lowest temperature setting, see Operating Set Point And Differential Adjustment on page 48.
2. When the water heater has completed its shut down sequence and enters the standby mode, turn the water heater's on/off switch to the "off" position.
3. Close Main Gas Shutoff Valve, see Figure 54 on page 40.

HIGH ALTITUDE INSTALLATIONS

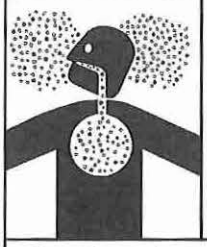
⚠WARNING

Fire and Explosion Hazard

- Under no circumstances should the input exceed the rate shown on the water heater's rating label.
- Overfiring could result in fire or explosion.
- Gas and carbon monoxide detectors are available.

⚠WARNING

Breathing Hazard - Carbon Monoxide Gas



- Under no circumstances should the input exceed the rate shown on the water heater's rating label.
- Overfiring could result in damage to the water heater and sooting.
- Gas and carbon monoxide detectors are available.

Breathing carbon monoxide can cause brain damage or death. Always read and understand instruction manual.

The heater models covered by this manual are certified for use without modification for altitudes up to 10,100 feet (3,078 m).

Most gas utility companies de-rate their gas for high altitudes, making it unnecessary to install high altitude orifices.

For installations above the certified elevations listed above call the technical support phone number listed on the back cover of this manual for further technical assistance. Call the local gas or utility company to verify Btu per cubic foot content before calling for technical assistance and have that information available.

NOTE: The actual firing rate of the water heater must not exceed the input rating on the water heater's rating label under any circumstances.

NOTE: Due to the input rating reduction at high altitudes, the output rating of the water heater is also reduced and should be compensated for in the sizing of the equipment.

TROUBLESHOOTING

INSTALLATION CHECKLIST

The list below represents some of the most critical installation requirements that, when overlooked, often result in operational problems, down time and needless parts replacement. This is not a complete list. Before performing any troubleshooting procedures use the list below to check for installation errors. Costs to correct installation errors are not covered under the limited warranty. Ensure all installation requirements and instructions in this manual have been maintained and followed.

WATER HEATER LOCATION

1. Ensure proper clearances to combustibles are maintained and there is sufficient room to service the water heater. See Clearance To Combustible Materials on page 12.
2. Ensure the area is free of corrosive elements and flammable materials. See the instructions on page16.

VENTING

1. Ensure the intake air and/or vent (exhaust) piping is the correct size for the installed length. See Venting Requirements on page 22.
2. Ensure the maximum equivalent feet of pipe has not been exceeded for the intake air and/or vent pipe. See Table 6 on page 23.
3. Ensure the maximum number of elbows has not been exceeded in the intake air and/or vent pipe. See Venting Requirements on page 22.
4. Ensure the intake air screen has been removed from the intake air connection on the water heater when installing the water heater in a Direct Vent configuration. See Figure 18 on page 25.
5. Ensure all exterior clearances for the intake air, vent, concentric, and low profile terminations are maintained. See Vertical Termination Installation on page 25, Sidewall Termination Installation on page 27, Concentric Termination Installation on page 30 and Low Profile Termination Installation on page 34. These clearances and those cited by local and national codes must be maintained.

GAS SUPPLY AND PIPING

1. Ensure a supply gas regulator has been installed for each water heater. See the requirements for a Supply Gas Regulator on page 13.
2. Ensure the supply gas line to each water heater meets the minimum supply gas line size requirements. See the requirements for the Gas Supply Systems on page 13 and the installation instructions on page 40 and 41.

CONDENSATE DRAIN

Ensure the condensate drain is properly connected to the exhaust elbow on the water heater and draining freely to a suitable floor drain. See Figure 8 on page 16 and Condensate Drain Installation on page 39.

ELECTRICAL CONNECTIONS

1. Ensure the power supply connections to the water heater are polarity correct. See the requirements for the Power Supply on page 13 and Electrical Wiring on page 41.
2. Ensure the water heater is properly grounded. Flame sensing requires an adequate earth ground. If the water heater is not properly grounded it will cause Ignition Failure.

SEQUENCE OF OPERATION

Read the Sequence of Operation below before attempting to correct any operational problems. Refer to the Features And Components section beginning on page 7 for the location of various water heater components described below. See the Sequence Of Operation Flow Chart on page 58 also.

1. When the control system is first powered, during boot up, it will display water heater model information during initialization. After a few moments the control system LCD which is part of the UIM (user interface module) will display the default screen known as the "Desktop" screen.
2. If the control system determines that the actual water temperature inside the tank is below the programmed Operating Set Point minus the Differential setting, a heating cycle is activated.
3. The control system then performs selected diagnostic system checks. This includes confirming the low gas pressure, blocked exhaust, blocked intake and ECO (energy cut out) switch contacts are closed. The Blower Prover Switch contacts are confirmed open.
4. If all diagnostic checks are successfully passed, the control system energizes the Combustion Blower for pre-purge.
5. The control system must confirm the Blower Prover Switch contacts close after the Combustion Blower is energized.
6. If the Blower Prover Switch contacts are confirmed closed the control system energizes the Spark Ignition Control.
7. The control system energizes the 24 Volt Gas Valve allowing gas to flow to the Main Burner.
8. The control system monitors the flame sensor to confirm a flame is present at the Main Burner. If a flame is not verified during the ignition trial period the control system will try for ignition up to two more times. If flame can not be verified after three trials for ignition, the control system will lock out and display the "Ignition Failure" Fault message.
9. If a flame is verified, the control system will enter the heating mode where it will continue heating the water until the Operating Set Point is reached. At this point, the control system will de-energize the 24 Volt Gas Valve and enter the post-purge cycle (approximately 30 seconds).
10. The control system de-energizes the Spark Ignition Control.
11. The water heaters covered by this manual are capable of modulating their firing rate. The firing rate is dictated by the hot water draw and various other temperature limitations.
12. The Combustion Blower will run for the duration of the post-purge cycle to purge the water heater of all combustion gases. When the post-purge cycle is complete, the blower is de-energized and will coast to a stop.
13. The control system now enters the standby mode while continuing to monitor the internal storage tank water temperature and the state of other system devices. If the tank temperature drops below the Operating Set Point minus the Differential setting, the control will automatically return to Step 2 and repeat the operating cycle.

SEQUENCE OF OPERATION FLOW CHART

Sequence is shown with Enable/Disable Switch in the Enable position

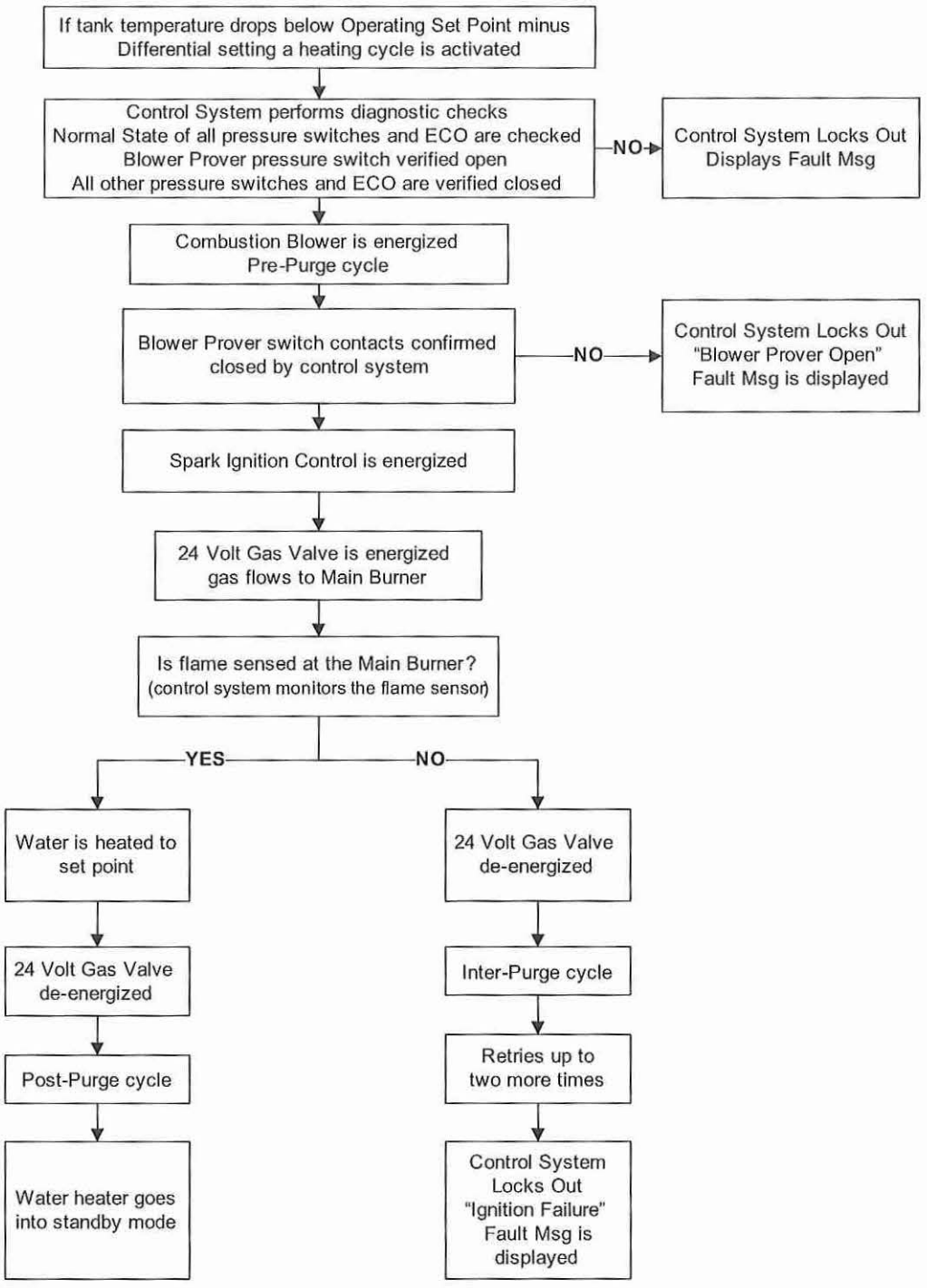


Figure 63

OPERATIONAL PROBLEMS

⚠ WARNING

Read and understand this instruction manual and the safety messages herein before installing, operating or servicing this water heater.

Failure to follow these instructions and safety messages could result in death or serious injury.

This manual must remain with the water heater.

This section of the manual is intended to be an aid in correcting common operational problems, it is not all inclusive. The installer may be able to observe and correct certain problems which might arise when the water heater is first put into operation or when it is re-fired after a prolonged shutdown. However, only qualified service agents, as defined in Qualifications on page 6, using appropriate test equipment, should perform any service procedures on the water heater.

NOTE: Call the technical support phone number listed on the back cover of this manual for further technical assistance or to locate a qualified service agent in your area.

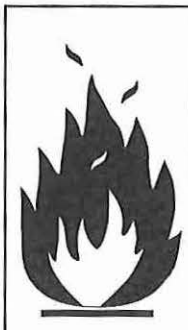
INSTALLATION ERRORS

Operational problems on new installations are often the result of installation requirements that have been overlooked rather than failed components. IE: A "Low Gas Pressure" Fault condition is most often caused by low supply gas pressure rather than a defective Low Gas Pressure switch. Rough starting and rough operation are often caused by undersized supply gas lines and/or the absence of a supply gas regulator at the water heater.

Prior to performing any operational checks inspect the water heater installation to ensure all installation requirements and instructions have been maintained and followed. See the Installation Checklist on page 57

NOTE: Costs to correct installation errors are not covered under the limited warranty.

ROUGH STARTING, ROUGH OPERATION



⚠ WARNING

Fire and Explosion Hazard

- Do not use water heater with any gas other than the gas shown on the rating label.
- Excessive gas pressure to gas valve can cause serious injury or death.
- Turn off gas lines during installation.
- Contact a qualified installer or service agency for installation and service.

- Undersized supply gas line (low volume of supply gas) - see Gas Supply Systems on page 13.
- Supply gas regulator is not installed per installation requirements (erratic gas supply volume/pressures) - see Supply Gas Regulator on page 13.
- Excessive supply gas pressure - see Table 3 on page 11 and Supply Gas Pressure Adjustment on page 55.
- Vent (exhaust) gas recirculation at the vent and intake air pipe terminations on Direct Vent installations - see Direct Vent Installation on page 24.
- Excessive equivalent lengths of intake air and/or vent (exhaust) piping installed - see Venting Requirements on page 22.
- Debris clogging/blocking the intake air screen(s) - see Figure 18 on page 25 and Figure 25 on page 27.
- Debris clogging/blocking the Main Burner - see Figure 2 on page 7.

MOMENTARY IGNITION

⚠ CAUTION

Burn Hazard

- The combustion chamber and burner sleeve and housing become very hot during operation.
- Do not reach into the burner housing or combustion chamber if the water heater is still hot.
- Allow the water heater to cool and always use gloves when handling the main burner.

If the Main Burner ignites momentarily but does not sustain ignition allow the water heater to try to ignite up to two more times until control system locks out and the Ignition Failure Fault message is displayed on the control system's LCD. If the water heater is experiencing rough starts - see Rough Starting, Rough Operation on this page. For momentary ignition problems without rough starting check the following:

- Undersized supply gas line (low volume of supply gas) - see Gas Supply Systems on page 13.
- Supply gas regulator is not installed per installation requirements (erratic gas supply volume/pressures) - see Supply Gas Regulator on page 13.
- See the list of possible causes and things to check and repair for the Ignition Failure Fault message on page 61.
- Debris clogging/blocking the intake air screen(s) - see Figure 18 on page 25 and Figure 25 on page 27.
- Debris clogging/blocking the Main Burner - see Figure 2 on page 7.

NOT ENOUGH OR NO HOT WATER

- No power to the water heater, check breaker, fuses and the water heater on/off switch.
- Enable/Disable switch in "disabled" position. Set to enable to allow unit to operate.
- Hot water supply valve(s) to fixtures closed.
- Operating Set Point is set too low, Differential setting is set too high. See Control System Operation on page 45.
- Upper and/or Lower Probe Offset settings are causing the heating cycles to terminate prematurely - see Temperatures Menu (cont) on page 49.
- Ensure there is not any external supervisory control (using the enable/disable circuit) disabling heating operation.
- The heating capacity of the water heater has been exceeded, the water heater is unable to meet demand.
- Colder incoming water temperature lengthening the time required to heat water to desired temperature.
- Hot water piping leaks, open faucets, water heater drain valve leaking or open.

- Sediment or lime scale accumulation may be affecting water heater operation. See Maintenance on page 63 for sediment and lime scale removal procedures.
- Water heater not firing at full input rating. Check actual firing rate of the water heater, see instructions on page 56. Note that the water heaters covered by this manual are capable of modulating their firing rate. The firing rate is dictated by the hot water draw and various other temperature limitations.

WATER IS TOO HOT

- Operating Set Point is set too high. See Operating Set Point And Differential Adjustment on page 48.
- If installed check Thermostatic Mixing Valve settings
- Upper and/or Lower Probe Offset settings improperly set - see Temperatures Menu (cont) on page 49.
- Lime build-up on temperature probes. Inspect and Clean.
- Improper water piping - see diagrams beginning on page 69.

NOISY OPERATION

- Sediment or lime scale accumulations can cause rumbling and pounding noises during heating cycles. See the Maintenance section of this manual beginning on page 63 for sediment and lime scale removal procedures.
- Normal operating noise of electrical components; Combustion Blower, transformer hum, relay contact closure.

WATER LEAKAGE IS SUSPECTED

- Ensure the water heater drain valve is tightly closed.
- Check cleanout opening for leaks - see Figure 4 on page 9.
- Check inlet/outlet water connections and system piping.
- Check the Temperature-Pressure Relief Valve.
  - Excessive water temperature.
  - Excessive water pressure.
  - Defective Temperature-Pressure Relief Valve.

NOTE: Excessive water pressure is the most common cause of Temperature-Pressure Relief Valve leakage. Excessive water system pressure is most often caused by "thermal expansion" in a "closed system." See Thermal Expansion and Closed Water Systems on page 14. The Temperature-Pressure Relief Valve is not intended for the constant relief of thermal expansion.

Temperature-Pressure Relief Valve leakage due to pressure build up in a closed system that does not have a thermal expansion tank installed is not covered under the limited warranty. Thermal expansion tanks must be installed on all closed water systems.

REPLACEMENT PARTS

Replacement parts may be ordered from the manufacturer, authorized service agencies or distributors. When ordering parts be sure to have the complete water heater Model Number, Serial Number and Series Number available. This information can be found on the rating label affixed to the water heater.

Refer to the parts list included with the water heater from the factory for more information or call the parts department or technical support phone number listed on the back cover of this manual for further assistance.

FAULT AND ALERT CONDITIONS

FAULT CONDITIONS

When the control system declares a Fault condition it will display a Fault message on the control system's LCD with an exclamation "!" mark. The control system will lock out and disable heating operation until the condition is corrected. The water heater must be serviced by a qualified service agent before operation can be restored.

ALERT CONDITIONS

When the control system declares an Alert condition it will display an Alert message on the control system's LCD with a question "?" mark. The water heater will continue to operate during an Alert condition but the water heater must be serviced by a qualified service agent as soon as possible.

RESETTING CONTROL SYSTEM LOCK OUTS

To reset the control system from a lock out condition; turn the power supply off at the breaker for approximately 20 seconds and then back on. Keep in mind; if the condition that caused the Fault has not been corrected, the control system will continue to lock out.

DIAGNOSTIC CHECKS

⚠ WARNING

Electrical Shock Hazard

- Turn off power at the branch circuit breaker serving the water heater before performing any service.
- Label all wires prior to disconnecting when performing service. Wiring errors can cause improper and dangerous operation.
- Verify proper operation after servicing.
- Failure to follow these instructions can result in personal injury or death.

The following section, Fault And Alert Messages on page 61, lists some of the messages the control system will display on the LCD when there are operational problems. This is not a complete list. Along with each of the Fault and Alert messages described there will be a list of possible causes and things to check and repair.

Only qualified service agents, as defined in Qualifications on page 6, using appropriate test equipment, should perform any service procedures on the water heater.

NOTE: If you are not qualified and licensed or certified as required by the authority having jurisdiction to perform a given task do not attempt to perform any of the diagnostic or service procedures described in the following section.

If you do not understand the instructions in the following section do not attempt to perform any procedures.

Call the technical support phone number listed on the back cover of this manual for further technical assistance or to locate a qualified service agent in your area.

⚠ WARNING

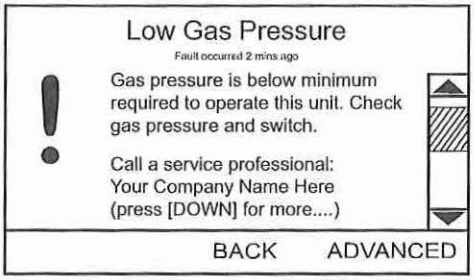
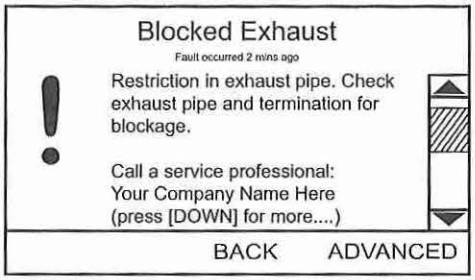
Jumping out control circuits or components can result in property damage, personal injury or death.

- Service should only be performed by a qualified service technician using proper test equipment.
- Altering the water heater controls and/or wiring in any way could result in permanent damage to the controls or water heater and is not covered under the limited warranty.

Any bypass or alteration of the water heater controls and/or wiring will result in voiding the appliance warranty.

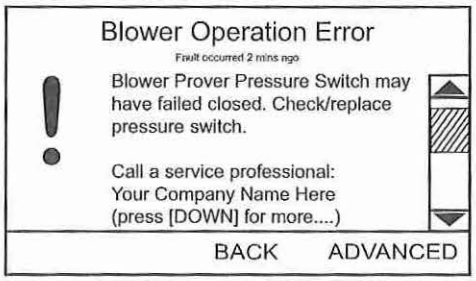
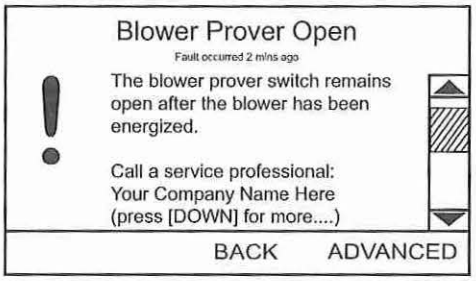
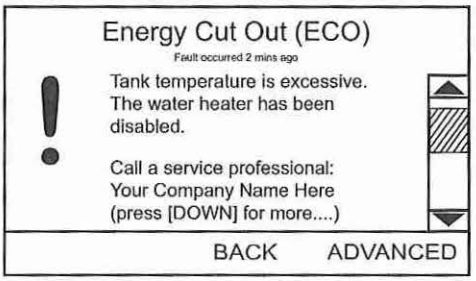
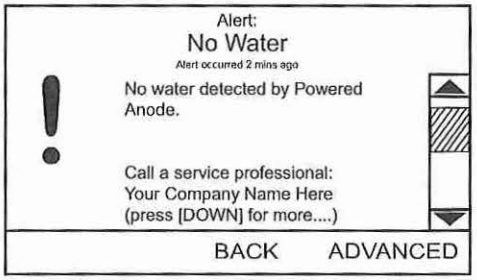
FAULT AND ALERT MESSAGES

Call the technical support phone number listed on the back cover for further technical assistance or to locate a qualified service agent in your area.

POSSIBLE CAUSES - CHECK/REPAIR	DISPLAYED FAULT/ALERT MESSAGE
• Using a manometer, ensure that gas supply pressure is above minimum requirement listed on heater's data plate and does not drop more than 1.5" W.C. when unit fires. • Ensure wire connections to gas valve are clean and tight. • Ensure wire connections to flame sensor are clean and tight. • Ensure wire connections to spark igniter are clean and tight. • Inspect flame sensor, clean/replace as needed. • Inspect spark igniter, realign igniter gap as needed • Ensure adequate electrical ground to heater.	
• Confirm supply gas is turned on. • Using a manometer, ensure the supply gas pressure is above minimum pressure requirement listed on heater's data plate before and during operation. • Ensure wire connections to gas pressure switch are clean and tight. • If all above conditions are met, replace gas pressure switch.	
• If Blocked Exhaust error occurs when blower is running, check for restrictions in exhaust pipe, including exhaust elbow, condensate drain, and outside termination. Also check exhaust pipe installation (size/length) per manual. • If Blocked Exhaust error occurs before blower runs, make sure pressure switch connections are clean and tight. Check pressure switch continuity/resistance. Switch should be closed (continuity/0 ohms). Replace switch if open (no continuity). • Other possible causes: high wind conditions and excessive negative air pressure in building.	

FAULT AND ALERT MESSAGES (CONT)

Call the technical support phone number listed on the back cover for further technical assistance or to locate a qualified service agent in your area.

POSSIBLE CAUSES - CHECK/REPAIR	DISPLAYED FAULT/ALERT MESSAGE
• Ensure excessive wind is not pressurizing the intake air or exhaust pipe. • Confirm wire connections of the blower prover switch are clean, tight, and not jumped/shorted. • Use multi-meter to check continuity/resistance of blower prover pressure switch. Switch should be open (no continuity) when blower is not operating. Replace switch if contacts are closed when blower is off.	
• Confirm that blower runs during a call for heat. • If blower runs, confirm sensing tube is connected and clear of obstructions, blower port for sensing tube is clear of obstructions, and wire connections for blower prover switch are clean and tight. • If all above conditions are met, replace pressure switch.	
• If Blocked Intake error occurs before blower runs, make sure pressure switch connections are clean and tight. Check pressure switch continuity/resistance. Switch should be closed (continuity/0 ohms). Replace switch if open (no continuity). • If Blocked Intake error occurs when blower is running, check for restrictions in intake pipe, including intake air connection, outside termination, and inlet condensate drains (if installed). • Other possible causes: High wind conditions, excessive negative air pressure in building.	
• Ensure wire connections to upper temperature probe are clean and tight. • Using a thermometer, check the water temperature of the heater. • Use a multi-meter and check for continuity between the two red wires of the upper temperature probe. • If the two red wires are open (no continuity) and water temperature is below 160°F, replace upper temperature probe. • If the water temperature exceeds 195°F, turn off electric power and gas supply and call Tech Support for further instructions.	
• Confirm the water heater is full of water. • Confirm the powered anode wire connections are tight and free of debris or moisture (i.e. rust, solder, metal pipe shavings). • Confirm proper electrical ground to the water heater.	

MAINTENANCE

GENERAL

Do not have any combustible materials (such as gasoline, flammable liquids or flammable vapors) within the water heater area. See Locating The Water Heater on page 11.

Water heater maintenance includes periodic tank flushing and cleaning, and removal of lime scale. The water heater should be inspected and adjusted to maintain proper combustion. See Initial Start Up on page 53. A periodic inspection of the venting system should be made. Where used, water circulating pump(s) should be oiled according to the pump manufacturers recommendations.

PRECAUTIONS

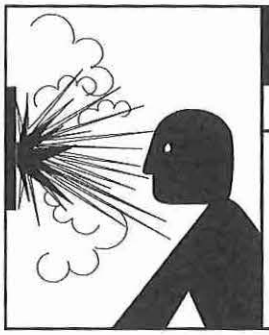
⚠ CAUTION

Do not operate the water heater if it has been exposed to or exhibits the following:

- Exposed to flooding or water damage
- External damage.
- Firing without water.
- Sooting.

Do not operate the water heater until all corrective steps have been made by a qualified service technician.

Never operate the water heater without first being certain it is filled with water and a properly sized and rated Temperature-Pressure Relief Valve is installed in the relief valve opening on the water heater. See Temperature-Pressure Relief Valve on page 15.



⚠ WARNING

Explosion Hazard

- Overheated water can cause water tank explosion.
- Properly sized temperature and pressure relief valve must be installed in the opening provided.

Should overheating occur or the gas supply fail to shut off, turn off the Main Gas Shutoff valve. See Figure 54 on page 40.

Water heater maintenance includes periodic tank flushing and cleaning, and removal of lime scale. The water heater should be inspected and adjusted to maintain proper combustion. Refer to the following table. A periodic inspection of the venting system should be made. Where used, the water circulating pump should be oiled according to the pump manufacturer's recommendations.

MAINTENANCE SCHEDULE

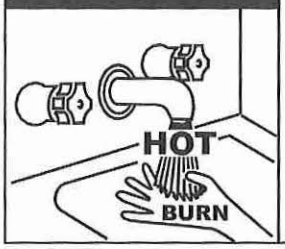
TABLE 17

COMPONENT	OPERATION	INTERVAL	REQUIRED
Tank	Sediment Removal	Semi Annually	Flushing
Tank	Lime Scale Removal	Semi Annually	UN-LIME®
Anode Rods	Inspection Cleaning	Annually	Clean Scale Deposits
T&P Valve	Test Operation	Semi Annually	Test
Vent System	Inspection	Annually	Termination Screens Clean Reseal/Repair

DRAINING AND FLUSHING

It is recommended that the water heater storage tank be drained and flushed every 6 months to reduce sediment buildup. The water heater should be drained if being shut down during freezing temperatures. See Features And Components on page 7 for the location of the water heater components described below.

⚠ DANGER



- Burn hazard.
- Hot water discharge.
- Keep hands clear of drain valve discharge.

To drain the water heater storage tank:

1. Turn off the electrical supply to the water heater.
2. Turn off the gas supply at the Main Gas Shutoff Valve if the water heater is going to be shut down for an extended period.
3. Ensure the cold water inlet valve is open.
4. Open a nearby hot water faucet and let the water run until the water is no longer hot.
5. Connect a hose to the water heater drain valve and terminate it to an adequate drain.
6. Close the cold water inlet valve.
7. Open the water heater drain valve and allow all the water to drain from the storage tank.
8. Close the water heater drain valve when all water in the storage tank has drained.
9. Close the hot water faucet opened in Step 4.
10. If the water heater is going to be shut down for an extended period, the drain valve should be left open.

To Flush the tank perform the following steps:

1. Turn off the electrical supply to the water heater.
2. Ensure the cold water inlet valve is open.
3. Open a nearby hot water faucet and let the water run until the water is no longer hot. Then close the hot water faucet.
4. Connect a hose to the drain valve and terminate it to an adequate drain.

5. Ensure the drain hose is secured before and during the entire flushing procedure. Flushing is performed with system water pressure applied to the water heater.
6. Open the water heater drain valve to flush the storage tank.
7. Flush the water heater storage tank to remove sediment and allow the water to flow until it runs clean.
8. Close the water heater drain valve when flushing is completed.
9. Remove the drain hose.
10. Fill the water heater - see Filling The Water Heater on page 53.
11. Turn on the electrical supply to place the water heater back in operation.
12. Allow the water heater to complete several heating cycles to ensure it is operating properly.

FILLING THE WATER HEATER

See Filling The Water Heater on page 53.

SEDIMENT REMOVAL

Waterborne impurities consist of the particles of soil and sand which settle out and form a layer of sediment on the bottom of the tank.

For convenience, sediment removal and lime scale removal should be performed at the same time.

LIME SCALE REMOVAL

When water is heated dissolved minerals in the water such as calcium and magnesium carbonate (lime scale) become less soluble. As the water temperature rises these minerals will precipitate or "fall out" of solution.

The amount of lime scale released from water is in direct proportion to water temperature and usage. The higher the water temperature or water usage, the more lime deposits are dropped out of the water.

Water hardness also affects lime scale accumulation. With the temperature and usage being the same, hard water will release more lime scale than softer water.

Lime scale reduces heating efficiency as it accumulates inside a water heater. Heating transfer surfaces become coated with lime scale deposits which increases fuel costs to operate the water heater. Lime scale deposits can also cause rumbling and pounding noises as air molecules trapped in the lime scale escape when heated. Lime scale accumulation also reduces the life span of water heaters. For these reasons a regular schedule for deliming should be set up.

The depth of lime accumulation in the bottom of the water heater should be measured periodically. Inspect by removing the cleanout cover once every 6 months at first. Deliming maintenance should then be performed based on the time it takes for 1 inch (2.5 cm) of lime to accumulate in the bottom of the water heater.

Sediment and lime scale removal may be accomplished manually through the cleanout opening furnished on the water heater, see Figure 64.

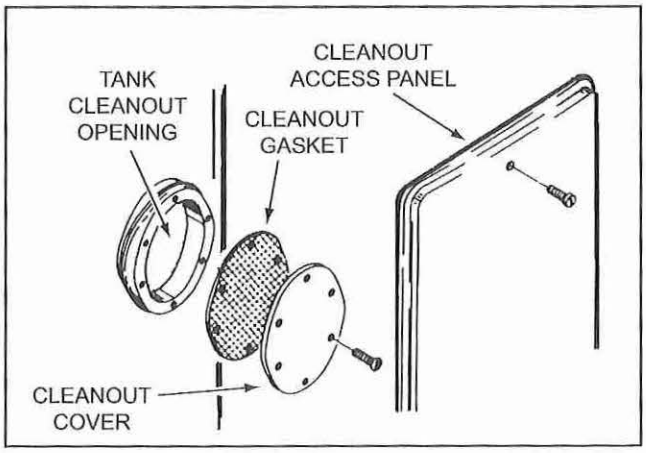


Figure 64

MANUAL LIME SCALE REMOVAL

NOTE: Contact your local distributor or call the parts department phone number on the back cover of this manual to order a new cleanout gasket. Have the new gasket available before removing the cleanout cover.

The cleanout opening is shown in Figure 64. To remove lime scale manually through the cleanout opening proceed as follows:

1. Turn off the electrical supply to the water heater.
2. The water heater must be drained, see Draining And Flushing on page 63, follow the instructions on how to drain the water heater.
3. Remove outer cleanout access plate from lower side of the water heater jacket.
4. Remove the cleanout cover from cleanout opening.
5. Remove lime, scale and/or sediment using care not to damage the glass-lining.
6. Install a new cleanout gasket if required.
7. Reinstall the cleanout cover. Be sure to draw plate up tight by tightening screws securely.
8. Close the water heater drain valve.
9. Fill the water heater - see Filling The Water Heater on page 53.
10. Turn on the electrical supply to place the water heater back in operation. See Initial Start Up on page 53.
11. Allow the water heater to complete several heating cycles to ensure it is operating properly.
12. Check for water leakage.
13. Reinstall the cleanout access plate.

CHEMICAL LIME SCALE REMOVAL

To dissolve and remove more stubborn lime scale deposits, UN-LIME® Professional Delimer should be used.

UN-LIME® Professional Delimer is an easy to handle patented food grade acid formulated specifically for lime scale removal from all types of water using equipment. Hydrochloric base acids must not be used to delime the water heaters covered in this manual.

Follow the instructions on the UN-LIME® to delime the water heater.

NOTE: Call the parts department phone number on the back cover of this manual to order UN-LIME® Professional Delimer. See Table 18 on page 65 for part numbers.

TABLE 18

UN-LIME® PROFESSIONAL DELIMER	
Part Number	**Description**
9005416105	4 - 1 gallon (case)
9005417105	1 - 5 gallon

POWERED ANODE RODS

To insure a long, trouble-free operating life, the water heaters covered in this manual are factory equipped with a powered anode system. The anode rod(s) are of a permanent design and do not need replacing unless damaged. Inspection and cleaning should be performed once a year.

NOTE: Follow the instructions to drain the water heater storage tank on page 63 first. Remove the powered anodes from the water heater by loosening the 3/4" NPT bushing that forms the top of the anodes. Do not disassemble the retaining nut and wire terminal from the top while installed in the water heater, the anode's electrode may fall inside the tank. Remove the entire anode rod from the water heater prior to inspection. Clean the anode rods with a soft cloth and reinstall. Follow the instructions for filling the water heater on page 53 when finished.

DRAIN VALVE AND ACCESS PANELS

The water heaters covered in this manual are equipped with a drain valve, see Features And Components on page 7 for location. The water heaters covered in this manual are also equipped with a cleanout opening for sediment and lime scale removal. See Figure 64 on page 64.

TEMPERATURE-PRESSURE RELIEF VALVE TEST

⚠DANGER

- Burn hazard.
- Hot water discharge.
- Keep clear of Temperature-Pressure Relief Valve discharge outlet.

It is recommended that the Temperature-Pressure Relief Valve should be checked to ensure that it is in operating condition every 6 months.

When checking the Temperature-Pressure Relief Valve operation, make sure that (1) no one is in front of or around the outlet of the Temperature-Pressure Relief Valve discharge line, and (2) that the water discharge will not cause any property damage, as the water may be extremely hot. Use care when operating valve as the valve may be hot.

To check the relief valve, lift the lever at the end of the valve several times, see Figure 65. The valve should seat properly and operate freely.

If after manually operating the valve, it fails to completely reset and continues to release water, immediately close the cold water inlet to the water heater and drain the water heater, see Draining And Flushing on page 63. Replace the Temperature-Pressure Relief Valve with a properly rated/sized new one, see Temperature-Pressure Relief Valve on page 15 for instructions on replacement.

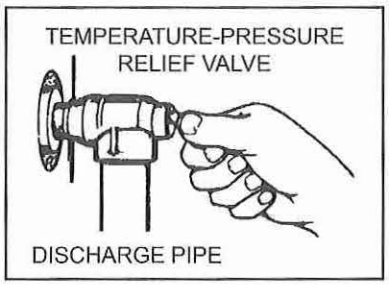


Figure 65

If the Temperature-Pressure Relief Valve on the water heater weeps or discharges periodically, this may be due to thermal expansion.

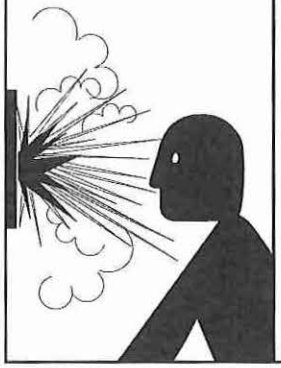
NOTE: Excessive water pressure is the most common cause of Temperature-Pressure Relief Valve leakage. Excessive water system pressure is most often caused by "thermal expansion" in a "closed system." See Thermal Expansion and Closed Water Systems on page 14. The Temperature-Pressure Relief Valve is not intended for the constant relief of thermal expansion.

Temperature-Pressure Relief Valve leakage due to pressure build up in a closed system that does not have a thermal expansion tank installed is not covered under the limited warranty. Thermal expansion tanks must be installed on all closed water systems.

DO NOT PLUG THE TEMPERATURE-PRESSURE RELIEF VALVE OPENING. THIS CAN CAUSE PROPERTY DAMAGE, SERIOUS INJURY OR DEATH.

⚠WARNING

Explosion Hazard



- Temperature-Pressure Relief Valve must comply with ANSI Z21.22-CSA 4.4 and ASME code.
- Properly sized temperature-pressure relief valve must be installed in opening provided.
- Can result in overheating and excessive tank pressure.
- Can cause serious injury or death.

VENT SYSTEM

Examine the vent system once a year. Points of inspection are as follows:

1. Check for obstructions and/or deterioration of the intake air and/or vent piping and the intake air and vent terminations. Replace immediately where needed.
2. The debris screens in the intake air and vent terminations should be should be cleaned of foreign material and soot. See Figure 25 on page 27.

   NOTE: Do not reach inside the vent termination when the heater is in operation.
3. Check all vent system connections for leakage and repair or reseal as necessary.

DIAGRAMS

CCB - CENTRAL CONTROL BOARD LAYOUT

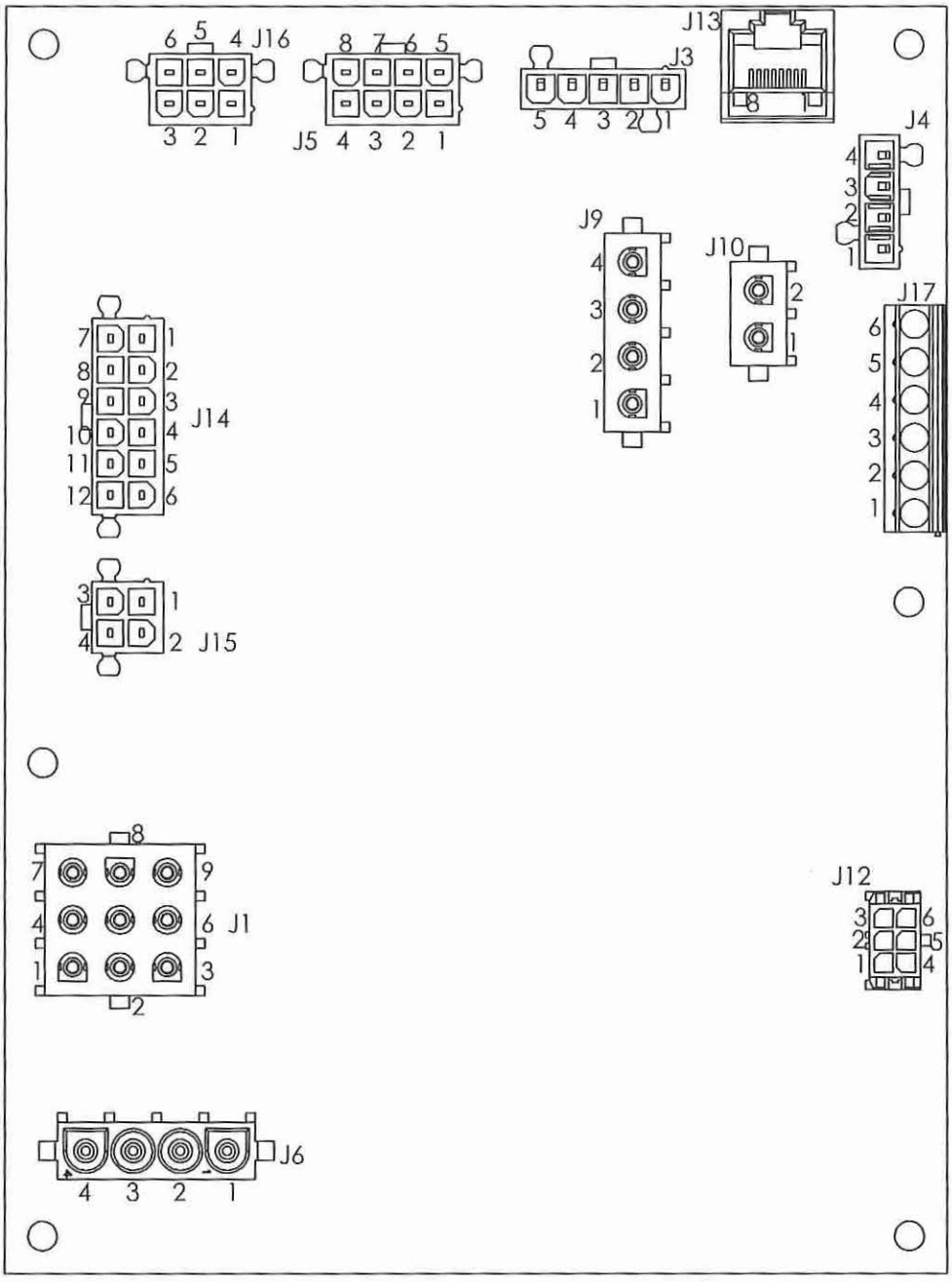


Figure 66

WIRING DIAGRAM

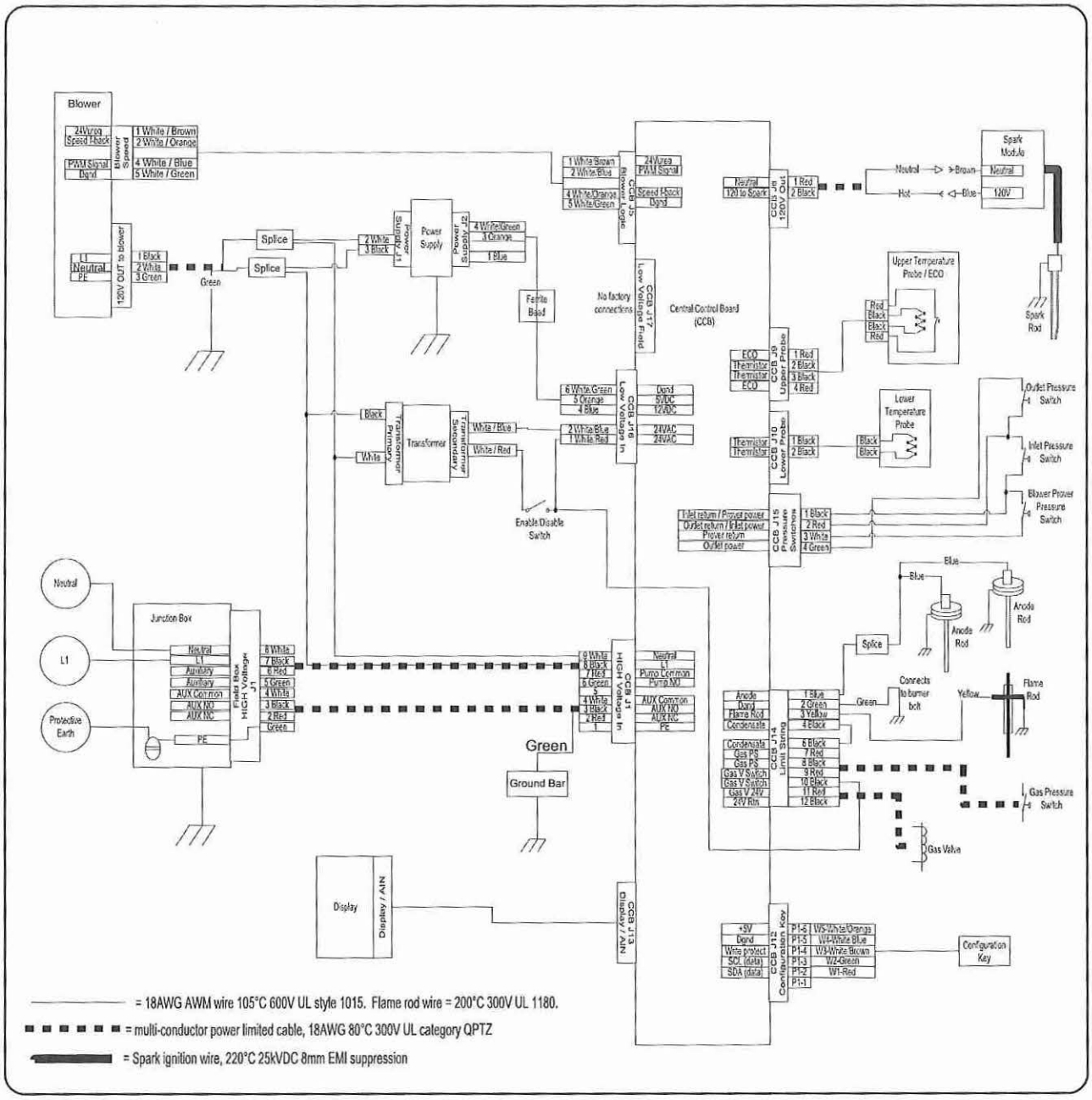


Figure 67

CIRCULATION PUMP WIRING DIAGRAMS

CIRCULATING PUMP WIRING DIAGRAM
STORAGE TANK OR BUILDING RECIRCULATION

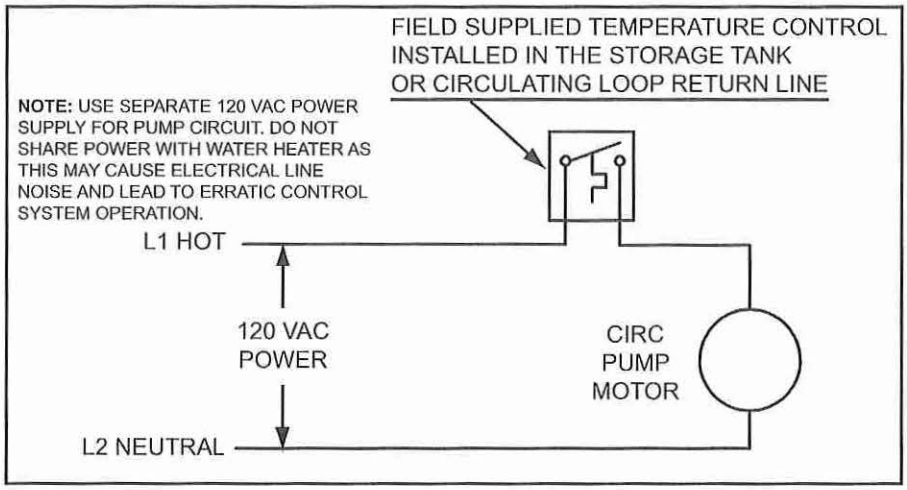


Figure 68

CIRCULATING PUMP WIRING DIAGRAM
DISHWASHER LOOP WITH TOGGLE SWITCH

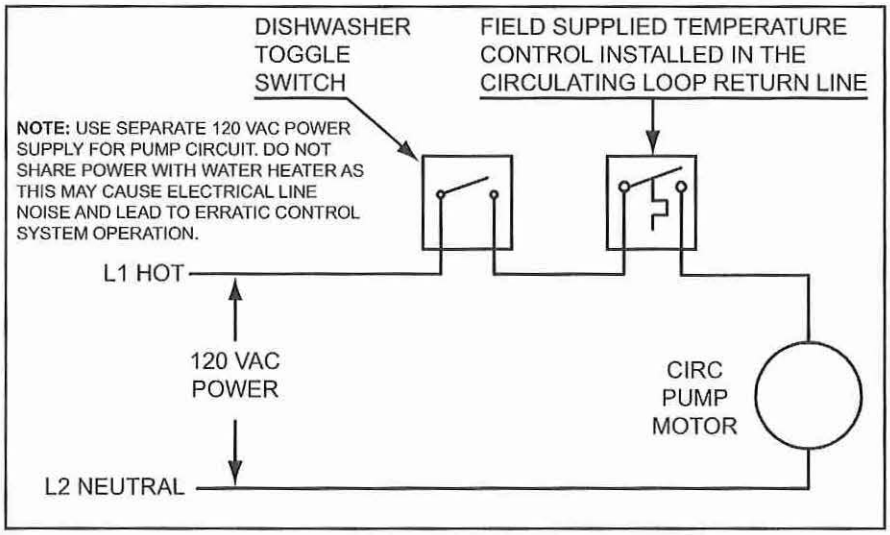


Figure 69

WATER PIPING DIAGRAMS

Before installation of water piping review the following:

1. See Mixing Valves on page 14.
2. See Dishwashing Machines on page 14.
3. See Temperature-Pressure Relief Valve on page 15.
4. See Closed Systems and Thermal Expansion on page 14.
5. See Water Line Connections on page 43.
6. If a pump is being installed between a water heater and storage tank or on a building recirculation loop wire according to Figure 68 on page 68.
7. If a pump is being installed in a recirculation loop between the water heater and a commercial dishwasher wire according to Figure 68 or Figure 69 on page 68.

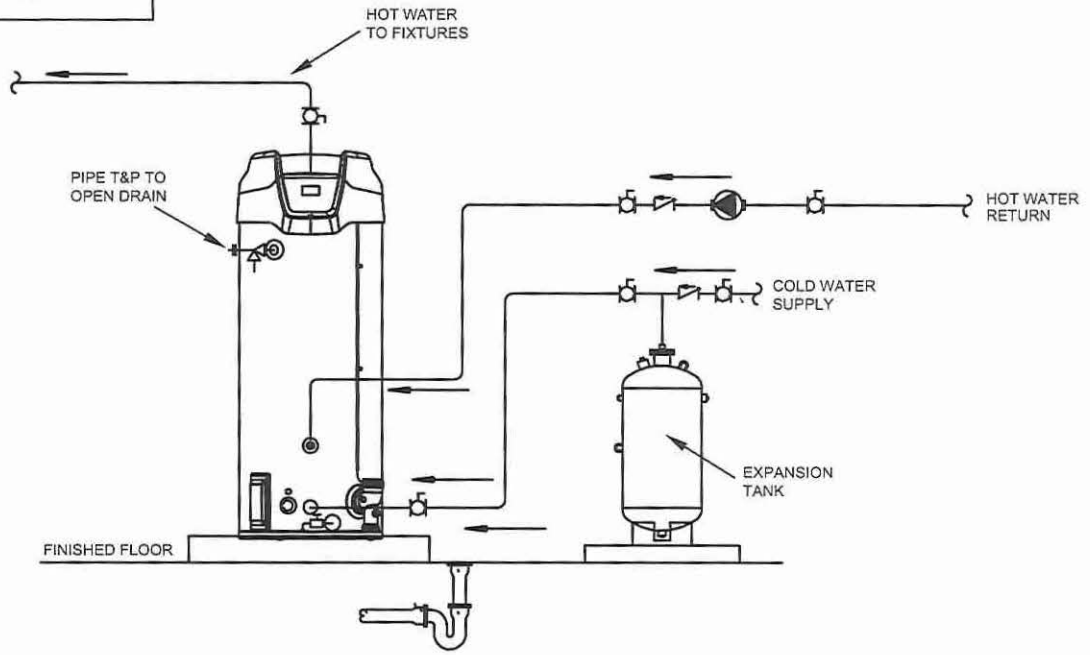
ONE WATER HEATER, SINGLE TEMPERATURE WITH BUILDING RECIRCULATION

WARNING: THIS DRAWING SHOWS SUGGESTED PIPING CONFIGURATION AND OTHER DEVICES; CHECK WITH LOCAL CODES AND ORDINANCES FOR ADDITIONAL REQUIREMENTS.

ANY MATERIAL, COMPONENT OR VENDOR CHANGE MUST HAVE PRIOR APPROVAL BY THE APPLICABLE PRODUCT ENGINEERING DEPARTMENT.

LEGEND

- TEMPERATURE & PRESSURE RELIEF VALVE
- TEMPERATURE CONTROL PROBE
- CHECK VALVE
- PRESSURE RELIEF VALVE
- DRAIN
- TEMPERATURE GAGE
- CIRCULATING PUMP
- FULL PORT BALL VALVE
- WATER FLOW SWITCH



NOTES:

1. Preferred piping method.
2. The temperature and pressure relief valve setting shall not exceed pressure rating of any component in the system.
3. Service valves are shown for servicing unit. However, local codes shall govern their usage.

WATER PIPING DIAGRAMS

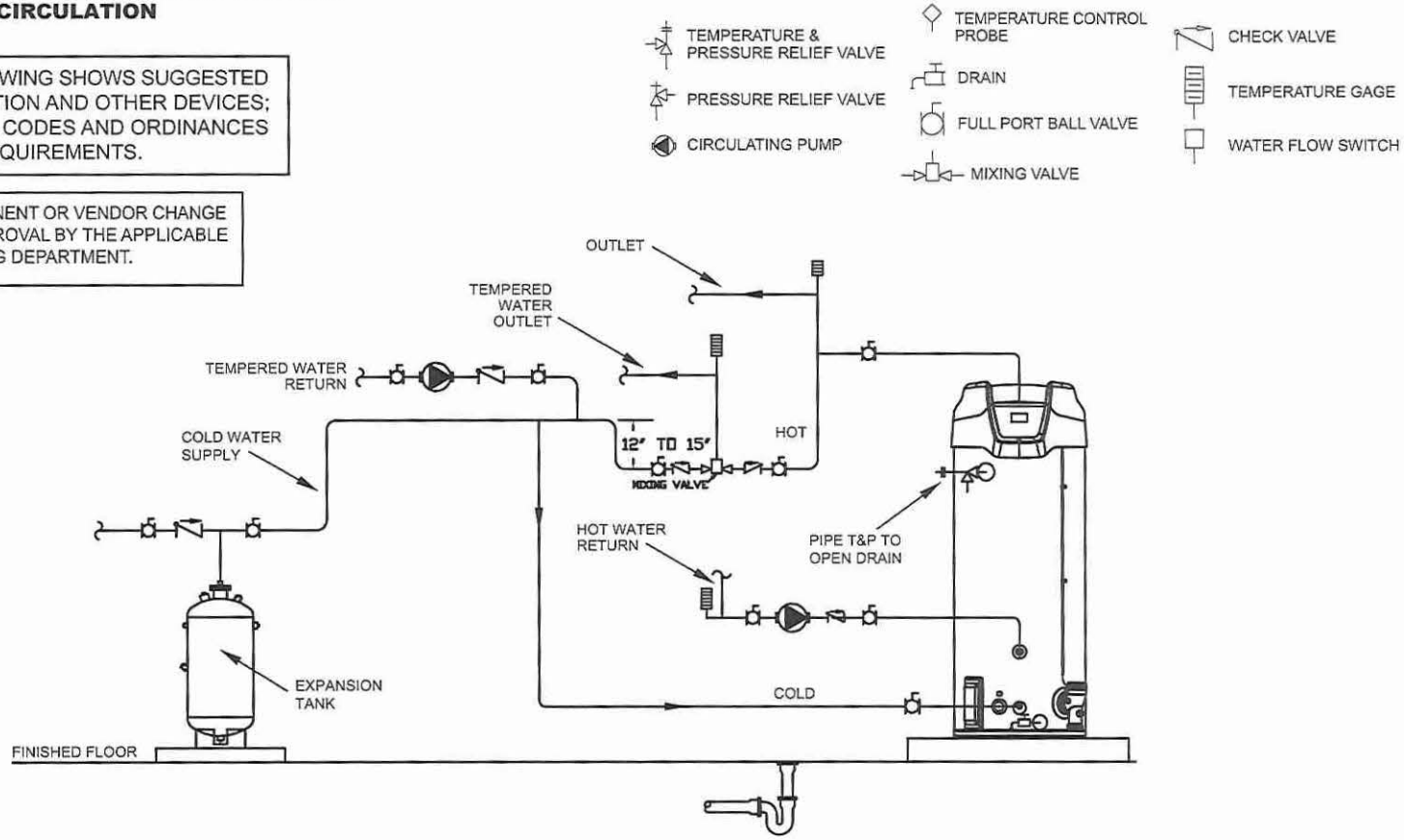
Before installation of water piping review the following:

1. See Mixing Valves on page 14.
2. See Dishwashing Machines on page 14.
3. See Temperature-Pressure Relief Valve on page 15.
4. See Closed Systems and Thermal Expansion on page 14.
5. See Water Line Connections on page 43.
6. If a pump is being installed between a water heater and storage tank or on a building recirculation loop wire according to Figure 68 on page 68.
7. If a pump is being installed in a recirculation loop between the water heater and a commercial dishwasher wire according to Figure 68 or Figure 69 on page 68.

ONE WATER HEATER, TWO TEMPERATURE WITH HIGH TEMPERAURE LOOP RECIRCULATION WITH BUILDING RECIRCULATION

WARNING: THIS DRAWING SHOWS SUGGESTED PIPING CONFIGURATION AND OTHER DEVICES; CHECK WITH LOCAL CODES AND ORDINANCES FOR ADDITIONAL REQUIREMENTS.

ANY MATERIAL, COMPONENT OR VENDOR CHANGE MUST HAVE PRIOR APPROVAL BY THE APPLICABLE PRODUCT ENGINEERING DEPARTMENT.



NOTES:

1. Preferred piping method.
2. The temperature and pressure relief valve setting shall not exceed pressure rating of any component in the system.
3. Service valves are shown for servicing unit. However, local codes shall govern their usage.

WATER PIPING DIAGRAMS

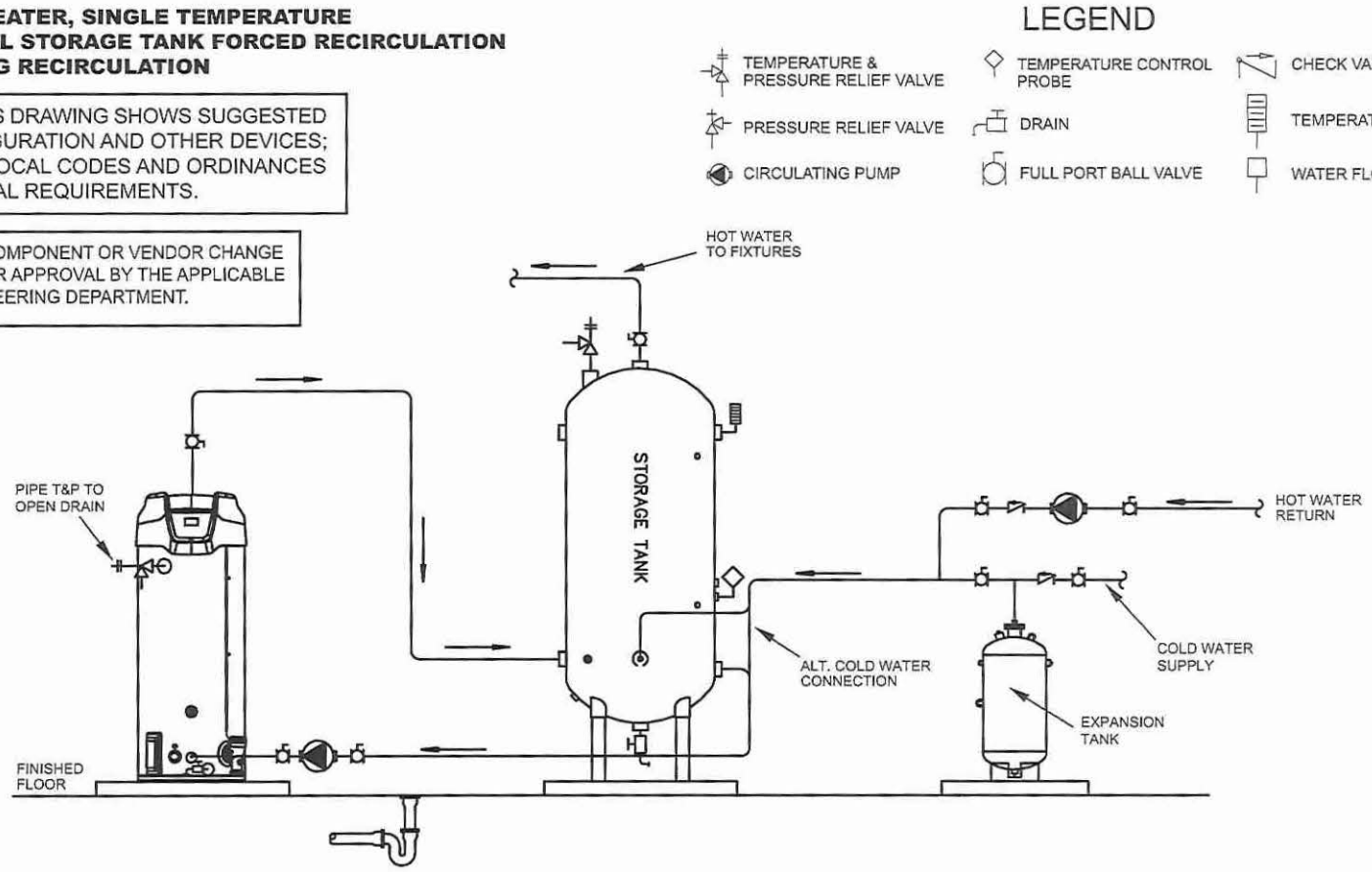
Before installation of water piping review the following:

1. See Mixing Valves on page 14.
2. See Dishwashing Machines on page 14.
3. See Temperature-Pressure Relief Valve on page 15.
4. See Closed Systems and Thermal Expansion on page 14.
5. See Water Line Connections on page 43.
6. If a pump is being installed between a water heater and storage tank or on a building recirculation loop wire according to Figure 68 on page 68.
7. If a pump is being installed in a recirculation loop between the water heater and a commercial dishwasher wire according to Figure 68 or Figure 69 on page 68.

ONE WATER HEATER, SINGLE TEMPERATURE WITH VERTICAL STORAGE TANK FORCED RECIRCULATION WITH BUILDING RECIRCULATION

WARNING: THIS DRAWING SHOWS SUGGESTED PIPING CONFIGURATION AND OTHER DEVICES; CHECK WITH LOCAL CODES AND ORDINANCES FOR ADDITIONAL REQUIREMENTS.

ANY MATERIAL, COMPONENT OR VENDOR CHANGE MUST HAVE PRIOR APPROVAL BY THE APPLICABLE PRODUCT ENGINEERING DEPARTMENT.



NOTES:

1. Preferred piping method.
2. The temperature and pressure relief valve setting shall not exceed pressure rating of any component in the system.
3. Service valves are shown for servicing unit. However, local codes shall govern their usage.
4. The tank temperature control should be wired to and control the pump between the water heater(s) and the storage tank(s).
5. The water heater's operating thermostat should be set 5 degrees F higher than the tank temperature control.

WATER PIPING DIAGRAMS

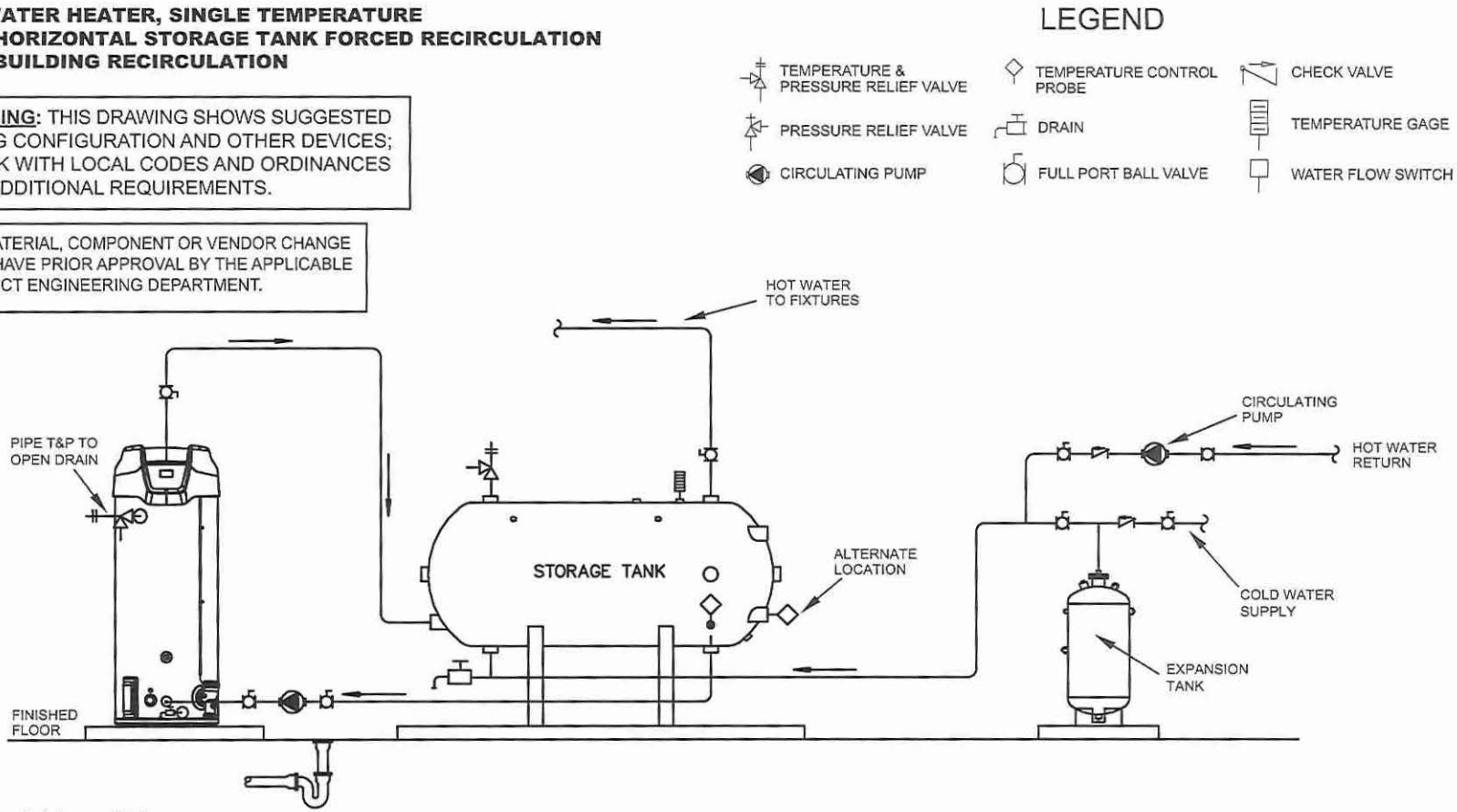
Before installation of water piping review the following:

1. See Mixing Valves on page 14.
2. See Dishwashing Machines on page 14.
3. See Temperature-Pressure Relief Valve on page 15.
4. See Closed Systems and Thermal Expansion on page 14.
5. See Water Line Connections on page 43.
6. If a pump is being installed between a water heater and storage tank or on a building recirculation loop wire according to Figure 68 on page 68.
7. If a pump is being installed in a recirculation loop between the water heater and a commercial dishwasher wire according to Figure 68 or Figure 69 on page 68.

ONE WATER HEATER, SINGLE TEMPERATURE WITH HORIZONTAL STORAGE TANK FORCED RECIRCULATION WITH BUILDING RECIRCULATION

WARNING: THIS DRAWING SHOWS SUGGESTED PIPING CONFIGURATION AND OTHER DEVICES; CHECK WITH LOCAL CODES AND ORDINANCES FOR ADDITIONAL REQUIREMENTS.

ANY MATERIAL, COMPONENT OR VENDOR CHANGE MUST HAVE PRIOR APPROVAL BY THE APPLICABLE PRODUCT ENGINEERING DEPARTMENT.



NOTES:

1. Preferred piping method.
2. The temperature and pressure relief valve setting shall not exceed pressure rating of any component in the system.
3. Service valves are shown for servicing unit. However, local codes shall govern their usage.
4. The tank temperature control should be wired to and control the pump between the water heater(s) and the storage tank(s).
5. The water heater's operating thermostat should be set 5 degrees F higher than the tank temperature control.

WATER PIPING DIAGRAMS

Before installation of water piping review the following:

1. See Mixing Valves on page 14.
2. See Dishwashing Machines on page 14.
3. See Temperature-Pressure Relief Valve on page 15.
4. See Closed Systems and Thermal Expansion on page 14.
5. See Water Line Connections on page 43.
6. If a pump is being installed between a water heater and storage tank or on a building recirculation loop wire according to Figure 68 on page 68.
7. If a pump is being installed in a recirculation loop between the water heater and a commercial dishwasher wire according to Figure 68 or Figure 69 on page 68.

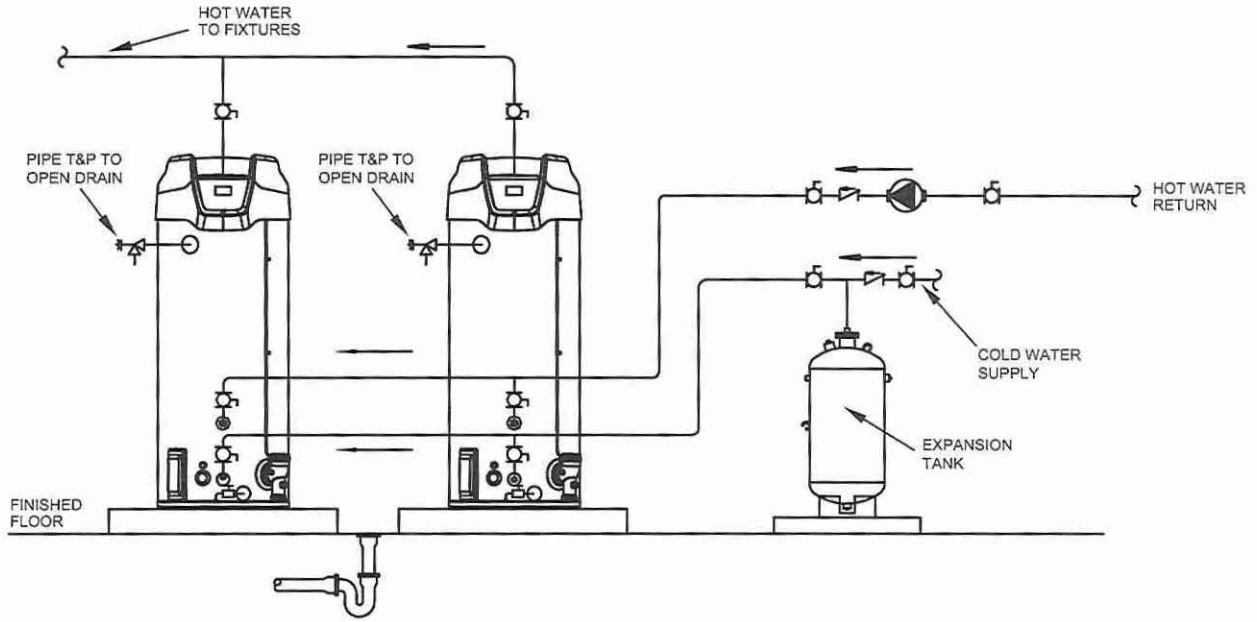
TWO WATER HEATERS, SINGLE TEMPERATURE WITH BUILDING RECIRCULATION

WARNING: THIS DRAWING SHOWS SUGGESTED PIPING CONFIGURATION AND OTHER DEVICES; CHECK WITH LOCAL CODES AND ORDINANCES FOR ADDITIONAL REQUIREMENTS.

ANY MATERIAL, COMPONENT OR VENDOR CHANGE MUST HAVE PRIOR APPROVAL BY THE APPLICABLE PRODUCT ENGINEERING DEPARTMENT.

LEGEND

- TEMPERATURE & PRESSURE RELIEF VALVE
- TEMPERATURE CONTROL PROBE
- CHECK VALVE
- PRESSURE RELIEF VALVE
- DRAIN
- TEMPERATURE GAGE
- CIRCULATING PUMP
- FULL PORT BALL VALVE
- WATER FLOW SWITCH



NOTES:

1. Preferred piping method.
2. The temperature and pressure relief valve setting shall not exceed pressure rating of any component in the system.
3. Service valves are shown for servicing unit. However, local codes shall govern their usage.

WATER PIPING DIAGRAMS

Before installation of water piping review the following:

1. See Mixing Valves on page 14.
2. See Dishwashing Machines on page 14.
3. See Temperature-Pressure Relief Valve on page 15.
4. See Closed Systems and Thermal Expansion on page 14.
5. See Water Line Connections on page 43.
6. If a pump is being installed between a water heater and storage tank or on a building recirculation loop wire according to Figure 68 on page 68.
7. If a pump is being installed in a recirculation loop between the water heater and a commercial dishwasher wire according to Figure 68 or Figure 69 on page 68.

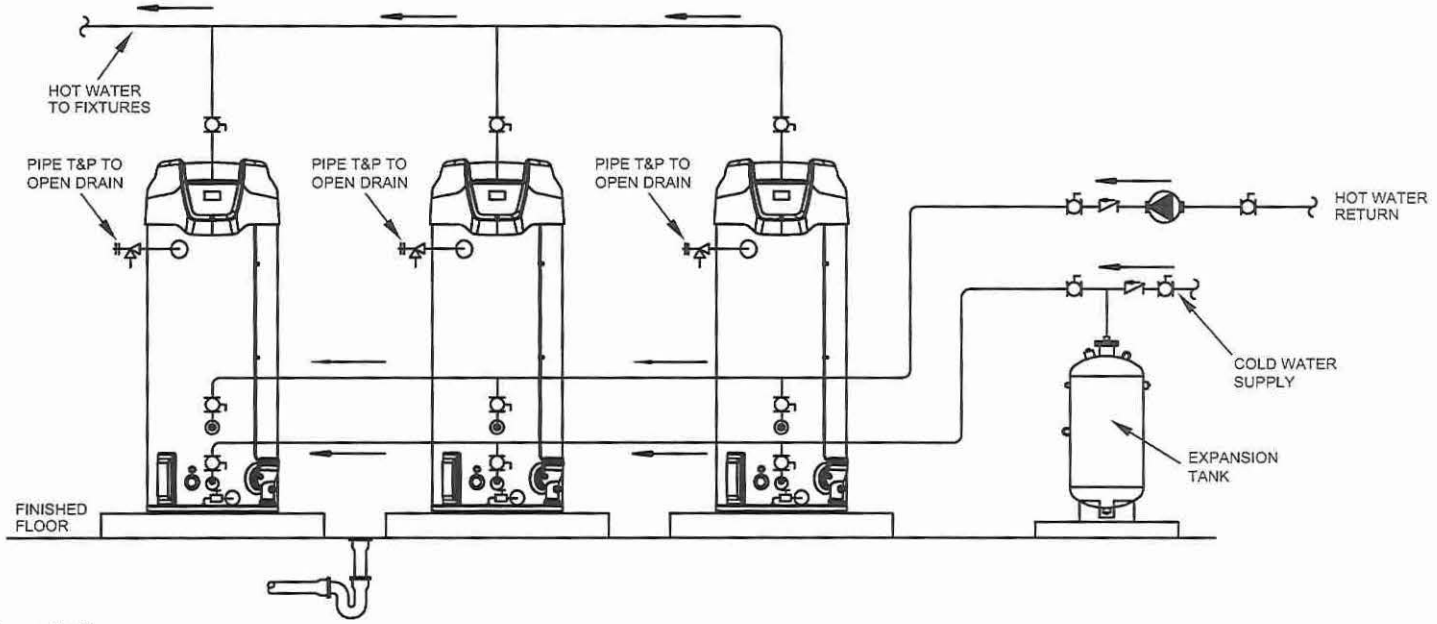
THREE WATER HEATERS, SINGLE TEMPERATURE WITH BUILDING RECIRCULATION

WARNING: THIS DRAWING SHOWS SUGGESTED PIPING CONFIGURATION AND OTHER DEVICES; CHECK WITH LOCAL CODES AND ORDINANCES FOR ADDITIONAL REQUIREMENTS.

ANY MATERIAL, COMPONENT OR VENDOR CHANGE MUST HAVE PRIOR APPROVAL BY THE APPLICABLE PRODUCT ENGINEERING DEPARTMENT.

LEGEND

- TEMPERATURE & PRESSURE RELIEF VALVE
- TEMPERATURE CONTROL PROBE
- CHECK VALVE
- PRESSURE RELIEF VALVE
- DRAIN
- TEMPERATURE GAGE
- CIRCULATING PUMP
- FULL PORT BALL VALVE
- WATER FLOW SWITCH



NOTES:

1. Preferred piping method.
2. The temperature and pressure relief valve setting shall not exceed pressure rating of any component in the system.
3. Service valves are shown for servicing unit. However, local codes shall govern their usage.

WATER PIPING DIAGRAMS

Before installation of water piping review the following:

1. See Mixing Valves on page 14.
2. See Dishwashing Machines on page 14.
3. See Temperature-Pressure Relief Valve on page 15.
4. See Closed Systems and Thermal Expansion on page 14.
5. See Water Line Connections on page 43.
6. If a pump is being installed between a water heater and storage tank or on a building recirculation loop wire according to Figure 68 on page 68.
7. If a pump is being installed in a recirculation loop between the water heater and a commercial dishwasher wire according to Figure 68 or Figure 69 on page 68.

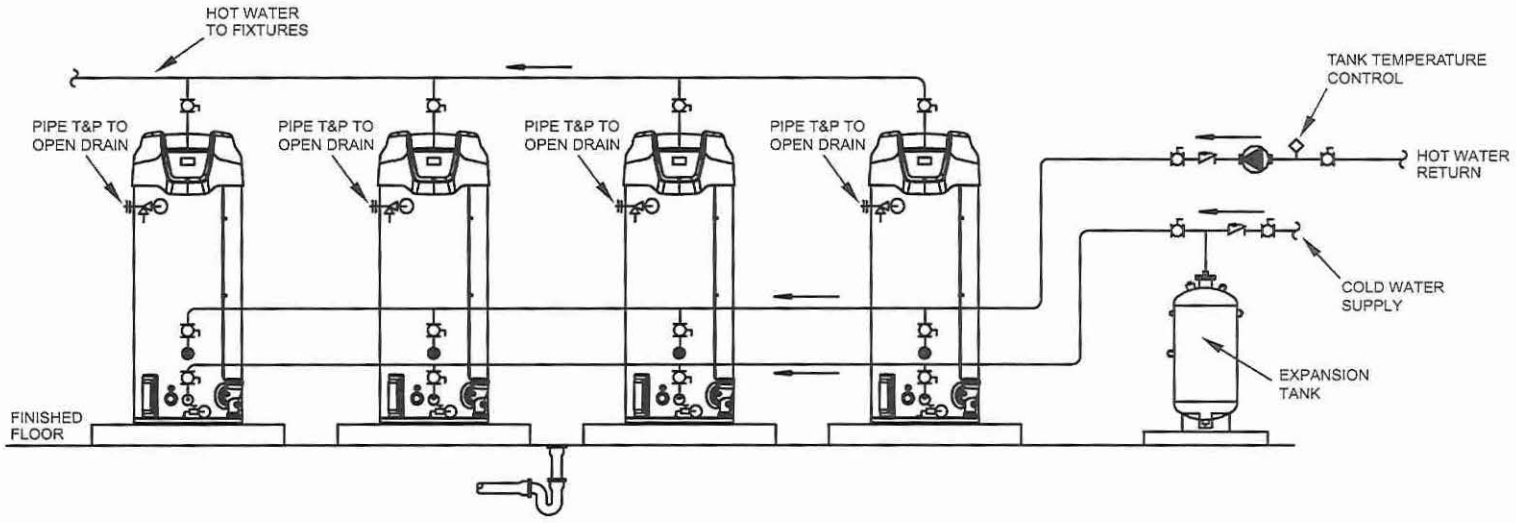
FOUR WATER HEATERS, SINGLE TEMPERATURE WITH BUILDING RECIRCULATION

WARNING: THIS DRAWING SHOWS SUGGESTED PIPING CONFIGURATION AND OTHER DEVICES; CHECK WITH LOCAL CODES AND ORDINANCES FOR ADDITIONAL REQUIREMENTS.

ANY MATERIAL, COMPONENT OR VENDOR CHANGE MUST HAVE PRIOR APPROVAL BY THE APPLICABLE PRODUCT ENGINEERING DEPARTMENT.

LEGEND

- TEMPERATURE & PRESSURE RELIEF VALVE
- TEMPERATURE CONTROL PROBE
- CHECK VALVE
- PRESSURE RELIEF VALVE
- DRAIN
- TEMPERATURE GAGE
- CIRCULATING PUMP
- FULL PORT BALL VALVE
- WATER FLOW SWITCH



NOTES:

1. Preferred piping method.
2. The temperature and pressure relief valve setting shall not exceed pressure rating of any component in the system.
3. Service valves are shown for servicing unit. However, local codes shall govern their usage.

COMMERCIAL WATER HEATER LIMITED WARRANTY

A.O. Smith

EFFECTIVE

For 3 Years, in the event of a tank leak, we will repair or, at our discretion, replace the defective water heater.

For 1 Year, in the event of part failure, we will repair or, at our discretion, replace the defective part.

We warrant this product against defects in materials or workmanship as described in this document if installed within the United States or Canada and provided the product remains at its original place of installation.

Warranty coverage begins the date of installation OR the date of manufacture if installation cannot be verified.

WHAT'S COVERED

Subject to these terms, in the event of defect in materials and/or workmanship resulting in a **tank leak** during the **first three years**, we will:

- Replace the water heater should the tank leak.

Subject to these terms, in the event of a defect in materials and/or workmanship appearing during the **first year**, we will:

- Repair or, at our discretion, replace any part of the water heater covered under this limited warranty excluding parts subject to normal maintenance (Example: non-electronic anode rod, filter, etc)

Service/labor, shipping, delivery, installation, handling or any other costs are not covered at any time under this warranty.

Any replacement part or product will be warranted only for the unexpired portion of the original water heater's limited warranty period.

If an identical model is no longer available due to a change in law, regulation, or standard, we will replace the product with one having comparable capacity and input. In these instances, the owner will have the option of paying the difference between what was paid for the original model and the new model with the additional features, or receiving a refund of the portion of the purchase price, on a pro-rata basis allocable to the unexpired portion of the warranty.

WHAT'S NOT COVERED

- Problems caused by improper: gas supply line sizing, gas type, venting, connections, combustion air, voltage, wiring, or fusing
- Failure to follow applicable codes
- Failure to follow printed instructions
- Abuse, misuse, accident, fire, flood, Acts of God
- Improper installation, sizing, delivery, or maintenance
- Claims related to rust, noise, smell, or taste of water
- Failure to conduct authorized factory start up if required
- Alterations to the water heater
- Non-outdoor heaters installed outdoors
- Damages due to a failure to allow for thermal expansion
- Heat exchanger failure due to lack of adequate / proper supply of water
- Heaters moved from their original location
- Service trips to explain proper installation, use, or maintenance of the product/unit or to describe compliance requirements under applicable codes and regulations
- Charges related to accessing your heater including but not limited to door/wall removal, equipment rental, etc.
- Replacement parts after expiration of this warranty

LIMITATIONS

NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, THIS IS YOUR SOLE AND EXCLUSIVE WARRANTY. ALL OTHER WARRANTIES INCLUDING A WARRANTY OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE ARE EXPRESSLY DISCLAIMED. SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES. TOTAL LIABILITY ARISING AT ANY TIME SHALL NOT EXCEED THE PURCHASE PRICE PAID WHETHER BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER LEGAL THEORY.

SERVICE INQUIRIES:

For service inquiries call the telephone number listed below. Be prepared to provide the following information: name, address, and telephone number; the model and serial number of the water heater; proof of installation; and a clear description of the problem.

For your records, fill in the product:

Serial: _____
Model: _____

U.S. Customers:

A. O. Smith Corporation
500 Tennessee Waltz Parkway
Ashland City, Tennessee 37015
800-527-1953
www.hotwater.com

Canadian Customers:

P. O. Box 310 – 768 Erie Street
Stratford (Ontario) N5A 6T3
800-265-8520

Warranty

1. TOTO® warrants its products to be free from manufacturing defects under normal use and service for a period of three (3) years from the date of purchase. This warranty is extended only to the ORIGINAL PURCHASER.
2. TOTO's® obligations under this warranty are limited to repair or replacement, at TOTO's® option, of products or parts found to be defective, provided that such products were properly installed and used in accordance with OWNER'S MANUAL. TOTO® reserves the right to make such inspections as may be necessary in order to determine the cause of the defect. TOTO® will not charge for labor or parts in connection with warranty repairs or replacements. TOTO® is not responsible for the cost of removal, return and/or reinstallation of products.
3. This warranty does not apply to the following items:
   a) Damage or loss sustained in a natural calamity such as fire, earthquake, flood, thunder, electrical storm, etc.
   b) Damage or loss resulting from any unreasonable use, misuse, abuse, negligence, or improper maintenance of the product.
   c) Damage or loss resulting from removal, improper repair, or modification of the product.
   d) Damage or loss resulting from sediments or foreign matter contained in a water system.
   e) Damage or loss resulting from improper installation or from installation of a unit in a harsh and/or hazardous environment.
   f) Damage or loss resulting from acts of animals such as mice and insects.
   g) Damage or loss resulting from a use of abnormal power supply.
   h) Damage or loss resulting from abrasion of consumable supplies.
   i) Damage or loss resulting from frost.
4. This warranty gives you specific legal rights. You may have other rights which vary from State to State.
5. To obtain warranty repair service under this warranty, you must take the product or deliver it prepaid to a TOTO® service facility together with a letter stating the problem, or contact a TOTO® distributor or products service contractor, or write directly to TOTO® U.S.A., INC., 1155 Southern road, Morrow, Georgia 30260, (888) 295-8134. If, because of the size of the product or nature of the defect, the product cannot be returned to TOTO®, receipt by TOTO® of written notice of the defect shall constitute delivery. In such case, TOTO® may choose to repair the product at the purchaser's location or pay to transport the product to a service facility.

THIS WRITTEN WARRANTY IS THE ONLY WARRANTY MADE BY TOTO®. REPAIR OR REPLACEMENT AS PROVIDED UNDER THIS WARRANTY SHALL BE THE EXCLUSIVE REMEDY AVAILABLE TO THE PURCHASER. TOTO® SHALL NOT BE RESPONSIBLE FOR LOSS OF USE OF THE PRODUCT OR FOR OTHER INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES OR EXPENSES INCURRED BY PURCHASER, OR FOR LABOR OR OTHER COSTS DUE TO INSTALLATION OR REMOVAL, OR COSTS OF REPAIRS BY OTHERS, OR FOR ANY OTHER EXPENSE NOT SPECIFICALLY STATED ABOVE. EXCEPT TO THE EXTENT PROHIBITED BY APPLICABLE LAW, ANY IMPLIED WARRANTIES, INCLUDING THAT OF MERCHANTABILITY OR FITNESS FOR USE, ARE EXPRESSLY LIMITED TO THE DURATION OF THIS WARRANTY.
SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS. OR THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION AND EXCLUSION MAY NOT APPLY TO YOU.

TOTO®

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Printed in February ,2011

03584T2R v02 2012.01

TOTO®

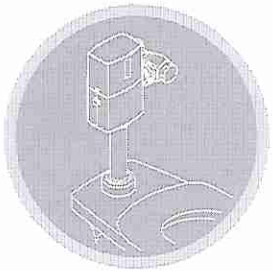
Owner's Manual

NOTE TO INSTALLER : PLEASE GIVE THIS MANUAL TO THE CUSTOMER AFTER INSTALLATION.

EcoPower® Flush Valve

Models

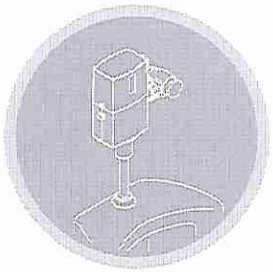
■ **AUTOMATIC TOILET FLUSH VALVE**



TET1GNC-32
TET6GNC-32
TEW1GNC-32
TEW6GNC-32

TET1LN(32)#CP
TET6LN(32)#CP

■ **AUTOMATIC URINAL FLUSH VALVE**



TEU1GNC-(12,22)
TEU1LN(12,22)#CP
TEU1UN(12)#CP

Important Safeguards

(For your safety, please follow the instructions below.)

Read these Important Safeguards instruction thoroughly before using your EcoPower® Flush Valve and follow the precaution instructions carefully.

After you read this Owner's Manual, keep it where it can be easily referred to again.
Symbols are shown for safe and proper use of your EcoPower® Flush Valve and in order to alert you possible personal injury and damage to your property. The symbols and their meanings are as follows.

⚠Warning	Ignoring these symbols may cause personal injury or property damage.

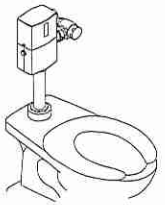
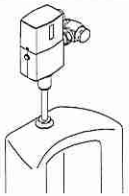
The items of observation are classified and described.

	Absolutely "Do not".		Do not install the product in high humidity area such as a shower area or sauna.
	Do not disassemble.		This means mandatory.
	Do not touch the area specified.		

⚠Warning

Do not	**Never splash water on the controller.** The EcoPower® Flush Valve is an electrical appliance, this may cause product malfunction.	
	Do not strike or kick to the EcoPower® Flush Valve. This may cause product malfunction or water leakage.	
	Do not use the EcoPower® Flush Valve at temperatures exceeding what local codes allow. This may cause product malfunction.	OK! below local code
Do not use in humid areas	**Do not place an item with this symbol displayed in a room with high humidity such as shower area or sauna.** This may cause product malfunction.	
Do not disassemble	**Never attempt to disassemble, reassemble, repair or modify the EcoPower® Flush Valve, unless you are an electrician.** This may cause product malfunction and electric shock.	

Model Number and Specifications

		Toilet		Urinal		
Figure						
Model number		TET1GNC-32 TET6GNC-32 TEW1GNC-32 TEW6GNC-32	TET1LN(32)#CP TET6LN(32)#CP	TEU1GNC-(12,22)	TEU1LN (12,22)#CP	TEU1UN (12)#CP
Dimension of Cover		7-3/4" (H)×4-1/2"(W)×3-1/8"(D) (198mm(H)×115mm(W)×80mm(D))				

Detection range from the front		TET1GNC-32, TEW1GNC-32, TEU1GNC-(12,22): Within 31-1/2" (800 mm)
		TET6GNC-32, TEW6GNC-32: Within 33-1/2" (850mm)
		TET1LN(32)#CP,TEU1LN(12,22)#CP,TEU1UN(12)#CP : Within 31-1/2" (800 mm)
		TET6LN(32)#CP: Within 33-1/2" (850mm)				

Detection time		6 seconds or more				
Ambient temperature		32-104°F(0-40°C)				
Water temperature		34-104°F(1-40°C)				
Connection of the water		1"NPT		3/4"NPT		
The flush valve inlet		1-1/4"NPSM				
The flush valve outlet		1-1/2"NPSM				
Supply water pressure	Minimum (Flowing)	15PSI(103kPa)	35PSI(241kPa)	15PSI(103kPa)		
	Maximum*	125PSI(862kPa)	125PSI(862kPa)	125PSI(862kPa)		
Shutoff pressure		7PSI(48kPa)				
Discharge quantity per flush at 28 PSI (196kPa)		Approx. 1.6 gallon (6L) TET1GNC-32 TET6GNC-32 Approx. 3.5 gallon (13L) TEW1GNC-32 TEW6GNC-32	Approx. 1.28 gallon (4.8L) TET1LN(32)#CP TET6LN(32)#CP	Approx. 0.5 ~1.0 gallon (1.9~3.8L) (Fuzzy Logic adjusted flush volume) TEU1GNC-(12,22)	Approx. 0.5 gallon(1.9L) TEU1LN(12,22)#CP	Approx. 0.125 gallon(0.47L) TEU1UN(12)#CP
Toilet/Urinal Type		Flushometer type bowl		Wash down flush		
Trap seal protection Automatic flushing, if not used		every 24 hour		every 12 hour		

Note The minimum pressure required to the valve is determined by the type of fixture selected. Consult fixture manufacturer for pressure requirement. TET6*N(32)#CP and TEW6GNC-32 are to be used only with 24" or longer vacuum breakers. Valve will not have proper detection range with shorter vacuum breakers. *"Water pressures over 80psi are not recommended for most plumbing fixtures.*

Green Feature

1. Hydropowered generator (See "Bits of Knowledge About TOTO's EcoPower® Flush Valve")
The EcoPower® Flush Value detects the user on the toilet/urinal through an infrared sensor and automatically flushes the toilet/urinal. This flushing activates the hydro-power generator, which charges the automatic flush valve.

2.Fully Automatic
The EcoPower® Flush Value detects the user on the toilet/urinal through an infrared sensor and automatically flushes the toilet/urinal. It does not require any manual operation for flushing.

3. Keeps the Toilet Hygienic.
The EcoPower® Flush Value operates automatically, flushing the toilet/urinal each time it is used, there by keeping the toilet hygienic.

4. System Protection Timer.
When the toilet/urinal is not used for a 24 HR. PERIOD (12 HR PERIOD FOR TEU1LN(12, 22)#CP and TEU1UN(12)#CP) the protection timer commands the system to flush, maintaining a trap seal.

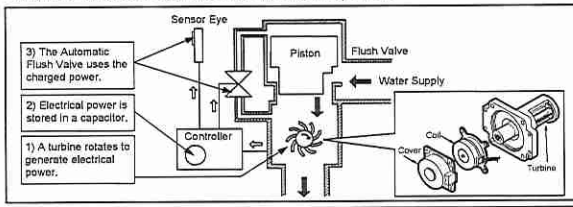
5. Anti Consecutive Flushing after Manual Operated Flushing
The EcoPower® Flush Value offers water saving consecutive flush prevention. The valve will not automatically flush again for 10 seconds after it has been flushed (for urinals) or for 30 seconds (for toilets).

6. Manual Function
For maintenance and emergency use, the flush valve is equipped with a manual flushing button.

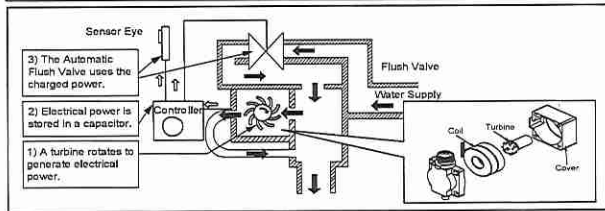
7. Conserves Water by Fuzzy Logic Control. (See "Bits of Knowledge About Fuzzy Logic Control")
The flush valve has a fuzzy logic control function, for urinal flush valve only, that enables it to detect through the infrared sensor how often and long the urinal has been used and deliver the needed quantity of flush water each time the urinal is used.

Bits of Knowledge About TOTO's EcoPower® Flush Valves

• **Mechanism for Hydro-Powered Generator**
The flow of water causes the turbine in the power generator to rotate. The generator generates electrical power, and enables the Automatic Flush Valve to operate.



TET1GNC-32
TET6GNC-32
TEW1GNC-32
TEW6GNC-32
TEU1GNC-(12,22)
TET1LN(32)#CP
TET6LN(32)#CP
TEU1LN(12,22)#CP



TEU1UN(12)#CP

Flushing 12 times (30 times for TEU1LN(12,22)#CP;45 times for TEU1UN(12)#CP) per day will keep the EcoPower® Flush Valve fully charged for 10 years. It may vary according to the discharge quantity and the flow rate.

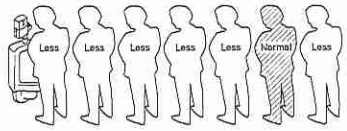
Bits of Knowledge About Fuzzy Logic Control (TEU1GNC only)

●The fuzzy logic control function automatically adjusts the discharge quantity according to the frequency of usage. (See ① and ②.)

The fuzzy logic control system judges the frequency of usage by the idle time of the urinal and causes the flush valve to discharge water in an optimal flushing pattern based on the usage.

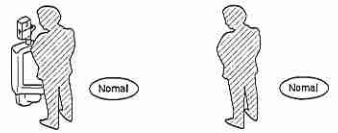
If the idle time is short, the system assumes frequent use of the urinal, causing the flush valve to discharge less water. If the idle time is long, the system assumes infrequent use, causing the flush valve deliver a normal quantity of water for thorough flushing.

①When the frequency of usage is high. (at the time of a lunch break, an intermission in a movie theatre, etc.)



※ If less water is discharged five times in succession, a normal quantity of water is discharged in the above flushing pattern.

②When the frequency of usage is low. (in an office in the early morning or at night, a park with few visitors, etc.)



●The fuzzy logic control function automatically adjusts the discharge quantity according to the volume of urine. (See ③ and ④.)

The fuzzy logic control system assumes the volume of urine based on how long the urinal has been used and causes the flush valve to discharge an optimal quantity of flush water according to the assumed volume. If the duration of urination is short, the system assumes the volume of urine is small, causing the flush valve to discharge less flush water. If the duration of urination is long, it assumes the volume of urine is large, causing the flush valve to deliver a normal quantity of flush water.

③When the duration of urination is short.

④When the duration of urination is long.

TEU1GNC-(12,22)

Operation Procedure

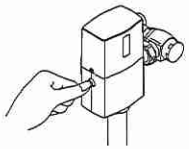
■ For The Toilet Flush Valve

① Infrared Sensor	② Flushing	③ Flushing Every 24 hours
		
The infrared sensor detects a user sitting on the toilet seat, or standing.	When the user stays in place longer than 6 seconds then moves away, the controller sends a signal to the operating unit to automatically trip the flush valve.	If toilet is not used, the system automatically flushes every 24hours as a maintenance and hygienic precaution.

■ For The Urinal Flush Valve

① Infrared Sensor	② Flushing	③ Flushing Every 24 hrs/ 12 hrs
		
The infrared sensor detects a user standing in front of the urinal within 2 ft (600mm).	When the user stays in place longer than 6 seconds then moves away, the controller sends a signal to the operating unit to automatically trip the flush.	If urinal is not used, the system automatically flushes every 24hours (12 hours for TEU1LN(12,22)#CP and TEU1UN(12)#CP) as a maintenance and hygienic precaution.

■ Common

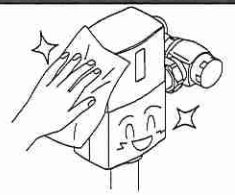
Manual Flushing Button

Use the manual flush button for maintenance and/or emergencys.

Day-to-Day Care

In order to enjoy your new product, please follow the guidelines below on a day-to-day basis.

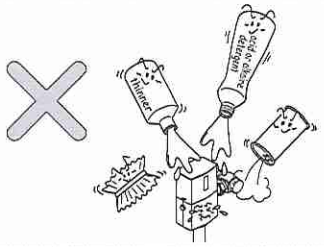
Care with a Cloth

- **For Light Cleaning**
  Please wring out a cloth that has been soaked in water and wipe away any debris adhering to the EcoPower® Flush Valve.
- **For Heavy-Duty Cleaning**
  After wiping away debris with a cloth containing a suitable amount of a neutral, dishwashing detergent, wipe clean with a damp cloth.



Caution

- ***Please avoid using cleansers that might scratch the surface of the EcoPower® Flush Valve. These include:***
  - *Detergents containing acid, chlorine bleach or alkali.*
  - *Solvents like paint thinner or benzene.*
  - *Detergents with coarse granules, polishing powder or cleanser. Nylon scrubbers, pot scrubbers, brushes, etc.*



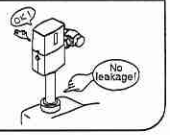
Periodical Checking

Please check your EcoPower® Flush Valve at least once a month according to the following instructions.

Leakage

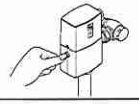
Check the piping to see whether there is any leakage.

Ignoring this may cause property damage.



Hydro-powered Generator

Press the manual flushing button and make sure the sensor red light is on for 2 seconds to see if the generator performs properly or not.
If the red light is not on, check the generator to see if pebbles, iron, rust, or other debris are clogged up at the turbine of the generator.

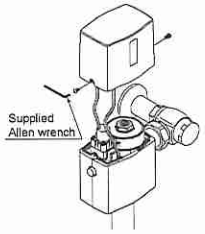


Troubleshooting

	Possible Cause	Suggested Action	Ref.Page
No water comes from the flush valve.	The main valve in water supply line or the control stop is shut off.	Open the main valve or the control stop.	-
	The connector is not connected.	Connect the wire.	-
	The surface of the glass in front of the infrared sensor is dirty.	Clean the surface of the glass.	-
	The glass is broken.	Contact distributor for replacement.	-
	There is a reflective surface in front of the sensor.	Remove the reflective surface from the sensor.	10
	The infrared sensor or the solenoid is out of order.	Contact distributor for replacement.	-
	The small holes in the solenoid diaphragm are clogged.	Clean the small hole in the diaphragm and strainer.	9
	Hydropower generator clogged.	Service Hydropower Generator.	6
Water does not stop flowing.	The small hole in the piston is clogged. *(not for TEU1UN(12)#CP)*	Clean the small hole in the piston.	8
	The sealing area of the piston is dirty.*(not for TEU1UN(12)#CP)*	Clean the sealing area of the piston.	8
	The sealing area of the solenoid diaphragm is dirty.	Clean the sealing area of the diaphragm and strainer.	9
	Piston U-packing damaged. *(not for TEU1UN(12)#CP)*	Inspect & replace if necessary.	8
The discharge quantity is too small.	The screw of the control stop or the screw of the piston valve are not adjusted properly.	Adjust the discharge quantity by the screw of the control stop and the screw of the piston valve.	10
The discharge quantity is too much.			
The flow rate is too low.	Water supply pressure is too low. (below 15 PSI(103kPa))(Flowing)	Consult with a plumbing contractor.	-
	The control stop is not open enough.	Adjust the control stop properly.	10
The flow rate is too high.	The control stop is not adjusted properly.	Adjust the control stop properly.	10
A red light in the sensor window blinks.	The battery is weak.	Replace with battery provided by TOTO®.	9

Note Do not dismantle parts of the flush valve which are not specified in the troubleshooting guide. If you need further assistance, please call TOTO® Tech Support at (888) 295-8134.

■ DISASSEMBLY

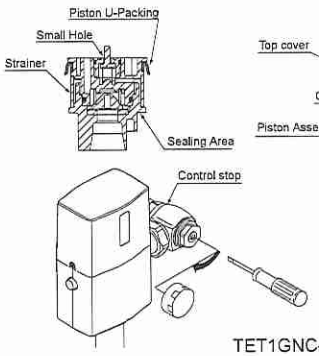


If the whole valve needs to be removed from the water supply for servicing, please be aware of the cautions below:

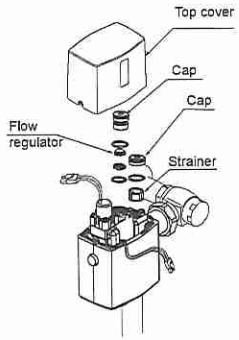
1) Be careful not to lose or tear the friction washer at the outlet connection to the vacuum breaker tube nut. To maintain a proper seal, replace the washer if necessary.
2) Be careful when re-installing the valve to the water supply to avoid pinching the O-ring.

■ CLEANING PISTON ASSEMBLY AND STRAINER

1. Turn the screw of the control stop clockwise to turn off the water.
2. Take out the piston assembly (Strainer for TEU1UN(12)#CP).
3. Check the small hole in the piston to see if it is clogged with debris, insert a small wire to unclog hole.
4. Check the strainer to see if it is clogged with debris and gently brush it to clean.
5. Check the sealing area of the piston and clean it if it is dirty.
6. Check the U-Packing for cracks or damage.



TET1GNC-32 TEU1GNC-(12,22)
TET6GNC-32 TET1LN(32)#CP
TEW1GNC-32 TET6LN(32)#CP
TEW6GNC-32 TEU1LN(12,22)#CP

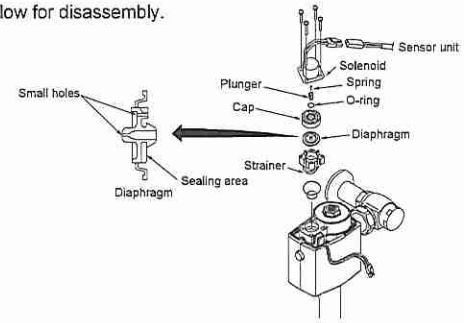


TEU1UN(12)#CP

■ CLEANING DIAPHRAGM AND STRAINER

1. Turn the screw on the control stop clockwise to turn off the water.
   (See step 1 of page 8 "Cleaning Piston Assembly")
2. Disconnect the solenoid.
3. Remove the solenoid and take out the diaphragm. Then check the small holes and sealing.

Note See this page below for disassembly.



Note Do not stretch or alter the shape of the spring in the solenoid valve in any way. It will void the warranty.

Solenoid can be checked for proper function by two methods after assuring that the batteries are properly placed and wires are connected.

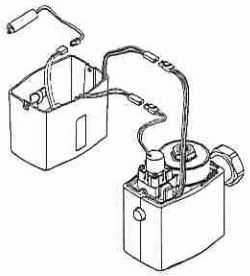
Method 1: With water supply turned off, place your hand in front of the sensor for 6 seconds, remove and listen for a "click" sound after 3 seconds. This indicates the solenoid plunger has been activated.
Method 2: Remove the 4 screws from solenoid assembly and remove diaphragm portion to expose solenoid, spring and plunger assembly only. Next, activate by covering the sensor for 6 seconds. After uncovering hands, the plunger will retract after 3 seconds. This indicates proper function.

■ BATTERY REPLACEMENT

A special lithium back-up battery is used.
*Replace only with the battery provided by TOTO®.

If a red light in the sensor window blinks with the cycle of 4 seconds, it is time to replace the battery.

1. Remove the old battery.
2. Set the new battery at the proper position.

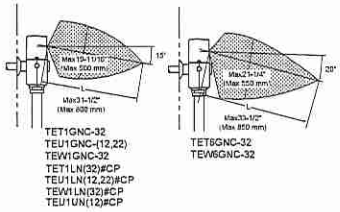


■ ADJUSTMENT OF THE FLOW RATE

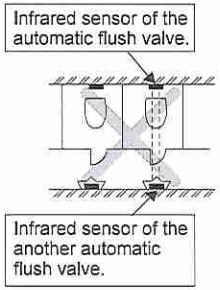
1. Adjust the flow rate by the turning screw on the control stop.
2. Turn the screw to the right to decrease the flow rate and turn to the left to increase.

■ THE DETECTION RANGE

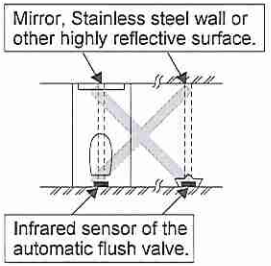
The detection range of the infrared sensor does not need to be adjusted because it has been previously set at the factory. The detectoin zone may differ according to color of user's clothes. When a user wears black clothes, the detection zone may become smaller and the valve may not flush.

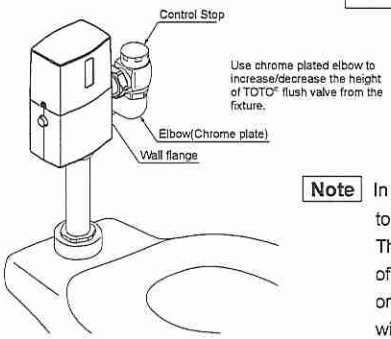


"AVOID"
DO NOT place the Infrared sensor of one urinal so that it is in line with the sensor of another automatic flush valve sensor.



"AVOID"
DO NOT place the Infrared sensor in front of a mirror, stainless steel wall or other highly reflective surface.



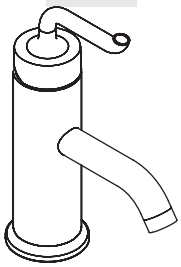


Note In same cases, the valve may not detect a user if the toilet seat is left in an upright position.
This can be due to the rough-in dimension or gap/width of the open front commercial seat. Please lower the seat or arrange to change the height of the valve. (Consult with TOTO® or plumbing contractor)

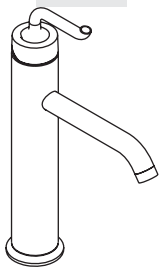
Homeowners Guide

Single-Control Lavatory Faucet

K-14402



K-14404



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Español, pagina “Español-1”

THE BOLD LOOK OF KOHLER®

1104903-5-A

Thank You For Choosing Kohler Company

Thank you for choosing Kohler Company. Your Kohler Company product reflects the true passion for design, craftsmanship, artistry, and innovation Kohler Company stands for. We are confident its dependability and beauty will surpass your highest expectations, satisfying you for years to come.

All information in this guide is based upon the latest product information available at the time of publication. At Kohler Company, we strive to fulfill our mission of improving the level of gracious living for each person who is touched by our products and services. We reserve the right to make changes in product characteristics, packaging, or availability at any time without notice.

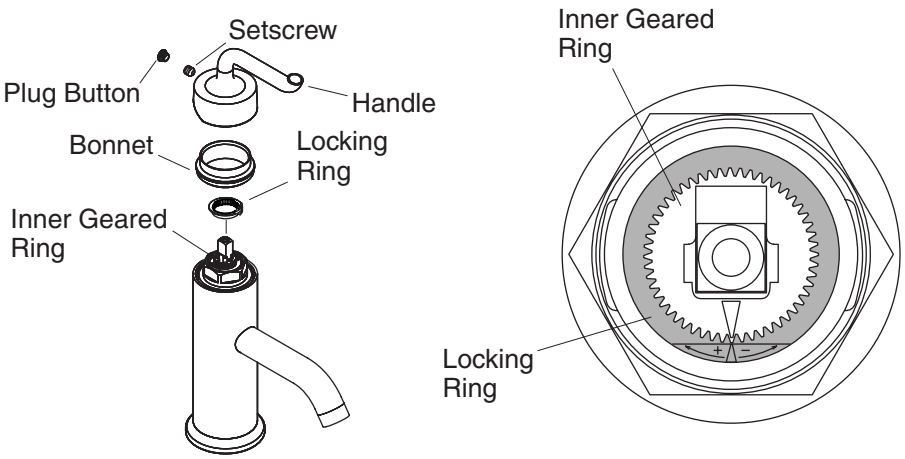
Please take a few minutes to review this guide. Pay special attention to the care and cleaning instructions.

Care and Cleaning

For best results, keep the following in mind when caring for your KOHLER product:

- Always test your cleaning solution on an inconspicuous area before applying to the entire surface.
- Wipe surfaces clean and rinse completely with water immediately after applying cleaner. Rinse and dry any overspray that lands on nearby surfaces.
- Do not allow cleaners to soak on surfaces.
- Use a soft, dampened sponge or cloth. Never use an abrasive material such as a brush or scouring pad to clean surfaces.
- The ideal cleaning technique is to rinse thoroughly and blot dry any water from the surface after each use.

For detailed cleaning information and products to consider, visit www.kohler.com/clean. To order Care & Cleaning information, call 1-800-456-4537.



Optional Temperature Limiting Adjustment

NOTE: Your faucet has the capability to limit the range of temperatures controlled by lever position. Setting the position of the locking ring will reduce the quantity of either hot water flow or cold water flow. If the supplied hot water is higher than is comfortable or safe, the quantity of cold water flow can be increased relative to the hot water flow.

Use the following procedure to adjust the limit-temperature locking ring:

- ☐ Pry off the plug button using a small flat-blade screwdriver or equivalent tool.
- ☐ Using a hex wrench, loosen the setscrew and remove the handle.

NOTE: The inner and outer rings have location arrows. These arrows are aligned with one another when the assembly is shipped. If the outer ring is rotated clockwise in respect to the inner ring, cold water flow will be restricted. If the outer ring is rotated counterclockwise in respect to the inner ring, hot water flow will be restricted. The handle can still be used to adjust temperature within the limited range.

- ☐ Note the position of the outer locking ring relative to the inner geared ring.

NOTE: Pry the outer locking ring up equally at either side in order to remove it from the valve.

Optional Temperature Limiting Adjustment (cont.)

- ☐ Using a small flat-blade screwdriver, pry up the outer locking ring.
- ☐ Rotate the position of the locking ring relative to the inner geared ring as desired.
- ☐ Align the geared teeth and slide the locking ring back into position.
- ☐ Place the handle back onto the assembly.
- ☐ If desired, test the setting and repeat these steps in order to make further adjustments.
- ☐ When all adjustments are complete, secure the handle by tightening the setscrew with a hex wrench.
- ☐ Place the plug button in place.

Lifetime Limited Warranty

Kohler Co. warrants its faucets manufactured after January 1, 1997, to be leak and drip free during normal residential use for as long as the original consumer purchaser owns his/her home. *If the faucet should leak or drip during normal use, Kohler will, free of charge, mail to the purchaser the cartridge necessary to put the faucet in good working condition.

Kohler also warrants all other aspects of the faucet, except gold finish, to be free of defects in material and workmanship during normal residential use for as long as the original consumer purchaser owns his/her own home. If a defect is found in normal residential use, Kohler Co. will, at its election, repair, provide a replacement part or product, or make appropriate adjustment. Damage to a product caused by accident, misuse, or abuse is not covered by this warranty. Proof of purchase (original sales receipt) must be provided to Kohler with all warranty claims. Kohler Co. is not responsible for labor charges, installation, or other consequential costs. In no event shall the liability of Kohler exceed the purchase price of the faucet.

If the faucet is used commercially, Kohler warrants the faucet to be free from defects in material and workmanship for one (1) year from the date the product is installed, with all other terms of this warranty applying except duration.

If you believe that you have a warranty claim, contact Kohler Co., either through your Dealer, Plumbing Contractor, Home Center or E-tailer, or by writing: Kohler Co., Attn.: Customer Service Department, 444 Highland Drive, Kohler, WI 53044, USA. Please be sure to provide

Lifetime Limited Warranty (cont.)

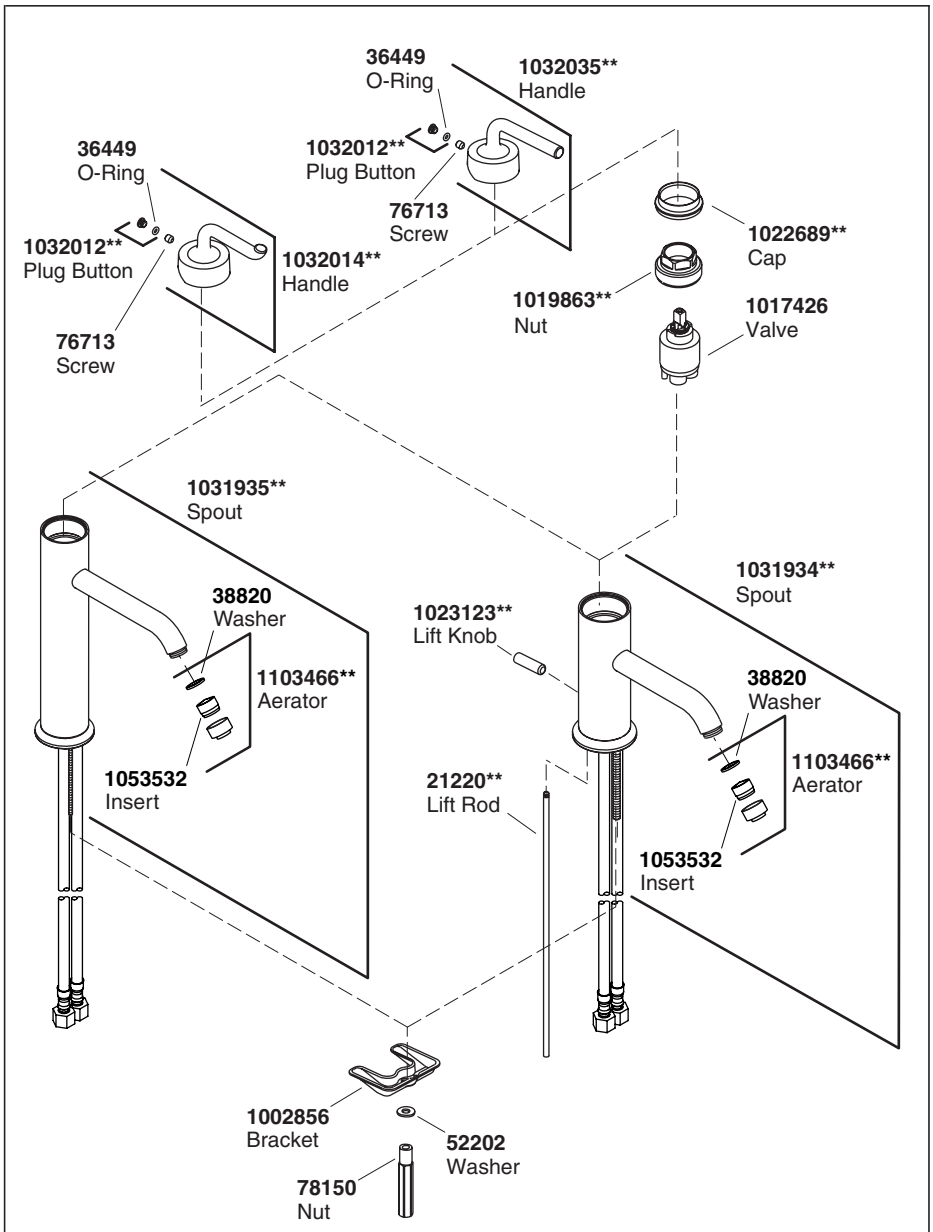
all pertinent information regarding your claim, including a complete description of the problem, the product, model number, color, finish, the date the product was purchased and from whom the product was purchased. Also include your original invoice. For other information, or to obtain the name and address of the service and repair facility nearest you, call 1-800-4-KOHLER from within the USA, 1-800-964-5590 from within Canada and 001-877-680-1310 from within Mexico.

The foregoing warranties are in lieu of all other warranties, express or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose.

Seller disclaims any liability for special, incidental or consequential damages. Some states/provinces do not allow limitations of how long an implied warranty lasts or the exclusion or limitation of such damages, so these limitations and exclusions may not apply to you. This warranty gives the consumer specific legal rights. You may also have other rights that vary from state/province to state/province. This warranty is to the original consumer purchaser only, and excludes product damage due to installation error, product abuse, or product misuse, whether performed by a contractor, service company, or the consumer.

This is our exclusive written warranty.

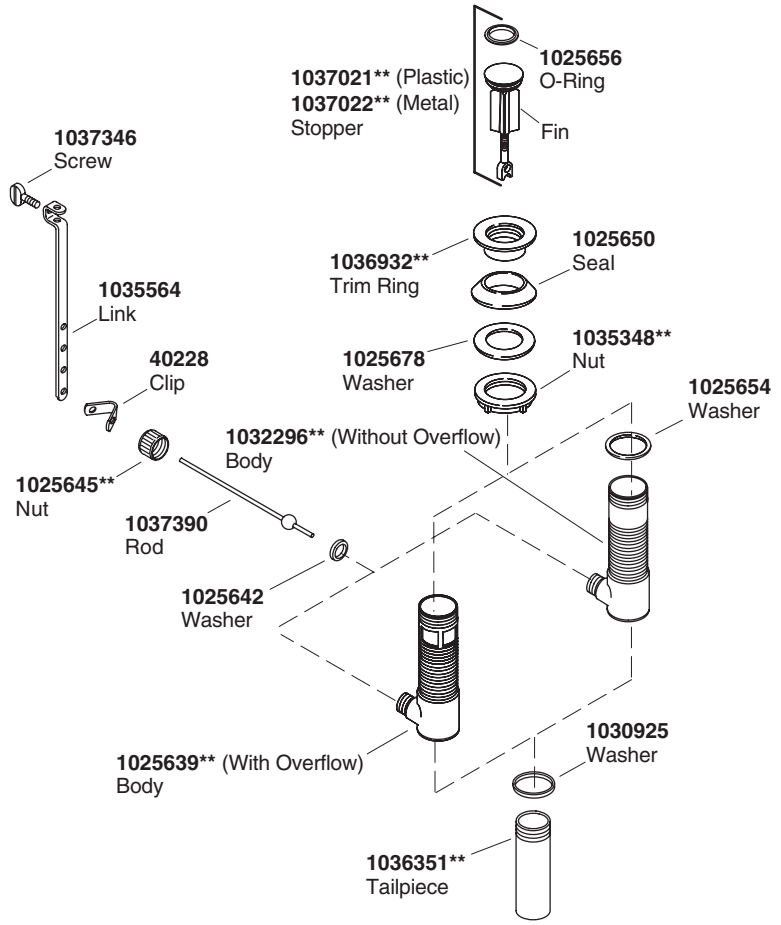
*Trend® faucets, MasterShower™ Tower, polished gold finish, all items within the "Fixture Related" section of the KOHLER Faucets Price Book, drains, Duostrainer® sink strainers, soap/lotion dispensers and faucets used in commercial settings are covered by Kohler's one-year limited warranty.



****Finish/color code must be specified when ordering.**

Service Parts

1035351** (Metal stopper fins without overflow)
1035350** (Metal stopper fins with overflow)
1037023** (Plastic stopper fins with overflow)
Drain



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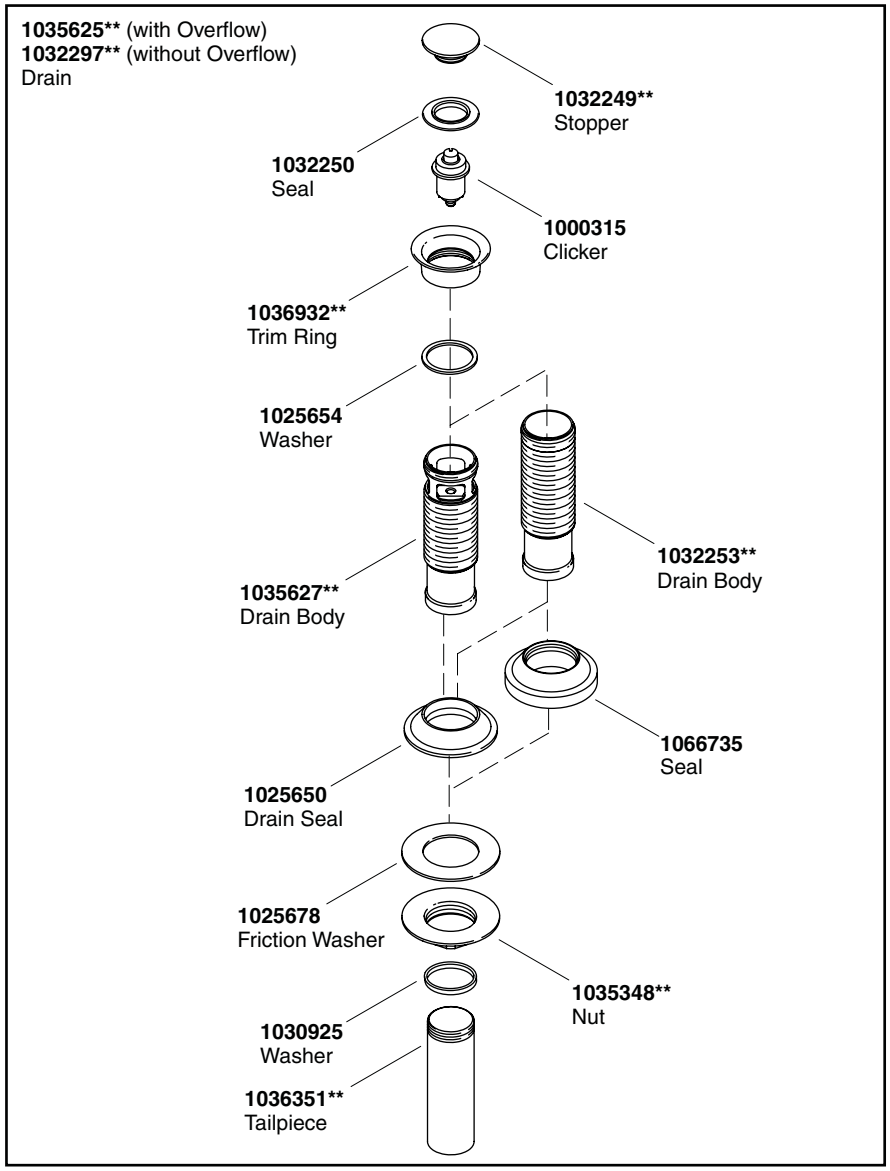


****Finish/color code must be specified when ordering.**

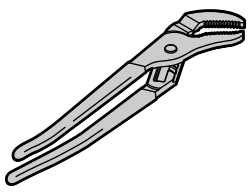
KOHLER®

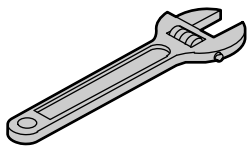
Installation Guide
Guide d'installation
Guía de instalación

Record your model number for future reference: _____.

Enregistrer le numéro du modèle pour référence ultérieure: _____.

Apunte su número de modelo para referencia futura: _____.





Rags
Chiffons
Trapos

Stainless (Non-Staining) Plumbers Putty
Mastic de plombier non tachant
Masilla de plomería que no manche

Important Information

For service parts information, visit www.kohler.com/serviceparts.
For care and cleaning and other information, visit www.us.kohler.com.

Informations importantes

Pour obtenir de l'information sur les pièces de rechange, consulter le site www.kohler.com/serviceparts.
Pour obtenir de l'information sur l'entretien et le nettoyage et de l'information supplémentaire, consulter le site www.us.kohler.com.

Información importante

Para información sobre piezas de repuesto, visite www.kohler.com/serviceparts.
Para el cuidado y la limpieza y otra información, visite www.us.kohler.com.

Important Information

If possible, assemble the faucet and drain to the bathroom sink before installing the sink.

Informations importantes

Si possible, assembler le robinet et le drain au lavabo avant d'installer ce dernier.

Información importante

De ser posible, ensamble la grifería y el desagüe en el lavabo de baño antes de instalar el lavabo.

Do not use petroleum-based plumbers putty on marble or stone surfaces.

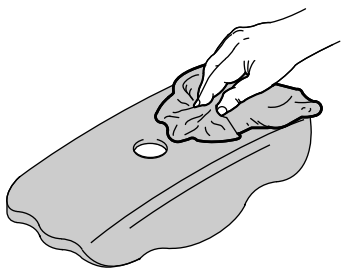
Ne pas utiliser du mastic de plombier à base de pétrole sur les surfaces en marbre ou en pierre.

No utilice masilla de plomería con base de petróleo en superficies de mármol o piedra.

1 Clean the sink surface.

Nettoyer la surface du lavabo.

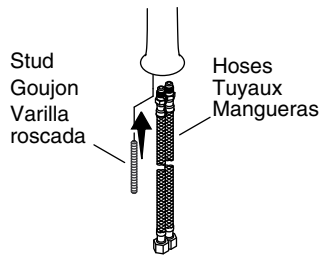
Limpie la superficie del lavabo.



2 Install the stud.

Installer le goujon.

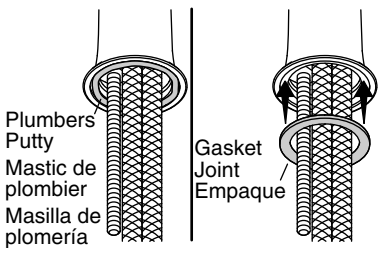
Instale la varilla roscada.



3 Apply plumbers putty or install the gasket.

Appliquer du mastic de plombier ou installer la rondelle.

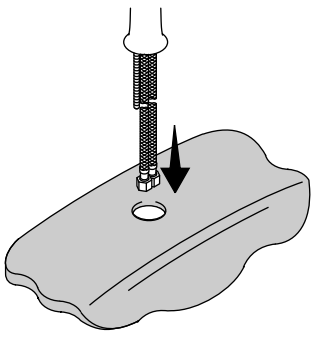
Aplique masilla de plomería o instale el empaque.



4 Insert the faucet.

Insérer le robinet.

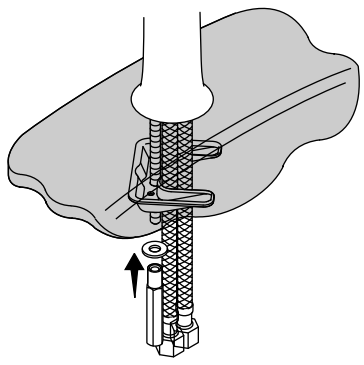
Inserte la grifería.



5 Secure the faucet.

Sécuriser le robinet.

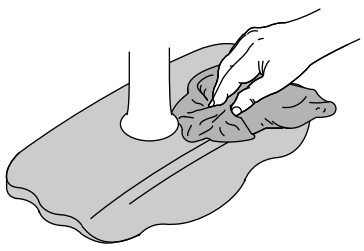
Fije la grifería.



6 Remove excess sealant.

Retirer tout excédent de mastic.

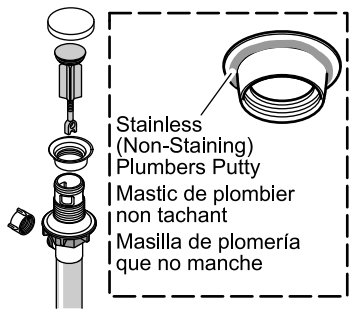
Limpie el exceso de sellador.



7 **Pop-Up Drain:** Disassemble the drain. Apply plumbers putty to the underside of the flange.

Drain mécanique: Désassembler le drain. Appliquer du mastic de plombier sur le dessous de la bride.

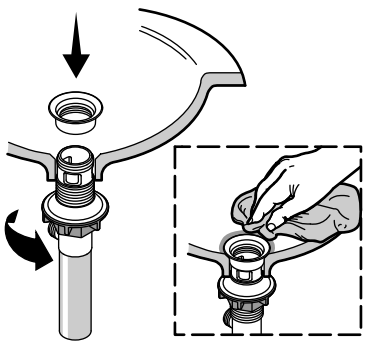
Desagüe automático: Desensamble el desagüe. Aplique masilla de plomería al dorso de la brida.



Install the flange. Tighten the nut. Remove excess sealant.

Installer la bride. Serrer l'écrou. Retirer tout excédent de mastic.

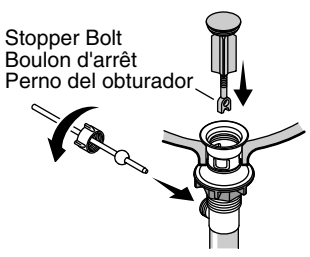
Instale la brida. Apriete la tuerca. Limpie el exceso de sellador.



Insert the rod and tighten the nut. Insert the stopper. If needed, turn the stopper bolt to adjust the height.

Insérer la tige et serrer l'écrou. Insérer le bouchon d'arrêt. Si nécessaire, tourner le boulon du bouchon pour régler la hauteur.

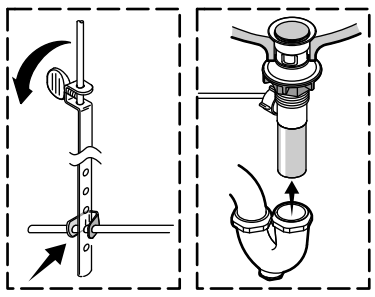
Inserte la varilla y apriete la tuerca. Inserte el obturador. Si es necesario, gire el perno del obturador para ajustar la altura.



Tighten the thumbscrew. Connect the lift rod using the clip. Connect the trap to the tailpiece.

Serrer la vis de serrage. Connecter la tige de levage en utilisant le clip. Connecter le siphon à la pièce de raccordement.

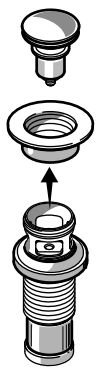
Apriete el tornillo de mariposa. Conecte el tirador utilizando el clip. Conecte la trampa al tubo final.



8 **Clicker Drain:** Disassemble the drain.

Drain à poussoir: Désassembler le drain.

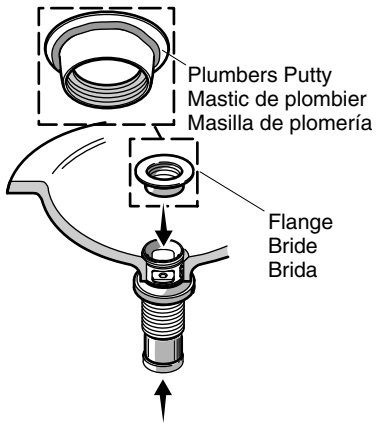
Desagüe de presionar para abrir/cerrar: Desensamble el desagüe.



Apply plumbers putty to the flange and attach.

Appliquer du mastic de plombier sur la bride et attacher.

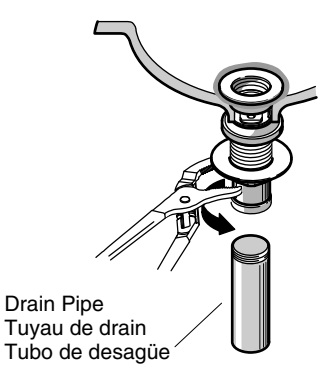
Aplique masilla de plomería a la brida e instale.



Tighten the nut. Apply thread sealant to the drain pipe threads.

Serrer l'écrou. Appliquer du mastic d'étanchéité pour filets sur les filets du tuyau d'évacuation.

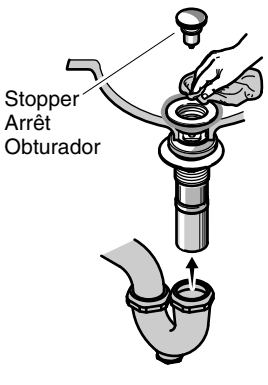
Apriete la tuerca. Aplique cinta selladora de roscas a las roscas del tubo del desagüe.



Install the stopper. Connect the trap. Remove excess sealant.

Installer le bouchon d'arrêt. Raccorder le siphon. Retirer tout excédent de mastic.

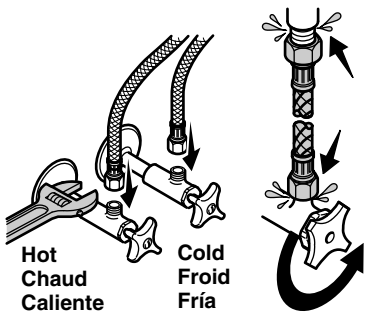
Instale el obturador. Conecte la trampa. Limpie el exceso de sellador.



9 Connect and tighten the supply hoses. Check for leaks.

Connecter et serrer les tuyaux d'alimentation. Rechercher des fuites.

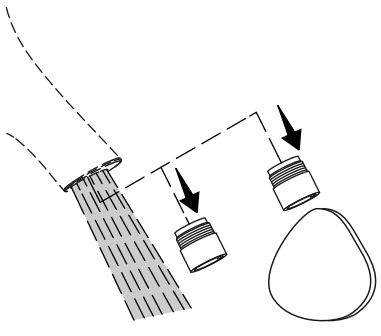
Conecte y apriete las mangueras de suministro. Verifique que no haya fugas.



10 Remove the aerator. Flush the lines.

Retirer l'aérateur. Purger les conduits.

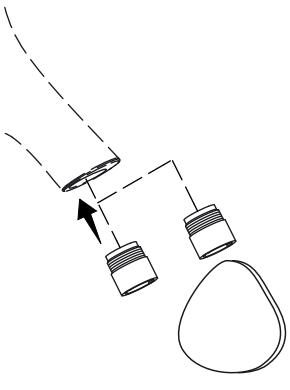
Retire el aireador. Haga circular agua por las líneas.



11 Reinstall the aerator.

Réinstaller l'aérateur.

Vuelva a instalar el aireador.



SERVICE PARTS

For service parts information, visit your product page at www.kohler.com/serviceparts.

For care and cleaning and other information go to: www.us.kohler.com.

KOHLER® Faucet Lifetime Limited Warranty

Kohler Co. warrants its Faucets* manufactured after January 1, 1997, to be leak and drip free during normal residential use for as long as the original consumer purchaser owns his or her home. If the Faucet should leak or drip during normal use, Kohler Co. will, free of charge, mail to the purchaser the cartridge necessary to put the Faucet in good working condition. This warranty applies only to Kohler Faucets installed in the United States of America, Canada or Mexico ("North America").

Kohler Co. also warrants all other aspects of the faucet or accessories ("Faucet")*, (except gold, non-Vibrant®, non-chrome finishes) to be free of defects in material and workmanship during normal residential use for as long as the original consumer purchaser owns his or her home. This warranty applies only to Kohler Faucets installed in North America. If a defect is found in normal residential use, Kohler Co. will, at its election, repair, provide a replacement part or product, or make appropriate adjustment. Damage to a product caused by accident, misuse, or abuse is not covered by this warranty. Improper care and cleaning will void the warranty**. Proof of purchase (original sales receipt) must be provided to Kohler Co. with all warranty claims. Kohler Co. is not responsible for labor charges, installation, or other incidental or consequential costs. In no event shall the liability of Kohler Co. exceed the purchase price of the Faucet.

If the Faucet is used commercially or is installed outside of North America, or if the finish is gold, non-Vibrant or a painted or powder coated color finish, Kohler Co. warrants the Faucet to be free from defects in material and workmanship for one (1) year from the date the product is installed, under Kohler Co.'s standard one-year limited warranty.

If you believe that you have a warranty claim, contact Kohler Co., either through your Dealer, Plumbing Contractor, Home Center or E-tailer, or by writing Kohler Co., Attn.: Customer Care Center, 444 Highland Drive, Kohler, WI 53044, USA. Please be sure to provide all pertinent information regarding your claim, including a complete description of the problem, the product, model number, color, finish, the date the product was purchased and from whom the product was purchased. Also include your original invoice. For other information, or to obtain the name and address of the service and repair facility nearest you, call 1-800-4-KOHLER (1-800-456-4537) from within the USA and Canada, and 001-800-456-4537 from within Mexico, or visit www.kohler.com within the USA, www.ca.kohler.com from within Canada, or www.mx.kohler.com in Mexico.

KOHLER CO. AND/OR SELLER ARE PROVIDING THESE WARRANTIES IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. KOHLER CO. AND/OR SELLER DISCLAIM ALL LIABILITY FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES. Some states/provinces do not allow limitations of how long an implied warranty lasts or the exclusion or limitation of such damages, so these limitations and exclusions may not apply to you. This warranty gives the consumer specific legal rights. You may also have other rights that vary from state/province to state/province.

This is Kohler Co.'s exclusive written warranty.

*Trend® faucets, MasterShower® tower, BodySpa systems and components; WaterHaven® tower, systems and components; Tripoint® faucets, Polished Gold, non-Vibrant and painted or powder coated finishes, fittings; all items within the "Fixture Related" section of the Kohler Faucets Price Book, drains, Duostrainer® sink strainers, soap/lotion dispensers; and faucets used in commercial settings, and outside North America, are covered by Kohler Co.'s one-year limited warranty.

**Never use cleaners containing abrasive cleansers, ammonia, bleach, acids, waxes, alcohol, solvents or other products not recommended for chrome. This will void the warranty.

USA/Canada: 1-800-4KOHLER
Mexico: 001-800-456-4537
www.kohler.com

PIÈCES DE RECHANGE

Pour obtenir de l'information sur les pièces de rechange, visitez votre page de produits sur le site www.kohler.com/serviceparts.

Pour obtenir de l'information sur l'entretien et le nettoyage et de l'information supplémentaire, visiter le site: www.us.kohler.com.

Garantie limitée à vie du robinet KOHLER®

Kohler Co. garantit que les robinets* fabriqués après le 1er janvier 1997 ne fuient pas et ne gouttent pas lors d'une utilisation domestique normale, aussi longtemps que l'acquéreur d'origine demeure propriétaire de son domicile. Si le robinet goutte ou présente des fuites lors d'une utilisation normale, Kohler Co. enverra par courrier à l'acheteur, sans frais, la cartouche nécessaire pour réparer le robinet. La présente garantie s'applique uniquement aux robinets Kohler installés aux États-Unis, au Canada ou au Mexique ("Amérique du Nord").

Kohler Co. garantit également toutes les autres caractéristiques du robinet ou des accessoires ("Robinet")*, (à l'exception des finitions dorées, non-Vibrant®, non chromées) contre tout vice de matériau et de fabrication lors d'une utilisation domestique normale, aussi longtemps que l'acquéreur d'origine demeure propriétaire de son domicile. La présente garantie s'applique uniquement aux robinets Kohler installés en Amérique du Nord. Si un vice est décelé lors d'une utilisation domestique normale, Kohler Co. choisira, à sa discrétion, la réparation, le remplacement ou la rectification appropriée. Cette garantie n'offre pas de protection contre les dommages dus à un accident, une mauvaise utilisation ou un mauvais traitement. Un entretien et un nettoyage inadéquats annulent la garantie**. Une preuve d'achat (ticket de caisse d'origine) doit être présentée à Kohler Co. avec toutes les réclamations au titre de la garantie. Kohler Co. n'est pas responsable des frais de main-d'œuvre, d'installation ou de tout autre frais particulier, accessoire ou indirect. La responsabilité de Kohler Co. ne dépassera en aucun cas le prix d'achat du robinet.

Si le robinet est utilisé dans un commerce ou s'il est installé en dehors d'Amérique du Nord, ou si la finition est dorée, non-Vibrant, peinte ou revêtue d'une poudre, Kohler Co. garantit le robinet contre tout vice de matériau et de fabrication pendant un (1) an à partir de la date d'installation du produit, selon les modalités de la garantie limitée standard d'un an de Kohler Co.

Pour toute réclamation au titre de la présente garantie, contacter Kohler Co. par l'intermédiaire du vendeur, plombier, centre de rénovation ou revendeur par internet, ou bien par écrit à l'adresse suivante Kohler Co., Attn.: Customer Care Center, 444 Highland Drive, Kohler, WI 53044, USA. Fournir tous les renseignements pertinents à la réclamation, dont notamment une description complète du problème et du produit, le numéro de modèle, la couleur, la finition, la date et le lieu d'achat du produit. Joindre également l'original de la facture. Pour de plus amples renseignements ou pour obtenir les coordonnées du service de réparation le plus proche, appeler le 1-800-4-KOHLER (1-800-456-4537) à partir des E.-U. et du Canada, et le 001-800-456-4537 à partir du Mexique, ou consulter le site www.kohler.com aux É.-U., www.ca.kohler.com à partir du Canada, ou www.mx.kohler.com au Mexique.

KOHLER CO. ET/OU LE REVENDEUR FOURNISSENT CES GARANTIES AU LIEU ET PLACE DE TOUTES AUTRES GARANTIES, EXPRESSES OU TACITES, Y COMPRIS LES GARANTIES TACITES DE COMMERCIALITÉ ET D'ADAPTATION À UN USAGE PARTICULIER. KOHLER CO. ET/OU LE REVENDEUR DÉCLINENT TOUTE RESPONSABILITÉ CONTRE LES DOMMAGES PARTICULIERS, ACCESSOIRES OU INDIRECTS. Certains états et provinces ne permettent pas de limite sur la durée de la garantie tacite, ni l'exclusion ou la limite des dommages, et, par conséquent, lesdites limites et exclusions peuvent ne pas s'appliquer à votre cas. La présente garantie accorde au consommateur des droits juridiques particuliers. Vous pouvez également avoir d'autres droits qui varient d'un état ou d'une province à l'autre.

Ceci constitue la garantie écrite exclusive de Kohler Co.

*Les robinets Trend®, la colonne MasterShower®, les systèmes et éléments BodySpa, la colonne, les systèmes et les éléments WaterHaven®, les robinets Tripoint®, les finitions or poli, non-Vibrant et peintes ou á revêtement de poudre, les raccords; tous les articles de la section "Fixture Related" du le catalogue des prix des robinets Kohler, les drains, les crépines d'évier Duostrainer®, les distributeurs de savon/lotion; et les robinets utilisés dans des milieux commerciaux et en dehors d'Amérique du Nord, sont couverts par la garantie limitée d'un an de Kohler Co.

**Ne jamais utiliser de nettoyants contenant des agents abrasifs, de l'ammoniaque, de l'eau de Javel, des acides, des cires, de l'alcool, des dissolvants ou autres produits non recommandés pour le chrome. Ceci annulera la garantie.

PIEZAS DE REPUESTO

Para información sobre piezas de repuesto, visite la página de su producto en www.kohler.com/serviceparts.

Para el cuidado y la limpieza y otra información visite: www.us.kohler.com.

Garantía limitada de por vida para la grifería KOHLER®

Kohler Co. garantiza que la Grifería* fabricada después del 1 de enero de 1997 está libre de problemas de fugas y goteo durante el uso residencial normal, mientras el comprador consumidor original sea el propietario de su casa. En caso de que la Grifería presente fugas o goteo durante el uso normal, Kohler Co. enviará por correo y sin ningún cargo al comprador original, el cartucho necesario para que la Grifería funcione correctamente. Esta garantía se aplica sólo a la Grifería Kohler instalada en los Estados Unidos de América, Canadá o México ("Norteamérica").

Kohler Co. también garantiza que todas las demás características de la grifería o accesorios ("Grifería")*, (excepto los acabados de oro, que no sean Vibrant®, o que no sean de cromo) están libres de defectos de material y mano de obra, durante el uso residencial normal, mientras el comprador consumidor original sea el propietario de su casa. Esta garantía se aplica sólo a la Grifería Kohler instalada en Norteamérica. Si se encuentra un defecto durante el uso residencial normal, Kohler Co., a su criterio, reparará, proveerá un repuesto o producto, o realizará los ajustes pertinentes. Esta garantía no cubre daños causados por accidente, abuso o uso indebido del producto. El cuidado y la limpieza indebidos anularán la garantía**. Al presentar las reclamaciones de garantía a Kohler Co., es necesario incluir la prueba de compra (recibo de venta original). Kohler Co. no se hace responsable de costos de mano de obra, instalación u otros costos incidentales o indirectos. En ningún caso la responsabilidad de Kohler Co. excederá el precio de compra de la Grifería.

Si la Grifería se utiliza comercialmente o se instala fuera del territorio de Norteamérica, o si el acabado es de oro, no es Vibrant o un acabado de color con revestimiento de pintura o polvo, Kohler Co. garantiza que la Grifería está libre de defectos de material y mano de obra por un (1) año, a partir de la fecha de instalación, bajo la garantía limitada de un año estándar de Kohler Co.

Si usted considera que tiene una reclamación en virtud de la garantía, comuníquese con Kohler Co. a través de su distribuidor, contratista de plomería, centro de remodelación o distribuidor por Internet, o escriba a Kohler Co., Attn.: Customer Care Center, 444 Highland Drive, Kohler, WI 53044, USA. Por favor, asegúrese de proporcionar toda la información pertinente a su reclamación, incluyendo una descripción completa del problema, el producto, el número de modelo, el color, el acabado, la fecha de compra y el lugar de compra del producto. También incluya el recibo original. Para información adicional, o para obtener el nombre y dirección del lugar de reparación y servicio más cercano a usted, llame al 1-800-4-KOHLER (1-800-456-4537) desde los EE.UU. y Canadá, y al 001-800-456-4537 desde México, o visite www.kohler.com desde los EE.UU., www.ca.kohler.com desde Canadá, o www.mx.kohler.com en México.

KOHLER CO. Y/O EL VENDEDOR OFRECEN ESTAS GARANTÍAS QUE SUSTITUYEN TODAS LAS DEMÁS GARANTÍAS, EXPRESAS O IMPLÍCITAS, INCLUYENDO, ENTRE OTRAS, LAS GARANTÍAS IMPLÍCITAS DE COMERCIALIZACIÓN E IDONEIDAD PARA UN USO DETERMINADO. KOHLER CO. Y/O EL VENDEDOR DESCARGAN TODA RESPONSABILIDAD POR CONCEPTO DE DAÑOS PARTICULARES, INCIDENTALES O INDIRECTOS. Algunos estados/provincias no permiten limitaciones en cuanto a la duración de una garantía implícita o a la exclusión o limitación de dichos daños, por lo que estas limitaciones y exclusiones pueden no aplicar a su caso. Esta garantía otorga al consumidor ciertos derechos legales específicos. Además, usted puede tener otros derechos que varían de estado a estado y provincia a provincia.

Ésta es la garantía exclusiva por escrito de Kohler Co.

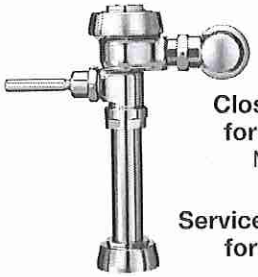
*La grifería Trend®, la torre MasterShower®, los sistemas y componentes BodySpa, la torre, sistemas y componentes WaterHaven®, las griferías Tripoint®, el acabado en oro pulido, que no sea Vibrant y los acabados con revestimiento de pintura o en polvo, las conexiones, todos los artículos contenidos en la sección "Fixture Related" de la lista de precios de la grifería Kohler, los desagües, las coladeras de fregadero Duostrainer®, los dispensadores de jabón y loción, y la grifería de uso comercial e instalada fuera del territorio de Norteamérica, están cubiertos por la garantía limitada de un año de Kohler Co.

**Nunca utilice limpiadores que contengan limpiadores abrasivos, amoniaco, blanqueador, ácidos, ceras, alcohol, disolventes u otros productos no recomendados para el cromo. Esto anulará la garantía.

Code No. 0816195
Rev. 6 (02/15)

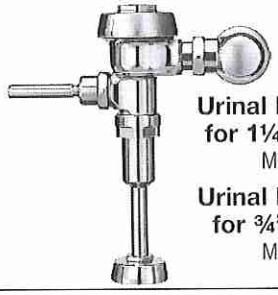
SLOAN®

INSTALLATION INSTRUCTIONS FOR EXPOSED ROYAL® FLUSHOMETERS



Closet Flushometer for 1½" Top Spud
MODELS 110/111, 113, 115 & 116

Service Sink Flushometer for 1½" Top Spud
MODEL 117



Urinal Flushometer for 1¼" Top Spud
MODEL 180

Urinal Flushometer for ¾" Top Spud
MODEL 186

Closet Flushometer for 1½" Back Spud
MODELS 120, 121 & 122

PRIOR TO INSTALLATION

Before you install the flushometer, be sure the items listed below are installed. Also, refer to the rough-in diagram below.

• Closet fixture • Drain line • Water supply line

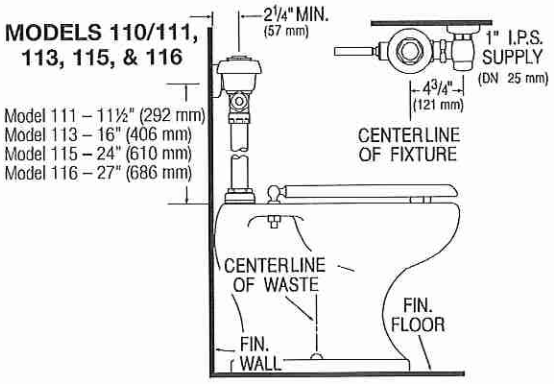
IMPORTANT:

- **ALL PLUMBING SHOULD BE INSTALLED IN ACCORDANCE WITH APPLICABLE CODES AND REGULATIONS.**
- **WATER SUPPLY LINES MUST BE SIZED TO PROVIDE AN ADEQUATE VOLUME OF WATER FOR EACH FIXTURE.**
- **FLUSH ALL WATER LINES PRIOR TO MAKING CONNECTIONS.**

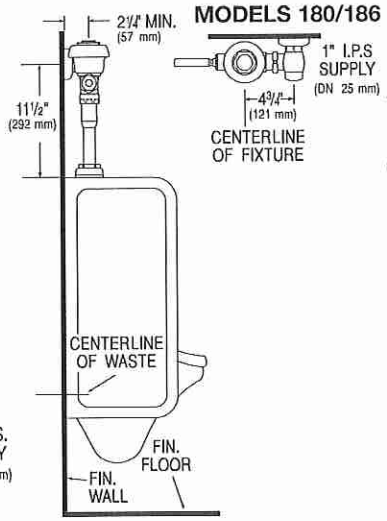
Sloan's flushometers are designed to operate with 15 to 80 psi (103 to 552 kPa) of water pressure. **THE MINIMUM PRESSURE REQUIRED TO THE VALVE IS DETERMINED BY THE TYPE OF FIXTURE SELECTED.** Consult fixture manufacturer for minimum pressure requirements. Most High Efficiency water closets require a minimum flowing pressure of 25 psi (172 kPa). Many building codes and the ASME A112.19.2 fixture standard list Maximum static water pressure as 80 PSI (552 kPa).

ROUGH-INS

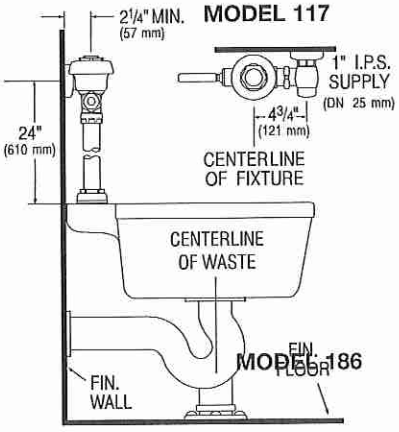
MODELS 110/111, 113, 115, & 116



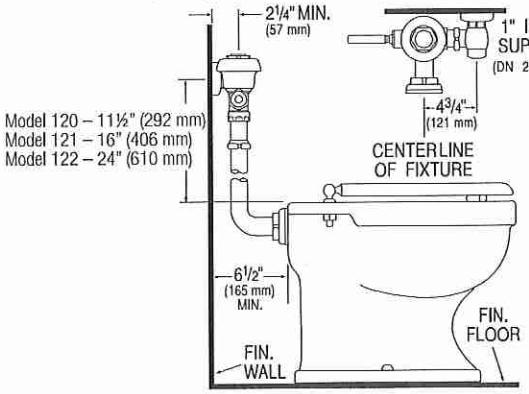
MODELS 180/186



MODEL 117



MODELS 120, 121, & 122



!!! IMPORTANT !!!

WHEN MOUNTED ON AN ADA ACCESSIBLE BOWL, THE ROUGH-IN TO THE SUPPLY INLET SHOULD BE NO HIGHER THAN 37½" OR THE HANDLE WILL EXCEED MAXIMUM HEIGHT ALLOWANCES UNDER ADA GUIDELINES.

TOOLS REQUIRED FOR INSTALLATION

- Straight blade screwdriver
- Sloan A-50 Super-Wrench™, Sloan A-109 Plier Wrench or smooth jawed spud wrench

!!! IMPORTANT !!!

PROTECT THE CHROME OR SPECIAL FINISH OF SLOAN FLUSHOMETERS — DO NOT USE TOOTHED TOOLS TO INSTALL OR SERVICE THESE VALVES. USE A SLOAN A-50 SUPER-WRENCH™, SLOAN A-109 PLIER WRENCH OR SMOOTH JAWED SPUD WRENCH TO SECURE ALL COUPLINGS. SEE "CARE AND CLEANING" SECTION.

!!! IMPORTANT !!!

NEVER OPEN CONTROL STOP TO WHERE THE FLOW FROM THE VALVE EXCEEDS THE FLOW CAPABILITY OF THE FIXTURE. IN THE EVENT OF A VALVE FAILURE, THE FIXTURE MUST BE ABLE TO ACCOMMODATE A CONTINUOUS FLOW FROM THE VALVE.

!!! IMPORTANT !!!

WITH THE EXCEPTION OF CONTROL STOP INLET, DO NOT USE PIPE SEALANT OR PLUMBING GREASE ON ANY VALVE COMPONENT OR COUPLING!

!!! IMPORTANT !!!

THIS PRODUCT CONTAINS MECHANICAL AND/OR ELECTRICAL COMPONENTS THAT ARE SUBJECT TO NORMAL WEAR. THESE COMPONENTS SHOULD BE CHECKED ON A REGULAR BASIS AND REPLACED AS NEEDED TO MAINTAIN THE VALVE'S PERFORMANCE.

Please take the time to read this manual to ensure proper product installation and longevity.

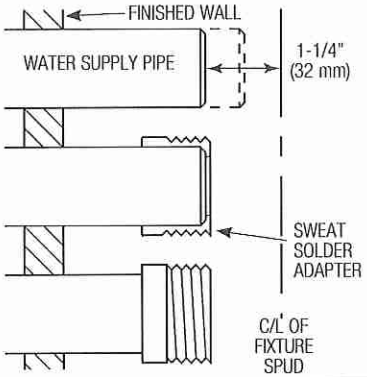
When further assistance is required, please contact your local Sloan Representative or Sloan Technical Support at: 1-888-SLOAN-14 (1-888-756-2614)

1 - INSTALL OPTIONAL SWEAT SOLDER ADAPTER (ONLY IF YOUR SUPPLY PIPE DOES NOT HAVE A MALE THREAD)

A Measure from finished wall to C/L of fixture spud. Cut pipe 1¼" (32 mm) shorter than this measurement. Chamfer O.D. and I.D. of water supply pipe.

B Slide threaded adapter fully onto pipe.

C Sweat solder the Adapter to pipe.

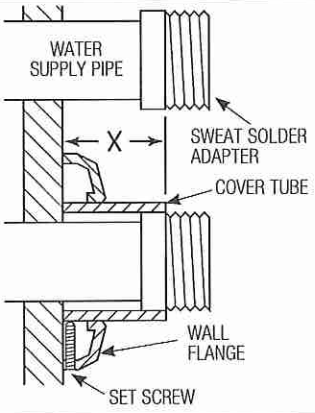


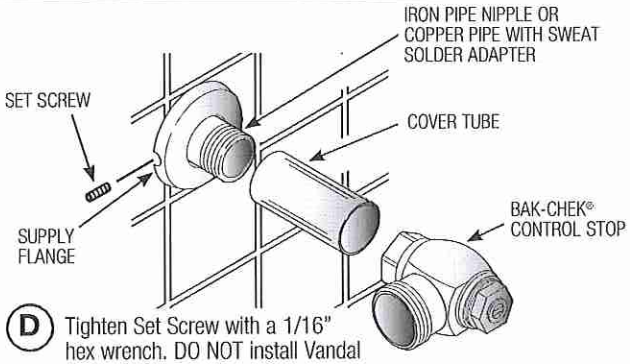
2 - INSTALL COVER TUBE, WALL FLANGE AND CONTROL STOP TO SUPPLY PIPE

A Measure from finished wall to first thread of Adapter or threaded supply pipe (dimension "X"). Cut Cover Tube to this length.

B Slide Cover Tube over pipe. Slide Wall Flange over Cover Tube until against wall.

C Thread Control Stop onto pipe. Tighten with a wrench.





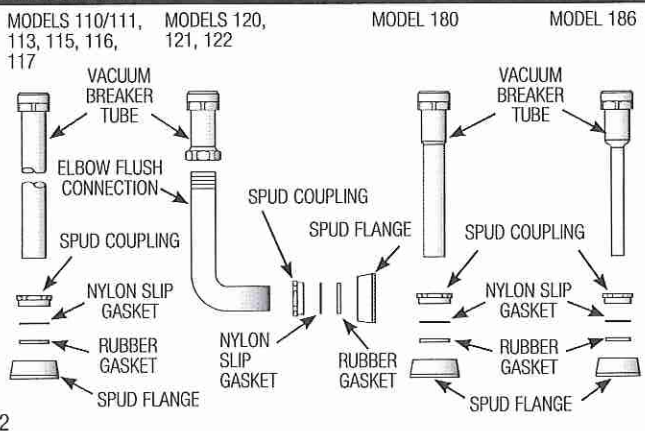
D Tighten Set Screw with a 1/16" hex wrench. DO NOT install Vandal Resistant Stop Cap at this time.

3 - INSTALL VACUUM BREAKER FLUSH CONNECTION

A Slide Spud Coupling, Nylon Slip Gasket, Rubber Gasket and Spud Flange over Vacuum Breaker Tube.

B Insert Tube into Fixture Spud.

C Hand tighten Spud Coupling onto Fixture Spud.



4 - INSTALL FLUSHOMETER AND TRIPLE SEAL HANDLE ASSEMBLY

NOTE

For high efficiency urinal flushometers (0.5, 0.25 and 0.125 gpf), it is necessary to first insert the flow control component into the tailpiece assembly. See the H1015A flow control kit and separate instructions for details on how to install.

A Lubricate tailpiece O-ring with water. Insert Adjustable Tailpiece into Control Stop. Tighten Tailpiece Coupling by hand.

B Align Flushometer directly above the Vacuum Breaker Flush Connection by sliding the Flushometer Body IN or OUT as needed. Tighten Vacuum Breaker Coupling by hand.

NOTE

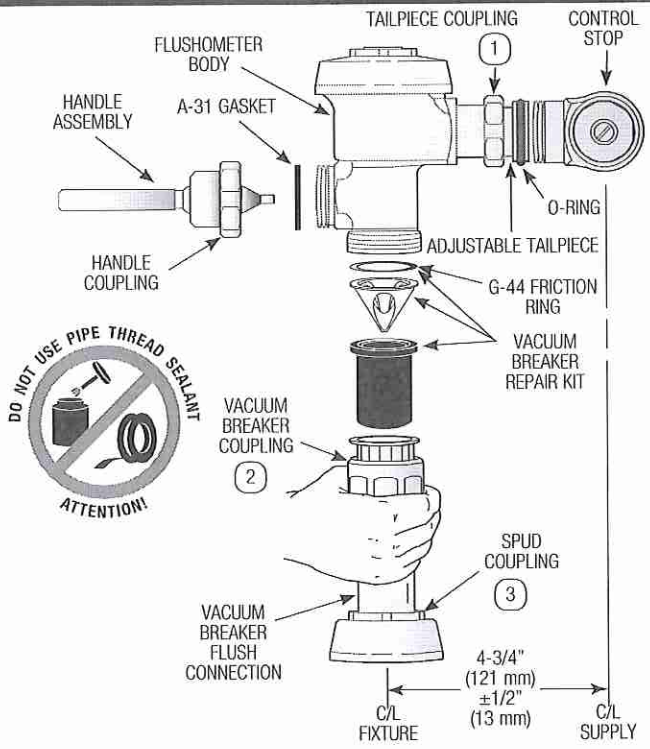
Maximum adjustment of the Sloan Adjustable Tailpiece is 1/2" (13 mm) IN or OUT from the standard 4-3/4" (121 mm) (centerline of Flushometer to centerline of Control Stop).

If roughing-in measurement exceeds 5-1/4" (133 mm), consult factory for longer tailpiece.

C Align Flushometer Body and securely tighten first the Tailpiece Coupling (1), then the Vacuum Breaker Coupling (2), and finally the Spud Coupling (3). Use a wrench to tighten these couplings in the order shown.

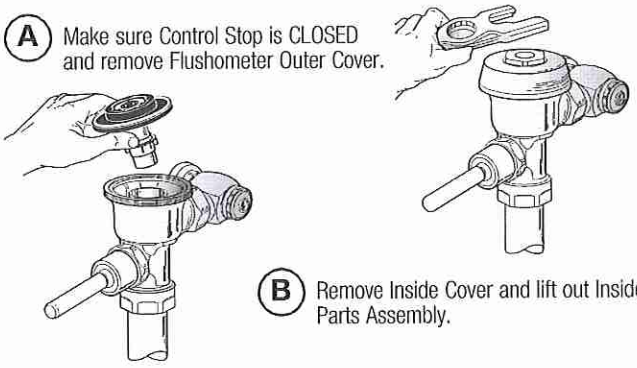
D Install the red A-31 Handle Gasket on the Handle Assembly. Insert the Handle Assembly into the Handle opening in the Flushometer Body. Securely tighten the Handle coupling with a wrench.

Sloan's triple-sealed Flushometer Handle is ADA-complaint.



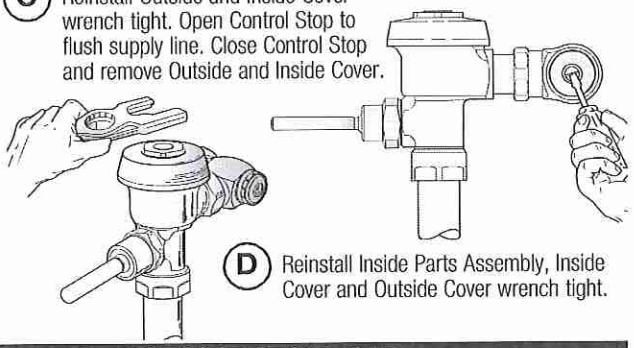
5 - FLUSH OUT SUPPLY LINE

A Make sure Control Stop is CLOSED and remove Flushometer Outer Cover.



B Remove Inside Cover and lift out Inside Parts Assembly.

C Reinstall Outside and Inside Cover wrench tight. Open Control Stop to flush supply line. Close Control Stop and remove Outside and Inside Cover.



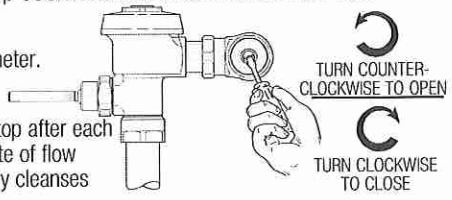
D Reinstall Inside Parts Assembly, Inside Cover and Outside Cover wrench tight.

6 - ADJUST CONTROL STOP AND INSTALL VANDAL RESISTANT STOP CAP

A Open Control Stop COUNTERCLOCKWISE one FULL turn from closed position.

B Activate Flushometer.

C Adjust Control Stop after each flush until the rate of flow delivered properly cleanses the fixture.



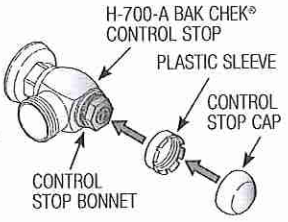
!!! IMPORTANT !!!

Sloan's flushometers are engineered for quiet operation. Excessive water flow creates noise, while too little water flow may not satisfy the needs of the fixture. Proper adjustment is made when plumbing fixture is cleansed after each flush without splashing water out from the lip AND a quiet flushing cycle is achieved.

Never open Control Stop to where the flow from the valve exceeds the flow capability of the fixture. In the event of a valve failure, the fixture must be able to accommodate a continuous flow from the valve.

D Install Vandal Resistant Control Stop Cap onto Control Stop.

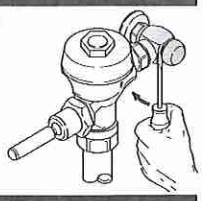
- Thread the Plastic Sleeve onto the Stop Bonnet until it is snug (tighten only by hand; do not use pliers or a wrench).
- Place the metal Control Stop Cap over the plastic Sleeve and use the palm of the hand to push or "pop" the Cap over the fingers of the Plastic Sleeve. The Cap should spin freely.



Important: DO NOT install Cap onto Sleeve unless the Sleeve has been threaded onto Control Stop Bonnet. If the Sleeve and Cap are assembled off of the Control Stop, the Sleeve WILL NOT come apart from the Cap.

VANDAL RESISTANT CONTROL STOP CAP REMOVAL

Use a large flat screwdriver as a lever to remove the Cap from the Control Stop. Insert the screwdriver blade between the bottom edge of the Cap and the flat surface of the Control Stop body as shown. Push the screwdriver handle straight back toward the wall to gently lift the Cap. If necessary, work the screwdriver around the diameter of the Cap until you can grasp the Cap and lift it completely off the Sleeve. The Sleeve should remain attached to the bonnet of the Control Stop.



TROUBLESHOOTING GUIDE

1. Flushometer does not function (no flush).

A. Control stop or main valve is closed. Open control stop or main valve.
B. Handle assembly is damaged. Replace handle or install handle repair kit.
C. Relief Valve is damaged. Replace relief valve.

2. Volume of water is not sufficient to siphon fixture.

A. Control stop is not open wide enough. Adjust control stop for desired delivery of water volume.
B. Diaphragm assembly is damaged. Replace diaphragm assembly.
C. Incorrect diaphragm assembly is installed in flushometer; for instance, urinal assembly inside a closet flushometer, or low consumption assembly inside a higher consumption fixture. Determine the flush volume required by the fixture and replace diaphragm. Use valve label and markings on fixture for reference.
D. Water supply volume or pressure is inadequate. If no gauges are available to properly measure supply pressure or volume of water at the flushometer, then remove the relief valve from the diaphragm assembly, reassemble the flushometer and completely open the control stop.
- If the fixture siphons, more water volume is required. Install a higher flushing volume diaphragm. **IMPORTANT – LAWS AND REGULATIONS PROHIBIT THE USE OF HIGHER FLUSHING VOLUMES THAN LISTED ON FIXTURE OR FLUSHOMETER.**
- If the fixture DOES NOT siphon or if a low consumption flush is required, steps must be taken to increase the water supply pressure and/or volume. Contact the fixture manufacturer for minimum water supply requirements of the fixture.

3. Length of flush is too short (short flush).

A. Diaphragm assembly is worn or damaged. Replace diaphragm assembly.
B. Handle assembly is damaged. Replace handle or install handle repair kit.
C. Incorrect diaphragm assembly is installed in flushometer; for instance, urinal assembly inside a closet flushometer, or low consumption assembly inside a higher consumption fixture. Determine the flush volume required by the fixture and replace diaphragm. Use valve label and markings on fixture for reference.

4. Length of flush is too long (long flush) or continuous.

A. Metering bypass hole (upper filter ring) in diaphragm is clogged. Remove the diaphragm assembly. Remove the primary and secondary filter rings from the diaphragm, wash under running water, and reassemble. Replace as necessary.
B. Diaphragm or relief valve is damaged. Replace diaphragm or relief valve.
C. Incorrect diaphragm assembly is installed in flushometer; for instance, closet assembly inside a urinal flushometer, or water saver assembly inside a low consumption flushometer. Determine the flush volume required by the fixture and replace the diaphragm. Use valve label and markings on fixture for reference.
D. Inside cover is damaged. Replace Inside cover.
E. Supply line water pressure has dropped and is not sufficient to close the valve. close control stop until pressure is restored.
F. Relief valve is not seated properly. Disassemble diaphragm components (relief valve, filter rings, and diaphragm unit), wash under running water, and reassemble. Replace as necessary.

5. Chattering noise is heard during flush.

A. Inside cover is damaged. Replace inside cover.
B. Relief valve or diaphragm is damaged. Replace relief valve or diaphragm assembly.

6. Handle Leaks.

A. Handle seal or assembly is damaged. Replace handle or install handle repair kit.

7. Water splashes from fixture.

A. Control stop is open wider than necessary. Adjust control stop for desired delivery of water volume.
B. Water saver/conventional diaphragm assembly is installed on low consumption fixture or closit diaphragm assembly is installed on urinal fixture. Determine the required flush volume (see label on valve or markings on fixture). Replace diaphragm assembly or relief valve for appropriate flush volume of fixture.

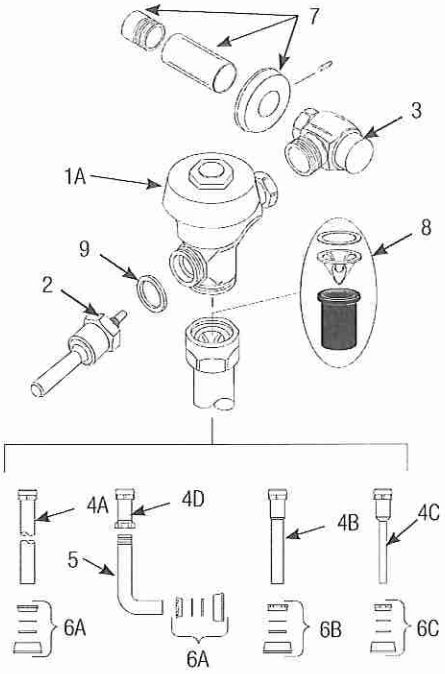
When assistance is required, please contact your local Sloan Representative or Sloan Technical Support at: 1-888-SLOAN-14 (1-888-756-2614)

CARE AND CLEANING

DO NOT use abrasive or chemical cleaners (including chlorine bleach) to clean Flushometers that may dull the luster and attack the chrome or special decorative finishes. Use ONLY mild soap and water, then wipe dry with clean cloth or towel.

While cleaning the bathroom tile, protect the Flushometer from any splattering of cleaner. Acids and cleaning fluids will discolor or remove chrome plating.

PARTS LIST



Item No.	Part No.	Description
1	†	Valve Assembly
2	B-73-A	ADA Compliant Handle Assembly
3	H-700-A	Bak-Chek® Control Stop
4A	V-600-AA	1½" (38 mm) Vacuum Breaker Assembly ‡
4B	V-600-AA	1¼" (32 mm) Vacuum Breaker Assembly
4C	V-600-AA	¾" (19 mm) Vacuum Breaker Assembly
4D	V-600-A	Vacuum Breaker Assembly
5	F-109	1½" (38 mm) Elbow Flush Connection
6A	F-56-A	1½" (38 mm) Spud Coupling Assembly
6B	F-57-A	1¼" (32 mm) Spud Coupling Assembly
6C	F-58-A	¾" (19 mm) Spud Coupling Assembly
7	H-634-AA	1" (25 mm) Sweat Solder Kit with Cast Set Screw Flange
	H-636-AA	¾" (19 mm) Sweat Solder Kit with Cast Set Screw Flange
8	V-651-A	High Back Pressure Vacuum Breaker Repair Kit
9	A-31	Handle Gasket

† Part number varies with valve model variation; consult factory.
‡ Length varies with valve model variation; consult factory.

NOTE: The information contained in this document is subject to change without notice.

SLOAN • 10500 SEYMOUR AVENUE • FRANKLIN PARK, IL 60131
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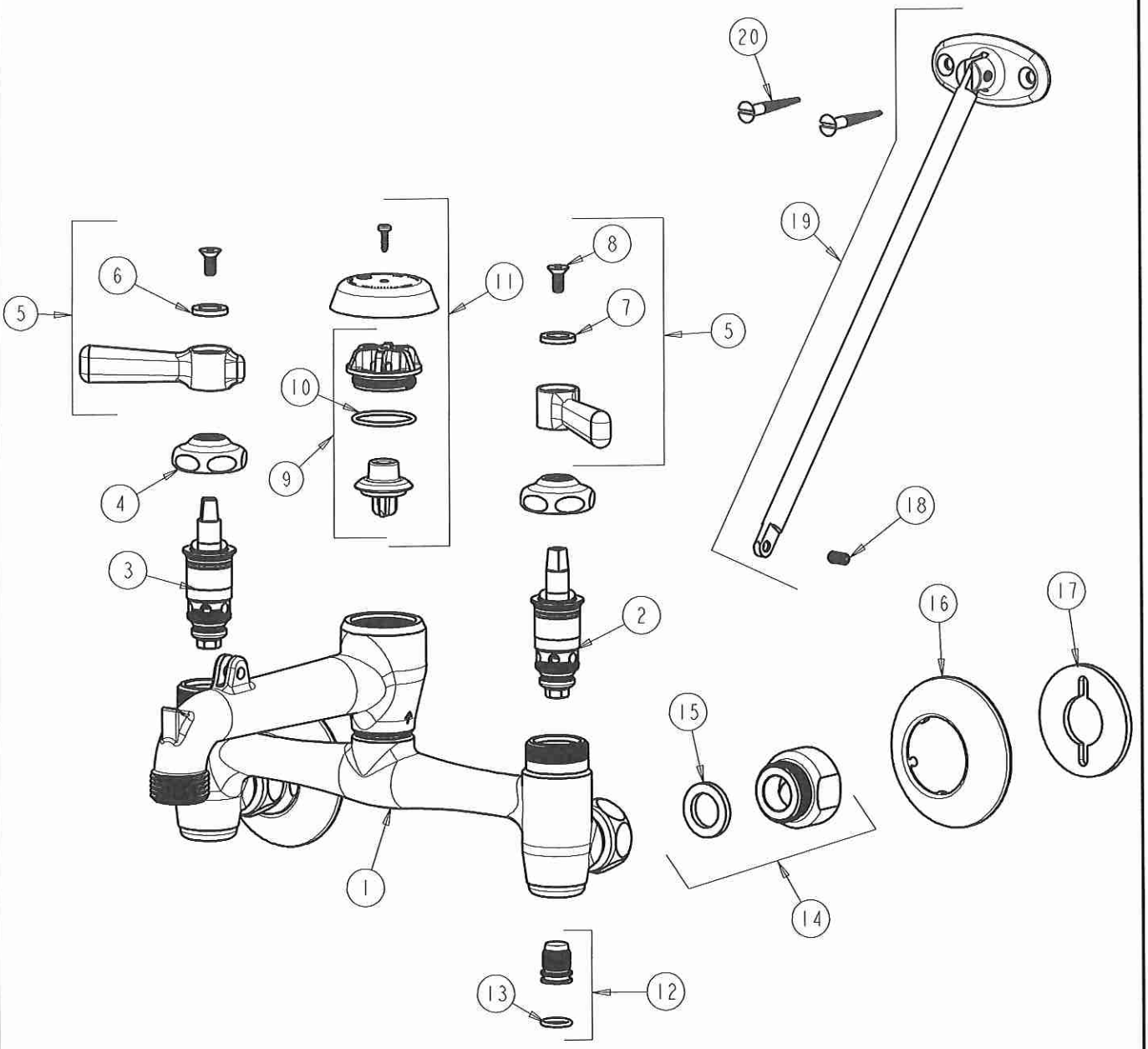
REPAIR PARTS

BY: SID	DATE: 10-03-00
CHK: JAR	REV: 06-22-15

FITTING NO.
897-RCF
SUBMITTED MODEL NO.

ITEM NO.



ITEM	PART NO.	DESCRIPTION	ITEM	PART NO.	DESCRIPTION
1	------	VALVE BODY (NOT SOLD SEPERATELY	11	892-402KJKABNF	KIT, VACUUM BREAKER ASSEMBLY
2	1-099XTJKABNF	QUATURN CARTRIDGE (RH)	12	897-014KJKRBF	INTEGRAL STOP STEM ASSEMBLY
3	1-100XTJKABNF	QUATURN CARTRIDGE (LH)	13	1104-007JKABNF	O RING
4	1-214JKCP	CAP	14	897-012JKRCF	ARM ASSEMBLY (INCLUDES WASHER)
5	369-PRJKCP	HANDLE, 2-3/8 LEVER (PAIR)	15	1-011JKABNF	WASHER, .97 X .62 X .12
6	633-023JKNF	INDEX BUTTON (RED)	16	633-201JKCP	WALL FLANGE
7	633-123JKNF	INDEX BUTTON (BLUE)	17	807-112JKNF	WASHER
8	420-020JKNF	SCREW, 1/8 FLAT HEX HEAD X 1/2	18	665-116JKNF	SET SCREW
9	892-302KJKABNF	VACUUM BREAKER REPAIR KIT	19	897-013KJKCP	BRACE ROD ASSEMBLY
10	80-007JKABNF	O RING 0.989 X .070	20	173-006JKCP	FLAT HEAD WOOD SCREW

Trapzilla®
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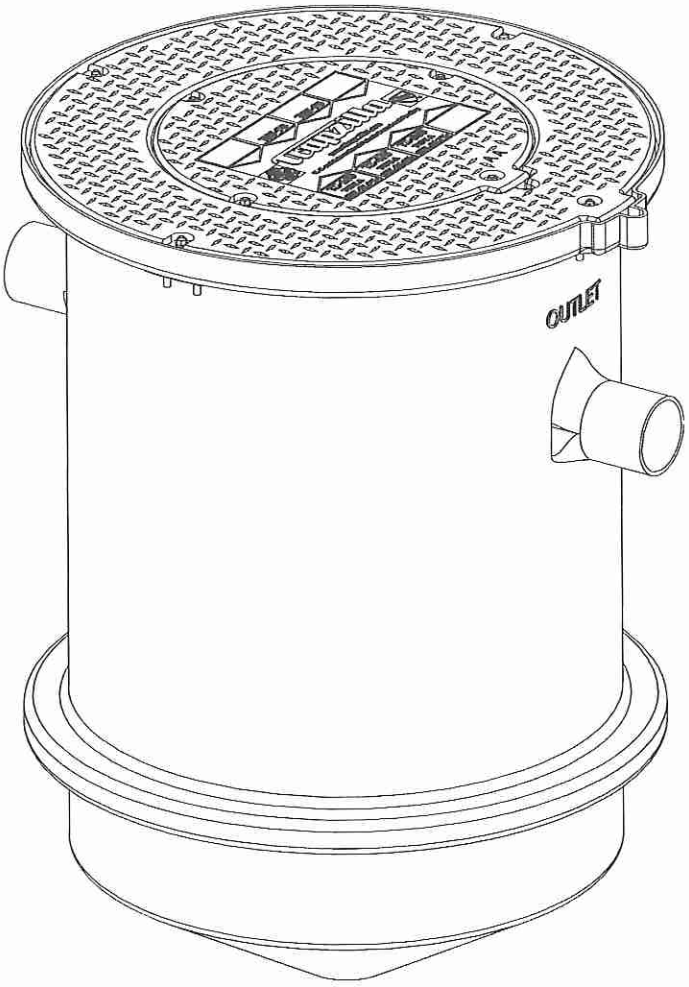
Installation & Maintenance Instructions For Trapzilla® Grease Interceptors



UPC®

Conforms to ASME Standard
ASME A112.14.3-2000
Please consult Thermaco, Inc. for specific models tested, certified and/or listed by these organizations.

CE*

Please consult Thermaco, Inc. for specific models tested, certified and/or listed by these organizations.

Toll Free: (800) 633-4204 • Phone: (336) 629-4651 • Fax: (336) 626-5739
info@thermaco.com • www.trapzilla.com

Trapzilla
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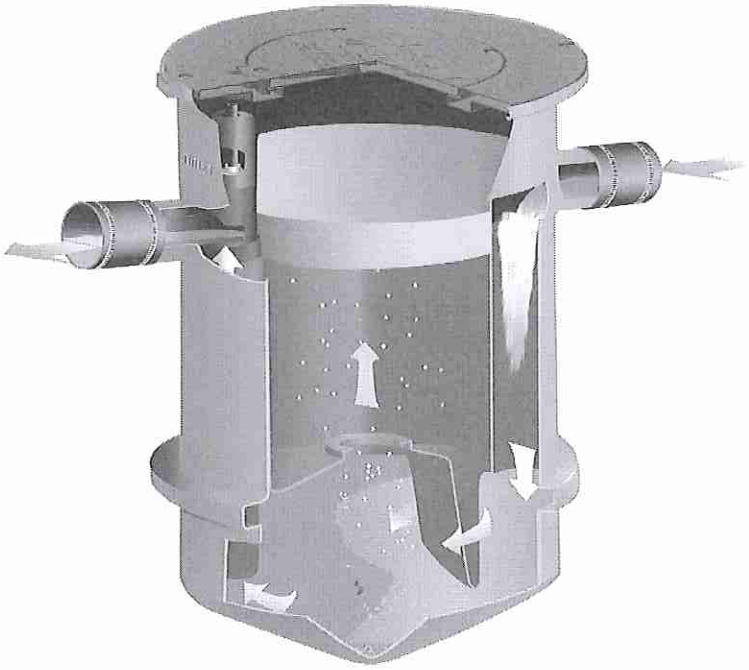
Table of Contents

Trapzilla® A THERMACO® Technology

Section I: Trapzilla® Grease Interceptors

System Overview

The **Thermaco, Inc. Trapzilla®** Supercapacity Grease Interceptor collects free-floating grease & oils contained in kitchen drain water flows. As most food service facility managers already know, grease buildup inside a building's grease containment system is a major cause of problems due to exterior drain line blockages. These problems jeopardize normal operations as well as create health and safety hazards within the facility itself.



The proper installation of a Trapzilla® Supercapacity Grease Interceptor can reduce or eliminate grease problems and costly sewer surcharges and fines through efficient separation and retention of free-floating grease & oils.

The Trapzilla offers patented flat separation curve technology. This means that the unit does not lose grease separation efficiency as it fills with retained grease. Thus, the Trapzilla stores large quantities of grease without losing efficiency. The unique compact design of the Trapzilla allows for installation into most facilities. Options are available that enable a Trapzilla unit to be installed on the floor, suspended from the ceiling or in-ground outside the facility.

Trapzilla units are designed to treat high flows of kitchen drainwater with large grease storage capacity within a small footprint unit. These units are easy to manueuver into position and just as easy to plumb.

Grease interceptors, grease traps, automatic recovery units, grease removal devices and other similar plumbing devices receiving kitchen flows from sinks, floor drains, woks and other food bearing sources may generate odors. There are many factors influencing odor evolution and dissemination. These include room ventilation, kitchen menu, ambient temperatures, ware washing practices, grease/oil input, daily input fluid volume, sanitizers, installation plumbing design and product maintenance/upkeep. Odors are usually prevented by good area ventilation, frequent fluid inputs, good product maintenance practices and proper product installation. Additional steps, including aeration, chlorination, pH control, improved area ventilation and additional maintenance may be needed at some sites.

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Section II: Models and Options

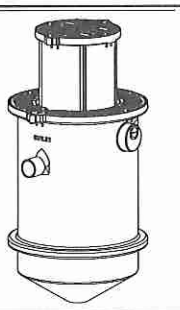
In-Ground Models

TZ-600-ECA

635 pounds of grease storage, ASME rated at 75 gpm, while hydromechanically capable of flow rates of up to 150 gpm. Equipped with 4" inlet/outlet, 2" vessel vent connection, and 4" Low-Head Flow Control Accessory to limit flow to 75 gpm.

Comes with: 18" tall Extension Collar Adapter Lid Assembly with 22" diameter lid.

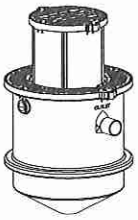
*Model available with 6" Inlet/Outlet, add suffix -6 to model.



TZ-400-ECA

405 pounds of grease storage, ASME rated at 75 gpm. Equipped with 4" inlet/outlet, 2" vessel vent connection, and 4" Low-Head Flow Control Accessory to limit flow to 75 gpm.

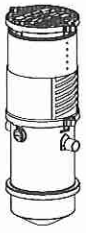
Comes with: 18" tall Extension Collar Adapter Lid Assembly with 22" diameter lid.



TZ-160-ECA

167 pounds of grease storage, ASME rated at 35 gpm. Equipped with 3" inlet/outlet, 2" vessel vent connection, and 3" Low-Head Flow Control Accessory to limit flow to 35 gpm.

Comes with: 22" diameter lid and 29" Telescoping Extension Collar.



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Section II: Models and Options

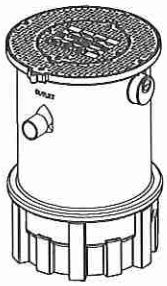
Above-Ground Models

TZ-600-SSA

635 pounds of grease storage, ASME rated at 75 gpm, while hydromechanically capable of flow rates of up to 150 gpm. Equipped with 4" inlet/outlet, 2" vessel vent connection, and 4" Low-Head Flow Control Accessory to limit flow to 75 gpm.

Comes with: Standard Adapter Top Cover with 22" diameter lid, and Support Stand SSOP-400/600.

*Model available with 6" Inlet/Outlet, add suffix -6 to model.



TZ-400-SSA

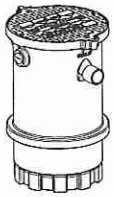
405 pounds of grease storage, ASME rated at 75 gpm. Equipped with 4" inlet/outlet, 2" vessel vent connection, and 4" Low-Head Flow Control Accessory to limit flow to 75 gpm.

Comes with: Standard Adapter Lid Ring with 22" diameter lid, and Support Stand SSOP-400/600.

TZ-160-SSA

167 pounds of grease storage, ASME rated at 35 gpm. Equipped with 3" inlet/outlet, 2" vessel vent connection, and 3" Low-Head Flow Control Accessory to limit flow to 35 gpm.

Comes with: 22" diameter lid and Support Stand SSA-160.



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Section II: Models and Options

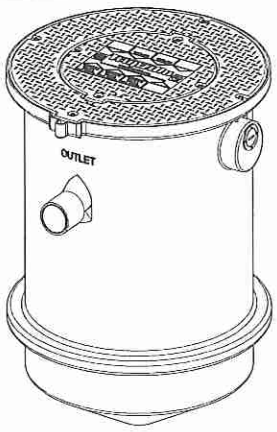
Basic Models

TZ-600

635 pounds of grease storage, ASME rated at 75 gpm, while hydromechanically capable of flow rates of up to 150 gpm. Equipped with 4" inlet/outlet, 2" vessel vent connection, and 4" Low-Head Flow Control Accessory to limit flow to 75 gpm.

Comes with: Standard Adapter Lid Ring with 22" diameter lid.

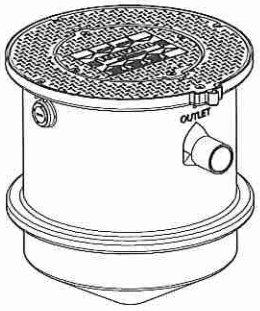
*Model available with 6" Inlet/Outlet, add suffix -6 to model.



TZ-400

405 pounds of grease storage, ASME rated at 75 gpm. Equipped with 4" inlet/outlet, 2" vessel vent connection, and 4" Low-Head Flow Control Accessory to limit flow to 75 gpm.

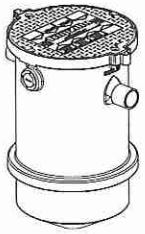
Comes with: Standard Adapter Lid Ring with 22" diameter lid.



TZ-160

167 pounds of grease storage, ASME rated at 35 gpm. Equipped with 3" inlet/outlet, 2" vessel vent connection, and 3" Low-Head Flow Control Accessory to limit flow to 35 gpm.

Comes with: 22" diameter lid.



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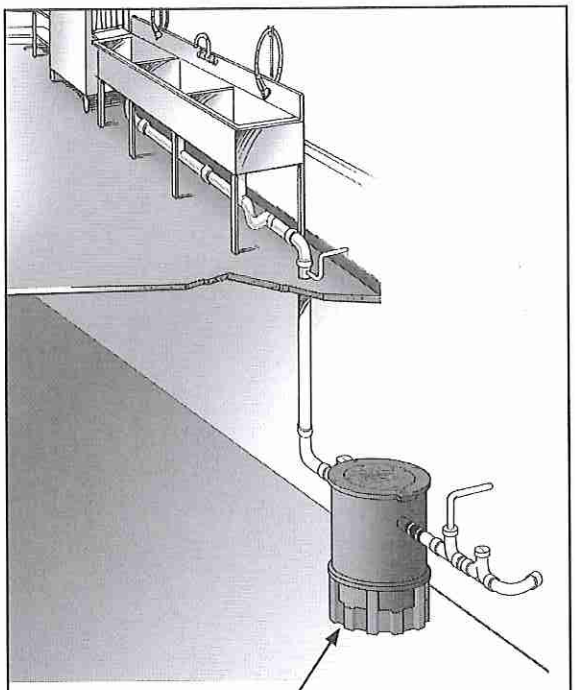
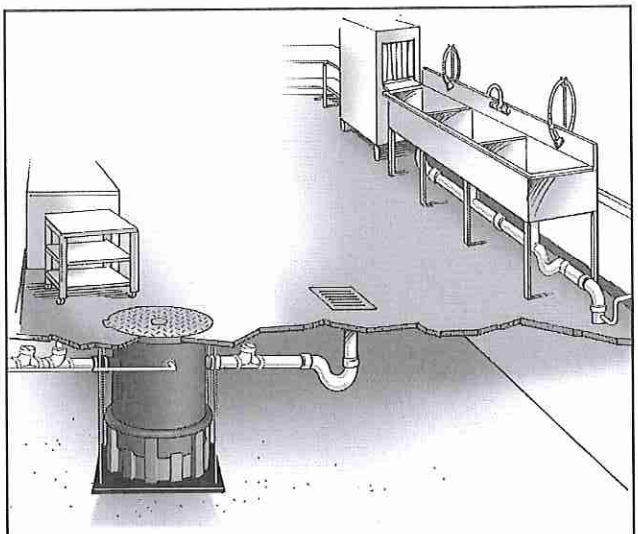
Section II: Models and Options

Options



SSOP-400/600
Support Stand for TZ-400 and TZ-600 models
Allows unit to be installed directly on the floor in a basement or mechanical room.
***Included with -SSA Models**



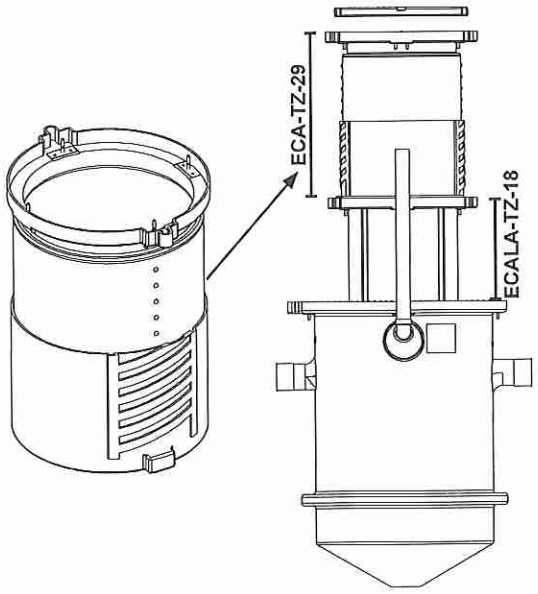
FTCA-36
Fabricated Top Cover Assembly with 36" diameter for additional traction in high foot-traffic areas and 4" Brass cleanout port.

FTCA-22 (not shown)
22" diameter cover available for In-Ground installations.

ECA-TZ-29 (in blue) for Trapzilla Models

These field-modifiable extension collars available to provide additional depth for existing kitchen drainage piping.

-ECA Models ship with built-in 0-18" extension collar.
ECA-TZ-29 adds 0-29" depth to -ECA Models or 4-29" to Basic Models.



Trapzilla® A THERMACO® Technology

Section III: Trapzilla® Installation

Plumbing Installation

Locating the Unit

The system should be visible and easily accessible for maintenance and inspection. Options are available to install the Trapzilla in a basement, suspended from a ceiling or in-ground in an exterior location. Make sure adequate room is provided around the unit to allow easy access for a pump truck operator. Make sure the height above the Trapzilla access cover is enough to properly service the system.

Inlet/Outlet Piping

The inlet and outlet piping connections require flexible sleeve pipe couplings. Keep outlet piping as straight as possible. Thermaco, Inc. recommends installation of Two-Way Cleanouts on both the Inlet and Outlet of Trapzilla Interceptors and Solids Separators in accordance with all applicable laws, regulations and codes. **These cleanouts should match the size of the Inlet and Outlet Piping (i.e. for 4" plumbing, a 4" cleanout should be used).** Use only "sweep" connections. Do not reduce the pipe sizing on the outlet piping. Do not install "P" trap on outlet connection of system. (Note: The system already has a internal gas trap)

Flow Controls

Trapzilla systems are supplied with a Low-Head Flow Control module (LHFC). This should be connected to the inlet of the Trapzilla unit in situations where flow rate needs to be restriced to the ASME rated flow or when vented flow control is required by local code.

Venting the Outlet

An outlet vent or approved air admittance valve of at least 1/2 the diameter of the system's outlet connection must be present as close as possible to the Trapzilla outlet to prevent possible siphonage problems. The Vent on the Outlet piping is to be installed in accordance with all applicable laws, regulations and codes. Failure to provide a vent for the system voids Thermaco's Limited Warranty for the system.

For High Head Height Applications Over Six (6) Feet (1.95 m)

For installations where there is head height of greater than 6 feet (1.95 meters), Thermaco, Inc. recommends installation of a code-approved Vented Flow Control Assembly (Thermaco VFCA not included with Trapzilla).

Note: Drawings for reference only. Equipment must be installed in compliance with all applicable laws, regulations and codes, including plumbing codes. Installation should be performed by a qualified plumber.

Trapzilla® A THERMACO® Technology

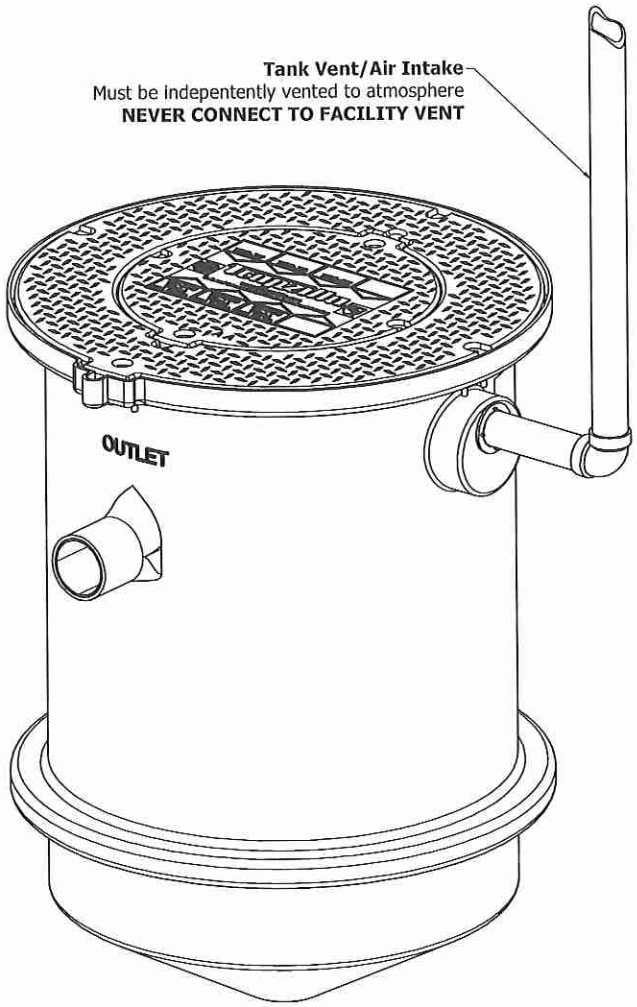
Section III: Trapzilla® Installation

Plumbing Installation

Venting of the Trapzilla tank is recommended by the manufacturer and required for in-door installations.

- Vent the tank through the provided 2" NPT threaded connector on the side of the tank (This vent may be located above the outlet or on the side of the tank depending on model).
- Remove and discard the 2" plug and connect 2" vent lines as indicated below.

**Models with 6" Inlet/Outlet have 3" NPT vessel vent



Note: Drawing for reference only. Equipment must be installed in compliance with all applicable laws, regulations and codes, including plumbing codes. Installation should be performed by a qualified plumber.

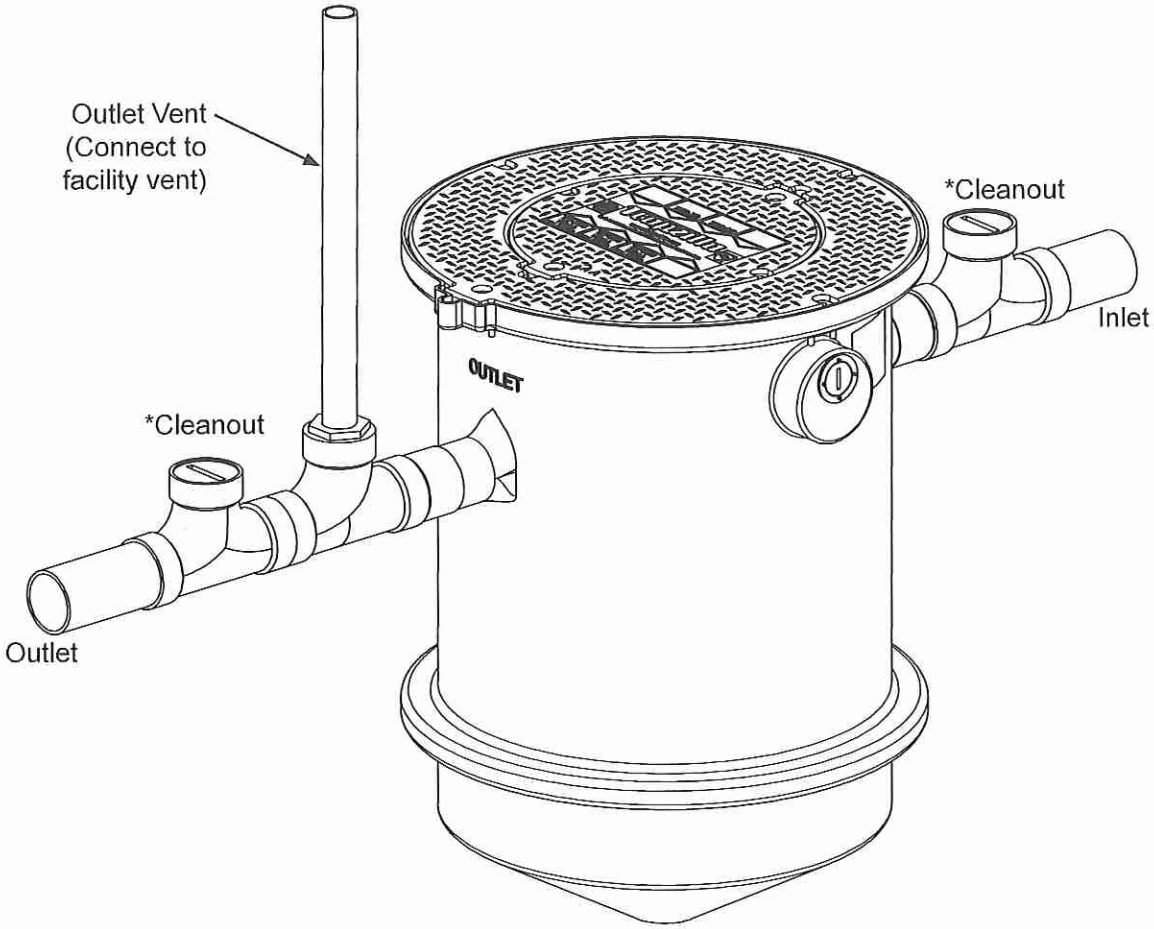
Trapzilla® A THERMACO® Technology

Section III: Trapzilla® Installation

Plumbing Installation

Plumbing Installation (for one Trapzilla GI)

Each Trapzilla unit is shipped with a Low Head Flow Control module (see LHFC box for additional instructions). This needs to be installed to the inlet of the Trapzilla and connected to a code-approved air intake. Thermaco, Inc. recommends installation of Two-Way Cleanouts on both the Inlet and Outlet of Trapzilla® in accordance with all applicable laws, regulations and codes. **These cleanouts should match the size of the Inlet and Outlet Piping (i.e. for 4" plumbing, a 4" cleanout should be used).** A Vent on the Outlet piping is also to be installed in accordance with all applicable laws, regulations and codes.



*Use a Two-Way Cleanout before and after all Trapzilla Installations

Note: Drawing for reference only. Equipment must be installed in compliance with all applicable laws, regulations and codes, including plumbing codes. Installation should be performed by a qualified plumber.

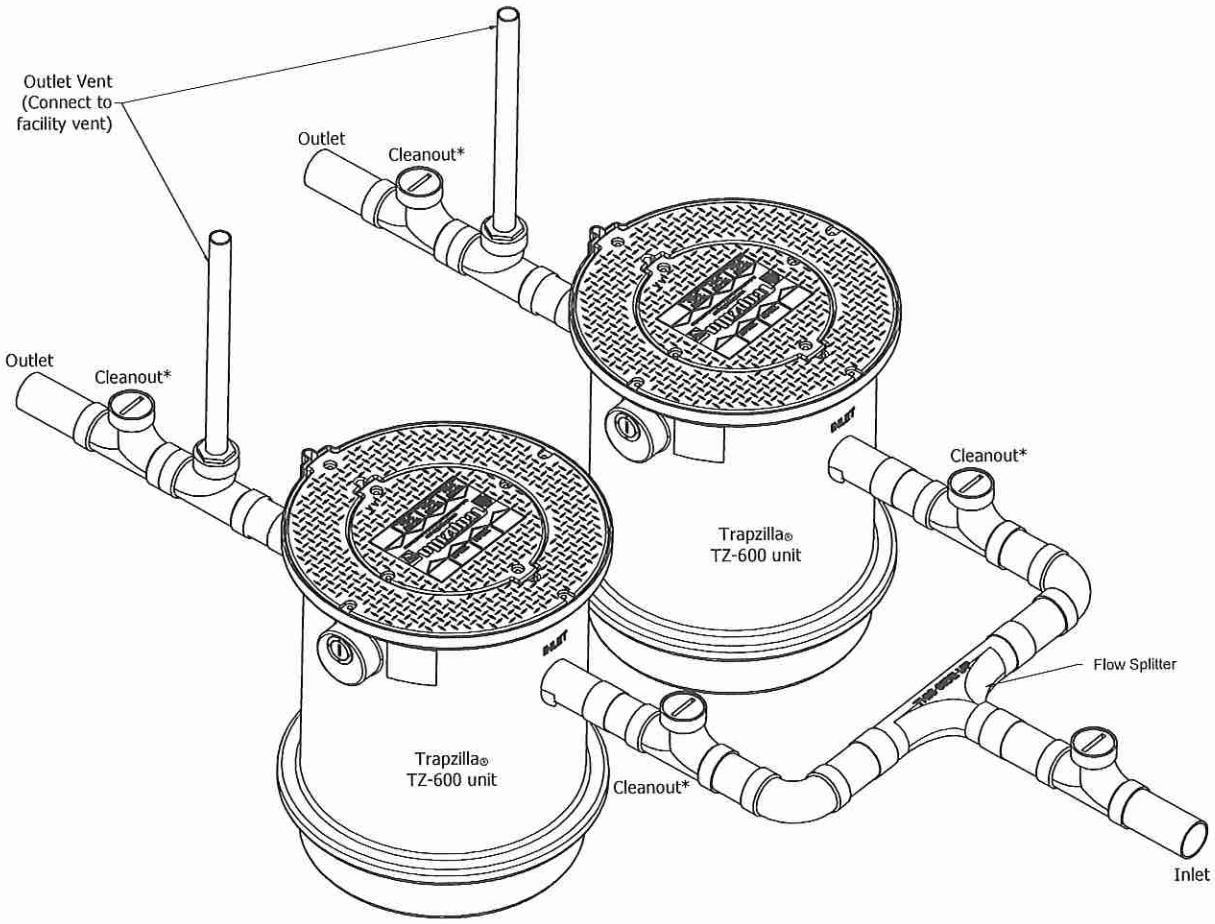
Trapzilla® A THERMACO® Technology

Section III: Trapzilla® Installation

Configurations

Two Trapzilla Units

Two Trapzilla Grease Interceptors should be installed in parallel with a Flow Splitter diverting the flow. Place Two-Way Cleanouts before, between and after the units as shown below, including before and after the flow splitter. Make sure to connect an outlet vent after each Trapzilla Grease Interceptor. A Low Head Flow Control (LHFC) is shipped with each unit, and if needed should only be installed after the first Cleanout and before the Flow Splitter.



*Use a Two-Way Cleanout before and after all Trapzilla Installations

Note: Drawing for reference only. Equipment must be installed in compliance with all applicable laws, regulations and codes, including plumbing codes. Installation should be performed by a qualified plumber.

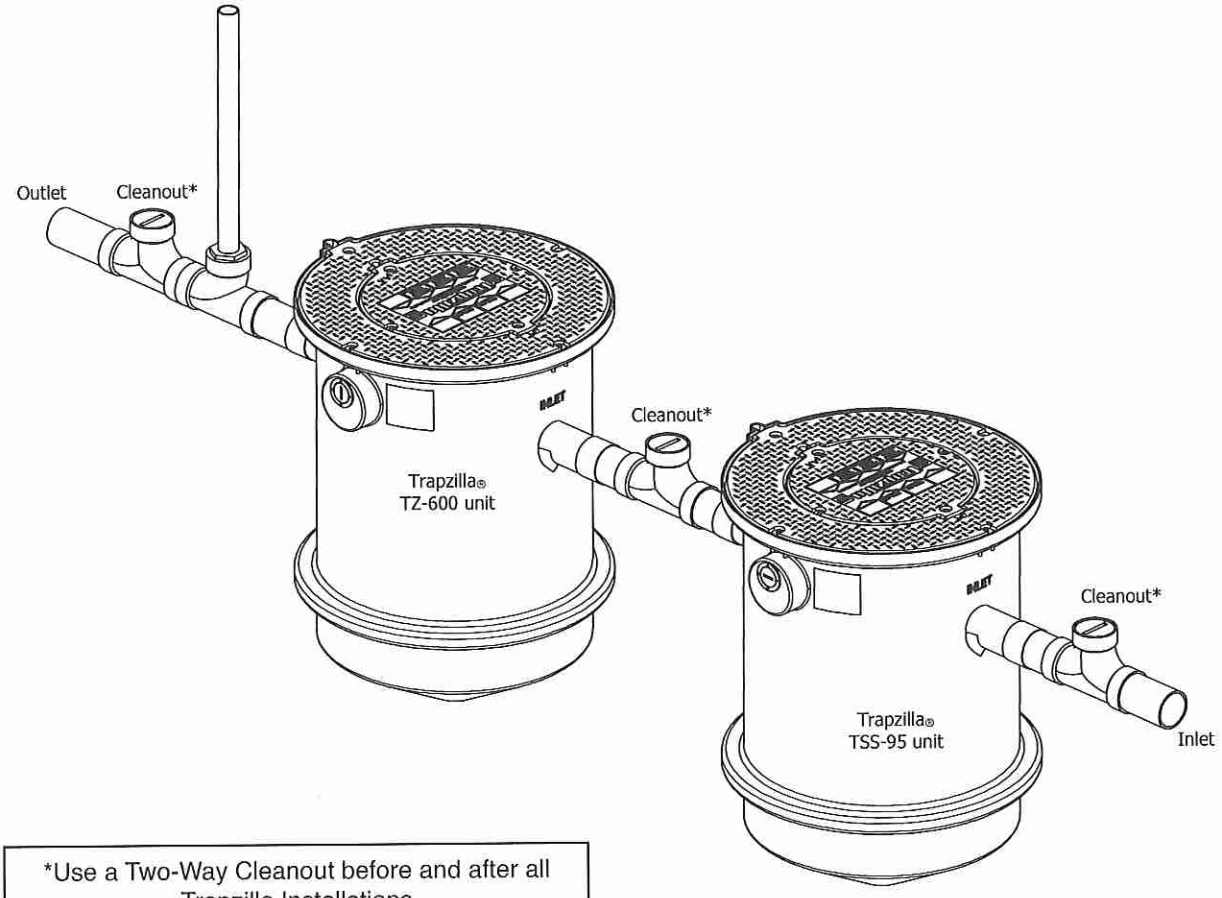
Trapzilla® A THERMACO® Technology

Section III: Trapzilla® Installation

Configurations

Two Trapzilla GI's in Series or One Solids Separator and One Trapzilla

Alternatively, two Trapzilla Grease Interceptors may be installed in series. A single Trapzilla Solids Separator and Trapzilla Grease Interceptor should always be installed in series. Place Two-Way Cleanouts before, between and after the units as shown below. Make sure to con- nect an outlet vent after the Trapzilla Grease Interceptor. A Low Head Flow Control (LHFC) is shipped with each unit, and if needed should only be installed after the first Cleanout and before the Trapzilla Solids Separator.



*Use a Two-Way Cleanout before and after all Trapzilla Installations

Note: Drawing for reference only. Equipment must be installed in compliance with all applicable laws, regulations and codes, including plumbing codes. Installation should be performed by a qualified plumber.

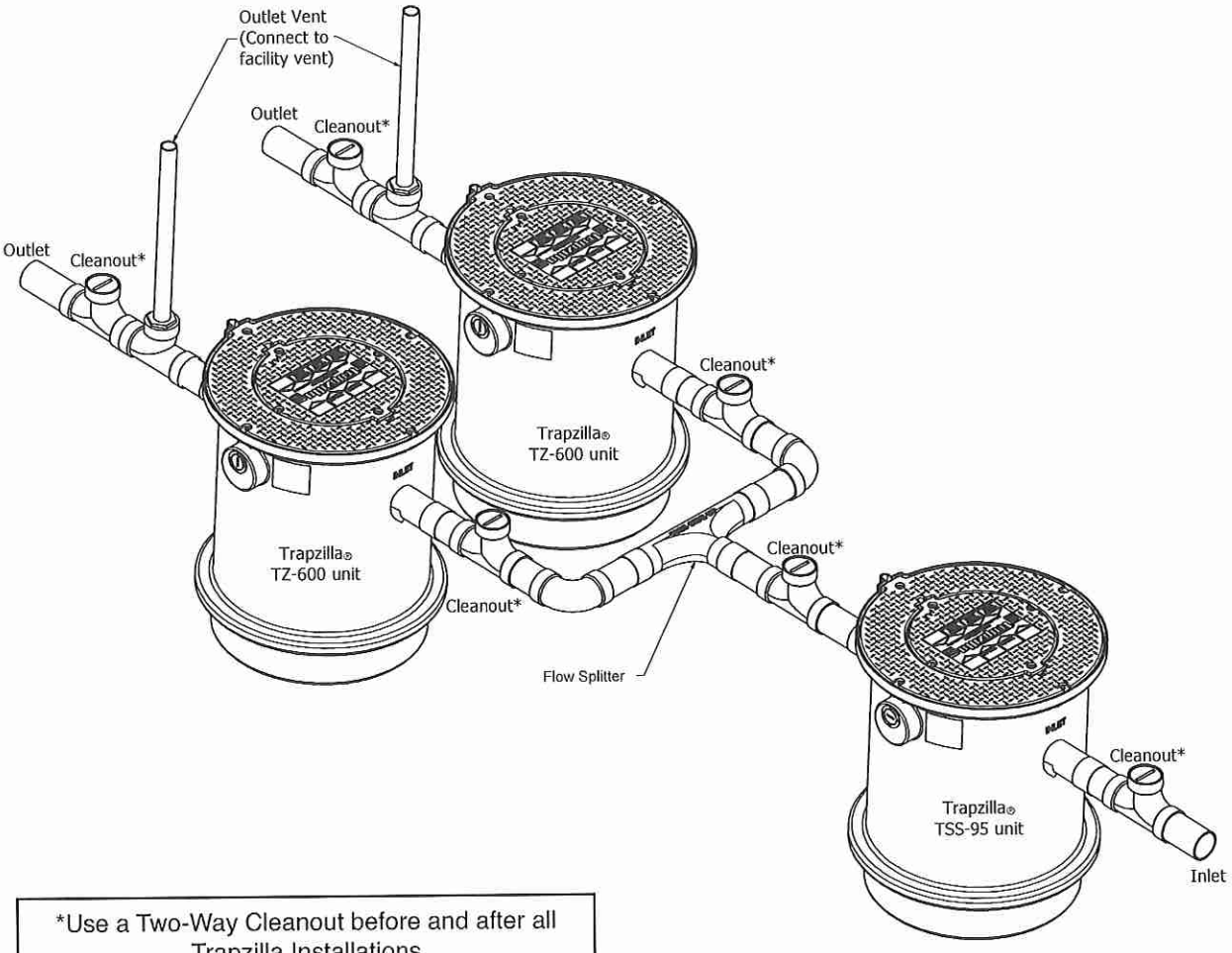
Trapzilla® A THERMACO® Technology

Section III: Trapzilla® Installation

Configurations

One Solids Separator and Two Trapzilla Units

A single Trapzilla Solids Separator and two Trapzilla Grease Interceptors should be installed by placing the Solids Separator in line and then using a Flow Splitter to divert the water flow to two separate Trapzilla units in parallel. Place Two-Way Cleanouts before, between and after the units as shown below, including before and after the flow splitter. Make sure to connect an outlet vent after the Trapzilla Grease Interceptor. A Low Head Flow Control (LHFC) is shipped with each unit, and if needed should only be installed after the first Cleanout and before the Trapzilla Solids Separator.



*Use a Two-Way Cleanout before and after all Trapzilla Installations

Note: Drawing for reference only. Equipment must be installed in compliance with all applicable laws, regulations and codes, including plumbing codes. Installation should be performed by a qualified plumber.

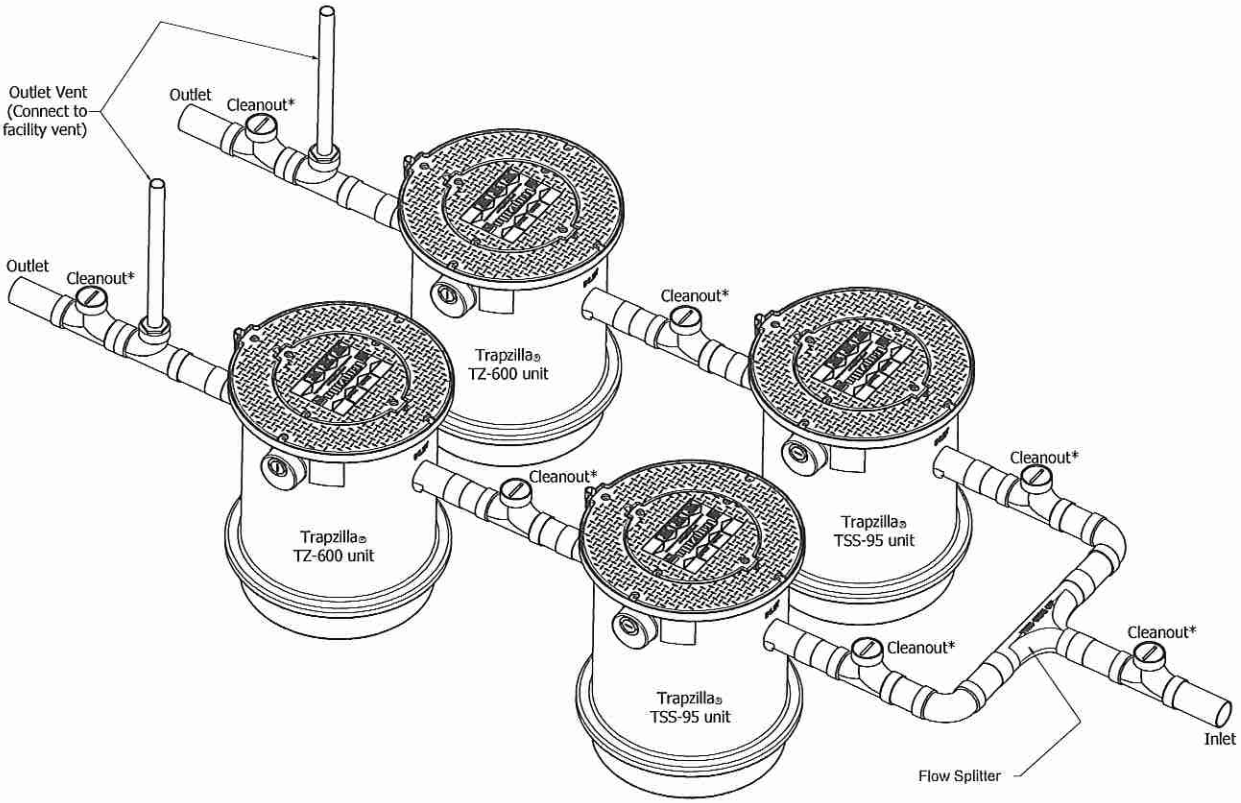
Trapzilla® A THERMACO® Technology

Section III: Trapzilla® Installation

Configurations

Two Solids Separators and Two Trapzilla Units

Two Trapzilla Solids Separator and two Trapzilla Grease Interceptors should be installed by placing a Flow Splitter to divert the water flow to two separate Solids Separators and Trapzilla units in parallel. Place Two-Way Cleanouts before, between and after the units as shown below, including before and after the flow splitter. Make sure to connect an outlet vent after the Trapzilla Grease Interceptor. A Low Head Flow Control (LHFC) is shipped with each unit, and if needed should only be installed after the first Cleanout and before the Flow Splitter.



*Use a Two-Way Cleanout before and after all Trapzilla Installations

Note: Drawing for reference only. Equipment must be installed in compliance with all applicable laws, regulations and codes, including plumbing codes. Installation should be performed by a qualified plumber.

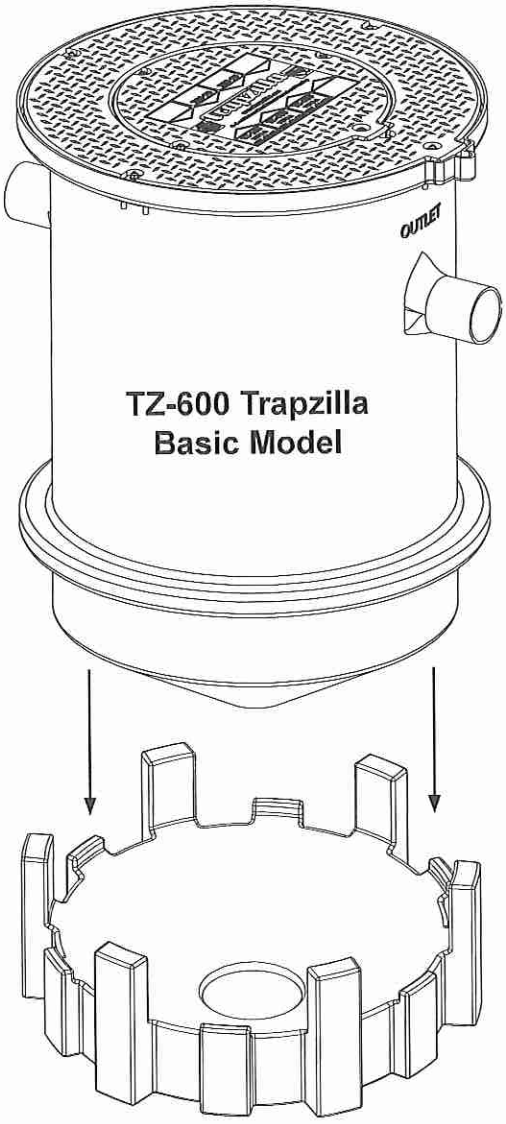
Trapzilla® A THERMACO® Technology

Section III: Trapzilla® Installation

Above-Ground Installation

Using a model-specific Support Stand, a Trapzilla unit may be installed directly on top of the floor in a location such as a basement or mechanical room.

TZ 400 or TZ-600: SSOP-400/600
TZ-160: SSA-160
***These items ship with all -SSA models.**



TZ-600 Trapzilla Basic Model

NOTE: SUPPORT STAND MUST BE INSTALLED OVER A CONTINUOUS SURFACE. NON-CONTINUOUS SURFACES SUCH AS GRATES ARE NOT SUITABLE FOR SUPPORT.

SSOP-400/600 Support Stand

The SSOP Support Stand is a one-piece assembly with a conical center that sits on the floor. It does not add appreciable height to the assembly.

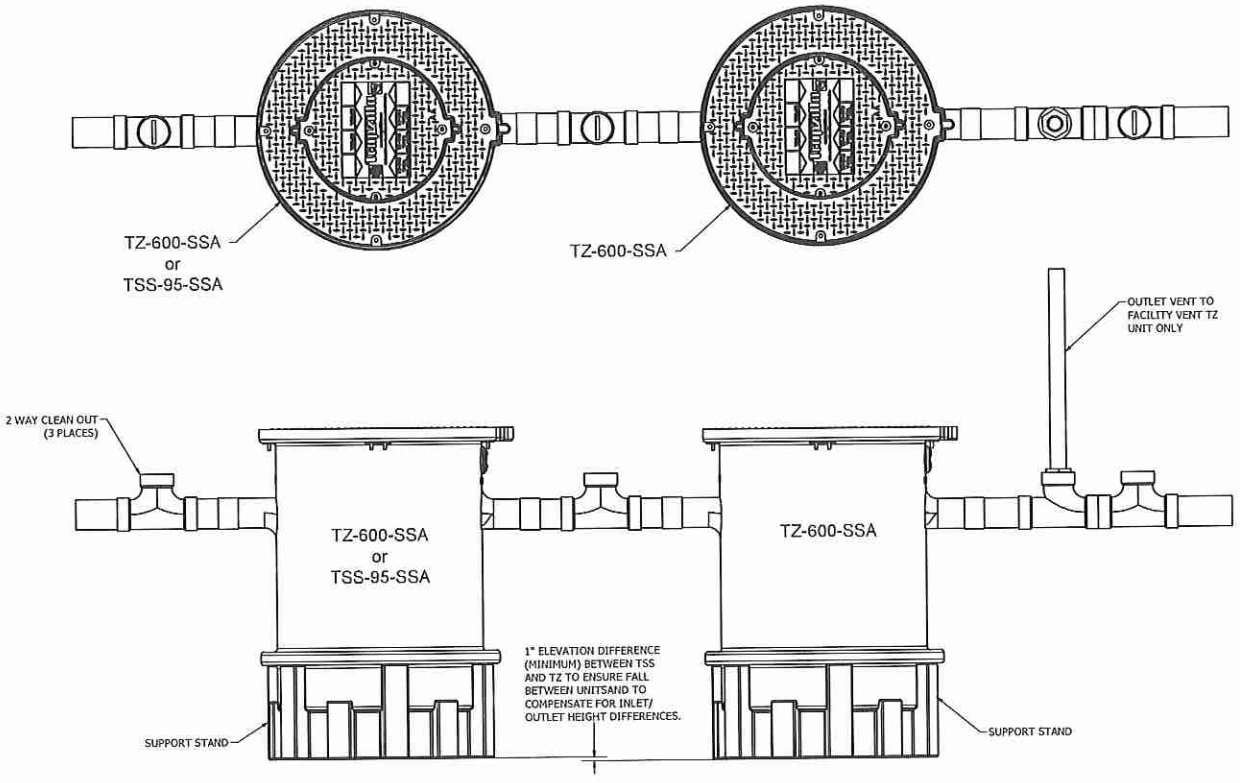
Trapzilla® A THERMACO® Technology

Section III: Trapzilla® Installation

Above-Ground Installation

When installing multiple Trapzilla units in series, the change in elevation from the inlet to the outlet of a unit requires that each preceeding unit be installed 1" higher than the unit after it. For above-ground units, pressure treated plywood may be placed fully beneath the support stand to create the height difference.

All installations inside of a building must have a vessel vent installed and piped to atmosphere.



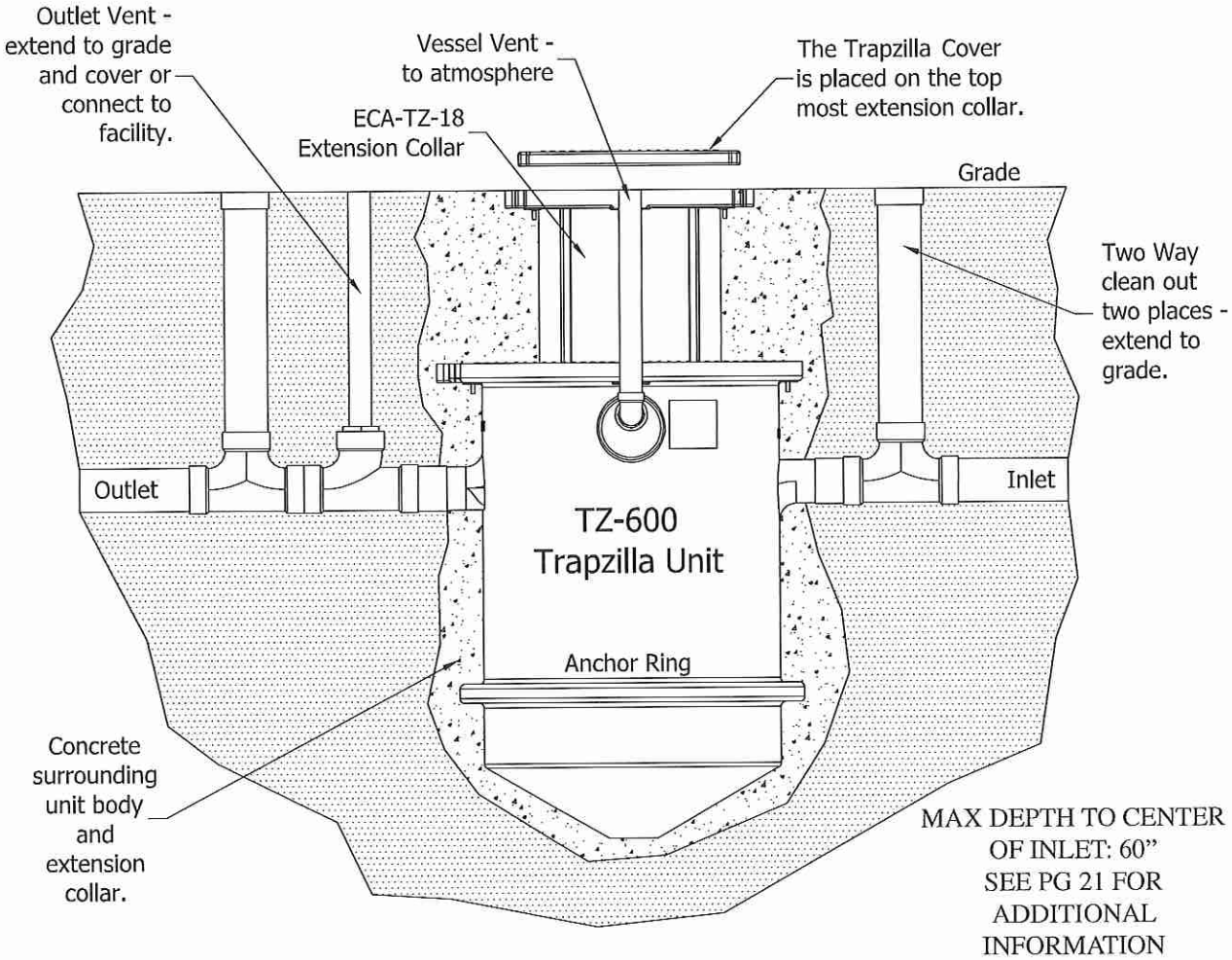
Trapzilla® A THERMACO® Technology

Section III: Trapzilla® Installation

In-Ground Installation

A Trapzilla unit may also be installed in the ground outside of the facility. For instances where the facility drainage piping requires an extension collar that is no more than 18", use the instructions for the full TZ-600-ECA unit. If the unit is to be deeper in the ground, the ECA-TZ-29 Extension Collar Assembly may be installed to align the Trapzilla inlet with the drainage piping. The ECA-TZ-29 may be trimmed in the field to fit. Trim both the inner and outer portions of the extension collar to make shorter than collapsed height. Thermaco, Inc. strongly recommends surrounding the in-ground Trapzilla with concrete to provide additional structural strength and to offset buoyancy effects. For Buoyancy Calculations & suggested concrete fill quantities please see page 21. Use the full TZ-600-ECA for 0-18" of collar needed or purchase separately the TZ-600 and ECA-TZ-29 for 4-29" of collar needed.

In-Ground Installations inside of a building must have a vessel vent installed and piped to atmosphere.



* Units using additional extension collars must use adapter lid and/or extension collars included with unit.

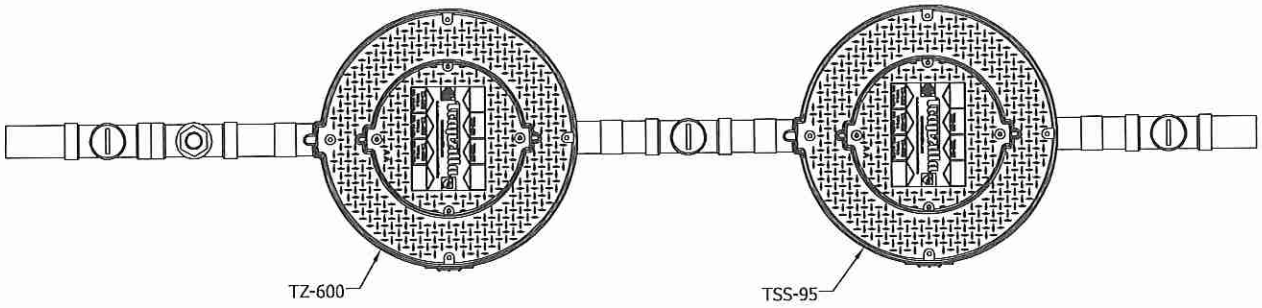
Trapzilla® A THERMACO® Technology

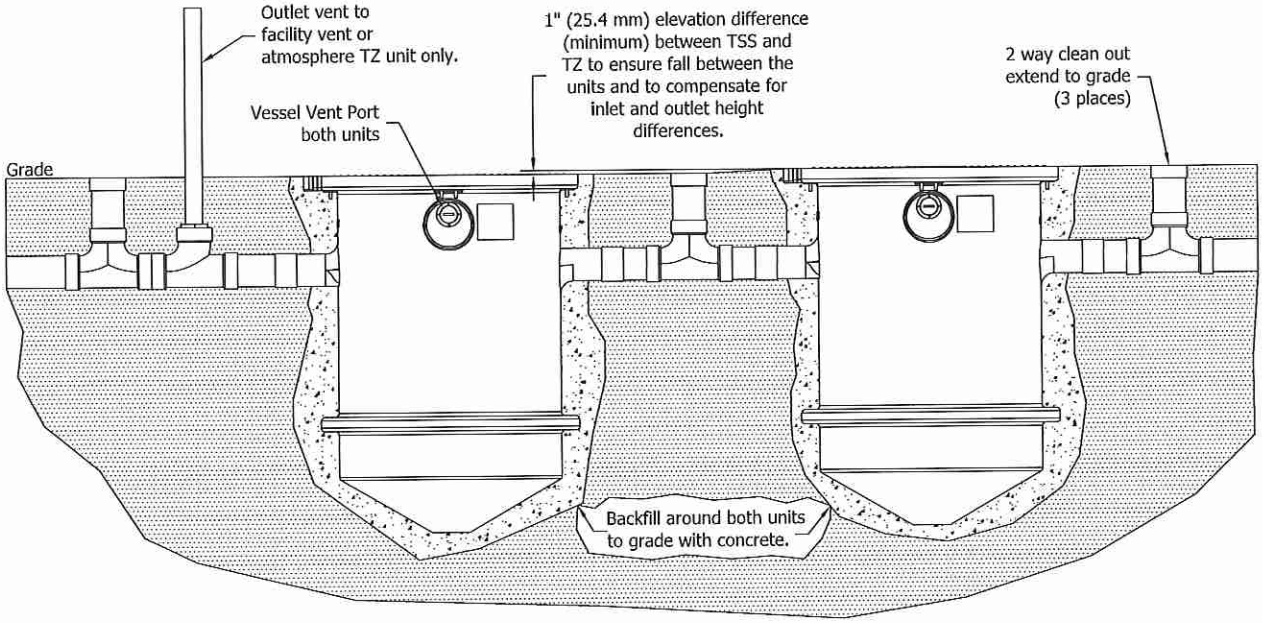
Section III: Trapzilla® Installation

In-Ground Installation

When installing multiple Trapzilla units in series, the change in elevation from the inlet to the outlet of a unit requires each preceeding unit to be installed 1" higher than the unit after it.

In-Ground Installations inside of a building must have a vessel vent installed and piped to atmosphere.





* Units using additional extension collars must use adapter lid and/or extension collars included with unit.

Trapzilla® A THERMACO® Technology

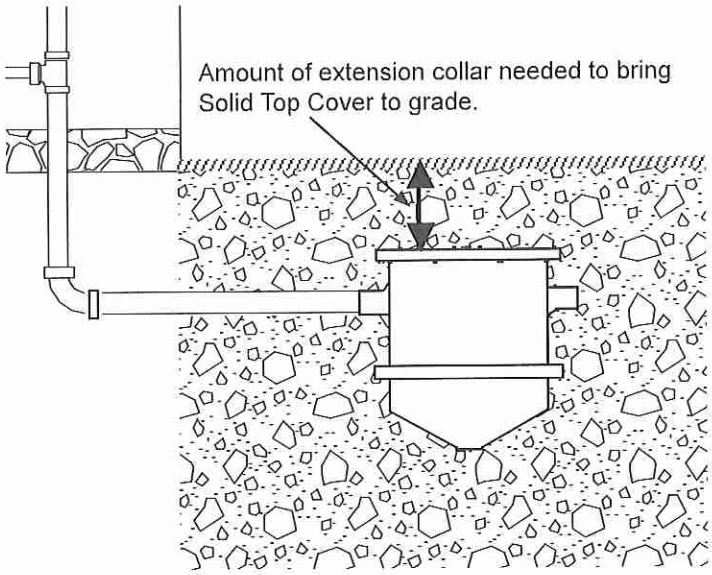
Section III: Trapzilla® Installation

In-Ground Installation

Trimming and Setting the ECA-TZ-18 Single-Piece Extension Collar

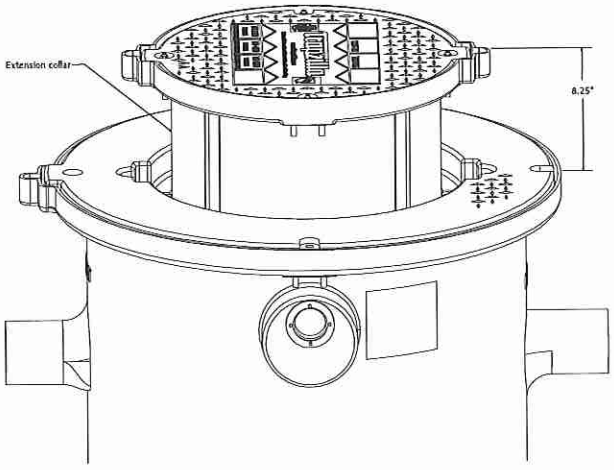
In-Ground Trapzilla Models ship with a built-in, single-piece, 18" extension collar that must be trimmed and then set to the correct height to bring the Solid Top Cover to grade.

Follow the steps below to set the extension collar prior to backfilling the hole with concrete.

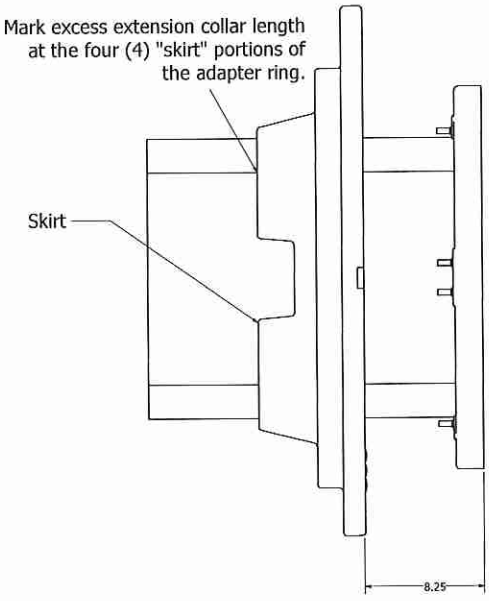


Step 1: With the Trapzilla unit installed in its permanent location, raise the telescoping extension collar to finished grade or floor level. Measure the height from the top of the unit to this finished extension collar height and record this dimension.

Note: If the floor will have a tile covering alow for the tile thickness when determining the extension collar height.



Step 2: Remove the extension collar adapter ring from the unit with the extension collar still in place. On the underside of the cover, mark the excess extension collar length at the bottom of the four (4) "skirt" portions of the adapter ring. Check the extension collar height dimension frequently during this marking to ensure that the collar has not moved. Extend this mark between the gaps in the "skirt" so that the collar is marked all around.

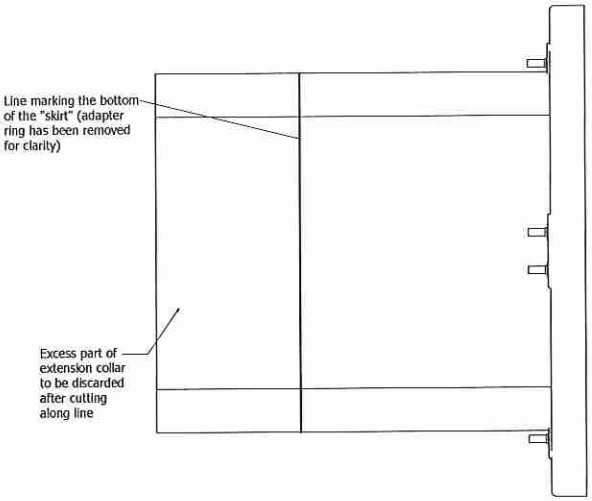


Trapzilla® A THERMACO® Technology

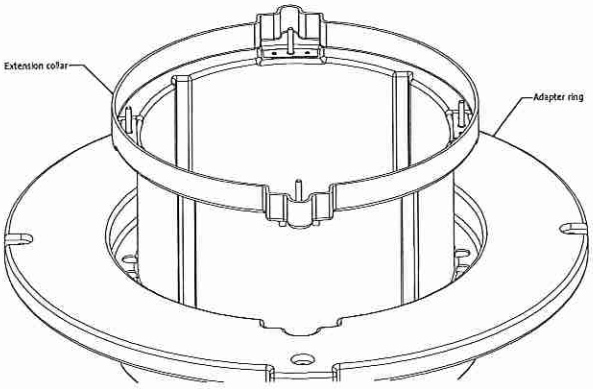
Section III: Trapzilla® Installation

In-Ground Installation

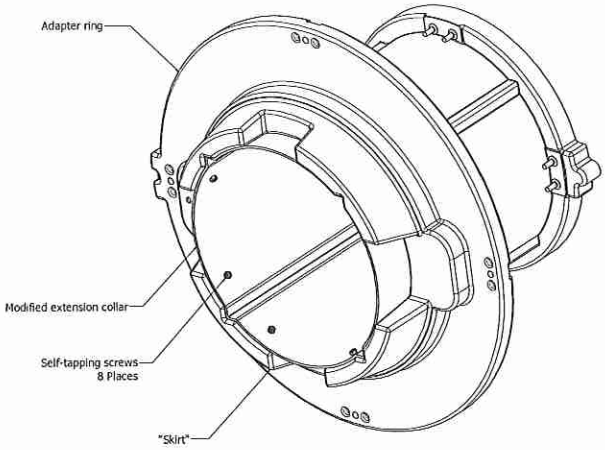
Step 3: Remove the extension collar from the adapter ring and, with an appropriate saw, cut along the line created in Step 2 to remove the excessive extension collar.



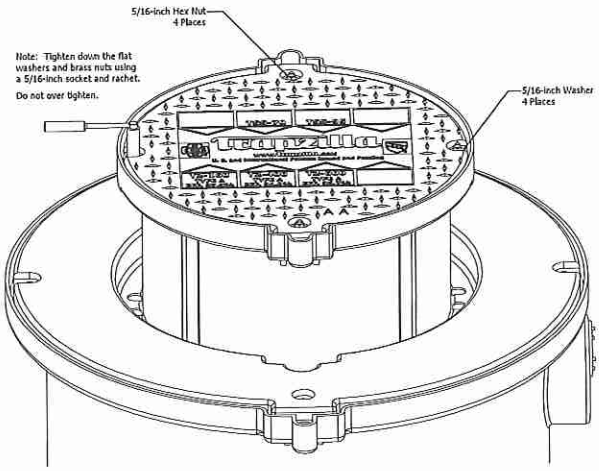
Step 4: Reinsert the extension collar into the adapter ring ensuring that the cover alignment key on the extension collar is aligned with its recess in the adapter ring. Reset the extension collar height to the dimension determined in Step 1.



Step 5: Working from the bottom of the assembly, install eight (8) self-drilling, self-tapping screws (provided) through the extension collar wall and into the adapter ring. Two of these screws should be installed in each of the four (4) skirt areas of the adapter ring. Check the extension collar height dimension frequently during this operation to ensure that the collar has not moved. Note: Use caution when tightening these screws to ensure that they do not strip.



Step 6: Place the adapter ring/extension collar assembly onto the Trapzilla unit. Position the small cover onto the extension collar. Secure the adapter ring and the small cover with the brass nuts and flat washers provided. Seal the gap between the 18" extension collar and extension collar adapter ring using a silicone sealant.



Trapzilla® A THERMACO® Technology

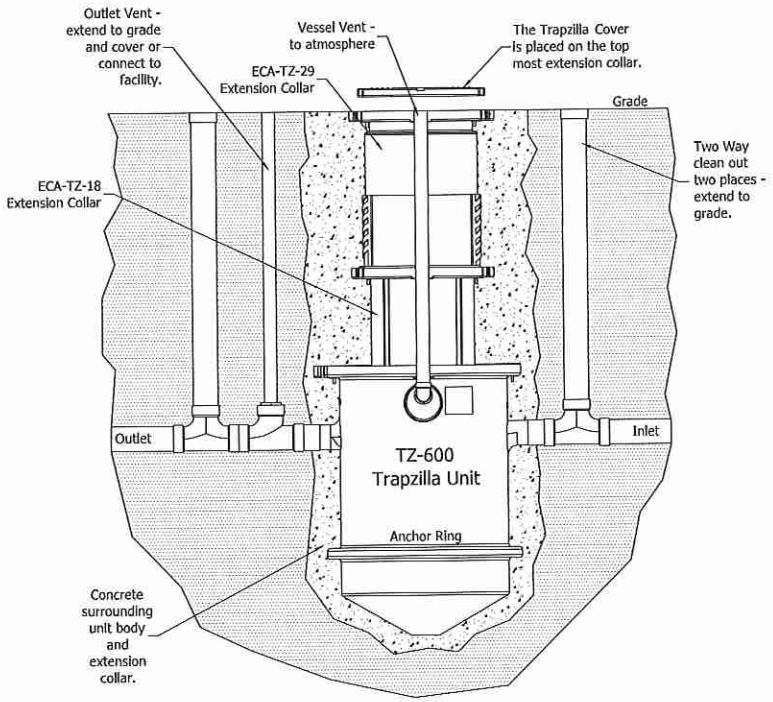
Section III: Trapzilla® Installation

In-Ground Installation

In order to offset the effects of buoyancy caused by groundwater (high water tables), strengthen the sideload of the unit, and prevent movement of the unit in the event of shifting earth, Thermaco, Inc. recommends concrete be poured around the entirety of Trapzilla® units installed in-ground in the amounts of concrete specified in the table below. The concrete must to be poured continuously and completely surrounding the Trapzilla® body (and Extension Collars if applicable) to ensure proper strength and security at a compression strength of 4000 psi (C28/35).

Concrete Calculations for TZ Models/Components*

Trapzilla Model	Amount of Concrete	
	Weight in lbs. (Kg)	Volume in Cubic Yards (m^3)
TZ-600-ECA	1975	0.50
TZ-400-ECA	1525	0.40
TZ-160-ECA	550	0.15
ECA-TZ-29*	600	0.20



Pictured Left:
Installation of TZ-600-ECA unit with Built-In 18" Extension Collar fully extended and 29" Two-Piece Extension Collar fully extended for a total of 47" of additional depth for unit. Concrete should fully encircle the unit up to the surface. A small amount of space (up to 4") may be left unfilled to cover with dirt and grass if installed outside.

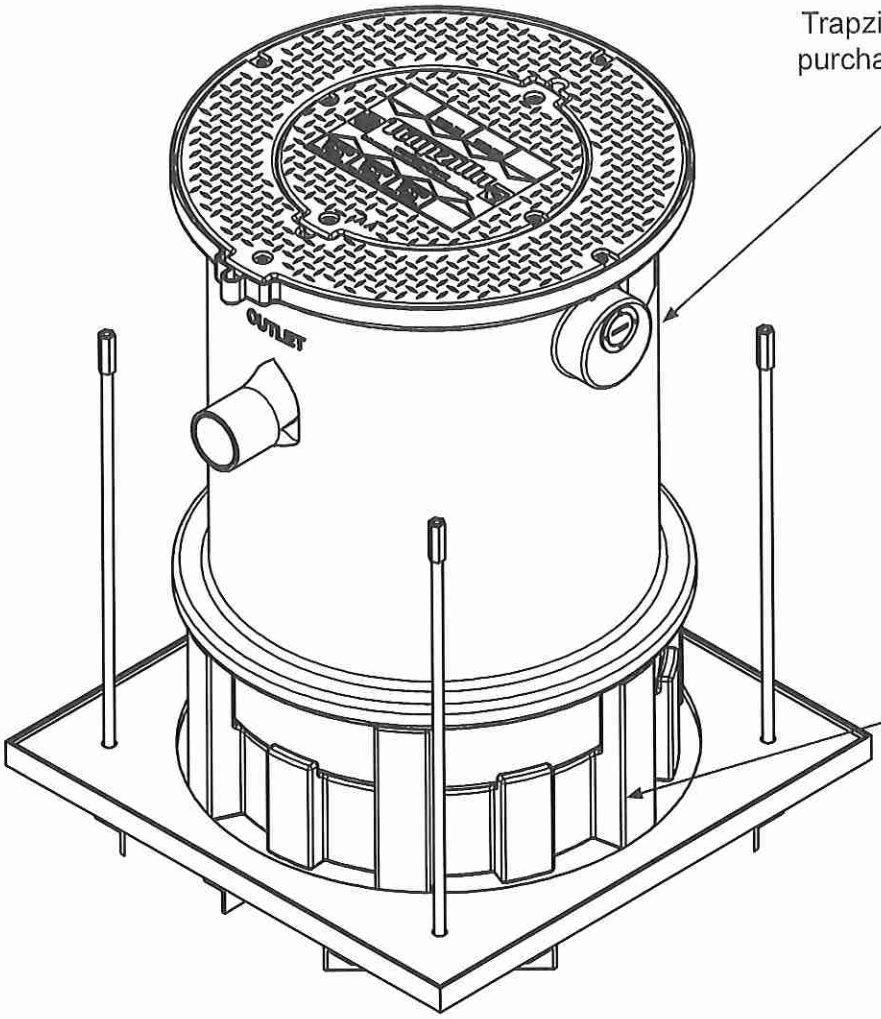
WARNING: PROPER INSTALLATION INSTRUCTIONS MUST BE FOLLOWED FOR THERMACO WARRANTY TO BE VALID. MAXIMUM INSTALLATION DEPTH PERMITTED FOR TRAPZILLA GREASE INTERCEPTORS AND SOLIDS SEPARATORS IS 60" MEASURING FROM CENTER OF INLET TO SURFACE. ANY INSTALLATION DEEPER THAN THIS VOIDS THE WARRANTY FOR THE UNIT. CONTACT THERMACO REGARDING INSTALLATIONS EXCEEDING THIS DEPTH.

Trapzilla® A THERMACO® Technology

Section III: Trapzilla® Installation

Hanging Installation

Using the Hanging Assembly option, a Trapzilla unit may be suspended from a ceiling below the floor of a kitchen or other room.



Thermaco, Inc. supplies the frame and support stand with the hanging assembly. This kit needs to be installed by a licensed contractor. The contractor is responsible for determining weight loads, preparation of the floor for installation and any construction necessary for installation of the suspension kit.

Note: Drawing for reference only. Equipment must be installed in compliance with all applicable laws, regulations and codes, including plumbing & building codes. Installation should be performed by a qualified plumber and contractor.

Trapzilla® A THERMACO® Technology

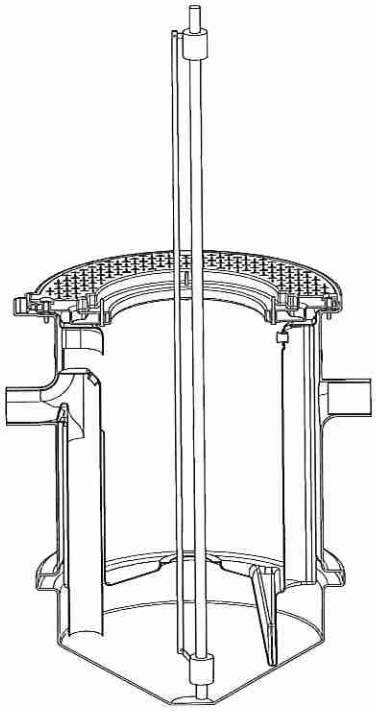
Section IV: System Maintenance

Measuring Grease/Solids Levels

Due to its unique design, Trapzilla is capable of retaining high quantities of grease in a compact footprint. Therefore, unlike traditional interceptors, Trapzilla can hold an extraordinarily high percentage of its volume in grease without losing separation efficiency. To determine the current levels of grease/solids in your Trapzilla grease interceptor, follow the instructions below.

1. Remove four nuts/washers securing the Solid Top Cover. Note the size of the unit which is marked on the cover by a metal plate.
2. Place a grease/sludge dipstick into the center of the Trapzilla, making sure that it goes through the hole in the horizontal baffle.
3. Once the dipstick has found its natural resting place at the lowest point in the conical shaped bottom, take the measurement.
4. Remove dipstick and compare grease/sludge levels to the corresponding unit in the charts below.

	Grease		Solids	
	Total Capacity (depth):	**Ready to pump at (depth):**	**Total Capacity (height):**	**Ready to pump at (height):**
TZ-600	17"	13.75"	14"	12"
TZ-400	9.375"	7.5"	14"	12"
TZ-160	13"	10.5"	10"	8"



Take grease measurement from top of liquid level downward and compare to chart above.

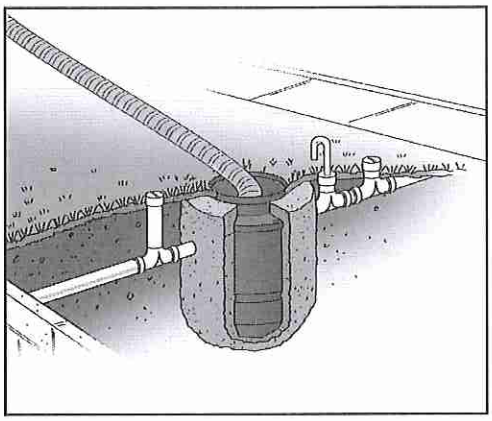
Take solids/sludge measurement from bottom of unit upward and compare to chart above.

Trapzilla® A THERMACO® Technology

Section IV: System Maintenance

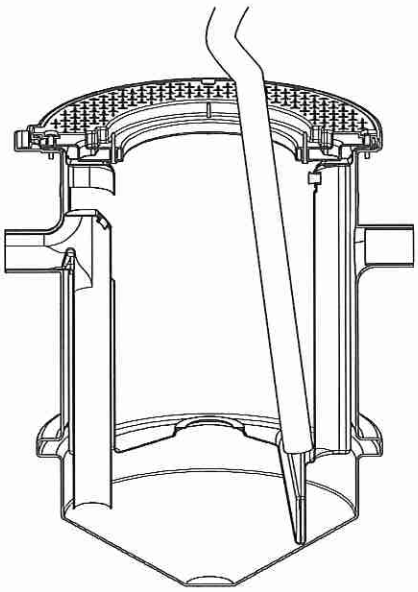
Maintaining Trapzilla

Periodically, the Trapzilla® unit will need to be serviced which involves pumping out the accumulated grease & solids. Each lid has four brass nuts securing the lid. Fully remove the lid to access the grease. Begin by taking the grease from the top of the main chamber. Upon reaching the horizontal baffle, you will see a hole through which you may access the rest of the grease and the solids. Be sure to lower the hose all the way to the bottom of the Trapzilla unit so that solids may be entirely removed.

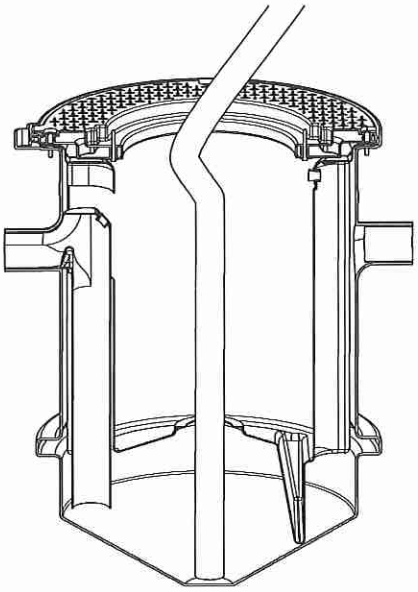


Note:

1. **<u>DO NOT</u> use mechanical crust breaking devices to break down any mat that has formed inside the Trapzilla unit.**
2. **Remove the four brass nuts from the bolts and fully remove the lid to pump out.**
3. **It is not necessary to remove adapter lid (ring) to pump out Trapzilla.**
4. **If necessary, use a water hose with spray nozzle to rinse off inside of unit.**
5. **<u>DO NOT</u> use grinding augers in maintenance of the Trapzilla unit.**



Begin by pumping grease from upper chamber, until you can see the entire horizontal baffle.
May be necessary to use water hose to rinse out parts of upper chamber.



Drop hose into lower chamber through hole in horizontal baffle, pumping out all liquids and solids remaining.
Again, it may be necessary to use water hose to rinse out lower chamber.

Trapzilla
A THERMACO® Technology

Limited Warranty & Remedy

Thermaco, Inc. warrants to the original user that the equipment manufactured by Thermaco and delivered with this warranty (the "Product") shall be free from material defects in workmanship and materials during the lifetime of the plumbing system in which the Product is initially installed.

Any claim under this warranty must be made in writing to Thermaco at 646 Greensboro Street, Asheboro, NC 27203 promptly after discovery of the defect and the Product must be delivered, prepaid, to Thermaco, together with proof of purchase and a return authorization number issued by Thermaco. If Thermaco determines that the Product is defective, Thermaco's sole obligation, and the purchaser's sole and exclusive remedy, is the repair or replacement, at Thermaco's option, of the defective Product.

This warranty shall not cover any defect or damage resulting directly or indirectly from: (i) failure to properly install, operate or maintain the Product in accordance with Thermaco's instructions, including, without limitation, use in excess of rated flow, installation deeper than manufacturer's recommendation or in conjunction with unapproved components, use to remove emulsified fats and oils or use that fails to comply with applicable laws, regulations or codes; (ii) damage in transit, handling or installation; (iii) modifications, adjustments, or alterations of the Product; (iv) disassembly of components other than as required for prescribed maintenance; or (v) any other causes not arising out of defects in workmanship or materials. Thermaco shall not be responsible for damage to Products resulting from ultraviolet light exposure, vault flooding, sewer line back-up, pumping or lift station failure, ambient water flow, freezing, or other sources of water damage. Costs for any service, adjustment, removal, repair, packing, or otherwise incurred with respect to the Product prior to submission for warranty are the responsibility of purchaser.

No distributor, sales representative or other person is authorized to make any warranty statements on behalf of Thermaco regarding Products other than as provided herein. This statement of warranty supersedes any quote, brochure, or other statement or document with respect to warranty of Thermaco products.

EXCEPT AS EXPRESSLY SET FORTH ABOVE, THERMACO MAKES NO REPRESENTATIONS, WARRANTIES OR GUARANTEES, EITHER EXPRESSED OR IMPLIED, INCLUDING, WITHOUT LIMITATION, AS TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHETHER OR NOT THERMACO HAD KNOWLEDGE OF PURCHASER'S PARTICULAR REQUIREMENTS OR NEEDS, OR WITH RESPECT TO ODOR GENERATION OR OTHER INCIDENTALS RELATING TO USE OF THE PRODUCT.

The sole and exclusive remedy with respect to this warranty or any other claim relating to defects or any other condition or use of Products, however caused, and whether such claim is based upon warranty, contract, tort, strict liability or any other theory, is LIMITED to the repair or replacement of the Product, excluding any cost to remove or install the Product or, at Thermaco's option, repay¬ment of the purchase price. IN NO EVENT SHALL THERMACO BE LIABLE, WHETHER IN CONTRACT, WARRANTY, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY, INDEMNITY OR ANY OTHER LEGAL THEORY, FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES. UNDER NO CIRCUMSTANCES WILL THE AGGREGATE LIABILITY OF THERMACO FOR ANY CAUSE OF ACTION RELATED TO THE PRODUCT COVERED HEREBY EXCEED THE NET PURCHASE PRICE RECEIVED BY THERMACO FOR THE PRODUCT.

Honeywell

L6006A Aquastat® Controller

INSTALLATION INSTRUCTIONS

APPLICATION

The Honeywell SUPER TRADELINE® L6006A Controller operates in response to temperature changes in hydronic heating systems. It provides spdt switching for high limit, low limit or circulator control.

The L6006A is designed for horizontal or vertical insertion/mounting using an immersion well (not included). Refer to Wells and Fittings for Temperature Controllers, form 68-0040, for part numbers and ordering information.

A package of heat-conductive compound is included for use when the sensing bulb is inserted into a well designed for a larger bulb.

NOTE: See form 69-0955, 107408, 120650 Heat Conductive Compounds Material Safety Data Sheet (MSDS) when used with this Aquastat® Controller.

A 124904 Well Adapter, for use on old wells that do not fit the L6006A Immersion Well Clamp, can be ordered separately, see form 68-0040. A setting stop is factory-installed to prevent setting above 240°F (116°C) limit. Adjustable differential range is 5°F to 30°F (3°C to 17°C).

Table 1. Electrical Ratings (Amperes):

Type	120 Vac	240 Vac
Full Load	8	5.1
Locked Rotor	48	30.6
Millivoltage	0.25 to 0.25 to 12 Vdc	

INSTALLATION

When Installing this Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

⚠ WARNING

Electrical Shock Hazard.
Can cause serious injury, death or equipment damage.
Disconnect power supply before connecting wiring to prevent electrical shock or equipment damage.

Follow instructions furnished by the system manufacturer, if available. Otherwise, refer to the following procedure.

To install this L6006A as a replacement for other L6006A models:

1. Shut off the power and remove the old control in the existing application. If the old immersion well appears suitable and if the adapter clamp on the L6006A Aquastat Controller fits the old immersion well spud, this immersion well does not need to be replaced.
2. If the immersion well is to be replaced and if the system is filled, drain the system to a point below the boiler tapping.
3. Remove plug (or old immersion well) from boiler tapping.
4. Install new immersion well (not included). When a boiler tapping is greater than 1/2 in. or 3/4 in. NPT, use a reduction fitting to adapt the boiler opening to the 1/2 in. or 3/4 in. NPT threads that are standard with the well or fitting. Use thread seal compound or equivalent on the fitting.

NOTE: Some models have an adjustable tubing length to 3 in. (76 mm). In these models, pull out extra tubing inside the case if needed.

5. Fill the system. Make sure that the well is screwed in tightly enough to prevent leakage. Do not tighten after controller is secured to the well, applying force to the case.
6. Loosen the screw (at the top of the case, above the scale setting), and remove the cover. Loosen the two screws that secure the adapter clamp (See Fig. 1).
7. Determine whether vertical or horizontal mounting method is desired; see Fig. 2 for mounting bracket placement.
8. Insert the sensing element into the immersion well.
9. Fasten the case of the Aquastat Controller to the well with the adapter clamp. Make certain that the clamp is properly positioned over the groove of the well spud. Also be sure the flange at the opening of the well fits snugly into the opening of the case. Be sure the sensing element bulb bottoms in the well.

Wiring

Disconnect power supply before connecting wiring to prevent electrical shock or equipment damage. Make sure all wiring complies with local electrical codes and ordinances. The case has a knockout for 1/2 in. conduit.

Fig. 3 and 4 show typical wiring diagrams of Aquastat® Controllers used in heating systems.

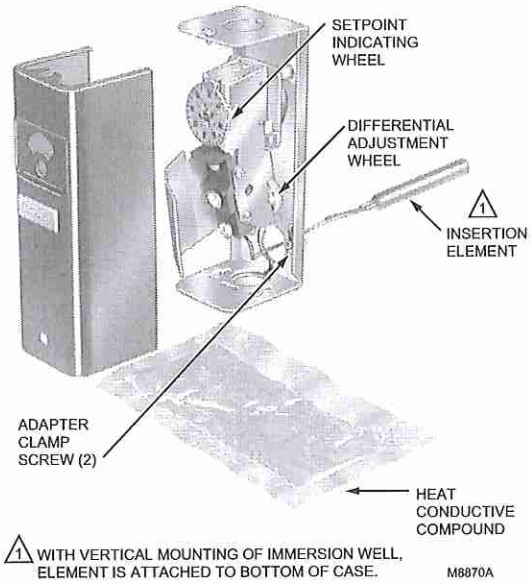


Fig. 1. Internal view of L6006A and accompanying components.

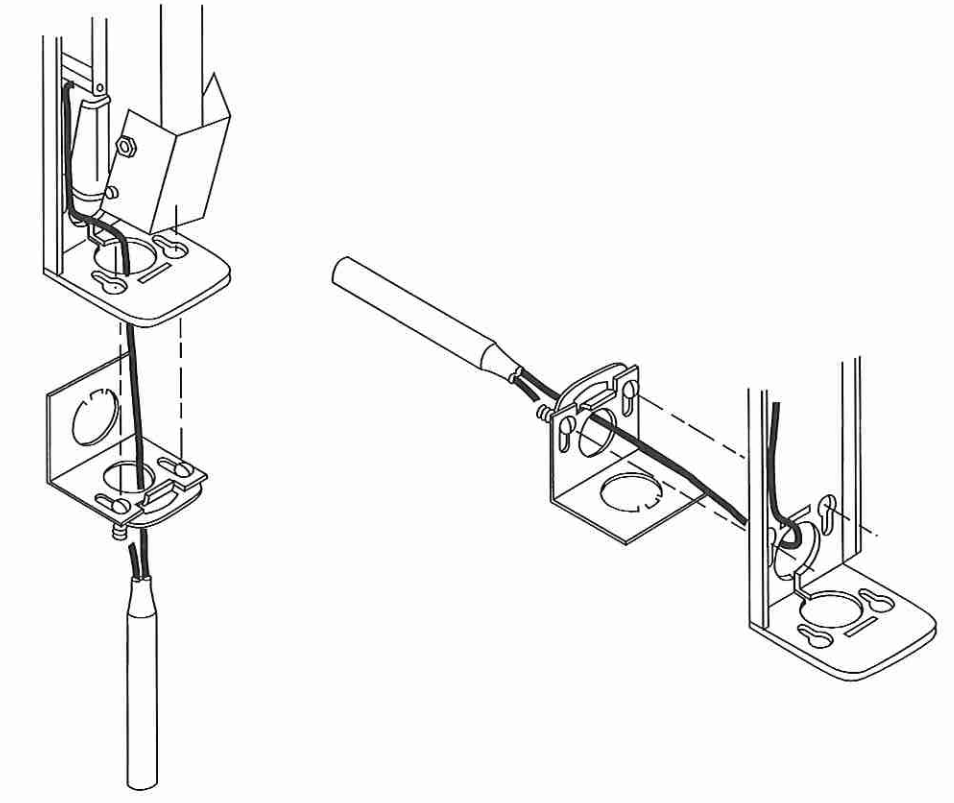


Fig. 2. Mounting bracket placement for vertical or horizontal mounting.

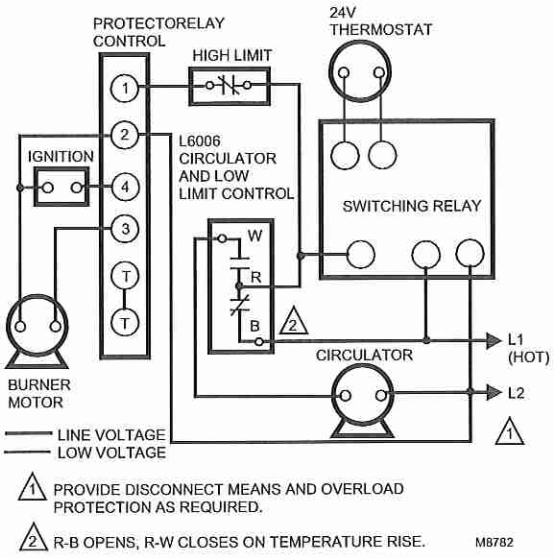


Fig. 3. Typical wiring hookup using L6006 for low limit and circulator control in oil-fired hydronic system.

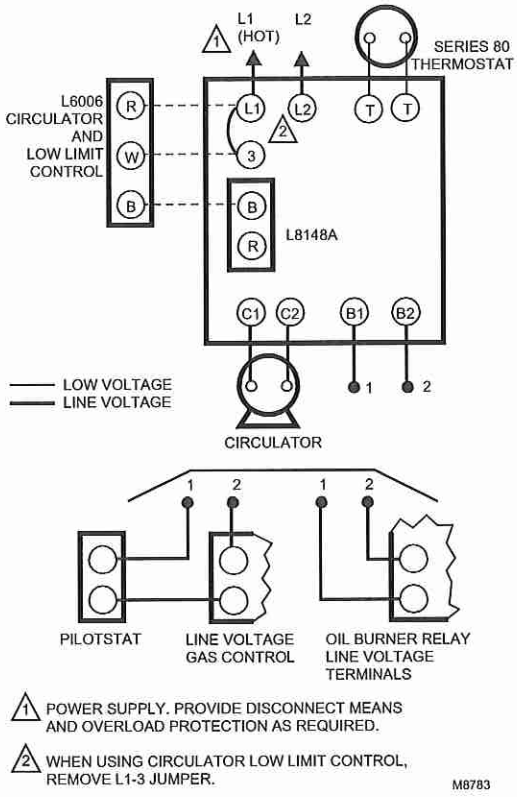


Fig. 4. Typical wiring hookup using L6006 with L8148A Aquastat Relay.

OPERATION

Select control settings according to the heating system manufacturer recommendations.

High-limit Controller—shuts off burner when water temperature exceeds high-limit setting. R-B contacts make, and burner restarts when temperature drops to high-limit setting minus the temperature differential.

Low-limit Controller—maintains minimum water temperature for domestic hot water; e.g., tankless coil in heating boiler. Makes R-B contacts at temperature setting minus differential.

Circulator Controller—prevents circulation of water that is not hot enough. Breaks R-W contacts for circulator circuit at temperature setting minus differential; remakes the R-W contacts for circuit when the temperature setting is reached.

Switching action operates as follows:

When there is a drop in water temperature (to dial setting, less differential), the R to B contacts make and the R to W contacts break, preventing circulator operation. When there is a rise in water temperature (to dial setting), R to B contacts break and R to W circulator contacts make.

ADJUSTMENT

Set the differential according to the system manufacturer recommendations. Rotate the wheel on the back of the snap switch until the desired reading is aligned with the V notch in the frame. The wheel provides an adjustment from 5°F to 30°F (3°C to 17°C). Replace the cover on the Aquastat Controller.

Adjust the control point according to the system manufacturer recommendations. To adjust, insert a screwdriver in the slotted screw type head located beneath the window in the cover. Turn the scale to the desired control point. Move the factory-set stop if desired, as shown in Fig. 5.

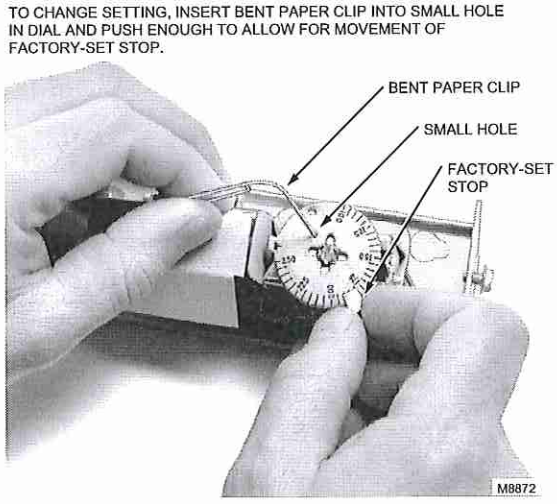


Fig. 5. Moving factory-set stop on L6006A.

CHECKOUT

Check to make certain that the Aquastat Controller was installed and adjusted properly. Put the system into operation and observe the action of the device through several cycles to make certain that it provides proper limit and circulator control.

Honeywell

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69-0235—5 G.R. Rev. 12-01

Taco Comfort Solutions
A Taco Group Company

Instruction Sheet

102-054

"00" Cartridge Circulators

SUPERSEDES: May 1, 2010

EFFECTIVE: July 1, 2015

Plant I.D. 001-934

APPLICATION:

1. Maximum operating pressure is 125 psi (862 kPa).
2. Maximum water temperature not to exceed nameplate rating.
3. Cast iron circulators are to be used for closed loop systems. Bronze or stainless steel circulators are to be used for open loop, fresh water, or potable water systems.
4. Taco Cartridge circulator pumps are for indoor use only – employer uniquement a l´interieur.

INSTALLATION:

1. Mounting position – Circulator must be mounted with the motor in a horizontal position. It may be mounted vertically with the motor up, provided that the system pressure is at least 20 psi (138 kPa).

CAUTION: DO NOT USE FLAT RUBBER GASKETS. ONLY USE O-RING GASKETS PROVIDED OR LEAKS MAY RESULT. WARRANTY WILL BE VOID.

2. Rotating body – Body has an arrow on the front that indicates direction of flow. To rotate body, remove the four body bolts, rotate body and replace bolts. Make sure that the junction box is NOT located underneath the circulator. (The junction box must NOT be located in the 6 o'clock position, as viewed from the motor end.)
3. Electrical connections – Observe all applicable codes when connecting to power supply. The motor is impedance protected, and does not require overload protection. Either colored wire from the capacitor box can be attached to either colored wire from the power supply. There is no "hot" or "common" wire leading from the capacitor box. Typical installation would be to attach the white wire to the white (common) power supply wire and either the yellow or blue wire to the black (hot) power supply wire. The pump cannot run backwards.

WARNING: Do not use in swimming pool or spa areas; pump has not been investigated for this application.

WARNING: In the event the retaining screws have been pulled out of the housing, DO NOT replace them. Use of any other screw may short out the stator windings, creating a risk of electrical shock.

CAUTION: When installing electrical connections, do not apply mechanical loads to the capacitor box; otherwise, retaining screws may be pulled out of the housing, making circulator unusable.

CAUTION: Installations at higher elevations over 5000 feet must have higher fill pressure of 20 psi minimum to prevent pump cavitation and flashing. Premature failure may result. Adjust expansion tank pressure to equal fill pressure. A larger size expansion tank may be required.

4. Fill system with tap water – The system must be filled before operating the circulator. The bearings are water lubricated and should not be allowed to operate dry. Filling the system will result in immediate lubrication of the bearings. It is always good practice to flush a new system of foreign matter before starting the circulator.

CAUTION: Never run the circulator dry or permanent damage will result.

5. Circulator operation – Operate the circulator for 5 minutes immediately after filling system to purge remaining air from the bearing chamber. This is especially important when installing the circulator during the off-season.

CAUTION: 1. The addition of petroleum based fluids or certain chemical additives to systems utilizing TACO equipment voids the warranty.
2. Use supply wires suitable for 90°C – ATTENTION: Employer des fils d´alimentation adequats pour 90°C.

WARNING: To avoid electrical shock, disconnect the power supply to the circulator and the main electrical unit.

REPLACING MOTOR ASSEMBLY:

1. Disconnect the electrical supply.
2. Reduce system pressure to 0 psi and allow system to return to room temperature. Isolate the circulator by closing the service valves or draining the system.
3. Remove the body bolts and swing motor assembly away from the body.
4. Install new motor, and reassemble circulator using the new gasket and bolts supplied.
5. Follow the "installation" procedure to start up the circulator.

REPLACING CARTRIDGE ASSEMBLY:

1. Disconnect the electrical supply.
2. Reduce system pressure to 0 psi and allow system to return to room temperature. Isolate the circulator by closing the service valves or draining the system.
3. Remove the body bolts and swing motor assembly away from the body.
4. Pull cartridge out of the motor housing.
5. Install replacement cartridge, making sure that the cover plate is between the cartridge flange and motor.
6. Make sure the replacement cartridge corresponds to the full circulator product number. A complete parts list is available from your local plumbing supply wholesaler.
7. Reassemble the circulator using the new gasket and bolts supplied.
8. Follow the "Installation" procedure to start up the circulator.

REPLACING CAPACITOR:

1. Replacement capacitor must have same rating as originally furnished.

LIMITED WARRANTY STATEMENT

Taco, Inc. will repair or replace without charge (at the company's option) any Taco 00 Series circulator or circulator part which is proven defective under normal use within three (3) years from the date of manufacture.

In order to obtain service under this warranty, it is the responsibility of the purchaser to promptly notify the local Taco stocking distributor or Taco in writing and promptly deliver the subject product or part, delivery prepaid, to the stocking distributor. For assistance on warranty returns, the purchaser may either contact the local Taco stocking distributor or Taco. If the subject product or part contains no defect as covered in this warranty, the purchaser will be billed for parts and labor charges in effect at time of factory examination and repair.

Any Taco product or part not installed or operated in conformity with Taco instructions or which has been subject to misuse, misapplication, the addition of petroleum-based fluids or certain chemical additives to the systems, or other abuse, will not be covered by this warranty.

If in doubt as to whether a particular substance is suitable for use with a Taco product or part, or for any application restrictions, consult the applicable Taco instruction sheets or contact Taco at (401-942-8000).

Taco reserves the right to provide replacement products and parts which are substantially similar in design and functionally equivalent to the defective product or part. Taco reserves the right to make changes in details of design, construction, or arrangement of materials of its products without notification.

TACO OFFERS THIS WARRANTY IN LIEU OF ALL OTHER EXPRESS WARRANTIES. ANY WARRANTY IMPLIED BY LAW INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS IS IN EFFECT ONLY FOR THE DURATION OF THE EXPRESS WARRANTY SET FORTH IN THE FIRST PARAGRAPH ABOVE.

THE ABOVE WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR STATUTORY, OR ANY OTHER WARRANTY OBLIGATION ON THE PART OF TACO.

TACO WILL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, INDIRECT OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF ITS PRODUCTS OR ANY INCIDENTAL COSTS OF REMOVING OR REPLACING DEFECTIVE PRODUCTS.

This warranty gives the purchaser specific rights, and the purchaser may have other rights which vary from state to state. Some states do not allow limitations on how long an implied warranty lasts or on the exclusion of incidental or consequential damages, so these limitations or exclusions may not apply to you.

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Visit our web site: www.TacoComfort.com | Printed in USA |

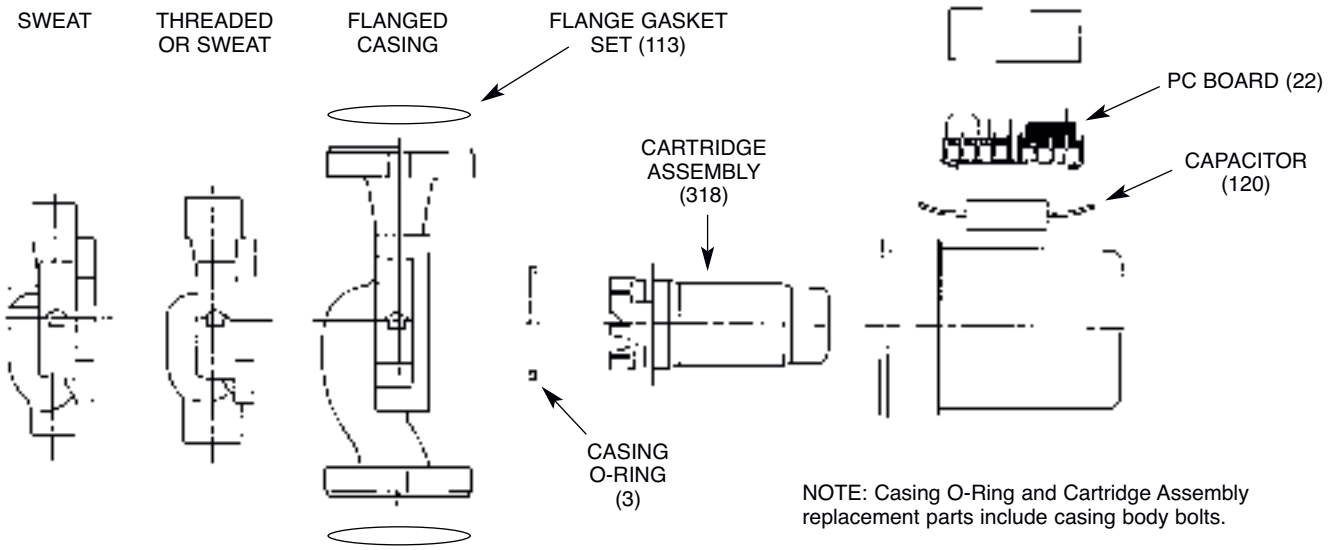
Replacement Parts List

104-110

00 Circulators

SUPERSEDES: February 4, 2015

EFFECTIVE: June 28, 2015



NOTE: Casing O-Ring and Cartridge Assembly replacement parts include casing body bolts.

003-

PUMP MODEL NUMBER	CASING O-RING	FLANGE GASKET SET	CAPACITOR or PC BOARD	CARTRIDGE ASSY. COMPLETE	VALVE ASSY. TRANS/RELAY
003-B4	007-003RP	NA	007-002RP	003-001RP	NA
003-B4-1 (GRAINGER)	NA	NA	NA	003-002RP	NA
003-B4-1IFC	007-003RP	NA	007-002RP	003-003RP	006-044RP
003-B4-1PNP	007-003RP	NA	007-002RP	003-001RP	NA
003-B4-2 (GRAINGER)	NA	NA	NA	003-002RP	NA
003-B4-2IFC	007-003RP	NA	007-002RP	003-001RP	006-047RP
003-B4-2PNP	007-003RP	NA	007-002RP	003-001RP	NA
003-B4-3PNP	007-003RP	NA	007-002RP	003-001RP	006-047RP
003-B4-4PNP	007-003RP	NA	007-002RP	003-001RP	006-047RP
003-B4-IFC	007-003RP	NA	007-002RP	003-003RP	006-044RP
003-B4-PNP	007-003RP	NA	007-002RP	003-001RP	NA
003-B5Y	007-003RP	NA	007-002RP	003-001RP	NA
003-B6Y	007-003RP	NA	008-054RP	003-001RP	NA
003-BC4	007-003RP	NA	007-002RP	003-001RP	NA
003-BC4-1	007-003RP	NA	007-002RP	003-001RP	NA
003-BC4-10PNP	007-003RP	NA	007-002RP	003-001RP	006-047RP
003-BC4-11PNP	007-003RP	NA	007-002RP	003-001RP	006-047RP
003-BC4-1IFC	007-003RP	NA	007-002RP	003-001RP	006-047RP
003-BC4-1PNP	007-003RP	NA	007-002RP	003-001RP	NA
003-BC4-2 (GRAINGER)	NA	NA	NA	003-002RP	NA
003-BC4-2IFC	007-003RP	NA	007-002RP	003-001RP	006-047RP
003-BC4-2PNP	007-003RP	NA	007-002RP	003-001RP	006-047RP
003-BC4-3 (GRAINGER)	NA	NA	NA	003-002RP	NA
003-BC4-3PNP	007-003RP	NA	007-002RP	003-001RP	006-047RP
003-BC4-4	007-003RP	NA	007-002RP	003-001RP	NA
003-BC4-4PNP	007-003RP	NA	007-002RP	003-001RP	NA
003-BC4-5PNP	007-003RP	NA	007-002RP	003-001RP	NA
003-BC4-6PNP	007-003RP	NA	007-002RP	003-001RP	006-047RP
003-BC4-7PNP	007-003RP	NA	007-002RP	003-001RP	006-047RP
003-BC4-8PNP	007-003RP	NA	007-002RP	003-001RP	NA
003-BC4-9PNP	007-003RP	NA	007-002RP	003-001RP	NA
003-BC4-IFC	007-003RP	NA	007-002RP	003-001RP	006-047RP

006- (Continued)

PUMP MODEL NUMBER	CASING O-RING	FLANGE GASKET SET	CAPACITOR or PC BOARD	CARTRIDGE ASSY. COMPLETE	VALVE ASSY. TRANS/RELAY
006-F4	007-003RP	007-007RP	007-002RP	005-019RP	
006-F4-1	007-003RP	007-007RP	007-002RP	005-019RP	
006-F5Y	007-003RP	007-007RP	007-002RP	005-019RP	
006-F7-IFC	007-003RP	007-007RP	007-002RP	005-019RP	006-047RP
006-F8Y-IFC	007-003RP	007-007RP	008-054RP	005-019RP	006-047RP
006-IQB4	007-003RP	NA	003-010RP	005-020RP	NA
006-IQBC4	007-003RP	NA	003-010RP	005-020RP	NA
006-IQBC7-1IFC	007-003RP	NA	003-010RP	005-020RP	006-047RP
006-IQBC7-IFC	007-003RP	NA	003-010RP	005-020RP	006-047RP
006-IQST4	007-003RP	NA	003-010RP	005-020RP	NA
006-IQST4-1	007-003RP	NA	003-010RP	005-020RP	NA
006-IQST4-2	007-003RP	NA	003-010RP	005-020RP	NA
006-SC4-1	007-003RP	NA	007-002RP	005-020RP	NA
006-SC4-1PNP	007-003RP	NA	007-002RP	005-020RP	NA
006-SC4-2PNP	007-003RP	NA	007-002RP	005-020RP	NA
006-SC4-3PNP	007-003RP	NA	007-002RP	005-020RP	NA
006-SC7-1PNP	007-003RP	NA	007-002RP	005-020RP	0010-025RP
006-SC7-IFC	007-003RP	NA	007-002RP	005-020RP	0010-025RP
006-SC7-PNP	007-003RP	NA	007-002RP	005-020RP	0010-025RP
006-ST4	007-003RP	NA	007-002RP	005-020RP	
006-ST4-1 (GRAINGER)	NA	007-066RP	NA	006-042RP	NA
006-ST4-1PNP	007-003RP	NA	007-002RP	005-020RP	
006-ST4-2PNP	007-003RP	NA	007-002RP	005-020RP	
006-ST4-3	007-003RP	NA	007-002RP	005-020RP	
006-ST4-3PNP	007-003RP	NA	007-002RP	005-020RP	NA
006-ST4-4PNP	007-003RP	NA	007-002RP	005-020RP	NA
006-ST4-PNP	007-003RP	NA	007-002RP	005-020RP	
006-ST4R	007-003RP	NA	007-002RP	005-020RP	NA
006-ST5A	007-003RP	NA	007-002RP	005-020RP	NA
006-ST5U	007-003RP	NA	007-046RP	005-020RP	NA
006-ST5Y	007-003RP	NA	007-002RP	005-020RP	
006-ST5Y-1	NA	NA	NA	006-042RP	NA
006-ST5Y-2	007-003RP	NA	007-002RP	005-020RP	
006-ST7-IFC	007-003RP	NA	007-002RP	005-020RP	006-051RP
006-ST8A	007-003RP	NA	008-054RP	005-020RP	NA
006-ST8Y	007-003RP	NA	008-054RP	005-020RP	NA
006-ST8Y-1	007-003RP	NA	008-054RP	005-020RP	NA
006-VRB4	007-003RP	NA	003-006RP	005-020RP	
006-VRBC4	007-003RP	NA	003-006RP	005-020RP	
006-VRBC7-1IFC	007-003RP	NA	003-006RP	005-020RP	006-047RP
006-VRBC7-IFC	007-003RP	NA	003-006RP	005-020RP	006-047RP
006-VRF4	007-003RP	007-007RP	003-006RP	005-019RP	
006-VRF7-IFC	007-003RP	007-007RP	003-006RP	005-019RP	006-047RP
006-VRST4	007-003RP	NA	003-006RP	005-020RP	NA
006-VSB4	007-003RP	NA	003-008RP	005-020RP	NA
006-VSBC4	007-003RP	NA	003-008RP	005-020RP	NA
006-VSBC7-1IFC	007-003RP	NA	003-008RP	005-020RP	006-047RP
006-VSBC7-IFC	007-003RP	NA	003-008RP	005-020RP	006-047RP
006-VSF4	007-003RP	007-007RP	003-008RP	005-019RP	NA
006-VSF7-IC	007-003RP	007-007RP	003-008RP	005-019RP	006-047RP
006-VSST4	007-003RP	NA	003-008RP	005-020RP	NA
006-VTB4	007-003RP	NA	003-009RP	005-020RP	NA
006-VTBC4	007-003RP	NA	003-009RP	005-020RP	NA
006-VTBC4-1	008-047RP	NA	003-009RP	005-020RP	NA
006-VTF4	007-003RP	007-007RP	003-009RP	005-019RP	NA
006-VVB4	007-003RP	NA	003-004RP	005-020RP	NA
006-VVBC4	007-003RP	NA	003-004RP	005-020RP	NA
006-VVBC7-1IFC	007-003RP	NA	003-004RP	005-020RP	006-047RP
006-VVBC7-2IFC	007-003RP	NA	003-004RP	005-020RP	006-047RP
006-VVBC7-IFC	007-003RP	NA	003-004RP	005-020RP	006-047RP
006-VVF4	007-003RP	007-007RP	003-004RP	005-019RP	NA
006-VVF7-IFC	007-003RP	007-007RP	003-004RP	005-019RP	006-047RP
006-VVST4	007-003RP	NA	003-004RP	005-020RP	NA
006-ZB4	007-003RP	NA	007-002RP	005-020RP	

For Residential and Commercial Applications

Job Name _____ Contractor _____

Job Location _____ Approval _____

Engineer _____ Contractor's P.O. No. _____

Approval _____ Representative _____

LEAD FREE*

Series LFU5B

Water Pressure Reducing Valves**

Sizes: ½" – 2" (15 – 50mm)

Series LFU5B Water Pressure Reducing Valves are designed to reduce incoming water pressure to a sensible level to protect plumbing system components and reduce water consumption. The LFU5B features Lead Free* construction to comply with Lead Free* installation requirements. This series is suitable for water supply pressures up to 300psi (20.7 bar) and may be adjusted from 25 – 75psi (172 – 517 kPa). The standard setting is 50psi (345 kPa). All parts are quickly and easily serviceable without removing the valve from the line. The LFU5B's standard bypass feature permits the flow of water back through the valve into the main when pressures, due to thermal expansion on the outlet side of the valve, exceed the pressure in the main supply.

Features

- Standard construction includes Z3 sealed spring cage and stainless steel corrosion resistant adjusting cage screws for accessible outdoor or pit installations
- Integral stainless steel strainer
- Replaceable seat module
- Lead Free* cast copper silicon alloy body construction
- Serviceable in line
- Bypass feature controls thermal expansion pressure (LFU5B-Z3)***
- High temperature resistant reinforced diaphragm for hot water

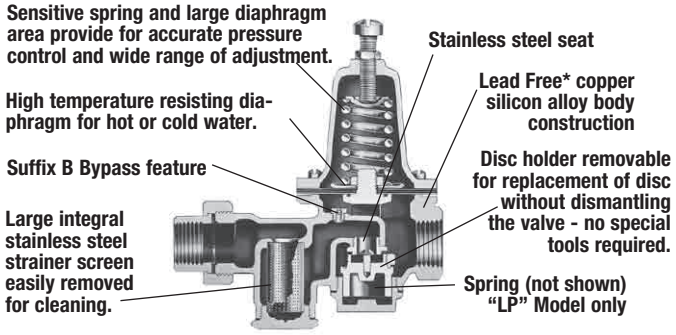
Models

LFU5B-Z3	NPT threaded female union inlet x NPT female outlet w/built in thermal expansion bypass
LFU5B-S-Z3	Solder union inlet x NPT female outlet w/built in thermal expansion bypass
LF5M3-Z6	Water meter threaded connections and 7½" (190mm) lay length for new or existing meter box installations. For ⅝" (16mm), ⅝" x ¾" (16 x 20mm) or ¾" (20mm) meter setters or resetters
LFU5B-QC-Z3	Quick-Connect Single-Union – Inlet end

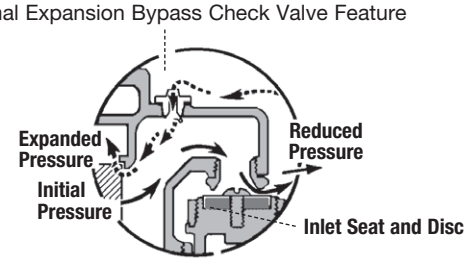
Specifications

Standard Specifications: A Water Pressure Reducing Valve with integral strainer shall be installed in the water service pipe near its entrance to the building where supply main pressure exceeds 60psi (413 kPa) to reduce it to 50psi (345 kPa) or lower. The water pressure reducing valve shall be constructed using Lead Free* materials. Lead Free* regulators shall comply with state codes and standards, where applicable, requiring reduced lead content. The valve shall feature a Lead Free* cast copper silicon alloy body suitable for water supply pressures up to 300psi (20.7 bar). Provision shall be made to permit the bypass flow of water back through the valve into the main when pressures, due to thermal expansion on the outlet side of the valve, exceed the pressure in the main supply. Water Pressure Reducing Valve with built-in bypass check valves will be acceptable. Approved valve shall be listed to ASSE 1003 and IAPMO and certified to CSA B356. Valve shall be a Watts Series LFU5B-Z3.

LFU5B-Z3



Suffix B
Thermal Expansion Bypass Check Valve Feature



*The wetted surface of this product contacted by consumable water contains less than 0.25% of lead by weight.

**A water saving test program concluded that reducing the supply pressure from 80-50psi (551-345 kPa) resulted in a water savings of 30%.

***The bypass feature will not prevent the pressure relief valve from opening on the hot water supply system with pressure above 150psi (10.3 bar).

WATTS®

Materials

Body:	Lead Free* cast copper silicon alloy
Seat:	Replaceable stainless steel
Integral Strainer:	Stainless steel
Diaphragm:	Reinforced EPDM
Valve Disc:	EPDM
Yoke:	Lead Free* cast copper silicon alloy

LF5M3-Z6 model provided with cast iron spring cage

Pressure – Temperature

Temperature Range: 33°F – 160°F (0.5°C – 71°C)
Maximum Working Pressure: 300psi (20.7 bar)
Adjustable Reduced Pressure Range: 25 – 75psi (172 – 517 kPa)
Standard Reduced Pressure Setting: 50psi (345 kPa)

Options

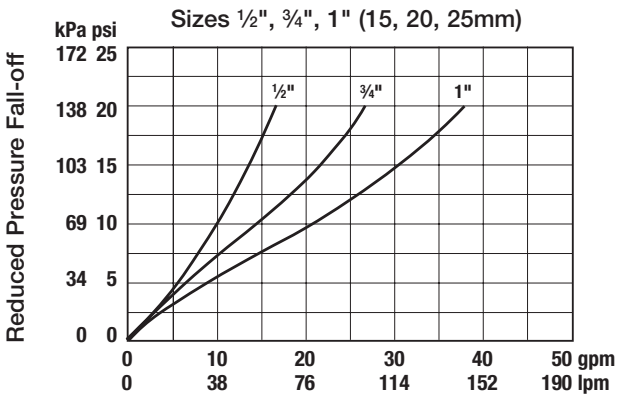
Add Suffix

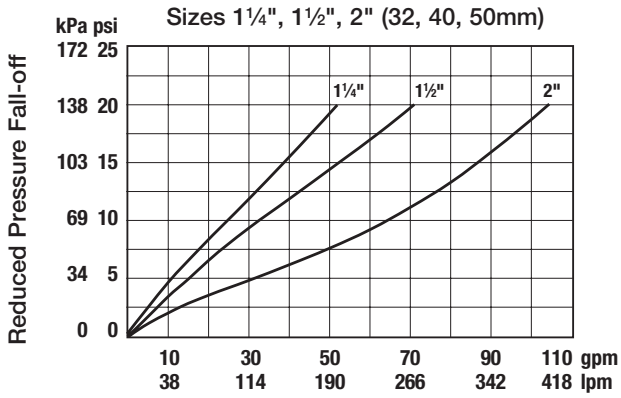
G	Gauge tapping
GG	Gauge tapping and 160psi (11.0 bar) gauge
HP	High pressure range 75 – 100psi (5.2 – 6.9 bar)
LP	Low pressure range 10 – 35psi (69 – 241 kPa)

Standards

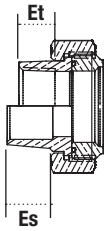
Meets requirements of ASSE Standard 1003; (ANSI A112.26.2); CSA Standard B356; Southern Standard Plumbing Code and listed by IAPMO.

Capacity

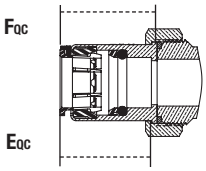


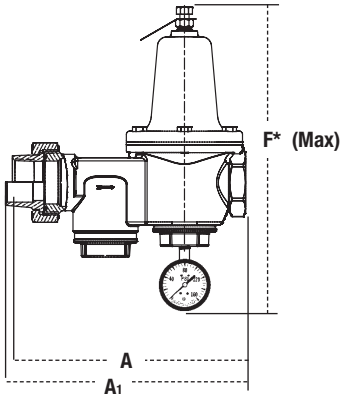


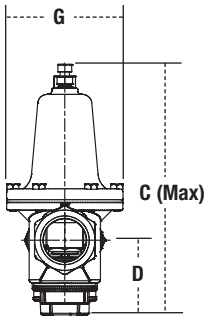
Dimensions - Weights



A - LFU5B-Z3
A1 - LFU5B-S-Z3
ET - NPT Engagement for tight joint
ES - Female sweat socket depth
EQC - Quick-Connect







MODEL	SIZE (DN)		DIMENSIONS																		WEIGHT	
			A		A1		C		D		G		Et		Es		EQC		FQC		F †			
	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	lbs.	kgs.
LFU5B-Z3	½	15	5⅝	142.8	5½	139.7	5⅞	149.2	1⅝	41.2	3 1/16	77.7	7/16	11.1	½	12.7	1 7/16	36	1½	38	10¼	260.3	4	1.8
	¾	20	6 3/16	157.1	6¼	158.7	6⅞	174.6	1⅞	47.6	3½	88.9	½	12.7	¾	19	1 9/16	40	1 11/16	42	11½	292.1	5	2.3
	1	25	6⅝	168.2	6¾	171.4	7⅜	187.3	2	50.8	4	101.6	9/16	14.2	⅞	22.2	1 11/16	43	1¾	45	12⅛	307.9	6	2.7
	1¼	32	7 15/16	190.5	7 11/16	195.2	8⅜	212.7	2¼	57.1	4½	113.3	⅝	15.8	1	25.4	———		———		13⅜	339.7	9.4	4.3
	1½	40	9 7/16	239.7	9¾	247.6	9⅜	238.1	2⅞	73	4¾	120.6	⅝	15.8	1⅛	28.5	———		———		15	381.0	14.4	6.5
	2	50	10⅞	276.2	11½	292.1	12¼	311.1	3¼	82.5	6	152.4	⅝	15.8	1⅜	34.9	———		———		18¼	463.5	23	10.4

† Dimension includes optional gauge

Johns Manville

Micro-Lok® *HP*

High-Performance Fiber Glass Pipe Insulation

DESCRIPTION

Micro-Lok *HP* Fiber Glass Pipe Insulation is a high-performance insulation made from rotary glass fibers bonded with a thermosetting resin and produced in 36" (0.92 m) lengths. Micro-Lok *HP* insulation is used to insulate standard iron pipe and copper tubing. The 3' (0.92 m) sections are available plain or with a factory-applied vapor-barrier jacket. The all-service (ASJ) vapor-retarder jacket includes a longitudinal, self-sealing closure lap. The jacket system is adhered to each fiber glass section using a specially formulated adhesive to ensure jacket securement. Latex paint may be applied to the Micro-Lok *HP* jacket after installation.

The factory-installed tape system permits installation at ambient temperatures down to 20°F (-7°C) and will not soften or separate when exposed to high ambient temperatures and humidity.

USES

Micro-Lok *HP* fiber glass pipe insulation is suitable for installation over hot, cold, concealed and exposed piping systems with operating temperatures up to 850°F (454°C). Weather-protective jacketing is required for outdoor applications. Pipes operating below ambient temperatures require all joints to be sealed with the factory-applied, self-seal lap and butt strips.

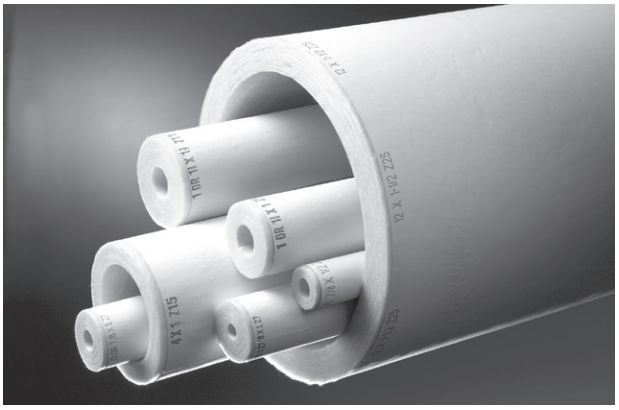
PHYSICAL PROPERTIES

Service Temp. Range (ASTM C411)	0°F to 850°F (-18°C to 454°C)
Moisture Sorption	<5% by weight
Alkalinity	<0.6% expressed as Na_2O
Corrosivity (ASTM C665)	Does not accelerate
Capillarity	Negligible (after 24 hours)
Shrinkage (ASTM C356)	None
Microbial Growth (ASTM C1338)	Does not promote microbial growth
Surface Burning Characteristics	Composite FHC 25/50 per ASTM E84, NFPA 255, CAN/ULC S102-M88
Limited Combustibility	NFPA 90A and 90B
Jacketing	ASTM C1136 (Type I)
Water Vapor Permeance (ASTM E96 – Procedure A)	0.02 perms max.
Burst Strength (ASTM D774)	50 Beach Units (1.5 Joules min.)
Tensile Strength (ASTM D828)	45 lbs./in. (7.9N/mm) width min. (MD) 30 lbs./in. (5.23N/mm) width min. (CD)

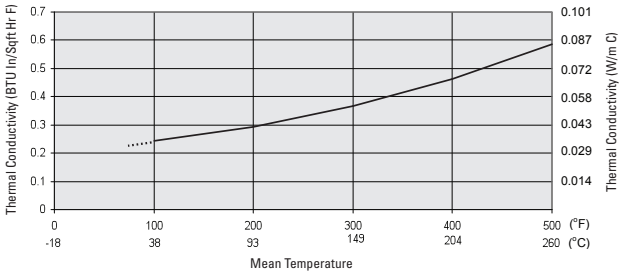
Operating Temperature Limits: 0°F to 850°F (-18°C to 454°C)

SPECIFICATION COMPLIANCE

- ASTM C547 Type I (Replaces HH-I-558B, Form D, Type III, Class 12, Class 13 up to 850°F [454°C])
- ASTM C585 – Dimension Standard
- ASTM C1136 (Jacketing) (Replaces HH-B-100B, Type I & II)
- MIL-I-22344D
- NRC 1.36, ASTM C795, MIL-I-24244C
- Coast Guard/IMO Approved 164.109/56/0 (plain, unjacketed only – excluding ⅞ x ½ [22 mm x 13 mm], ½ x ½ [13 mm x 13 mm])
- New York City MEA # 330-85-M
- California Bureau of Home Furnishings and Thermal Insulation – Registry Number CA-T040 (CO)
- Firestop Assemblies: Meets requirement for jacketed fiber glass pipe insulation product density at or above 3.5 pcf.



THERMAL CONDUCTIVITY ("K")



MEAN TEMPERATURE	K	K(SI)
75˚F (24˚C)	0.23	0.034
100˚F (38˚C)	0.24	0.035
200˚F (93˚C)	0.28	0.040
300˚F (149˚C)	0.34	0.049
400˚F (204˚C)	0.44	0.063
500˚F (260˚C)	0.55	0.079

GREEN BUILDING ATTRIBUTES

Manufacturing Location	Defiance, Ohio (43512)	
Recycled Content	36%	
Volatile Organic Compounds (ASTM D5116) (Analysis ASTM D6196 & ASTM D5197)	Total	0.15 g/l
Fiber Glass Pipe Insulation	Formaldehyde	0.009 ppm
	Aldehydes	0.009 ppm
Volatile Organic Compounds (Calculated)	Total	<49 g/l
Self-Sealing Lap & Butt Strips		

GREEN BUILDING CERTIFICATIONS

GREENGUARD®	
• Indoor Air Quality	Certified
• Children and Schools	Certified
LEED® Credits	
LEED-NC	See JM.com/buildgreen JM LEED Credit Guide (HIG-1231)

GREENGUARD® Certified products have been screened for more than 10,000 volatile organic compounds (VOCs) and meet stringent standards for low chemical emissions based on established criteria from key public health agencies.

GREENGUARD Children & Schools Indoor Air Quality Certified

Micro-Lok® *HP*

High-Performance Fiber Glass Pipe Insulation

SIZE AVAILABILITY

Insulation Thickness		Iron Pipe Size Range		Copper Tubing Size Range	
in.	mm	in.	mm	in.	mm
½	13	½–6	13–152	⅝–4⅛[§]	16–105
1	25	½–24	13–610	⅝–6⅛	16–156
1½	38	½–24	13–610	⅝–6⅛	16–156
2	51	½–24	13–610	1⅛–6⅛	29–156
2½	64	1–24	25–610	1⅜–6⅛	35–156
3	76	1–24	25–610	1⅜–6⅛	35–156
3½	89	1½–24[*]	38–610	–	–
4	102	3–24[**]	76–610	–	–
4½	114	3–24[†]	76–610	–	–
5	127	3–20[††]	76–508	–	–

Notes:

[*] *2½" and 23" IPS not available in this insulation thickness.*

[**] *22" and 23" IPS not available in this insulation thickness.*

[†] *21", 22" and 23" IPS not available in this insulation thickness.*

[††] *19" IPS not available in this insulation thickness.*

[§] *3⅝" CTS not available in this insulation thickness.*

QUALIFICATIONS FOR USE

A sufficient thickness of insulation must be used to keep the maximum surface temperature of Micro-Lok *HP* insulation below 150°F (66°C). In addition, at operating temperatures above 500°F (260°C), Micro-Lok *HP* pipe insulation must be applied in a thickness ranging from 2" (51 mm) minimum to 6" (152 mm) maximum.

During initial heat-up to operating temperatures above 350°F (177°C), an acrid odor and some smoke may be given off as the organic binders used in the fiber glass pipe insulation begin to decompose. When this occurs, caution should be exercised to ventilate the area well. This loss of binder does not directly affect the thermal performance of the pipe insulation, but the compressive strength and resiliency of the product are reduced. For applications with excessive physical abuse or vibration at high temperatures, consult your local Insulation Systems Market Development Manager for alternate material recommendations.

CHILLED WATER SYSTEMS

For chilled water systems, see Chilled Water InsulSpec™ – 3-Part Specification, CI-239.

APPLICATION RECOMMENDATIONS*

MICRO-LOK *HP* PIPE INSULATION AND BUTT STRIPS

1. Do not apply Micro-Lok *HP* insulation if air temperature is below 20°F (-7°C) or above 130°F (54°C) due to the effect of temperature on tape performance. We recommend stapling when application falls outside this temperature range.

When stapling, we recommend mastic be applied over staples to prevent moisture penetration.

2. If stored below 20°F (-7°C) or above 130°F (54°C), insulation cartons should stand within the recommended temperature range for 24 hours prior to application.

3. Once release paper is removed, both adhesive and lap must be kept free of dirt and water, and the lap sealed immediately.

4. When adhered, the lap and butt strips must be pressurized by rubbing firmly with a plastic squeegee or the back of a knife blade to ensure positive closure.

**For complete application recommendations and installation instructions, see CI-245 brochure.*

Johns Manville

717 17th St.
Denver, CO 80202
1-800-654-3103
specJM.com

North American Sales Offices, Insulation Systems

Eastern Region
P.O. Box 158
Defiance, OH 43512
(800) 334-2399
Fax: (419) 784-7866

Western Region & Canada
P.O. Box 5108
Denver, CO 80217
(800) 368-4431
Fax: (303) 978-4661

The physical and chemical properties of Micro-Lok® *HP* High-Performance Fiber Glass Pipe Insulation listed herein represent typical, average values obtained in accordance with accepted test methods and are subject to normal manufacturing variations. They are supplied as a technical service and are subject to change without notice. Numerical flame spread and smoke developed ratings are not intended to reflect hazards presented by these or any other materials under actual fire conditions. Check with the Regional Sales Office nearest you to ensure current information. **All Johns Manville products are sold subject to Johns Manville's standard Terms and Conditions including Limited Warranty and Limitation of Remedy. For a copy of the Johns Manville standard Terms and Conditions, Limited Warranty and Limitation of Remedy, and information on other Johns Manville thermal insulations and systems, call (800) 654-3103.**

CI-228 10/13 (Replaces 2/13)

JMCOM130140A

H-BLOCK PIPE SUPPORT INSULATION

icafittings.com

ASTM E84 25/50 APPROVED!

NEW HIGHER TEMPERATURE LIMIT!

DESCRIPTION

ICA H-Block is a 18# density molded fiberglass which is light amber in color. H-Block was designed to be utilized as a superior pipe support system and to prevent crushing and bottoming-out of the surrounding insulation. H-Block enhances the thermal and vibration control properties of the entire insulation system.

APPLICATION

ICA H-Block is designed for all types of piping systems operating at temperatures between -120° F. to +650° F. H-Block sizes will accommodate pipe sizes from ½" to 24" IPS, and insulation thicknesses from ½" to 4". For higher insulation thicknesses or other specialized sizes or applications, please contact ICA or your local distributor.

ADVANTAGES

ICA H-Block is available in a wide range of standard sizes. These basic sizes have been chosen to help you plan and install pipe support insulation for many types and sizes of piping systems. Because H-Block is continuously produced and stocked in these sizes, you can forget about ordering problems, long manufacturing lead times, and tying-up valuable inventory space.

In the field, H-Block is easy to handle and simple to install.

ICA H-Block is superior to a wood block application. It is incombustible; and immune to rot, corrosion, odors, insects, and oxidation. H-Block resists aging and thermal shock, and its compressive strength is unaffected by water, oils, gasoline, or common solvents.

FOR CUSTOMER SERVICE AND ORDER PLACEMENT CALL 610-377-4120

ICA H-BLOCK CUSTOMERS

The ICA H-Block is a 18# density fiberglass pipe support with widths of 1", 1 1/2", 2", 2 1/2" and 3". The block lengths are 6", 9", 12" and 14". When calculated and installed correctly, they provide adequate support and prevent crushing of the surrounding pipe insulation. The saddles being used must be long enough to provide full support of the blocks.

The following chart demonstrated how to figure the load factor of the blocks as described on the H-Block Technical Data Sheet.

If your calculations fall within these conditions, the blocks will provide adequate support for your system.

PIPE SIZE	WIDTH OF BLOCK	LENGTH OF HANGER & BLOCK	BLOCK REQUIRED	MAX. SUPPORT AT 5% DEFLECTION FORMULA: AXBXCX30^{PSI}	MAX. SUPPORT AT 10% DEFLECTION FORMULA: AXBXCX80^{PSI}
Up to 5"	1 1/2" 1 1/2" 1 1/2"	12" 18" 24"	1 1 1	18 sq. in 540# - 30 PSI 810# - 27 PSI 1080#	1440# - 80 PSI 2160# - 72 PSI 2880#
6" to 8"	1 1/2" 1 1/2" 1 1/2"	12" 18" 24"	2 2 2	1080# 1620# 2160#	2880# 4320# 5760#
10" to 12"	1 1/2" 1 1/2" 1 1/2"	12" 18" 24"	3 3 3	1620# 2430# 3240#	4320# 6480# 8640#
14" to 16"	1 1/2" 1 1/2" 1 1/2"	12" 18" 24"	4 4 4	2160# 3240# 4320#	5760# 8640# 11520#
18" to 24"	1 1/2" 1 1/2" 1 1/2"	12" 18" 24"	5 5 5	2700# 4050# 5400#	7200# 10800# 14400#

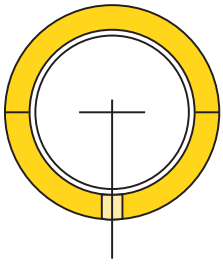
NOTE: For 18" H-Block use two 9" H-Blocks. For 24" H-Block use two 12" H-Blocks.

H-BLOCK PIPE SUPPORT INSULATION

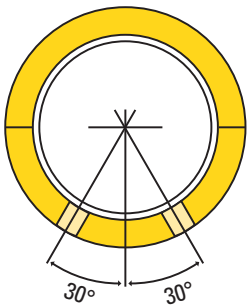
CUSTOM MOLDERS OF THERMAL ACOUSTICAL INSULATION

"Our unique molding process makes us different & better."

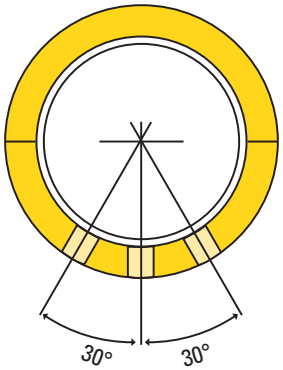
H-Block Recommendation Location: (not to scale)



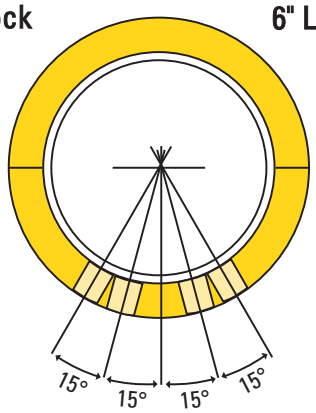
Up to 5" Pipe
6" Long Block



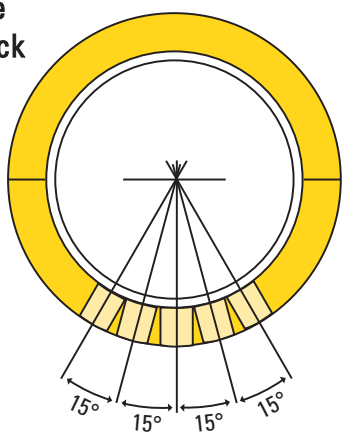
6" - 8" Pipe
6" Long Block



10" - 12" Pipe
9" Long Block



14" - 16" Pipe
12" Long Block

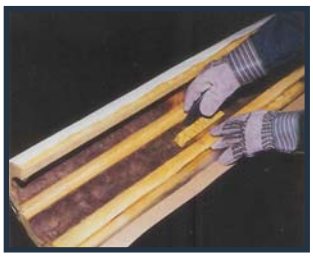


18" - 24" Pipe
14" Long Block

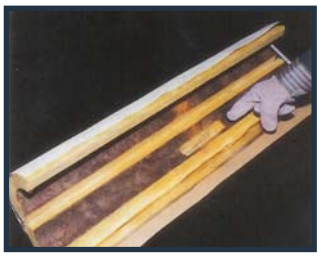
INSTALLATION:

ICA H-Block is placed between the bottom of the pipe to be supported and the metal shield. On pipe sizes above 5" IPS, H-Block should be oriented along the bottom 60° arc of the system. The thickness of the H-Block should be the same thickness as the insulation system. H-Block can be applied with minimum effort and simple tools by removing a "block section" from the pipe insulation, then replacing this section with a heavy density H-Block. Each H-Block is marked to identify which side is placed against the pipe.

1. Remove "block section" from pipe insulation



2. Replace this section of pipe insulation with H-Block



PHYSICAL PROPERTIES:

Service temperatures	-120° F. to +650° F.
Density	18 lb. cu./ft.
Moisture absorption	0.2% by volume, 96 hrs. at 120° F. 96% RH
Corrosion	Does not cause or accelerate corrosion
Safety	Non-combustible
Shrinkage	None. Dimensionally stable.
Alkalinity	Ph9
Thermal Conductivity	K = .30 (stable, non-deteriorating)
Compressive strength	nominal 5% deflection at 30^{PSI} nominal 10% deflection at 80^{PSI}
ASTM E84 25/50	10 flame spread index 10 smoke development

Our technical staff is ready to assist you!

For more data or free samples call us at 610-377-6100
or email us at service@icafittings.com.

icafittings.com

Johns Manville

Zeston® 2000 PVC

Insulated Fitting Covers and Jacketing

Description

Zeston 2000 fitting covers are designed to insulate and to provide a protective covering for pipe fittings. The fitting covers are supplied with Hi-Lo® Temp Formaldehyde-free™ fiber glass insulation inserts from the factory. Zeston PVC jacketing provides a protective covering for insulated or bare pipes. Zeston 2000 PVC fitting covers and jacketing are manufactured from high-impact, gloss white, UV-resistant polyvinyl chloride, which provides a simple, quickly installed system.

Available Shapes and Sizes

Fitting Covers. Zeston 2000 Series PVC fitting covers are available for the following: 45° and 90° (0.8 and 1.6 rad.) short- and long-radius elbows, tees, valves flanges, reducers, end caps, soil pipe hubs, traps and mechanical groove-type fittings.

Jacketing. Zeston PVC White and Color jacketing is available in rolls in thicknesses of 10, 15, 20 and 30 mil (0.3, 0.4, 0.5 and 0.8 mm).

Cut & Curled™ Jacketing. Zeston PVC White and Color Cut & Curled jacketing is available in thicknesses of 20 or 30 mil (0.5 mm or 0.8 mm). (30 mil white [0.8 mm] is recommended for outdoor applications.) It is available in factory-cut sizes to fit up to 30" (762 mm) O.D. All sections of Zeston PVC Cut & Curled jacketing are 48" (1,219 mm) in length and are factory curled to fit snugly.

Uses

Zeston 2000 PVC fitting covers and jacketing are ideally suited for indoor or outdoor use on chilled water, hot water, steam and other piping systems in commercial, institutional and industrial applications. The fitting covers, when combined with Zeston PVC jacketing and Perma-Weld® solvent welding adhesive, form a completely sealed system that meets the requirements of the USDA and FDA for applications in food, beverage and pharmaceutical facilities.

Qualifications for Use

General

- Install the Hi-Lo Temp fiber glass insert by wrapping it completely around the pipe fitting without overly compressing it or leaving any voids. Ensure that the insulation insert covers all exposed surfaces. The Zeston PVC fitting cover should then be installed over the pipe fitting and fiber glass insert by securing the throat using either serrated tacks, Perma-Weld adhesive or Zeston Z-Tape.

Hot Systems

- PVC covers must be kept below 150°F (66°C) by use of proper insulation thickness.
- PVC covers should be kept away from contact with and exposure to sources of direct or radiated heat.
- For fittings where operating temperatures exceed 250°F (121°C) or where pipe insulation thickness is greater than 1½" (38 mm), two or more layers of Hi-Lo Temp insulation inserts are required beneath fitting cover.

Cold Systems

- An approved vapor retarder mastic compatible with PVC must be applied between pipe insulation and fitting cover, and on fitting cover throat overlap seam.
- For fittings where operating temperature is below 45°F (7°C) or where the pipe insulation thickness is greater than 1½" (38 mm), two or more layers of Hi-Lo Temp insulation inserts are required beneath fitting cover.

Operating Temperature Limits:
PVC: Up to 150°F (66°C)
Insert: 0°F to 450°F (-18°C to +232°C)
Flame Spread: 25 or less (up to 30 mil [0.8 mm])
Smoke Developed: 50 or less (up to 30 mil [0.8 mm])
Grade: Weatherable
Color: White
Finish: Gloss

Refrigerant Systems and Cold Systems in Severe Ambient Conditions

- Mitered pipe insulation segments, fabricated or premolded insulation shapes may be used in lieu of Hi-Lo Temp insulation inserts.
- An intermediate vapor retarder compatible with PVC is required to completely seal the insulation prior to installing the Zeston 2000 PVC fitting cover. Care should be taken to ensure that the vapor barrier mastic is applied between the pipe insulation and the fitting cover, and on fitting cover throat overlap seam.

Totally Sealed Systems (USDA Approval)

- System requires that 20 or 30 mil (0.5 mm or 0.8 mm) Zeston PVC jacketing is applied to pipe insulation in conjunction with Zeston PVC fitting covers.
- All circumferential and longitudinal seams of jackets and fitting covers should be sealed with Zeston Perma-Weld solvent welding adhesive. Circumferential seams should be a minimum 1" (25 mm) overlap, and longitudinal seams should be 1½" to 2" (38 mm to 51 mm) overlap.
- Upon completion, all seams should visually be checked for seal and touched up, if necessary.
- Slip joints are required periodically between fixed supports and on continuous long runs of straight piping. Slip joints are achieved by increasing circumferential overlap to 8" to 10" (203 mm to 254 mm) and applying a flexible white caulking in the overlap area to maintain a sealed system.

Zeston® 2000 PVC

Insulated Fitting Covers and Jacketing

Physical Properties of Zeston 2000 PVC

Property	Value	ASTM Test Method
Specific Gravity	1.48	D792
Tensile Strength at Yield, psi (kPa)	6,000 (41,370)	D638
Elongation at Yield (MD), %	3.0	D638
Tensile Modulus, psi (kPa)	425,000 (2,930,270)	D638
Flexural Strength, psi (kPa)	11,000 (75,850)	D638 (min. 0.125" [3 mm] thick specimen)
Flexural Modulus, psi (kPa)	430,000 (2,964,750)	D790
Flame Spread (white only)	25 or less (up to 30 mil [0.8 mm])	E84
Smoke Developed (white only)	50 or less (up to 30 mil [0.8 mm])	E84
Electrical Conductance	Non-Conductor	D257
Gardner—SPI Impact, in. lb./mil by Ductile Failure	10 mil (0.3 mm) 1.3 15 mil (0.4 mm) 1.4 20 mil (0.5 mm) 1.5 30 mil (0.8 mm) 1.6	D3679 (4 lb. [1.8 kg] weight; 8 lb. [3.6 kg] for 30 mil [0.8 mm])

Chemical resistance data available on request.

General Properties of Hi-Lo® Temp Formaldehyde-free™ Fiber Glass Insulation Insert

Thermal conductivity	Mean Temperature °F	Mean Temperature °C	"k" Btu•in/(hr•ft²•°F)	"k" W/m•°C
	75	24	.28	.040
	150	66	.34	.049
	300	149	.45	.065
Temperature limits	0°F to 450°F (-18°C to +232°C)			
Sanitary	Odorless. Will not absorb odors. Provides no food for insects or rodents; will not mildew.			
Vibration resistant	Will not settle or separate.			
Fire safety	Meets most requirements of federal, state and local codes. Accepted for commercial, institutional, industrial and residential projects in all parts of U.S. The fiber glass inserts have UL 25/50 rating and are noncombustible per ASTM E136.			

Specification Compliance

USDA, Agriculture Canada
New York City MEA #7-87
ICBO
SBCCI
BOCA
ASTM D1784, Class 16354-C
L-P-535E,* Composition A, Type II, Grade GU
L-P-1035A,* Composition A, Type II, Grade GU
Canada: CGSB 51-GP-53M
CAN/ULC S102-M88

**Impact strength determined by Gardner-SPI test method rather than Izod, since Gardner is more appropriate for PVC sheeting materials.*

Johns Manville

717 17th St.
Denver, CO 80202
(800) 654-3103
specJM.com

CI-55 06/11 (Replaces 10/08)

North American Sales Offices, Insulation Systems

Eastern Region
P.O. Box 158
Defiance, OH 43512
(800) 334-2399
Fax: (419) 784-7866

Western Region and Canada
P.O. Box 5108
Denver, CO 80217
(800) 368-4431
Fax: (303) 978-4661

The physical and chemical properties of Zeston® 2000 PVC Insulated Fitting Covers and Jacketing listed herein represent typical, average values obtained in accordance with accepted test methods and are subject to normal manufacturing variations. They are supplied as a technical service and are subject to change without notice. Numerical flame spread and smoke developed ratings are not intended to reflect hazards presented by these or any other materials under actual fire conditions. Check with the Regional Sales Office nearest you to assure current information. **All Johns Manville products are sold subject to Johns Manville's standard Terms and Conditions, including Limited Warranty and Limitation of Remedy. For a copy of the Johns Manville standard Terms and Conditions, Limited Warranty and Limitation of Remedy and information on other Johns Manville thermal insulation and systems, call (800) 654-3103.**

JMCOM110360

PROTO FITTING COVERS

25/50 RATED
PER ASTM E-84 — LoSMOKE® PVC

PROTO REGULAR PVC
LoSMOKE® PVC JACKETING

SUBMITTAL SHEET

Effective: 05/01/07

Submitted Date: _____

PROTO CORP.
10500 47th Street North
Clearwater, FL 33762-5017
Tel: (727) 573-4665
Fax: (727) 572-6823
Toll Free (800) 875-7768

PVC FITTING COVERS, PRE-MOLDED, INSULATED
WHITE GLOSS FINISH — INDOOR OUTDOOR GRADE

SUBMITTAL SHEET DOES NOT SUPERCEDE WRITTEN SPECIFICATIONS OR OWNER AGREEMENT.

DESCRIPTION

The Proto Fitting Cover System consists of one piece and two piece pre-molded high impact LoSMOKE® PVC fitting covers with fiberglass inserts and accessories, which include elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, white and indoor color jacketing, Protop® Tank End Panels, tack fasteners, tapes and specialty items.

APPLICATIONS

The Proto Fitting Cover System is used to insulate mechanical piping systems at fitting locations and provide a PVC jacketing for straight run piping. Both give a quality appearance and have excellent durability.

FEATURES AND BENEFITS

25/50 Rated. All Proto PVC Fittings are made of LoSMOKE® grade PVC. Roll Jacketing is available in either 25/50 rated or regular PVC Grade (not 25/50 rated). The 25/50 products meet fire and smoke safety requirements of federal, state and local building codes.

Excellent Appearance. Bright high-gloss white coloring adds a distinct quality appearance to the system. The standard line of Proto Fitting Covers are made in LoSMOKE® PVC designed for indoor and outdoor use. Virtually all sizes pass 25/50 when made of LoSMOKE® PVC. Colored PVC is manufactured from a LoSMOKE® formula that is suitable for indoor use only.

Easy To Clean. Due to the smooth, high gloss finish on Proto PVC Fittings, the product cleans easily with soap and water. This makes the system ideal for food and drug facilities.

Low Cost Installation. Significant cost savings vs. conventional cement, molded sections, and mitered sections.

Fast and Easy. At fitting locations, wrap the fiberglass insert around the pipe fitting, apply the Proto PVC Fitting over the insert and tack or tape in place. Do not use tacks where a vapor retarder is applied.

Wide Temperature Range. May be used for mechanical piping systems operating from -20°F to +140°F surface temperature of insulation. Variety: LoSMOKE®, Indoor/Outdoor, Exod®, Exotuff®. Proto products are also available in LoSMOKE® Indoor colors. Exod® is CPVC, GOOD TO 225° F.

Long Lasting. Can be used more than once on retrofit projects, general maintenance.

Excellent Thermal Value. K value of .26 at 75°F (.037 W/m °C at 24°C) of fiberglass insert, mean temperature assures better thermal efficiency than conventional cement fittings.

Resistance To Fungi and Bacteria. (ASTM G 21, ASTM G 22) Does not promote growth of fungi or bacteria.

U.V. Resistant. Can be used on indoor or outdoor applications, for both (White) LoSMOKE® PVC and Regular PVC. Extra thick fitting covers should be used outdoors. (All Std. Proto Fitting covers are made of LoSMOKE® PVC.)

TECHNICAL PHYSICAL PROPERTIES OF PVC LoSMOKE® MATERIALS

Specific Gravity (ASTM D-792) 1.41
Tensile Modulus, PSI (ASTM D-638) . . . . . .361,000 (25,380 kg/cm²)
Tensile Strength, PSI (ASTM D-638) 6,011
Flexural Strength, PSI (ASTM D-790) 9,396
Izod Impact (1/4") ft. lb./in (ASTM D-256) 3.7
Heat Deflection Temp. (ASTM D-648) . . . . . .157°F (70°C)
at 264 PSI (8.95 kg/cm²), °F
VICAT Softening Temp. (ASTM D-1525) . . . . . .198°F (92°C)

Water Vapor Transmission
ASTM E 96-95
70°F & 50% Relative Humidity
.015" thick = .058
.020" thick = .047
.030" thick = .027

Surface Burning Characteristics of All Fitting Covers and Jacketing
LoSMOKE® PVC . . . . . .passes 25/50 ASTM-E 84
Up to .030" Thk.
Puncture Resistance (ASTM D 781) . . .006" thick = 178 Beach Units
.015" thick = 221 Beach Units

FEDERAL SPECIFICATIONS COMPLIANCE—

POLY VINYL CHLORIDE — ASTM 1784-92

LP-1035A Type II Grade GU and Type III

LP-535E Type II Grade GU and Type III

United States Department of Agriculture Authorized
Agriculture Canada Authorized
New York City MEA 243-84-M, Chicago, Los Angeles ASTM C-585-76 (sizes)
Canada CAN/CGSB - 51.53-95

TECHNICAL PROPERTIES OF FIBERGLASS INSERT MATERIAL

Thermal Conductivity (ASTM C 177)

Mean Temperature –	°F	"k" — BTU in/hr. Ft.2 °F
HH-I-558 Form B	75° 1(24°C)	.26 (.037 W/m. °C)
Type 1 Class B	150° 1(66°C)	.33 (.048 W/m. °C)
	250° (121°C)	.44 (.063 W/m. °C)

APPLICATION AND SPECIFICATION GUIDELINES

A. STORAGE

Protect cartons from water damage or other abuse. Proto Fitting Cover cartons are not designed for outside storage.

B. PREPARATION

Proto Fitting Covers should be applied on clean, dry surfaces.

C. APPLICATION

1. **General:** The matching fiberglass insert shall be wrapped completely around the metal fitting leaving no voids. Loose wrappings of twine is helpful in shaping difficult surfaces. The Proto Fitting Cover shall then be applied over the fitting and insert, and the throat secured by either tack fastening or taping.

2. **Cold Pipe:** Fitting systems below ambient temperature must have a continuous vapor retarder or vapor retardant mastic as specified by the engineer. When using Proto PVC Tape, a 2" (51mm) minimum downward overlap is recommended for optimum performance. Care should be taken not to stretch the last 2" (51mm) of Proto PVC Tape, to avoid stretching or creeping.

3. **Hot Pipe:** Insulate as per General Instructions given above. Due to PVC softening point at approximately 159°F (70.6°C), care should be taken to ensure sufficient insulation thicknesses are applied.

For hot piping which requires Pipe Insulation over 1 1/2" (38 mm) wall thickness, an extra fiberglass insert shall be applied for each additional inch of pipe insulation wall thickness. Proto recommends the surface temperature of the Pipe Insulation and PVC to be no higher than 125°F (52°C). To complete application of Proto PVC Fittings on hot piping, the throat seam shall be tack fastened or taped. Seal all laps outdoors and in wash down areas.

CAUTION: During initial heat-up to operating temperatures above 350°F, (177°C) an acrid odor and some smoke may be given off as a portion of the bonding material used in the insulation begins to undergo a controlled decomposition. If natural convection is not adequate in confined areas, forced ventilation should be provided in order to protect against any harmful fumes and vapors that might be generated.

4. **Outdoor Pipe:** Insulate as per above instructions.

Minimum Proto PVC Jacketing thickness for outdoor applications should be .030" (.7 mm). Over 15" O.D., .040 is recommended. Under 3 1/8" O.D., .020 is permitted. The PVC Jacketing shall be overlapped a minimum of 2" (51 mm) on the down side so as to shed water. All long and round joints shall be completely weather sealed with caulk adhesive.

On all piping, insulation shall be of sufficient thickness to keep the surface temperature below 125°F (52°C). Additionally, a slip type expansion joint of 8" (202 mm) minimum width shall be applied at least every 25 lineal feet (6.1 lineal meters) and between fittings.

Indoor Painting: Painting must be done only after priming the PVC surface with a suitable primer, such as X-1-M 400W Primer, or a similar, approved product. Test paint a section before proceeding.

Outdoor Painting: Only over White Exotuff® 195°F deflection temp. (modified PVC) or EXOD™ 225°F deflection temp. CPVC after X-1-M primer, or a similar, approved product. Use PVC compatible paints without strong solvents. Test paint a section before proceeding.

5. **CAUTION:** Fiberglass may cause temporary skin irritation. Wear long-sleeved, loose-fitting clothing, head covering, gloves and eye protection when handling and applying material. Wash with soap and warm water after handling. Wash work clothes separately and rinse washer. A disposable mask designed for nuisance type dusts should be used where sensitivity to dust and airborne particles may cause irritation to the nose or throat.

D. HEAVY INDUSTRIAL APPLICATIONS OUTDOORS

Use .030" or higher PVC Jacketing. Use "heavy duty" two piece fitting covers made from minimum .030" thick to .050" thick PVC sheet depending on size of fitting cover. Jacketing to be cut and oven precurled

E. FIRE TEST RESULTS: PROTO LoSMOKE® — PVC

USA: E-84 25/50 Rated up to .035" thick (The Best Rated PVC)

CANADA: Conforms to CAN 4-S102.2

LoSMOKE® fitting covers conform to virtually all city, state and federal codes, for use in hotel, commercial and industrial buildings.

LoSMOKE® fitting covers will be labeled on the box "Passes ASTM E-84." Flame spread 25; smoke developed 50".

All E-84 ratings shown here were tested on flat sheets from which fitting covers are made.

Virtually all Proto LoSMOKE® fitting covers will pass E-84 25/50 flame spread and smoke development rating requirements.

SUGGESTIONS

Slide Joints: Do not apply PVC Jacketing too tightly. Slide joints plus PVC thickness must work together to prevent cracks and puckering.

Vapor Retarder: A vapor retarder is required under all fitting covers for systems operating below ambient temperatures, such as chilled water lines, and is recommended for all outdoor applications. The fitting vapor retarder should provide a continuous seal with the adjacent pipe vapor retarder.

Outdoor Fitting Covers: Use extra thick, plastic heavy duty covers.

Outdoor and Indoor Washdown Areas: Use EXOD™ (CPVC) by Proto, for its higher deflection temperature (225°F). It is light grey.

PVC Outdoor Thickness (Reg. PVC Jacketing): Use .030" thick cut and oven precurled jacketing. Use "heavy duty" plastic fitting covers formed from minimum .030" to .050" thick PVC sheet depending on size of fitting cover. On pipe insulation larger than 15" O.D. use .040" thick PVC.

PVC Indoor Thickness: Use white or indoor color LoSMOKE® on piping. Use .020" thick with standard one piece fitting cover, .030" jacketing can also be used.

Vessels and Tank Tops: Use .050" or .060" thick tank panels for outdoor applications and .030" or .040" for indoor tanks. Use .050" thick Protop® segments for tank heads. (Only Proto Corp. has them.) Made of LoSMOKE® PVC.

Pipe Insulation End Caps: Use on all outdoor, indoor washdown areas, and all vapor sealed systems. End caps will be PVC, metal, or gasket materials appropriate for the metal pipe temperatures. Silicone rubber (500°F) can be applied (min. 1/16" thick) as an end cap outdoors.

Indoor hot piping need not be sealed to the end cap. Cap will be sealed or taped to the jacket.

Two-Ply Waterproofing System: Use .010" thick PVC with self-sealing long lap tape, as the first waterproof layer. Overlap ends 3" and PVC tape over. Caulk all openings with Celulon® or similar, approved product. The finished jacketing material should employ staggered joints with at least a .010 mil thick first layer. Recaulk again over last layer. Install slide joints every 25', caulk shut all other seams, openings, or end overlaps with PVC tape or caulk. Use vapor seal jacketing (instead of .010" thick PVC first layer) where a vapor seal system is required.

CPVC-High Chemical Resistance and High Deflection Temperature: Use "Exod®" CPVC jacketing and fitting covers for 225°F deflection temperature and maximum chemical resistance. Offered only by Proto Corp. as a substitute for stainless steel.

Regular PVC Jacketing Outdoors: Use regular PVC jacketing outdoors. It is less expensive, does the same job as LoSMOKE® PVC. Regular PVC has very good fire (self-extinguishing) properties — not as good as the LoSMOKE® PVC used in confined people areas (buildings), however much better than common plastics used outdoors.

Vessels with ends 24" O.D. or larger: Use .040" thick jacketing up to 48" O.D. On sides of vessels larger than 48" O.D. See Protop® brochure for instructions requiring a suspended band system, to hang panels from, (Gerrard & Company or equal). Use thick PVC panels on Outdoor Tanks not PVC Roll Jacketing. See Tank Tops above for end segments.

PROTO PVC CORP™

10500 47th Street North
Clearwater, FL 33762-5017
Tel: (727) 573-4665
Fax: (727) 572-6823
Toll Free (800) 875-7768

Control Wizards, Inc.
89 Taylor Avenue • Norwalk, CT 06854
Ph. 203.274.5284

Automatic Temperature Controls
Sequence of Operation

ConnCAT – Culinary Arts Program
4 Science Park: 1st Floor
New Haven, CT 06511

Submittal Date: 8-5-2015
Submittal *Revision 2: 10-4-2015 (change sequence for AHU-1)*
Changes in Bold-Italics Below
Submittal Rev 3: 10-23-2015
Additional changes for AHU-1, Delete Dishwasher Fan
Changes in Underlined Italics Below.
As-Built: 1-20-2016

Table of Contents

Project Overview (BMS):

General: This project consists of: a single Air Handing Unit with a DX condensing unit, economizer, and Hot Water Heating. There are VAV boxes for zone heating and cooling, which are also used for make-up air control.

HVAC/Building Management System (BMS)

General: The BMS system is a Honeywell WEBS based Building Management System based upon a WEBS-600 Series (JACE) WebServer/Controller. The WEBS controllers are based upon the Tridium Niagara AX ™ Framework. Each individual JACE 600 Controller performs multiple functions:

- Operates as a DDC Controller with its own Input/Output modules.
- Operates as a WebServer to serve up the Graphics Pages for the site to any Browser that can "see" the webserver via an Ethernet (Intranet or Internet).
- Communicate with and manage a number of DDC Equipment Controllers and DDC Terminal Equipment Controllers (VAV Box Controllers, XL10 Hydronic Heat Controllers, Rooftop LON/BACnet Cards, etc.) via LON,network communications.
- Perform 'global functions for all equipment: Scheduling, Data communications (for example, sending the supply air temperature from an Air Handler to all VAV boxes), trending, and alarming.

The WEBS DDC (JACE) 600 Controller will be located in: Janitors Closet (Ground Floor)

Communications: A connection with the buildings Router or a dedicated Internet connection (Cable or DSL) will be required for the graphics pages to be viewed via the Internet or Intranet and the alarm email system to function. This connection is by others.

The WEBS-600 Controller will include the following communication ports:

- Local Input and Output for monitoring and control at the WEBS-600 Controller (for the Air Handling Unit). The input and output for a WEBS 600 Controller can consist of up to 64 points per controller, made up with at least one 34 Point module and optionally one or two 16-port modules.
- LON Port: A LON Network is an open-protocol network that allows communication with dedicated HVAC Controllers as well as other smart controllers. (VAV Box Controllers)
- Ethernet Port: A standard Ethernet port is provided for Ethernet communication to the WEBS supervisor.
- RS485 Port: This port is provided and Drivers will be included for each WEBS 600 as required to communicate to Field Devices. This port can be used for Modbus communications or BACnet communication. At this submission, there are no Modbus or BACnet devices being provided on this project, so this port is a spare for future use.

Alarms: The Honeywell WEBS System will have 3 Classes of Alarms: Log-only, Warnings, and Critical Alarms defined as follows:

- Log-Only alarms will be recorded at the Webserver and can be viewed at any time from the system, but no notification will be emailed.
- Warnings will be emailed, but only during regular business hours of 8am to 4pm (schedule can be field-modified). This is for items that the maintenance staff needs to be aware of, but the repair is not urgent, for example when a lead pump has failed, but the backup pump is operating properly. The lead pump does need to be fixed, but not at 2am.
- Critical Alarms are alarms that will be emailed 24/7 – something that the maintenance staff needs to know as soon as it happens.
- The alarm class for each alarm is listed below. Please review the alarm class for these alarms listed below during the submittal process to insure that they meet the requirements of the buildings operation and maintenance staff.
- Once a week (default is Wednesday at 10am, schedule adjustable), the Webserver will send a Heartbeat Message to confirm operation of the Webserver, and email system.
- NOTE: Generally, the email alarms are sent to one address (warning or alarm) and the owners email system (Exchange) will forward the email alarms to the required recipients. This simplifies the changes to the actual email addresses used as staff and assigned duties change. The controllers can be set up to email alarms to a number of individual email addresses, but this makes changes more time consuming.

Scheduling

The system will have the following independent time of day schedules:

- If the zone has associated VAV Boxes, the VAV Boxes will be scheduled to be occupied 2 minutes before the AHU/Rooftop unit in the zone is started.

- Schedules A through C will all share a single Holiday/Special Days List. This list will allow for special events to turn all these units to occupied (graduation, etc), or unoccupied (snow day).

- NOTE: If any of the Hood Exhaust Fans are on (EF-1, EF-2, and EF-3), the AHU and associated VAV Boxes will stay in the occupied mode.

A: Entire 1st Floor (AHU, EF-5, and VAV Boxes)
B: Spare
C: Spare

NOTE: Engineer/Architect: Please advise if the project should have multiple schedules for different areas of the space.

VAV Air Handing Unit (AHU-1), Revision 3

General: AHU-1 provides conditioned air to the 1st floor of the building as a '***VAV' System (Variable Air Volume).*** . The Air Handing Unit is a DX cooling (with Hot Gas Reheat) and Hot Water Heating Unit with a Variable Speed Fan (VFD).

The VAV boxes control the amount of air from these units that is delivered to each space.

Sequence:

Emergency/Fail Safe Mode:

- Upon any emergency condition:
  - Manual Reset Freezestat
  - Automatic Reset Leak Detection at Drain Pan
  - Any Duct Smoke Detector (Supply or Return)
  - Signal from Building Fire Alarm Panel
- The Unit will operate as follows via Hardwired Interlocks (no programming required):
  - Supply fan OFF (interlock to 'Safety Interlock input on VFD
  - Return Air Damper Open (Spring Open)
  - Outside Air Damper Closed (Spring Closed)
  - Hot Water Valve Open (Spring Open)

Operation (non-emergency/fail safe mode):

Control Mode: The unit will be indexed to Occupied Mode based upon the Floor/Building Schedule (see above). Every VAV Box associated with a particular HVAC unit will switch to occupied mode at the same time the Unit is switched to occupied mode (or started for any reason – see below). In addition, if any of the Hood Exhaust fans are on (EF-1, 2 or 3), the Unit will be in occupied mode as long as these fans are ON.

Occupied Mode

- In unoccupied Mode, the Unit is off.
  - Night Setback will be handled via the VAV Boxes.
  - *No Night Cooling*
  - See details below
- The unit will operate with Optimum Start to provide a Cool down cycle as needed without outside air (unless outside air can be used for economizer operation) based upon an average space temperature.

- ***Heating vs. Cooling Operation: The unit will operate to provide 55 F supply air temperature at all times when is running. If the supply air temperature drops below 55 F, the heating valve will modulate to maintain a 55 F supply***

temperature. If the Supply Air Temperature Rises above 55 F, the cooling will operate to provide 55 F Supply Air Temperature (see below)

- The Outside Air and Return Air control dampers are interlocked together via control logic, so when the outside air damper modulates open, the return air damper will modulate closed.

- In Occupied Mode:
  - The Fan operates continuously.
  - The outside air damper will open to its minimum position – this setpoint will vary based upon the system exhaust. The Minimum OA Setpoint will be increased for each exhaust fan that is running. Damper Positions for each setpoint will be determined by the Air Balancer and programmed into the system.

    - Base Setpoint: 2000 CFM
    - If Production Kitchen Fan 1 (EF-1) is running, Add: 4,711 CFM
    - If Production Kitchen Fan 2 (EF-2) is running: Add 4,136 CFM
    - If Demo Kitchen Fan (EF-3), is running, add 1,200 CFM
    - The BMS will add up all the respective CFM requirements to generate a TOTAL OA CFM requirement (the Maximum Outside Air CFM shall be limited to 11049 CFM (per the AHU-1 Schedule).

  - CFM Setpoints shall be:

Condition	**Total OA Setpoint (CFM)**
Base	2000
Base and EF-1	6711
Base and EF-2	6136
Base and EF-3	3200
Base and EF-1 and EF-2	10847
Base and EF-1 and EF-3	7911
Base and EF-2 and EF-3	7336
Base and EF-1,2, and 3	11049
	(12,047, limited to Max of 11,049)

  - Upon a Request for Heating when the Supply Air Temperature Drops below 55 F (***See Heating vs. Cooling section above***), the Unit will provide heating as follows:
    - If the building is providing Heating Hot Water:

- ***The system will modulate the hot water valve to provide supply air at the Supply Air Setpoint – 55 F (See above).***
- ***The Fan will continue to modulate to maintain the duct static setpoint. .***

▪ If the building is not providing Hot Water:
- Generate an Alarm (Heating Needed, No Hot Water)

o Upon a Request for Cooling (***See Heating vs. Cooling section above)***, the Unit will provide Cooling as follows:

o Supply Air Setpoint:
▪ ***Supply Air Temperature Setpoint will be 55 F.***

o Economizer:
▪ ***When the unit is occupied, the Outside Air Dampers will be set to their minimum position, which will vary based upon which exhaust fans are operation (see Occupied Mode section above)***
▪ The first stage of cooling is the economizer, which will be enabled if the Outside Air Enthaply is less than the Return Air Enthaply. The economizer will operate to provide mixed air that is 2 F below the supply air setpoint. *In the economizer mode, the Outside Air Damper will modulate open above the minimum setting to maintain the mixed air temperature setpoint of 53 F.*
▪ If Economizer is not available or the unit is in economizer mode but the supply air temperature *is 5 F* above setpoint for more than 15 minutes, the Compressors will be enabled.

o Compressors:
o Once enabled the compressors will be staged (and the 1st stage modulated) to maintain the supply air temperature setpoint (See above)

o If the First Compressor is on and the Suction Pressure Sensor (provided and installed by the Unit Manufacturer) drops below 130 psi (adjustable – R-410A), the hot gas reheat will enabled.

o A duct static sensor in the Supply Air Duct will monitor the pressure in the duct and will vary the fan speed via the unit's VFD to maintain a fixed duct static setpoint.

o A supply air temperature sensor will limit the discharge air temperature of the unit and disable cooling the supply temperature falls below 45 F or disable heating if the supply temperature rises above *70 F*.

Unoccupied Mode:

- The Unit is OFF.
- Night Setback heating will be maintained with the fan powered VAV boxes – the AHU Unit will not be used for Night Setback Heating.
- *There is no night setback cooling, so the unit will be off.*
- The outside air damper will be closed and the return air dampers will be open.

Points:

- All fan Safeties are hardwired to a Fan Safety Relay (RIBMNLB-4) which will disable the Equipment: fans via VFD Safety Interlock input and turn off power to damper and valve actuators for fail safe operation. . Auxiliary contacts on each alarm are wired to the BMS for Monitoring No BMS logic is required for this fail safe mode.

- Fan VFD Drives:
  - Hardwired Control for:
    - Shutdown
    - Start/Stop
    - Speed Command (0-10 VDC)
    - Frequency feedback (HZ)

- See drawings and Valve/Damper Schedules for complete point list.

Alarms:

- Freezestat (critical)
- Pan Leak (critical)
- ~~Duct Smoke Detector (critical)~~
- Fire Alarm Shutdown (critical)
- Economizer enabled and hot water valve open more than 5%. (warning)
- Supply Fan Failure (critical)
- Sensor failure (Supply or Return Temperature sensor no reading) Critical

VAV Box Room 'Make-Up-Air' Function, *Rev 3*

General: The VAV boxes can be switched to "**Make-Up-Air Mode**" to provide additional air from the AHU when an exhaust fan for that space is running.

Make-Up-Air Mode (MUA) When a Kitchen Hood Exhaust Fan is running, as sensed by a current sensor switch on the fan, the associated VAV box will go into '***Make-Up-Air Mode'***, which will be create a new ***Minimum CFM Setpoint for the associated VAV Box***, regardless of Room Temperature (alternate: This can also be the damper being 100% open) and return grilles and return air ductwork will be dampered off per the table below (Type 8 Return Grilles***). The Make-Up-Air mode will override the Minimum CFM Setpoint parameter in all modes of operation***.

Fan	VAV Box	"MUA" SetPt	Return Air Damper
EF-1	VAV-H	2300 CFM	Close RG-DM Tagged H (next to VAV J)
EF-1	VAV-I	2000 CFM	Close RG-DM Tagged I (next to VAV J)
EF-2	VAV-F	2000 CFM	Close RG-DM Tagged F (next to box C)
EF-2	VAV-G	2000 CFM	Close RG-DM Tagged G (next to box C)
EF-3	VAV-C	1200 CFM	Close RG-DM Tagged C (Note 10)
EF-4	VAV-E	N/A	N/A (EF-4 – Dishwasher Removed)

RG-DM: Return Grille Damper Motor

Fans:

EF-1: Production Kitchen Fan West
EF-2: Production Kitchen Fan East
EF-3: Demonstration Kitchen Fan

VAV Box Return Air Control – VAV A and J

General: These VAV Boxes can return air either from the Ceiling Plenum or the Space via ducted return grilles. They are plenum return for cooling or ventilation and space return for heating. (Note 26 on ductwork Drawings).

- Heating Mode: Plenum Return Damper Closed, Space Return Air Damper Open
- Non-Heating Mode (Cooling/Ventilation): Plenum Return Damper Open, Space Return Air Damper Closed

VAV Boxes (Fan Powered, Hot Water Reheat, Parallel), Revision 3

General: Each VAV Box has:

- VAV Box with Damper and Velocity Pressure Sensor
- Honeywell CVL Stryker Series VAV Box Controller
- Wall Sensor Honeywell TR-21 (Sensors Only)
- Hot Water Reheat Valve (see VAV Box and Valve Schedule)
- Fan Relay

Control Mode: The unit will be indexed to Occupied Mode based upon the Floor/Building Schedule (see Schedule Section above). Every VAV Box associated with AHU-1 will switch to occupied mode at the same time the Rooftop unit is switched to occupied mode (or started for any reason – see below).

Setpoints: Each VAV Box will have the following setpoints (shown on the graphics pages and adjustable with the proper password level):

Unoccupied Heating (Default 65 F)
Standby Heating (Default 68) - Not in the logic for this project.
Occupied Heating (Default: 70 F)

Occupied Cooling (Default 74 F)
Standby Cooling (Default 76 F) - Not in the logic for this project.
Unoccupied Cooling *None*

Make-Up-Air Mode:

- If the VAV box gets a Make-Up-Air Command from the BMS System, the Minimum CFM Setpoint will Switch from the ***HVAC minimum Setpoint to the Make-Up-Air CFM Setpoint***. This will be implemented based upon the status of any associated exhaust fans: The Heating and cooling will still function as specified (although the ***Minimum CFM position will be at the Make-Up-Air Setpoint*** *rather than the HVAC Setpoint*)
- See ***Make-Up-Air*** section above for list of VAV boxes with ***Make-Up-Air*** mode and their MUA Setpoints.

Return Air Control Mode:

- See Section above for Return Air Control for boxes A and J.

Unoccupied Mode:

- The VAV Box damper will close
- If the space temperature drops below the Unoccupied Heating Setpoint the VAV Box Fan will start and Hot Water Valve will open
- ***There is no unoccupied cooling.***

Occupied Mode (see above for occupied/unoccupied control):

- The unit will operate to maintain the space occupied heating and cooling setpoints.
- The VAV Box has the following airflow setpoints and will modulate between the high and low CFM setpoints based upon the VAV Box Mode:
  - Cooling High Flow CFM Setpoint
  - Cooling Low Flow ***HVAC CFM*** Setpoint
  - Reheat CFM Setpoint
  - Make-Up-Air CFM Setpoint

- If the Room Air Temperature is above the Cooling Setpoint, the Damper will modulate *open (limited by its High Flow CFM Setpoint)*.

- If the Room Air Temperature is below the Cooling Setpoint, the damper will modulate to its minimum CFM Setpoint position ***(which may vary depend on the requirement for Make-Up-Air)***.

- If the space temperature drops below the heating setpoint, and the box has a reheat coil, the controller will operate the VAV Box damper to its minimum CFM Setpoint ***(which may vary depending on the requirement for Make-Up-Air***), turn the VAV Box Fan on, and modulate the Reheat Valve Open.

Alarms: An alarm will be generated at the BMS front end for a VAV box if:

- Loss of communication with a VAV Box (warning)
- Space Temperature Sensor Failure (warning)
- Invalid Setpoints (Heating higher than cooling for example) (warning).

BMS Monitoring: The BMS system will monitor the following

- Supply Air Temperature from VAV Box (after reheat coil): Monitor and trend only.
- Space Temperature: Monitor and trend
- Tenant Setpoint Adjustment: Monitor and Trend
- CFM Setpoint and measured CFM: Monitor and Trend.

VAV Boxes (Damper Only), VAV A and D, *Revision 3*

General: Each VAV Box has:

- VAV Box with Damper and Velocity Pressure Sensor
- Honeywell CVL Stryker Series VAV Box Controller
- Wall Sensor Honeywell TR-21 (Sensor Only)

Control Mode: The unit will be indexed to Occupied Mode based upon the Floor/Building Schedule (see above). Every VAV Box associated with AHU-1 will switch to occupied mode at the same time the Unit is switched to occupied mode (or started for any reason – see below).

Setpoints: Each VAV Box will have the following setpoints (shown on the graphics pages and adjustable with the proper password level):

Unoccupied Heating (Default 65 F)
Standby Heating (Default 68) - Not in the logic for this project.
Occupied Heating (Default: 70 F)

Occupied Cooling (Default 74 F)
Standby Cooling (Default 76 F) - Not in the logic for this project.
Unoccupied Cooling *None*

Unoccupied Mode:

- The VAV Box damper will close
- **There is no unoccupied heating or cooling.**

Occupied Mode (see above for occupied/unoccupied control):

- The unit will operate to maintain the space occupied ~~heating and~~ cooling setpoints.
- The VAV Box has the following airflow setpoints and will modulate between the high and low CFM setpoints based upon the VAV Box Mode:
  - Cooling High Flow CFM Setpoint
  - Cooling Low Flow ***HVAC CFM*** Setpoint
  - Make-Up-Air CFM Setpoint

- If the Room Air Temperature is above the Cooling Setpoint, the Damper will modulate **open (limited by its Maximum CFM Setpoint).**

- If the Room Air Temperature is below the Cooling Setpoint, the damper will modulate to its minimum HVAC CFM Setpoint position.

Alarms: An alarm will be generated at the BMS front end for a VAV box if:
- Loss of communication with a VAV Box (warning)
- Space Temperature Sensor Failure (warning)
- Invalid Setpoints (Heating higher than cooling for example) (warning).

BMS Monitoring: The BMS system will monitor the following
- Space Temperature: Monitor and trend
- Tenant Setpoint Adjustment: Monitor and Trend
- CFM Setpoint and measured CFM: Monitor and Trend.

Unit Heaters/Cabinet Unit Heaters *Rev 3*:

The Receiving Area Unit Heater will have a temperature sensor (no control valve) monitored by the BMS.

Upon a fall in space temperature below the setting on the wall thermostat (65 F, adjustable at the BMS Graphics) *and a Strap-on aquastat showing the Heating Hot Water is above 110 (adjustable*), the fan will start to provide heat to the space.

There will be a low temperature alarm (Warning) for this space.

Hot Water (Boiler) Plant:

General Description: This project uses hot water heat from a boiler plant that is not in this building. The BMS will monitor the HHW Supply Temperature to allow it to determine if Hot Water is available or not.

Alarms:
- HHW Plant issue: OAT less than 50 F and HHW temperature less than 110 F.

Exhaust Fan Control:

NOTE: For any fan, if there is an associated motorized damper with the fan, the motorized damper will be commanded to open and an end switch on the damper motor will start the fan once the damper is actually open

Each of the following exhaust fans will have a time of day schedule (see schedule section above) and will be turned on during occupied mode and turned off during unoccupied mode. If there is an associated motorized damper with the fan, the motorized damper will be commanded to open and an end switch on the damper motor will start the fan once the damper is actually open.

- EF-5, Toilet Exhaust Fan

The following fans will have a wall switch wired directly to the fan Motor Starter and shall operate when the wall switch is turned on. The BMS will monitor the Fan Status via a Current Sensor Switch on the motor leads.

EF-1: Production Kitchen Fan (West)
EF-2: Production Kitchen Fan 2 (East)
EF-3: Demonstration Kitchen Fan
~~EF-4 Dishwasher Exhaust Fan (Deleted)~~

General Alarm Monitoring

BMS Alarm Monitoring: The BMS system will monitor the following data points and take the defined actions:

No Standalone Alarm Monitoring of Auxiliary devices.

---- END ----

B3 Series, Three Way, Characterized Control Valve
Stainless Steel Ball and Stem

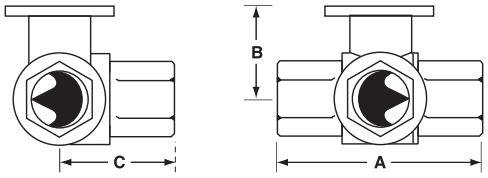
5 YEAR WARRANTY

Technical Data

Service	chilled or hot water, 60% glycol
Flow characteristic	A-port equal percentage B-port modified for constant common port flow
Controllable Flow Range	75°
Sizes	½", ¾", 1", 1¼", 1½", 2"
Type of end fitting	NPT female ends
Materials:	
Body	forged brass, nickel plated
Ball	stainless steel
Stem	stainless steel
Seats	PTFE
Characterizing disc	Tefzel®
Packing	2 EPDM O-rings, lubricated
Body pressure rating	
600 psi	½" - 1"
400 psi	1¼" - 2"
Media temp. range	0°F to 250°F [-18°C to 120°C]
Close off pressure	
200 psi	½" - 2"
Maximum differential pressure (ΔP)	50 psi for typical applications
Leakage	0% for A to AB <2.0% for B to AB
External leakage	according to EN 12266-1:2003
C_v rating	A-port: see product chart for values B-port: 70% of A to AB C_v

Tefzel® is a registered trademark of DuPont

Dimensions



3WayValve-B307-B320

	Valve Nominal Size		Dimensions (Inches [mm])		
Valve Body	Inches	DN [mm]	A	B	C
B307-B311	½"	15	2.41" [61.1]	1.39" [35.2]	1.20" [30.6]
B312-B316	½"	15	2.38" [60.4]	1.78" [45.2]	1.29" [32.8]
B317-B321	¾"	20	2.73" [69.3]	1.87" [47.4]	1.47" [37.3]
B322-B325	1"	25	3.09" [78.4]	1.87" [47.4]	1.59" [40.3]
B329-B331	1¼"	32	3.96" [100.6]	2.27" [57.7]	2.14" [54.3]
B338-B341	1½"	40	4.39" [111.6]	2.51" [63.7]	2.40" [61.1]
B347-B352	2"	50	4.90" [124.5]	2.73" [69.5]	2.74" [69.7]

Application

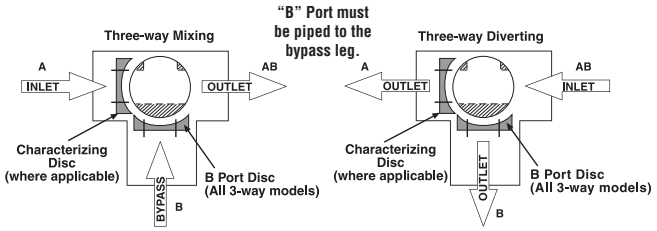
This valve is typically used in air handling units on heating or cooling coils, and fan coil unit heating or cooling coils. Some other common applications include Unit Ventilators, VAV box re-heat coils and bypass loops. This valve is suitable for use in a hydronic system with variable or constant flow.

*** (Not for use in change over applications)**

	Valve Nominal Size		Type	Suitable Actuators				
				Non-Spring			Spring	
C_v	Inches	DN [mm]	3-Way NPT	TR Series	LR Series	NR...N4 Series	TF Series	LF Series
0.3	½	15	B307					
0.46	½	15	B308					
0.8	½	15	B309					
1.2	½	15	B310					
1.9	½	15	B311					
3	½	15	B312					
4.7	½	15	B313					
10	½	15	B315					
16	½	15	B316					
4.7	¾	20	B317					
7.4	¾	20	B318					
14	¾	20	B320					
24	¾	20	B321					
7.4	1	25	B322					
10	1	25	B323					
30	1	25	B325*					
10	1¼	32	B329					
19	1¼	32	B330					
25	1¼	32	B331					
19	1½	40	B338					
29	1½	40	B339					
37	1½	40	B340					
46	1½	40	B341					
29	2	50	B347					
37	2	50	B348					
46	2	50	B349					
57	2	50	B350					
68	2	50	B351					
83	2	50	B352					

*Models without characterizing disc

Flow Patterns



AFRB24-SR, AFRX24-SR

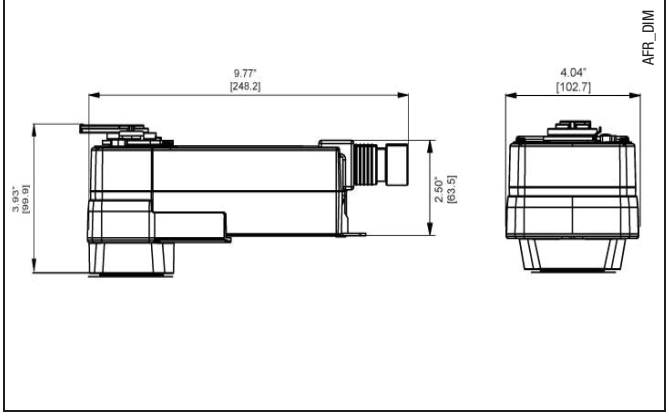
Proportional, Spring Return, 24 V, for 2 to 10 VDC or 4 to 20 mA Control Signal

Technical Data

Power supply		24 VAC ±20%, 50/60 Hz 24 VDC +20% / -10%
Power consumption	running	5.5 W
	holding	3 W
Transformer sizing		8.5 VA (class 2 power source)
Electrical connection		
AFRB...		3 ft, 18 GA appliance cable, 1/2" conduit connector **-S models:** two 3 ft, 18 gauge appliance cables with 1/2" conduit connectors
AFX...		3 ft [1m], 10 ft [3m] or 16 ft [5m] 18 GA appliance or plenum cables, with or without 1/2" conduit connector **-S models:** Two 3 ft [1m], 10 ft [3m] or 16 ft [5m] appliance cables, with or without 1/2" conduit connectors
Overload protection		electronic throughout 0 to 95° rotation
Operating range Y		2 to 10 VDC, 4 to 20mA
Input impedance		100 kΩ for 2 to 10 VDC (0.1 mA) 500 Ω for 4 to 20 mA
Feedback output U		2 to 10 VDC (max. 0.5 mA)
Direction of rotation	spring	reversible with CW/CCW mounting
	motor	reversible with built-in switch
Mechanical angle of rotation		95° (adjustable with mechanical end stop, 35° to 95°)
Running time	spring	< 20 seconds @ -4°F to 122°F [-20°C to 50°C]; < 60 seconds @ -22°F [-30°C]
	motor	95 seconds
Position indication		visual indicator, 0° to 95° (0° is full spring return position)
Manual override		5 mm hex crank (3/16" Allen), supplied
Humidity		max. 95% RH non-condensing
Ambient temperature		-22°F to 122°F [-30°C to 50°C]
Storage temperature		-40°F to 176°F [-40°C to 80°C]
Housing		Nema 2, IP54, Enclosure Type2
Housing material		zinc coated metal and plastic casing
Agency listings†		cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC & 2006/95/EC
Noise level		≤40dB(A) motor @ 95 seconds ≤62dB(A) spring return
Servicing		maintenance free
Quality standard		ISO 9001
Weight		4.6 lbs (2.1 kg); 4.9 lbs (2.25 kg) with switches

† Rated Impulse Voltage 800V, Type of action 1.AA (1.AA.B for -S version), Control Pollution Degree 3.

Dimensions (Inches [mm])



Accessories

AV 8-25	Shaft extension
IND-AFB	Damper position indicator
KH-AFB	Crank arm
K7-2	Universal clamp for up to 1.05” dia jackshafts
TF-CC US	Conduit fitting
Tool-06	8mm and 10 mm wrench
ZG-100	Universal mounting bracket
ZG-101	Universal mounting bracket
ZG-118	Mounting bracket for Barber Colman® MA 3../4.., Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crank arm type installations
ZG-AFB	Crank arm adaptor kit
ZG-AFB118	Crank arm adaptor kit
ZS-100	Weather shield (metal)
ZS-150	Weather shield (polycarbonate)
ZS-260	Explosion-proof housing
ZS-300	NEMA 4X housing

NOTE: When using AFRB24-SR, AFRB24-SR-S, AFRX24-SR and AFRX24-SR-S actuators, only use accessories listed on this page.
For actuator wiring information and diagrams, refer to Belimo Wiring Guide.

Typical Specification

Spring return control damper actuators shall be direct coupled type which require no crank arm and linkage and be capable of direct mounting to a jackshaft up to a 1.05” diameter. The actuator must provide proportional damper control in response to a 2 to 10 VDC or, with the addition of a 500Ω resistor, a 4 to 20 mA control input from an electronic controller or positioner. The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall use a brushless DC motor controlled by a microprocessor and be protected from overload at all angles of rotation. Run time shall be constant, and independent of torque. A 2 to 10 VDC feedback signal shall be provided for position feedback. Actuators shall be cULus Approved and have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

INSTALLATION NOTES

1 Provide overload protection and disconnect as required.

2 ***CAUTION** Equipment Damage!*
Actuators may be connected in parallel.
Power consumption and input impedance must be observed.

2 Up to 4 actuators may be connected in parallel if not mechanically mounted to the same shaft. With 4 actuators wired to one 500 Ω resistor.
Power consumption must be observed.

3 Actuator may also be powered by 24 VDC.

4 For end position indication, interlock control, fan startup, etc., AFB24-SR-S and AFX24-SR-S incorporates two built-in auxiliary switches: 2 x SPDT, 3A (0.5A) @250 VAC, UL Approved, one switch is fixed at +10°, one is adjustable 10° to 90°.

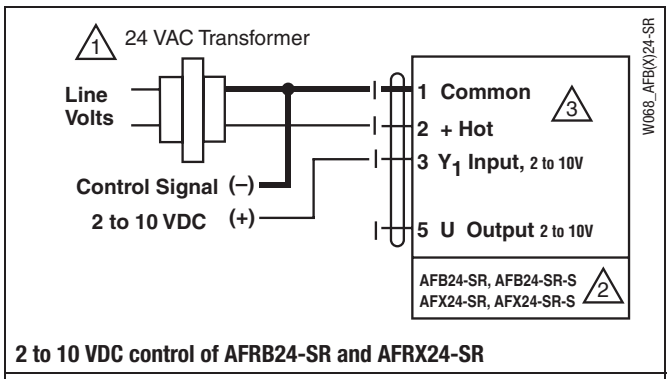
5 Only connect common to neg. (–) leg of control circuits

APPLICATION NOTES

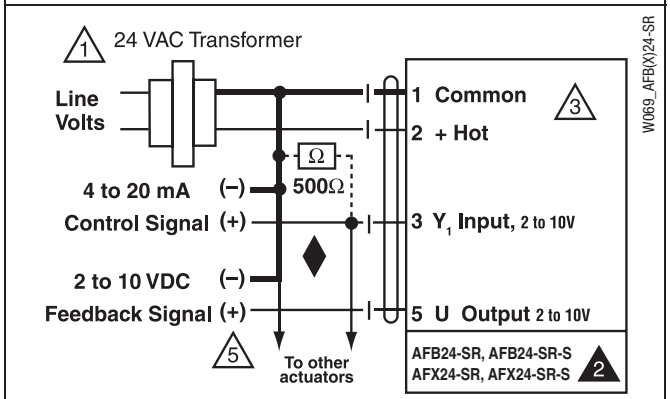
The ZG-R01 500 Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.

ATTENTION: AFRB24-SR(-S) and AFRX24-SR(-S) **cannot** be tandem mounted on the same damper or valve shaft. Only On/Off and MFT AF models can be used for tandem mount applications.

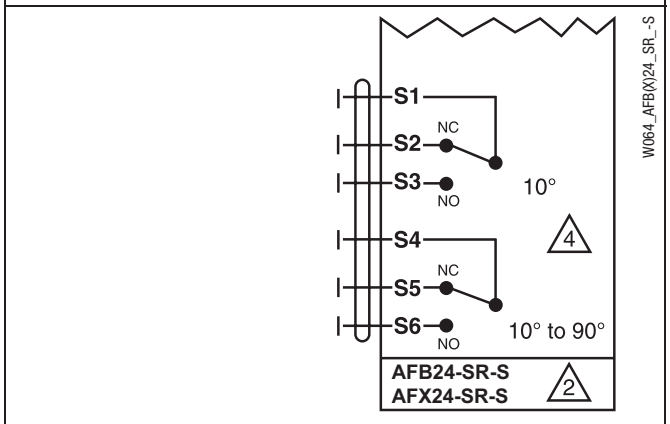
***WARNING** Live Electrical Components!*
During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.



2 to 10 VDC control of AFRB24-SR and AFRX24-SR



4 to 20 mA control of AFRB24-SR and AFRX24-SR with 2 to 10 VDC feedback output



Auxiliary switches for AFRB24-SR-S, AFX24-SR-S

B3 Series, 3-Way, Characterized Control Valve
Chrome Plated Brass Ball and Brass Stem

Application

This valve is typically used in air handling units on heating or cooling coils, and fan coil unit heating or cooling coils. Some other common applications include Unit Ventilators, VAV box re-heat coils and bypass loops. This valve is suitable for use in a hydronic system with variable or constant flow.

*** (Not for use in change over applications)**

	Valve Nominal Size		Type	Suitable Actuators			
C_v	Inches	DN [mm]	3-way NPT	Non-Spring		Spring	
0.3	½	15	B307B	TR Series	LR Series	TF Series	LF Series
0.46	½	15	B308B				
0.8	½	15	B309B				
1.2	½	15	B310B				
1.9	½	15	B311B				
3	½	15	B312B				
4.7	½	15	B313B				
10	½	15	B315B				
16	½	15	B316B				
4.7	¾	20	B317B				
7.4	¾	20	B318B				
14	¾	20	B320B				
24	¾	20	B321B				

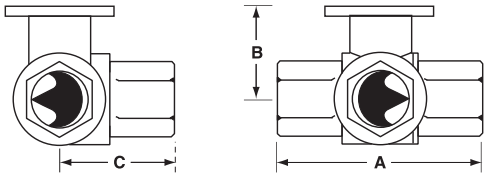
*Models without characterizing disc

Technical Data

Service	chilled or hot water, 60% glycol
Flow characteristic	A-port equal percentage B-port modified for constant common port flow
Controllable Flow Range	75°
Sizes	½", ¾"
Type of end fitting	NPT female ends
Materials:	
Body	forged brass, nickel plated
Ball	chrome plated brass
Stem	nickel plated brass
Seats	PTFE
Characterizing disc	Tefzel®
Packing	2 EPDM O-rings, lubricated
Body pressure rating	600 psi
Media temp. range	0°F to 250°F [-18°C to 120°C]
Close off pressure	200 psi
Maximum differential pressure (ΔP)	50 psi for typical applications
Leakage	0% for A to AB <2.0% for B to AB
External leakage	according to EN 12266-1:2003
C_V rating	A-port: see product chart for values B-port: 70% of A to AB C_V

Tefzel® is a registered trademark of DuPont

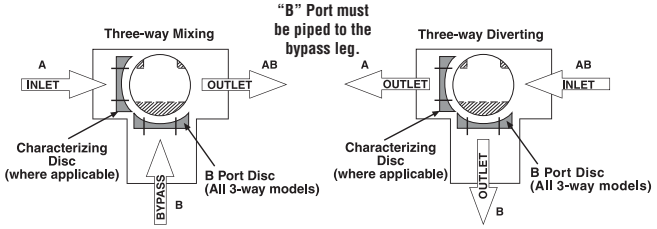
Dimensions



3WayValve-B307-B320

	Valve Nominal Size		Dimensions (Inches [mm])		
Valve Body	Inches	DN [mm]	A	B	C
B307B-B311B	½"	15	2.41" [61.1]	1.39" [35.2]	1.20" [30.6]
B312B-B316B	½"	15	2.38" [60.4]	1.78" [45.2]	1.29" [32.8]
B317B-B321B	¾"	20	2.73" [69.3]	1.87" [47.4]	1.47" [37.3]

Flow Patterns



TFRB(X)24-SR Actuators, Proportional

BELIMO

5 YEAR WARRANTY

Models

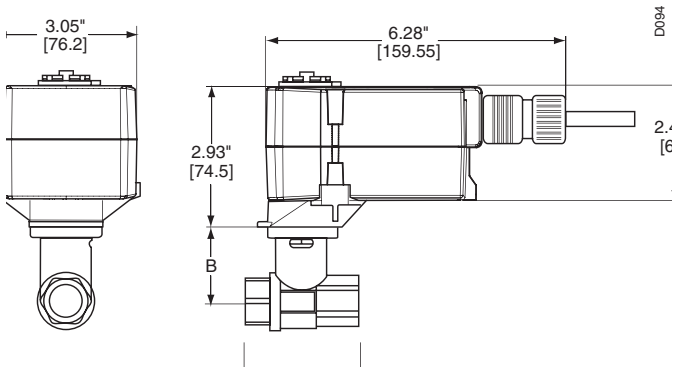
TFRB(X)24-SR
TFRB(X)24-SR-S w/built-in Aux. Switch

Technical Data	
Control	proportional
Power supply	24 VAC ± 20%, 50/60 Hz 24 VDC ± 10%
Power consumption running	2.5 W
holding	1.0 W
Transformer sizing	4 VA (class 2 power source)
Electrical connection (-S models have 2 cables) TFRB(X)24-SR...	½" conduit connector 18 GA plenum rated cable 3 ft [1m] 10 ft [3m] 16 ft [5m]
Electrical protection	actuators are double insulated
Overload protection	electronic throughout 0° to 95° rotation
Operating range Y	2 to 10 VDC, 4 to 20 mA
Input impedance	100k Ω (0.1mA), 500 Ω
Angle of rotation	95°
Direction of rotation spring	reversible with CW/CCW mounting
motor	reversible with built-in ↷/↶ switch
Position indication	visual indicator, 0° to 95°
Running time motor	95 sec constant, independent of load
spring	<25 sec @-4°F to 122°F [-20°C to 50°C] <60 sec @-22°F [-30°C]
Humidity	5 to 95% RH non-condensing
Ambient temperature	-22°F to 122°F [-30°C to 50°C]
Storage temperature	-40°F to 176°F [-40°C to 80°C]
Housing	NEMA type 2/IP42
Housing material	UL94 - 5VA
Agency listings†	cULus according to UL 60730-1A/-2-14, CAN/CSA E60730-1:02, CE according to 2004/108/EC and 2006/95/EC for line voltage and/or –S versions
Noise level (max) running	<35 db (A)
spring return	<62 dB (A)
Quality standard	ISO 9001

TFRB(X)24-SR-S	
Auxiliary switch	1 x SPDT, 3A (0.5A) @ 250 VAC, UL Listed, adjustable 0° to 95°

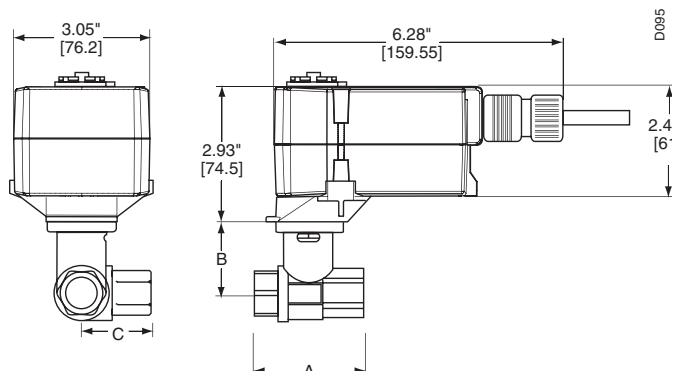
† Rated impulse voltage 800V (4kV for 120V model), Control pollution degree 3, Type of action 1.AA (1.AA.B for -S models)

Dimensions with 2-Way Valve



	Valve Nominal Size		Dimensions (Inches [mm])	
Valve Body	Inches	DN [mm]	A	B
B207(B)-B211(B)	½"	15	2.41" [61.1]	1.39" [35.2]
B212(B)-B215(B)	½"	15	2.38" [60.4]	1.78" [45.2]
B217(B)-B221(B)	¾"	20	2.73" [69.3]	1.87" [47.4]

Dimensions with 3-Way Valve



	Valve Nominal Size		Dimensions (Inches [mm])		
Valve Body	Inches	DN [mm]	A	B	C
B307(B)-B311(B)	½"	15	2.41" [61.1]	1.39" [35.2]	1.20" [30.6]
B312(B)-B315(B)	½"	15	2.38" [60.4]	1.78" [45.2]	1.29" [32.8]
B317(B)-B321(B)	¾"	20	2.73" [69.3]	1.87" [47.4]	1.47" [37.3]

Wiring Diagrams

INSTALLATION NOTES

△2 ***CAUTION** Equipment damage!*
Actuators may be connected in parallel.
Power consumption and input impedance must be observed.

△4 Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500 Ω resistor, a +2% shift of control signal may be required.
Power consumption must be observed.

△3 Actuators may also be powered by 24 VDC.

△5 Only connect common to neg. (—) leg of control circuits.

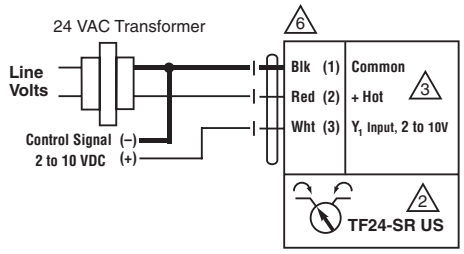
△6 Actuators with plenum rated cable do not have numbers on wires; use color codes instead.

△7 For end position indication, interlock control, fan startup, etc., TF24-SR-S US incorporates one built-in auxiliary switch: 1 x SPDT, 3A (0.5A) @250 VAC, UL listed, adjustable 0° to 95°.

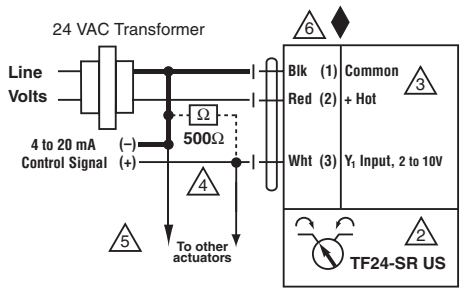
APPLICATION NOTES

♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

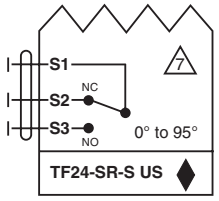
⚠ ***WARNING** Live Electrical Components!*
During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.



2 to 10 VDC control



4 to 20 mA control



Auxiliary switch

B310, 3-Way, Characterized Control Valve

Stainless Steel Ball and Stem

Application

This valve is typically used in air handling units on heating or cooling coils, and fan coil unit heating or cooling coils. Some other common applications include Unit Ventilators, VAV box re-heat coils and bypass loops. This valve is suitable for use in a hydronic system with variable or constant flow.

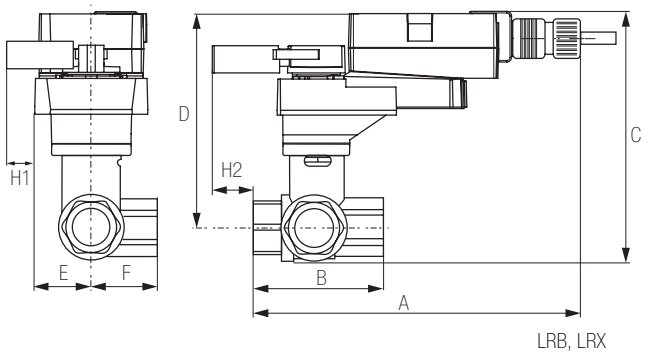
Suitable Actuators

	Non-Spring	Spring
B310	TR, LR, NRB(X)	TFB(X), LF

Technical data

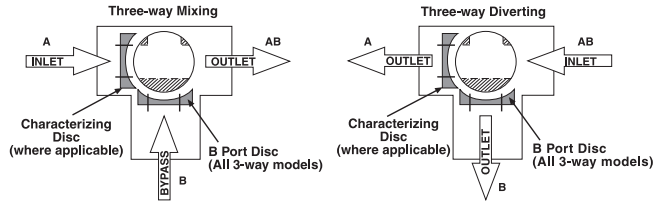
Service	chilled , hot water, up to 60% glycol
Flow characteristic	A-port equal percentage, B-port modified for constant common port flow
Controllable Flow Range	75°
Size [mm]	0.5" [15]
End Fitting	NPT female ends
Body	forged brass, nickel plated
Ball	stainless steel
Stem	stainless steel
Stem Packing	EPDM (lubricated)
Seat	Teflon® PTFE
Seat O-ring	EPDM (lubricated)
Characterized Disc	TEFZEL®
Body Pressure Rating [psi]	600
Media Temperature Range (Water)	0°F to 250°F [-18°C to +120°C]
Max Differential Pressure (Water)	50 psi (345 kPa)
Close-Off Pressure	200 psi
Leakage	0% for A to AB, <2.0% for B to AB
Cv	1.2
Servicing	maintenance free

Dimensions (Inches [mm])



A	B	C	D	E	F	H1	H2
8.5" [216]	2.38" [60]	5.19" [132]	4.61" [117]	1.3" [33]		1.18" [30]	1.1" [28]

Flow Pattern

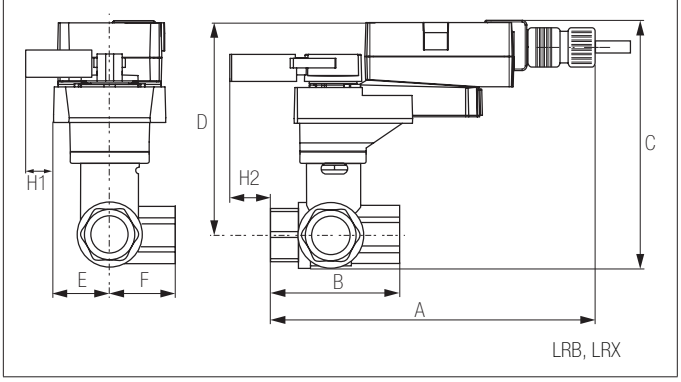


BELIMO

B310, 3-Way, Characterized Control Valve

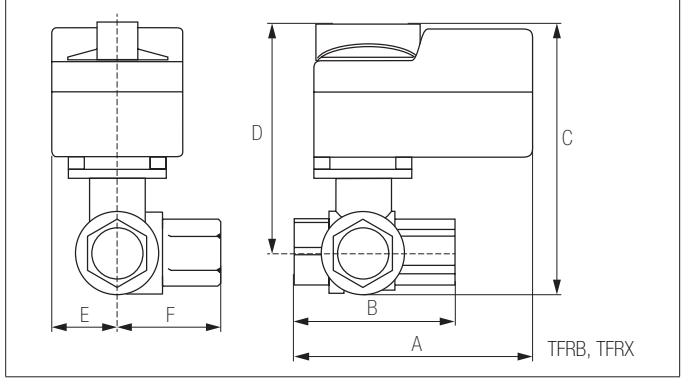
Stainless Steel Ball and Stem

Dimensions (Inches [mm])



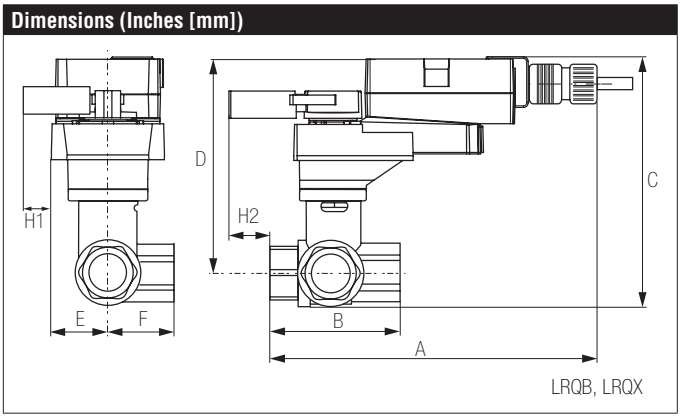
A	B	C	D	E	F	H()	H()
9.4” [239]	2.06” [52]	5.19” [132]	4.61” [117]	1.3” [33]		1.18” [30]	1.1” [28]

Dimensions (Inches [mm])



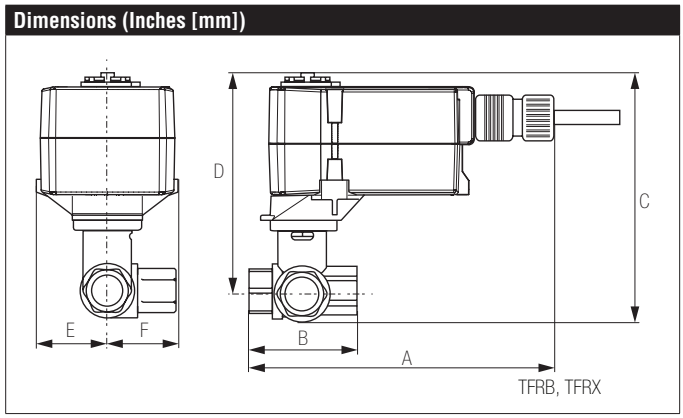
A	B	C	D	E	F
3.72” [95]	2.38” [60]	4.79” [122]	4.21” [107]	1.25” [32]	1.2” [31]

Dimensions (Inches [mm])



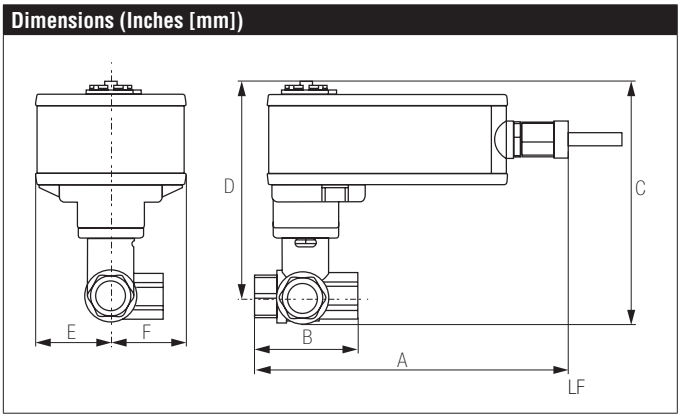
A	B	C	D	E	F	H()	H()
8.9” [226]	2.4” [61]	5.74” [146]	5.16” [131]	1.58” [40]		1.18” [30]	1.3” [33]

Dimensions (Inches [mm])



A	B	C	D	E	F
6.59” [167]	2.38” [60]	4.9” [124]	4.32” [110]	1.53” [38]	1.2” [31]

Dimensions (Inches [mm])



A	B	C	D	E	F
7.92” [201]	2.38” [60]	5.67” [144]	5.09” [129]	1.82” [46]	1.89” [48]

LRCB24-3

On/Off, Floating Point, Non-Spring Return, 24 V

Technical Data	
Power Supply	24 VAC ± 20%, 50/60 Hz, 24 VDC ± 10%
Power Consumption Running	1.5 W
Power Consumption Holding	0.2 W
Transformer Sizing	2.5 VA (class 2 power source)
Electrical Connection	3 ft, 18 GA plenum cable with 1/2" conduit connector
Overload Protection	electronic thoughout 0° to 90° rotation
Input Impedance	600 Ω
Angle of Rotation	90°, adjustable with mechanical stop
Direction of Rotation (Motor)	reversible with built-in switch
Position Indication	integrated into handle
Manual Override	external push button
Running Time (Motor)	40 seconds constant, independent of load
Humidity	5 to 95% RH non condensing (EN 60730-1)
Ambient Temperature Range	-22°F to +122°F [-30°C to +50°C]
Storage Temperature Range	-40°F to +176°F [-40°C TO +80°C]
Housing	NEMA 2, IP42, UL enclosure type 2
Housing Material	UL94-5VA
Agency Listings†	cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC and 2006/95/EC
Noise Level (Motor)	<45 dB (A)
Servicing	maintenance free
Quality Standard	ISO 9001
Weight	2.2 lb [1 kg]

†Rated Impulse Voltage 800V, Type action 1.B , Control Pollution Degree 3.

BELIMO

LRCB24-3

On/Off, Floating Point, Non-Spring Return, 24 V

Wiring Diagrams

⚠ WARNING! LIVE ELECTRICAL COMPONENTS!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

♦ Meets cULus requirements without the need of an electrical ground connection.

INSTALLATION NOTES

APPLICATION NOTES

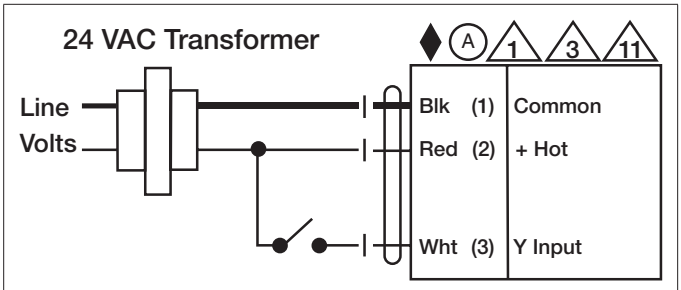
Ⓐ Actuators with appliance cables are numbered.

△1 Provide overload protection and disconnect as required.

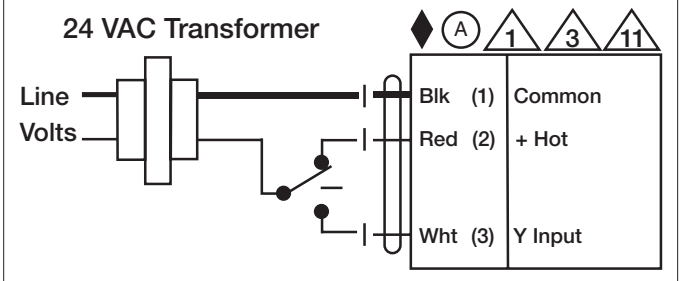
△3 Actuators may also be powered by 24 VDC.

△6 Actuators Hot wire must be connected to the control board common. Only connect common to neg. (-) leg of control circuits. Terminal models (-T) have no-feedback.

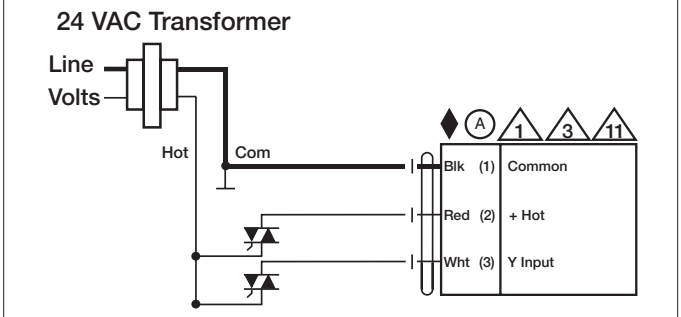
△11 Actuators may be connected in parallel if not mechanically linked. Power consumption and input impedance must be observed.



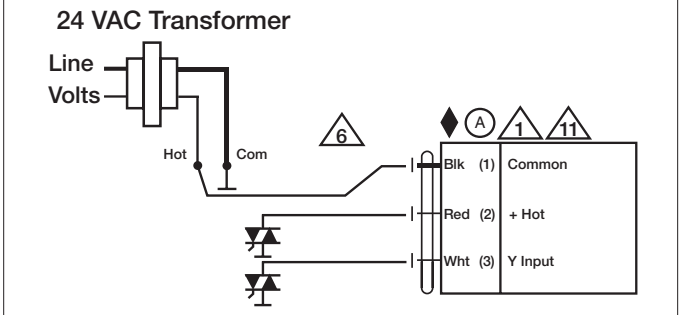
On/Off



Floating Point



Floating Point - Triac Source



Floating Point - Triac Sink

B312, 3-Way, Characterized Control Valve

Stainless Steel Ball and Stem

Application

This valve is typically used in air handling units on heating or cooling coils, and fan coil unit heating or cooling coils. Some other common applications include Unit Ventilators, VAV box re-heat coils and bypass loops. This valve is suitable for use in a hydronic system with variable or constant flow.

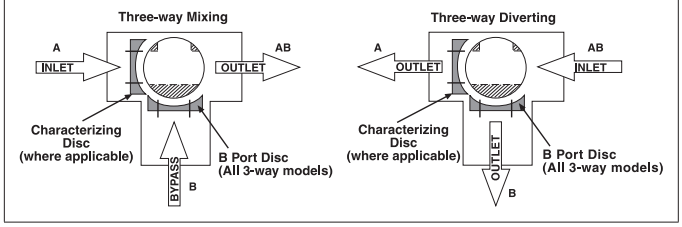
Suitable Actuators

	Non-Spring	Spring
B312	TR, LR, NRB(X)	TFB(X), LF

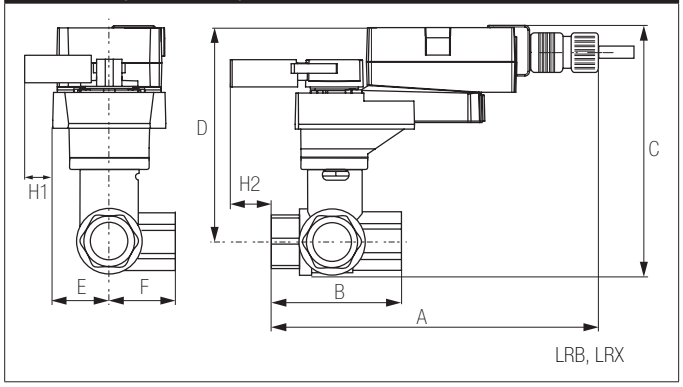
Technical data

Service	chilled , hot water, up to 60% glycol
Flow characteristic	A-port equal percentage, B-port modified for constant common port flow
Controllable Flow Range	75°
Size [mm]	0.5" [15]
End Fitting	NPT female ends
Body	forged brass, nickel plated
Ball	stainless steel
Stem	stainless steel
Stem Packing	EPDM (lubricated)
Seat	Teflon® PTFE
Seat O-ring	EPDM (lubricated)
Characterized Disc	TEFZEL®
Body Pressure Rating [psi]	600
Media Temperature Range (Water)	0°F to 250°F [-18°C to +120°C]
Max Differential Pressure (Water)	50 psi (345 kPa)
Close-Off Pressure	200 psi
Leakage	0% for A to AB, <2.0% for B to AB
Cv	3
Servicing	maintenance free

Flow Pattern



Dimensions (Inches [mm])

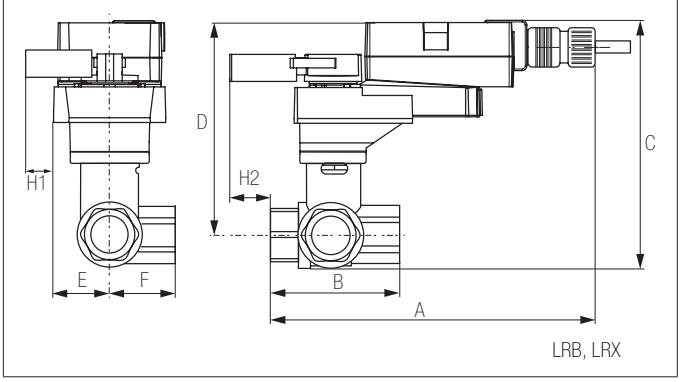


A	B	C	D	E	F	H1	H2
8.5" [216]	2.38" [60]	5.19" [132]	5" [127]	1.3" [33]		1.18" [30]	1.1" [28]

BELIMO

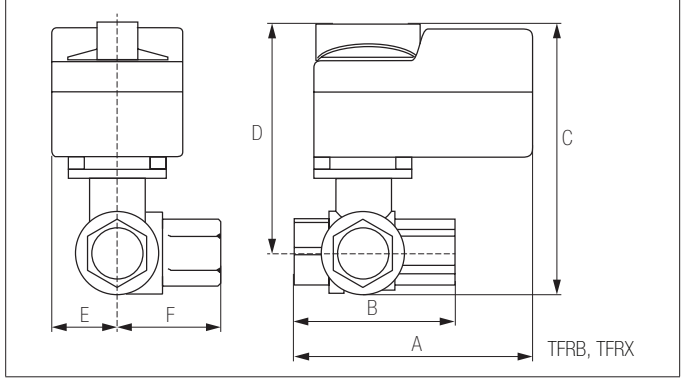
B312, 3-Way, Characterized Control Valve
Stainless Steel Ball and Stem

Dimensions (Inches [mm])



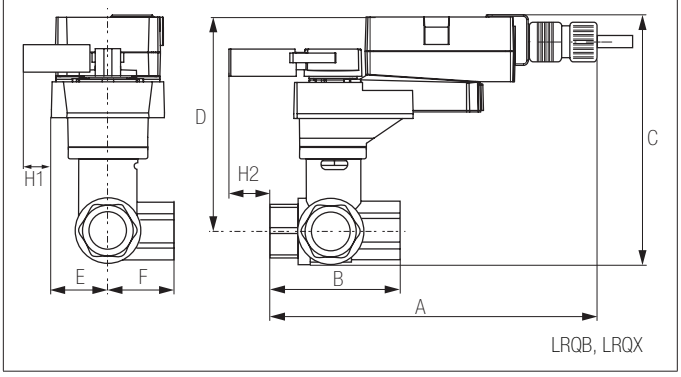
A	B	C	D	E	F	H()	H()
9.4" [239]	2.38" [60]	5.58" [142]	5" [127]	1.3" [33]		1.18" [30]	1.1" [28]

Dimensions (Inches [mm])



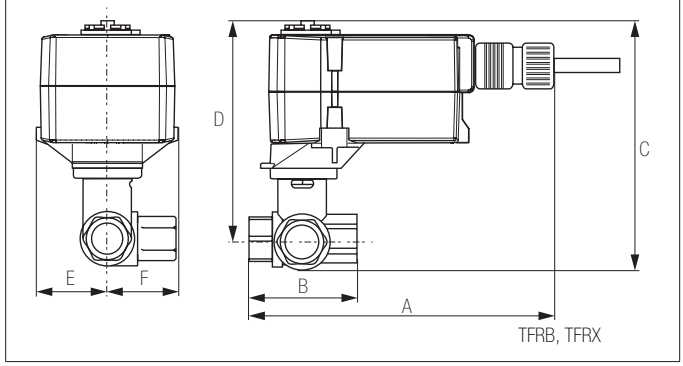
A	B	C	D	E	F
3.72" [95]	2.38" [60]	5.19" [132]	4.61" [117]	1.25" [32]	1.29" [33]

Dimensions (Inches [mm])



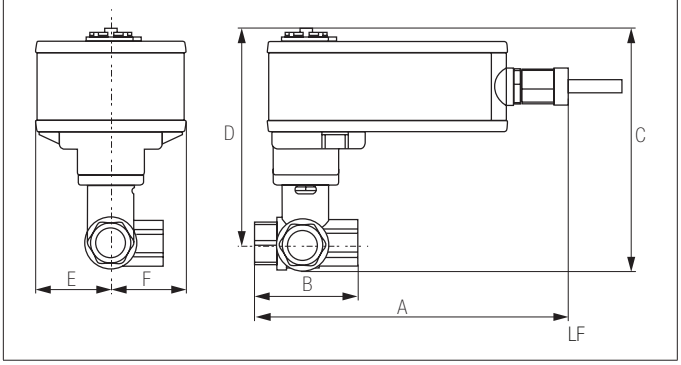
A	B	C	D	E	F	H()	H()
8.9" [226]	2.38" [60]	6.13" [156]	5.55" [141]	1.58" [40]		1.18" [30]	1.3" [33]

Dimensions (Inches [mm])



A	B	C	D	E	F
6.59" [167]	2.38" [60]	4.9" [124]	4.71" [120]	1.53" [38]	1.29" [33]

Dimensions (Inches [mm])



A	B	C	D	E	F
7.92" [201]	2.38" [60]	6.06" [154]	5.48" [139]	1.82" [46]	1.89" [48]

LRCB24-3

On/Off, Floating Point, Non-Spring Return, 24 V

Technical Data	
Power Supply	24 VAC ± 20%, 50/60 Hz, 24 VDC ± 10%
Power Consumption Running	1.5 W
Power Consumption Holding	0.2 W
Transformer Sizing	2.5 VA (class 2 power source)
Electrical Connection	3 ft, 18 GA plenum cable with 1/2" conduit connector
Overload Protection	electronic thoughout 0° to 90° rotation
Input Impedance	600 Ω
Angle of Rotation	90°, adjustable with mechanical stop
Direction of Rotation (Motor)	reversible with built-in switch
Position Indication	integrated into handle
Manual Override	external push button
Running Time (Motor)	40 seconds constant, independent of load
Humidity	5 to 95% RH non condensing (EN 60730-1)
Ambient Temperature Range	-22°F to +122°F [-30°C to +50°C]
Storage Temperature Range	-40°F to +176°F [-40°C TO +80°C]
Housing	NEMA 2, IP42, UL enclosure type 2
Housing Material	UL94-5VA
Agency Listings†	cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC and 2006/95/EC
Noise Level (Motor)	<45 dB (A)
Servicing	maintenance free
Quality Standard	ISO 9001
Weight	2.2 lb [1 kg]

†Rated Impulse Voltage 800V, Type action 1.B , Control Pollution Degree 3.

BELIMO

LRCB24-3

On/Off, Floating Point, Non-Spring Return, 24 V

Wiring Diagrams

⚠ WARNING! LIVE ELECTRICAL COMPONENTS!

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♦ Meets cULus requirements without the need of an electrical ground connection.

INSTALLATION NOTES

APPLICATION NOTES

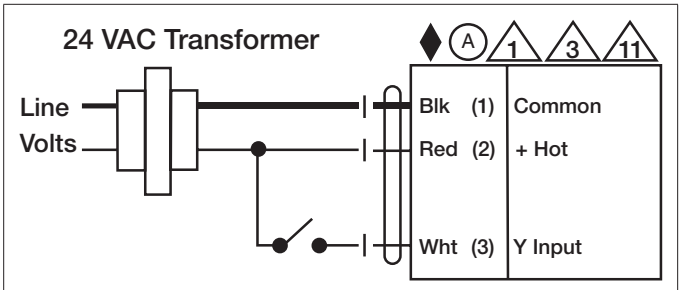
Ⓐ Actuators with appliance cables are numbered.

△1 Provide overload protection and disconnect as required.

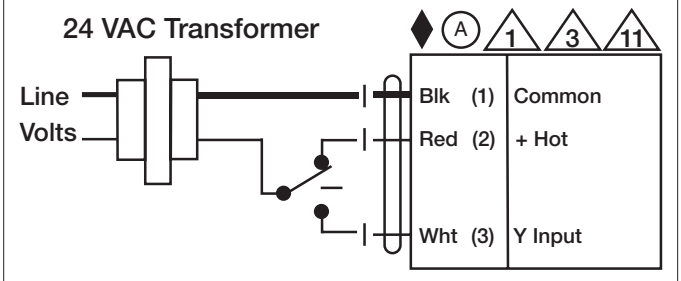
△3 Actuators may also be powered by 24 VDC.

△6 Actuators Hot wire must be connected to the control board common. Only connect common to neg. (-) leg of control circuits. Terminal models (-T) have no-feedback.

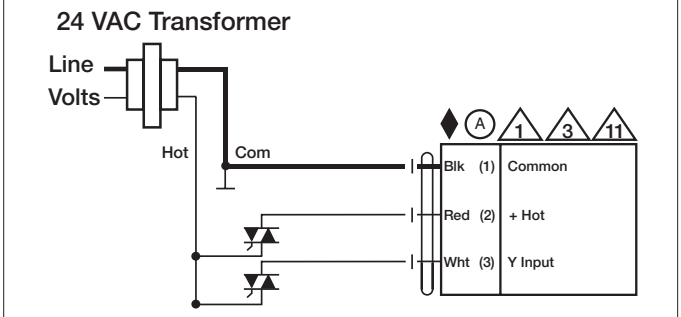
△11 Actuators may be connected in parallel if not mechanically linked. Power consumption and input impedance must be observed.



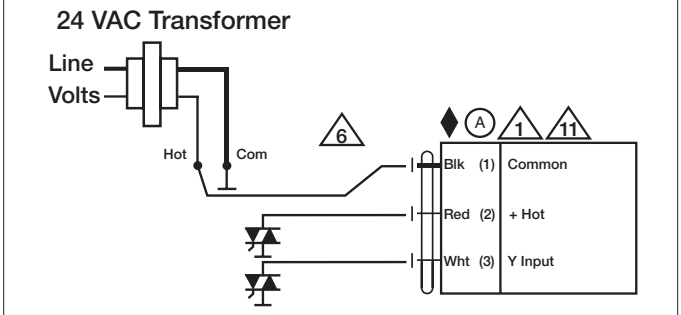
On/Off



Floating Point



Floating Point - Triac Source



Floating Point - Triac Sink

VALVE SCHEDULE

Control Wizards, Inc
89 Taylor Avenue
Norwalk, CT 06854
203-274-5284

PROJECT: CONNCat-Culinary, New Haven
ENGINEER: Gneral Drafting and Design
DATE : 1/20/2016
REVISIONS: As-Built

DUTY	QTY	GPM	TYPE	Valve Size	Design Delta-P (psi)	Design Cv	Actual CV	Actual Delta P (psi)	Max Closeoff (psi)	FAIL-SAFE	VALVE MODEL	ACTUATOR MODEL	NOTES
AHU-1 HHW	1	60.0	3-Way - Mod	1.5"	3.0	34.641	37.0	2.6	200	Open	Belimo B340	AFRB24-SR	
VAV - A	1	1.0	3-way - Mod	1/2"	3.0	0.57735	1.2	0.7	75	Open	B310	TFRB24-SR	
VAV - C	1	4.0	3-way - Mod	1/2"	3.0	2.3094	3.0	1.8	75	Open	B312	TFRB24-SR	
VAV - E	1	2.0	3-way - Mod	1/2"	3.0	1.1547	2.7	0.5	75	Open	B312	TFRB24-SR	
VAV - F	1	2.0	3-way - Mod	1/2"	3.0	1.1547	2.7	0.5	75	Open	B312	TFRB24-SR	
VAV - G	1	2.0	3-way - Mod	1/2"	3.0	1.1547	2.7	0.5	75	Open	B312	TFRB24-SR	
VAV - H	1	2.0	3-way - Mod	1/2"	3.0	1.1547	2.7	0.5	75	Open	B312	TFRB24-SR	
VAV - I	1	2.0	3-way - Mod	1/2"	3.0	1.1547	2.7	0.5	75	Open	B312	TFRB24-SR	
VAV - J	1	0.3	3-way - Mod	1/2"	3.0	0.17321	1.2	0.1	75	Open	B310	TFRB24-SR	

NOTES:
Flow Rates taken from Equipment Submittals

DAMPER SCHEDULE

Control Wizards, Inc
89 Taylor Avenue
Norwalk, CT 06854
203-274-5284

PROJECT: CONNCat-Culinary, New Haven
ENGINEER: Gneral Drafting and Design
DATE 1/20/2016
REVISIONS: As-Builts

ITEM/TAG	QNTY	SIZE (WxH) See NOTE 1	TYPE	FAIL-SAFE	DAMPER PRODUCT #	ACTUATOR PRODUCT #	NOTES (See 2 and 3 Below)
AHU-1 Outside Air	1	48x48	By Others	Closed	By others	NF24-SR	2-10 VDC
AHU-1 Return North	1	28" Round	By Others	Open	By Others	NF24-SR	2-10 VDC
AHU-1 Return Sound	1	28" Round	By Others	Open	By Others	NF24-SR	2-10 VDC
VAV A: Return Grille	1	2 Sq Ft	By Others	Open	By Others	TFB-24-S	With End Switch
VAV A: Plenum	1	2 Sq Ft	By Others	Closed	By Others	TFB-24-S	With End Switch
VAV J: Return Grille	1	2 Sq Ft	By Others	Open	By Others	TFB-24-S	With End Switch
VAV J: Plenum	1	2 Sq Ft	By Others	Closed	By Others	TFB-24-S	With End Switch
VAV-C Return Isolation	1	2 Sq Ft	By Others	Open	By Others	TFB-24-S	With End Switch
VAV-E Return Isolation	1	2 Sq Ft	By Others	Open	By Others	TFB-24-S	With End Switch
VAV-F Return Isolation	1	2 Sq Ft	By Others	Open	By Others	TFB-24-S	With End Switch
VAV-G Return Isolation	1	2 Sq Ft	By Others	Open	By Others	TFB-24-S	With End Switch
VAV-H Return Isolation	1	2 Sq Ft	By Others	Open	By Others	TFB-24-S	With End Switch
VAV-I Return Isolation	1	2 Sq Ft	By Others	Open	By Others	TFB-24-S	With End Switch

NOTES:

1: Dampers being provided by others. Sizes here are approximate -- shown for torque requiremnet only.
2: NF24: Modulating, Spring Return
3: TFB:: Two Posisiton, Spring Return

NF24-SR (-S) US

Proportional damper actuator, spring return failsafe, 24 V for 2 to 10 VDC, or 4 to 20 mA control signal.
Output signal of 2 to 10 VDC for position indication

Torque min. 60 in-lb, for control of air dampers

Application

For proportional modulation of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer's specifications.

The actuator is mounted directly to a damper shaft up to 1.05" in diameter by means of its universal clamp. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

The actuator operates in response to a 2 to 10 VDC, or with the addition of a 500Ω resistor, a 4 to 20 mA control input from an electronic controller or positioner. A 2 to 10 VDC feedback signal is provided for position indication or master-slave applications.

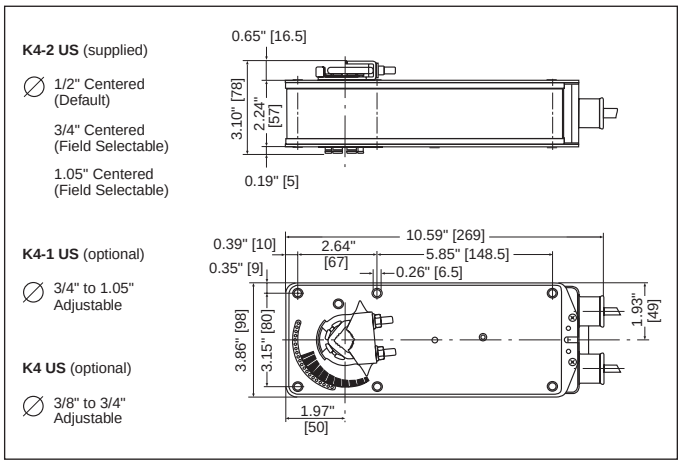
Operation

The NF series actuators provide true spring return operation for reliable fail-safe application and positive close-off on air tight dampers. The spring return system provides constant torque to the damper with, and without, power applied to the actuator. The NF series provides 95° of rotation and is provided with a graduated position indicator showing 0° to 95°.

The NF24-SR US uses a brushless DC motor which is controlled by an Application Specific Integrated Circuit (ASIC) and a microprocessor. The microprocessor provides the intelligence to the ASIC to provide a constant rotation rate and to know the actuator's exact fail-safe position. The ASIC monitors and controls the brushless DC motor's rotation and provides a digital rotation sensing function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches.

Technical Data	NF24-SR US
Power supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power consumption	running: 3 W; holding: 1 W
Transformer sizing	6 VA (class 2 power source)
Electrical connection	3 ft, 18 GA appliance cable 1/2" conduit connector
Overload protection	Electronic throughout 0 to 95° rotation
Operating range Y	2 to 10 VDC, 4 to 20mA
Input impedance	100 kΩ (0.1 mA), 500Ω
Feedback output U	2 to 10 VDC (max. 0.5 mA) for 95°
Angle of rotation	95°, adjustable 30° to 95° w/accessory
Torque	60 in-lb [7 Nm] constant torque
Direction of rotation	spring: reversible with cw/ccw mounting motor: reversible with built-in switch
Position indication	visual indicator, 0° to 95° (0° is spring return position)
Auxiliary switches (NF24-SR(-S)	1 x SPDT 7A (2.5A) @ 250 VAC, UL listed adjustable 5° to 85°
Running time (nominal)	motor: 150 sec constant, independent of load spring: < 60 sec
Humidity	5 to 95% RH non-condensing
Ambient temperature	-22°F to +122°F [-30°C to +50°C]
Storage temperature	-40°F to +176°F [-40°C to +80°C]
Housing	NEMA type 2 / IP54
Housing material	zinc coated metal
Agency listings	UL 873 listed, CSA C22.2 No.24 certified
Noise level	max. 45 dB (A)
Servicing	maintenance free
Quality standard	ISO 9001
Weight	6.0 lbs (2.7 kg.)

Dimensions [All numbers in brackets are in millimeters.]



BELIMO

NF24-SR (-S) US

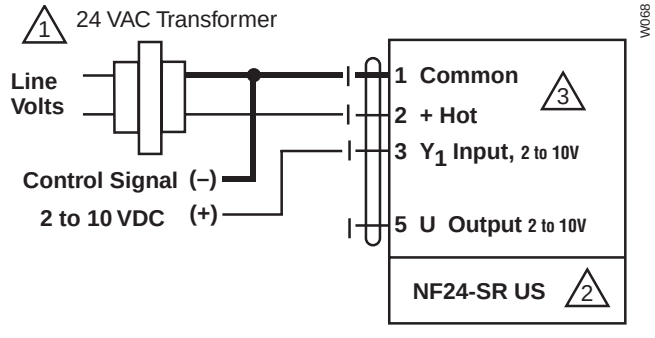
Proportional damper actuator, spring return failsafe, 24 V for 2 to 10 VDC, or 4 to 20 mA control signal. Output signal of 2 to 10 VDC for position indication

Accessories

AV 10-18	Shaft extension
IND-AF2	Damper position indicator
K4-1 US	Universal clamp for up to 1.05” dia jackshafts
K4-H	Universal clamp for hexshafts 3/8” to 5/8”
KH-AF	Crankarm for up to 3/4” round shaft
KH-AF-1	Crankarm for up to 1.05” jackshaft
KH-AFV	V-bolt kit for KH-AF and KH-AF-1
PTA-250	Pulse width modulation interface
Tool-06	8mm and 10 mm wrench
SGA24	Min. and/or man. positioner in NEMA 4 housing
SGF24	Min. and/or man. positioner for flush panel mounting
ZG-R01	500Ω resistor for 4 to 20mA control signal
ZG-HTR	Thermostat/Heater Kit
ZDB-AF2	Angle of rotation limiter
ZG-100	Universal mounting bracket
ZG-101	Universal mounting bracket
ZG-102	Multiple actuator mounting bracket
ZG-103	Universal mounting bracket
ZG-104	Universal mounting bracket
ZG-106	Mounting bracket for Honeywell® Mod IV replacement or new crankarm type installations
ZG-107	Mounting bracket for Honeywell® Mod III or Johnson® Series 100 replacement or new crankarm type installations
ZG-108	Mounting bracket for Barber Colman® MA 3../4.., Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crankarm type installations
ZG-AF US	Crankarm adaptor kit for AF/NF
ZG-AF108	Crankarm adaptor kit for AF/NF
ZS-100	Weather shield (metal)
ZS-150	Weather shield (polycarbonate)
ZS-260	Explosion-proof housing
ZS-300	NEMA 4X housing

Note: When using NF24-SR US actuators, only use accessories listed on this page.

Wiring diagrams



1 Provide overload protection and disconnect as required.

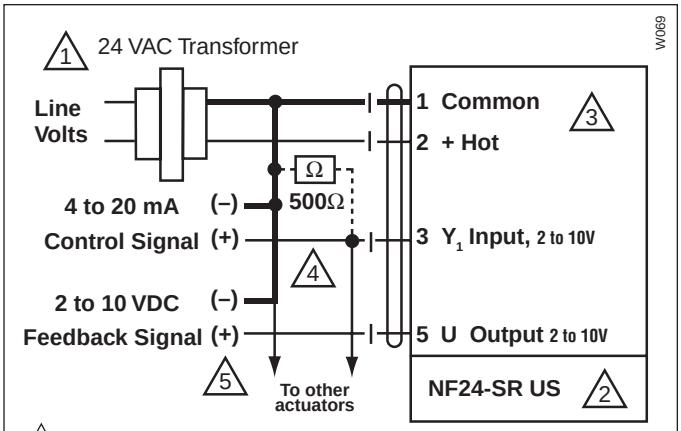
2 Actuators may be connected in parallel. Power consumption and input impedance must be observed.

3 Actuator may also be powered by 24 VDC.

0 to 10 VDC control of NF24-SR US

NF24-SR US Typical Specification

Spring return control damper actuators shall be direct coupled type which require no crankarm and linkage and be capable of direct mounting to a jackshaft up to a 1.05” diameter. The actuator must provide proportional damper control in response to a 2 to 10 VDC or, with the addition of a 500Ω resistor, a 4 to 20 mA control input from an electronic controller or positioner. The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall use a brushless DC motor controlled by a microprocessor and be protected from overload at all angles of rotation. Run time shall be constant, and independent of torque. A 2 to 10 VDC feedback signal shall be provided for position feedback or master-slave applications. Actuators shall be UL listed and CSA certified, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.



1 Provide overload protection and disconnect as required.

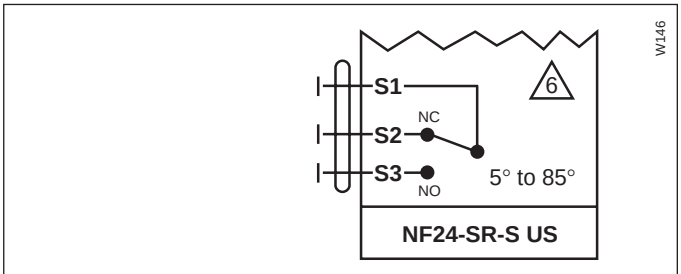
2 Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor. Power consumption must be observed.

3 Actuator may also be powered by 24 VDC.

4 A 500Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC. (ZG-R01)

5 Only connect common to neg. (–) leg of control circuits

4 to 20 mA control of NF24-SR US with 2 to 10 VDC feedback output



6 For end position indication, interlock control, fan start-up, etc., NF24-SR US incorporates a built-in auxiliary switch: 1 x SPDT, 7A (2.5A) @250 VAC, UL listed, adjustable 5° to 85°.

Auxiliary switch wiring

TFB24-SR(-S), TFX24-SR(-S)

Proportional, Spring Return, 24 V, for 2 to 10 VDC or 4 to 20 mA Control Signal

Torque min. 22 in-lbs, for control of air dampers

Application

For proportional modulation of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer's specifications.

The actuator is mounted directly to a damper shaft from 1/4" up to 1/2" in diameter by means of its universal clamp, 1/2" shaft centered at delivery. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

The actuator operates in response to a 2 to 10 VDC, or with the addition of a 500 Ω resistor, a 4 to 20 mA control input from an electronic controller or positioner.

Operation

The TF series actuators provide true spring return operation for reliable fail-safe application and positive close-off on air tight dampers. The spring return system provides consistent torque to the damper with, and without, power applied to the actuator.

The TF series provides 95° of rotation and is provided with a graduated position indicator showing 0 to 95°.

The TF uses a brushless DC motor which is controlled by an Application Specific Integrated Circuit (ASIC) and a microprocessor. The microprocessor provides the intelligence to the ASIC to provide a constant rotation rate and to know the actuator's exact fail-safe position. The ASIC monitors and controls the brushless DC motor's rotation and provides a digital rotation sensing function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches. Power consumption is reduced in holding mode.

The TF-S version is provided with one built-in auxiliary switch. This SPDT switch is provided for safety interfacing or signaling, for example, for fan start-up. The switching function is adjustable between 0° and 95°. The auxiliary switch in the TF-S is double insulated so an electrical ground in not necessary.

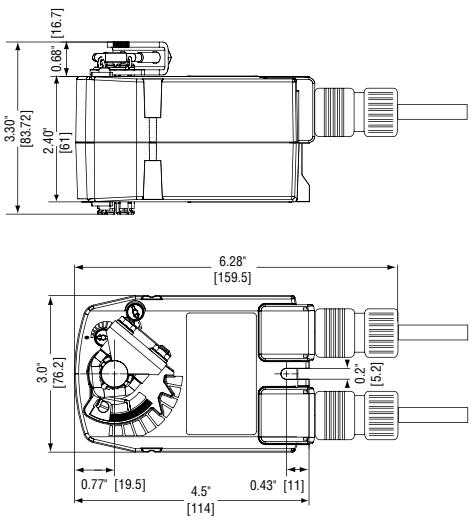
SAFETY NOTE
Screw a conduit fitting into the actuator's bushing. Jacket the actuator's input and output wiring with suitable flexible conduit. Properly terminate the conduit in a suitable junction box.

Technical Data		TFB24-SR(-S), TFX24-SR(-S)
Power supply		24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power consumption	running	2 W
	holding	1 W
Transformer sizing		4 VA (class 2 power source)
Electrical connection TFB...		3 ft, 18 GA plenum cable, 1/2" conduit connector **-S models:** two 3 ft, 18 gauge appliance cables with 1/2" conduit connectors
TFX		3 ft [1m], 10 ft [3m], or 16 ft [5m], 18 GA appliance or plenum cable, with or without 1/2" conduit connector **-S models:** two 3 ft [1m], 10 ft [3m] or 16 ft [5m] appliance cables with or without 1/2" conduit connectors
Overload protection		electronic throughout 0 to 95° rotation
Operating range Y		2 to 10 VDC, 4 to 20mA
Input impedance		100 kΩ (0.1 mA), 500 Ω
Feedback output U		2 to 10 VDC, 0.5 mA max
Angle of rotation		max 95°, adjust. with mechanical stop
Torque		22 in-lbs [2.5 Nm]
Direction of rotation	spring	reversible with cw/ccw mounting
	motor	reversible with built-in switch
Position indication		visual indicator, 0° to 95° (0° spring return position)
Running time	motor	95 sec constant, independent of load
	spring	< 25 sec @-4°F to 122°F [-20°C to 50°C] < 60 sec @-22°F [-30°C]
Humidity		5 to 95% RH non-condensing
Ambient temperature		-22°F to 122°F [-30°C to 50°C]
Storage temperature		-40°F to 176°F [-40°C to 80°C]
Housing		NEMA type 2 / IP42, UL enclosure type 2
Housing material		UL94-5VA
Agency listings†		cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC (and 2006/95/EC for -S versions)
Noise level (max)	running	< 35 db (A)
	spring return	62 dB (A)
Servicing		maintenance free
Quality standard		ISO 9001
Weight		1.4 lbs (0.6 kg), 1.5 lbs (0.7 kg) with switch

† Rated Impulse Voltage 800V, Type of action 1.AA (1.AA.B for -S version), Control Pollution Degree 3.

TFB24-SR-S, TFX24-SR-S	
Auxiliary switch	1 x SPDT 3A (0.5A) @ 250 VAC, UL approved adjustable 0° to 95° (double insulated)

Dimensions (Inches [mm])



Accessories

Tool-06	8mm and 10 mm wrench
KH-TF	Crank arm for up to 1/2" round shaft
ZG-TF2	Crank arm adaptor kit for TF
ZG-TF112	Mounting bracket, kit for TF
ZS-100	Weather shield (metal)
ZS-150	Weather shield (polycarbonate)

NOTE: When using TFB24-SR (-S), TFX24-SR (-S) actuators, only use accessories listed on this page.
For actuator wiring information and diagrams, refer to Belimo wiring guide.

Typical Specification

Spring return control damper actuators shall be direct coupled type which require no crank arm and linkage and be capable of direct mounting to a shaft up to a 1/2" diameter and center a 1/2" shaft. The actuator must provide proportional damper control in response to a 2 to 10 VDC or, with the addition of a 500 Ω resistor, a 4 to 20 mA control input from an electronic controller or positioner.The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall use a brushless DC motor controlled by a microprocessor and be protected from overload at all angles of rotation. Run time shall be constant, and independent of torque. If required, one SPDT auxiliary switch shall be provided having the capability of being adjustable. Actuators with auxiliary switch must be constructed to meet the requirements for Double Insulation so an electrical ground is not required to meet agency listings. Actuators shall be cULus listed certified, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

INSTALLATION NOTES

△2 ***CAUTION** Equipment Damage!*
Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500 Ω resistor, a +2% shift of control signal may be required. Power consumption must be observed.

△3 Actuator may also be powered by 24 VDC.

△5 Only connect common to neg. (–) leg of control circuits.

△6 Actuators with plenum rated cable do not have numbers on wires; use color codes instead.

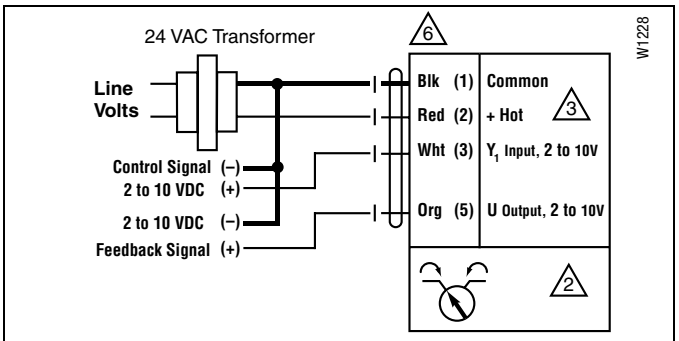
△7 For end position indication, interlock control, fan startup, etc., TFB24-SR-S, TFX24-SR-S incorporates one built-in auxiliary switch: 1 x SPDT, 3A (0.5A) @250 VAC, UL Approved, adjustable 0° to 95°.

APPLICATION NOTES

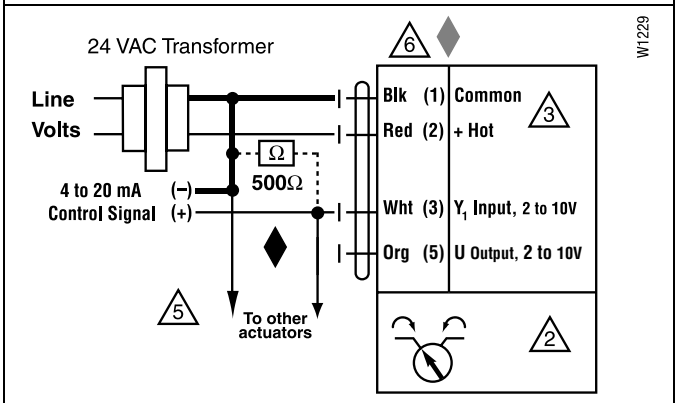
◆ Meets cULus requirements without the need of an electrical ground connection.

◆ The ZG-R01 500 Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.

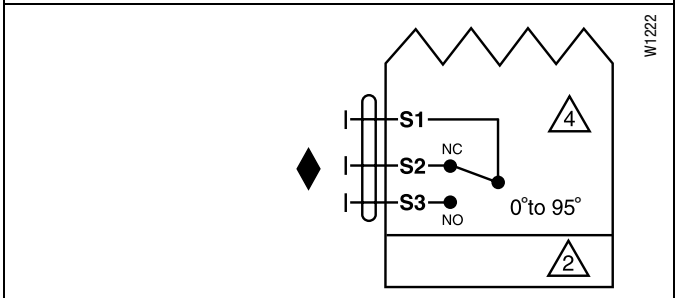
***WARNING** Live Electrical Components!*
During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.



2 to 10 VDC control of TFX24-SR(-S)



4 to 20 mA control of TFB24-SR(-S), TFX24-SR(-S)



Auxiliary switch of TFB24-SR-S, TFX24-SR-S

SCHEDULE OF CONTROL PRODUCTS BEING PROVIDED

PROJECT: CONNCat-Culinary, New Haven
ENGINEER: Gneral Drafting and Design
DATE SUBMITTED: 1/20/2016
REVISION: As-Built

Control Wizards, Inc
89 Taylor Avenue
Norwalk, CT 06854
203-274-5284

FILE REF	ITEM/TAG	MANUFACTURER	MODEL NUMBER	DESCRIPTION	WHERE USED
1	Panel	Kele	RET3626ULP	Metal Control Panel	With backplane
2	WEBS 600	Honeywell	WEB-600-O	DDC Controller	AHU DDC Controller
3	IO-34	Honeywell	IO-34-H	34 Point IO Module	AHU DDC Controller
4	VAV Ctlr	Honeywell	CVL4024NS-VAV1	VAV Box Controller	Configurable Controller
5	VAV Damper	Honeywell	ML6161B	VAV Box Damper Motor	Floating Type
6	P7640	Honeywell/Veris	P7640A1000	Air Differential Pressure Sensor	AHU DDC Controller
7	A70	Penn/Johnson	A70HA-1C	Freezestat/Low Temp Switch	AHU Freezestat
~~**8**~~	~~Pan Leak~~	~~Wagner~~	~~WS-1~~	~~Water Detector~~	~~AHU Unit~~
9	RIBMNLB	Functional Devices	RIBMNLB-6	Fan Safety Relay	AHU DDC Controller
10	A19ADC	Penn/Johnson	A19ADC	Strap-on Aquastat	Unit Heaters
11	RIB	Functional Devices	RIB-U1C	Control Relay	Misc
12	Relay	Idec	RH2B-UL-VV	Plug in Panel Mount Relay	VV=Voltage, SH2B-05 Socket
13	Duct-H/T	Honeywell	H7655B2014	Duct Humiity/Temp Sensor	Return Air and Outside Air
14	Spyder	Honeywell	PUL6438S	DDC Controller	Ground Floor DDC Controller
15	CT-S	Functional Devices	RIBXGF	Current Sensor Switch	
16	Duct-T	Honeywell	C7041B	Duct Sensors (Spot)	AHU,
17	Mixed-T	Honeywell	C7041J	Mixed Air Averaging Sensor	AHU Units (Averaging Type)
18	TR-21	Honeywell	TR-23	Wall Sensor	VAV Boxes
19	TR-21	Honeywell	TR-21	Wall Sensor Specs	Unit Heater

Auxiliary Compnetnts

Freezestat Bulb Mounting Clips

NOTE: **For valves and valve actuators, see Valve Section**
For Dampers and Damper Actuators, see Damper section of submittal

DESCRIPTION

The **RET Series** includes attractive, economical NEMA 1 enclosures designed to house controls and instruments in areas which do not require oil-tight and dust-tight ratings. The **RET Series** enclosures are furnished with a perforated metal subpanel for easy mounting of components. No drilling or layout is needed. Simply set the control components on the panel and attach with #7 or #8 self-tapping screws in the prepunched holes. The **RET Series** is also available in a UL listed version.

FEATURES

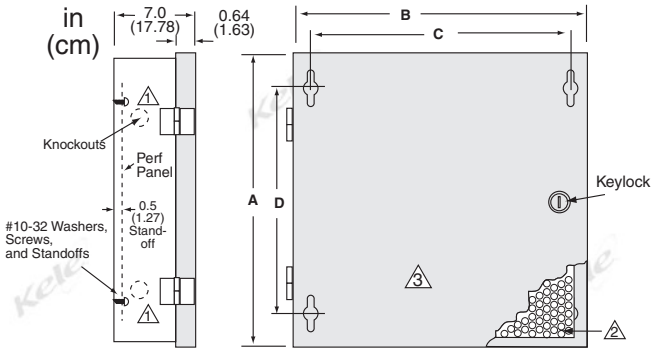
- ***Low-cost NEMA 1 enclosure***
- ***Mounted with door hinged on left or right side***
- ***Removable door***
- ***Attractive powder-coated finish, standard brown enclosure with tan door***
- ***Optional colors available***
- ***Key lock, two keys, and attractive gray powder-coated perf panel furnished***
- ***Mounting of control components simplified with perf panel***
- ***Optional UL-listed enclosures available***
- ***UL listed, File #E155405, for RET UL-listed panels***

RET OPTIONAL COLOR CHART

Dark Blue | Powder Blue | Orange | Green | Gray

Optional colors shown in approximate hue

DIMENSIONS



1. Knockouts are for 3/4" conduit, two knockouts on both sides, three knockouts top and bottom (except two on RET 1812).
2. Perf Panel is 16-ga powder-coated steel.
3. Standard color is brown enclosure with tan door.

ORDERING INFORMATION

ENCLOSURE MODEL	DIMENSIONS in (cm) A	B	C	D	ENCLOSURE MATERIAL	PERF PANEL	WEIGHT lb (kg)	PERF PANEL H x W in (cm)
RET2620†	26 (66)	20 (51)	18.75 (47)	17.75 (51)	16-ga steel	Included	36 (16.4)	23.5 x 17.5 (60 x 44)
RET3826†	38 (97)	26 (66)	24.75 (62)	29.75 (81)	16-ga steel	Included	61 (27.8)	35.5 x 23.5 (90 x 60)
RET4230†	42 (107)	30 (76)	28.75 (66)	33.75 (97)	14-ga steel	Included	83 (37.8)	39.5 x 27.5 (100 x 70)
RET1812ULP†	18 (46)	12 (31)	10.75 (28)	9.75 (36)	16-ga steel	Included	16 (7.3)	15.5 x 9.0 (39 x 23)
RET2018ULP†	20 (51)	18 (46)	16.75 (42)	11.75 (36)	16-ga steel	Included	27 (12.3)	17.5 x 15.5 (44 x 39)
RET2620ULP†	26 (66)	20 (51)	18.75 (47)	17.75 (51)	14-ga steel	Included	41 (18.6)	23.5 x 17.5 (60 x 44)
RET3626ULP†	36 (91)	26 (66)	24.75 (62)	27.75 (76)	14-ga steel	Included	69 (31.3)	33.5 x 23.5 (85 x 60)

† **-DB**: Dark Blue, **-PB**: Powder Blue, **-OR**: Orange, **-GN**: Green, **-GY**: Gray (Note: No suffix - Brown/Tan)

ACCESSORIES

RET-KEY	Replacement Key for Ret-Lock
RET-LOCK	Lock with key for RET enclosure

Honeywell

WEB-600

MODELS: WEB-600, WEB-600-O, WEB-600-US, WEB-600-O-US

SPECIFICATION DATA

GENERAL

The WEB-600 is a compact, embedded controller/server platform. It combines integrated control, supervision, data logging, alarming, scheduling and network management functions with Internet connectivity and web serving capabilities in a small, compact platform. The WEB-600 makes it possible to control and manage external devices over the Internet and present real time information to users in web-based graphical views.

The WEB-600 is a member of the WEBs-AX™ suite of Java®-based controller/server products, software applications and tools, which are designed to integrate a variety of devices and protocols into unified, distributed systems. WEBs-AX™ products are powered by the revolutionary Niagara^{AX} Framework®, the industry's first software technology designed to integrate diverse systems and devices into a seamless system. Niagara^{AX} supports a wide range of protocols including LONWORKS®, BACnet®, Modbus®, and Internet standards. The Niagara^{AX} Framework® also includes integrated network management tools to support the design, configuration, installation and maintenance of interoperable networks.

FEATURES

- **Supports open and legacy protocols.**
- **Web User Interface (standard) serves rich presentation and live data to a browser.**
- **Run stand-alone control, energy management, and multi-protocol integration.**
- **Standard and optional communications boards.**
- **Can be expanded with optional 16 and 34 point I/O Modules.**
- **Small compact design is easy to install and supports multiple power options.**
- **Embedded IBM® Power PC Platform.**

APPLICATION

The WEB-600 is ideal for smaller facilities, remote sites, and for distributing control and monitoring throughout large facilities. Optional I/O modules can be plugged in for applications where local control is required. The WEB-600 controller also supports a wide range of field busses for connection to remote I/O and stand-alone controllers. In small facility applications, the WEB-600 controller is all you need for a complete system.

The WEB-600 controller serves data and rich graphical displays to a standard web browser via an Ethernet LAN or remotely over the Internet, or dial-up modem. In larger facilities, multi-building applications and large-scale control system integrations, WEBStation-AX™ software can be used to aggregate information (real-time data, history, alarms, etc.) from large numbers of WEBs-AX™ controllers into a single unified application. The WEBStation-AX™ Supervisor can manage global control functions, support data passing over multiple networks, connect to enterprise level softwa

applications, and host multiple, simultaneous client workstations connected over the local network, the Internet, or dial-up modem.

Table 1.

Part Number	Description
WEB-600	Based unit including two Ethernet ports, one RS-232 port, one RS-485 port, one USB port, Web User Interface, Niagara^{AX} Connectivity, and oBix™ driver included.
WEB-600-O	WEB-600 with open license (NiCS has accept.wb.in="*")
WEB-600-US	WEB-600 controller manufactured in the USA.
WEB-600-O-US	WEB-600 controller with open license manufactured in the USA.

SPECIFICATIONS

Model: WEB-600 Controller: Base Unit including two Ethernet ports, one RS-232 port, one RS-485 port, one USB port, Web User Interface, Niagara^{AX} Connectivity, and oBix driver.

Platform: IBM® PowerPC® 440 524 MHz processor.
128 MB DDR RAM & 128 MB Serial Flash. Optional 256 MB DDR RAM.
Battery Backup - 5 minutes typical - shutdown begins within 10 seconds.
Real-time clock - 3 month backup maximum via battery.

Communications: 2 Ethernet Ports - 10/100 Mbps (RJ-45 Connectors).
1 RS-232 Port (9 pin D-shell connector).
1 RS-485 non isolated port (3 Screw Connector on base board).

256 MB Memory Upgrade Option: Memory upgrade option (NPM-256) increases memory to 256 MB DDR.

Operating System: QNX® RTOS, IBM J9™ JVM® Java Virtual Machine, Niagara^{AX} 3.1 or later.

Chassis: Construction: Plastic, din rail or screw mount chassis, plastic cover.
Cooling: Internal air convection.
Dimensions: 6.3 in. (160 mm) W x 4.8 in. (122 mm) H (including connectors) x 2.4 in. (61 mm) D.

Temperature Ratings: Operating temperature range: 32° to 122° F (0° to 50° C).
Storage Temperature range: 32° to 158° F (0° to 70° C).

Humidity Rating: 5% to 95% RH, non-condensing.

Approvals: RoHS, BTL (with optional BACnet driver), UL 916, C-UL listed to Canadian Standards Association (CSA) C22.2 No. 205-M1983 "Signal Equipment", CE, FCC part 15 Class A, C-tick (Australia).

Optional Communications Cards: Manufactured in the US

Table 2.

Part Number	Description
DR-LONFT10-AX	Optional 78 Kbps FTT10 A LON® Adapter and LonWorks communication driver. (card and driver bundle).
NBP-LON	Optional 78 kbps FTT10 LON adapter (card only).
NPB-RS232	Optional RS-232 port adapter with 9 pin D-shell connector.
NPB-2X-RS485	Optional dual port RS-485 adapter, electrically isolated.
NPB-MDM	Optional Auto-dial / Auto-answer 56 KBPS modem; consumes one option card slot; cannot be used if NPB-GPRS-H modem is selected.
NPB-GPRS-H	Optional GPRS Modem communications card with SIM card for connection via Wyless network; Wyless is the only approved service provider for the continental US, consumes one option card slot.

Power Supply Options:

Table 3.

Part Number	Description
NPB-PWR-H	Optional: 24 Vac/dc power supply module, Din Rail mounted. Manufactured in the US.
NPB-PWR-UN-H	Optional universal voltage input power supply module, Din Rail mounted. Input voltage is 90 - 263 Volts AC, 50/60 Hz, auto adjusting.
NPB-WPM-US	Optional Wall Power Module. Input 120 Vac, 50-60 Hz. US wall plug power supply.

Optional I/O Modules: Table 4 lists the I/O models that can be connected to the WEB-600. Optionally, IO-16-REM-H can be connected; details can be found in the data sheet 74-5082.

Table 4.

Feature	IO-16 WEB-IO-16	IO-16-US	IO-34 WEB-IO-34	IO-34-US
Manufactured in	China	USA	China	USA
Universal Inputs	8		16	
Relay Outputs	4		10	
Analog Outputs	4		8	
Dimensions (in inches)	3.2W x 4.8H x 2.4D		6.3W x 4.8H x 2.4D	
Dimensions (in mm)	82W x 122H x 61D		160W x 122H x 61D	
Max per WEB-600 controller	4 / 2*		1	

*4 or 2 in combination with IO-34/IO-34-US.

I/O Specifications - All Modules: Connection to WEB-600 Controller is via a single multi-pin plug.

Removable screw terminals (0.2 in. [5.08 mm] centers) for all inputs and outputs.

Universal Input types supported:

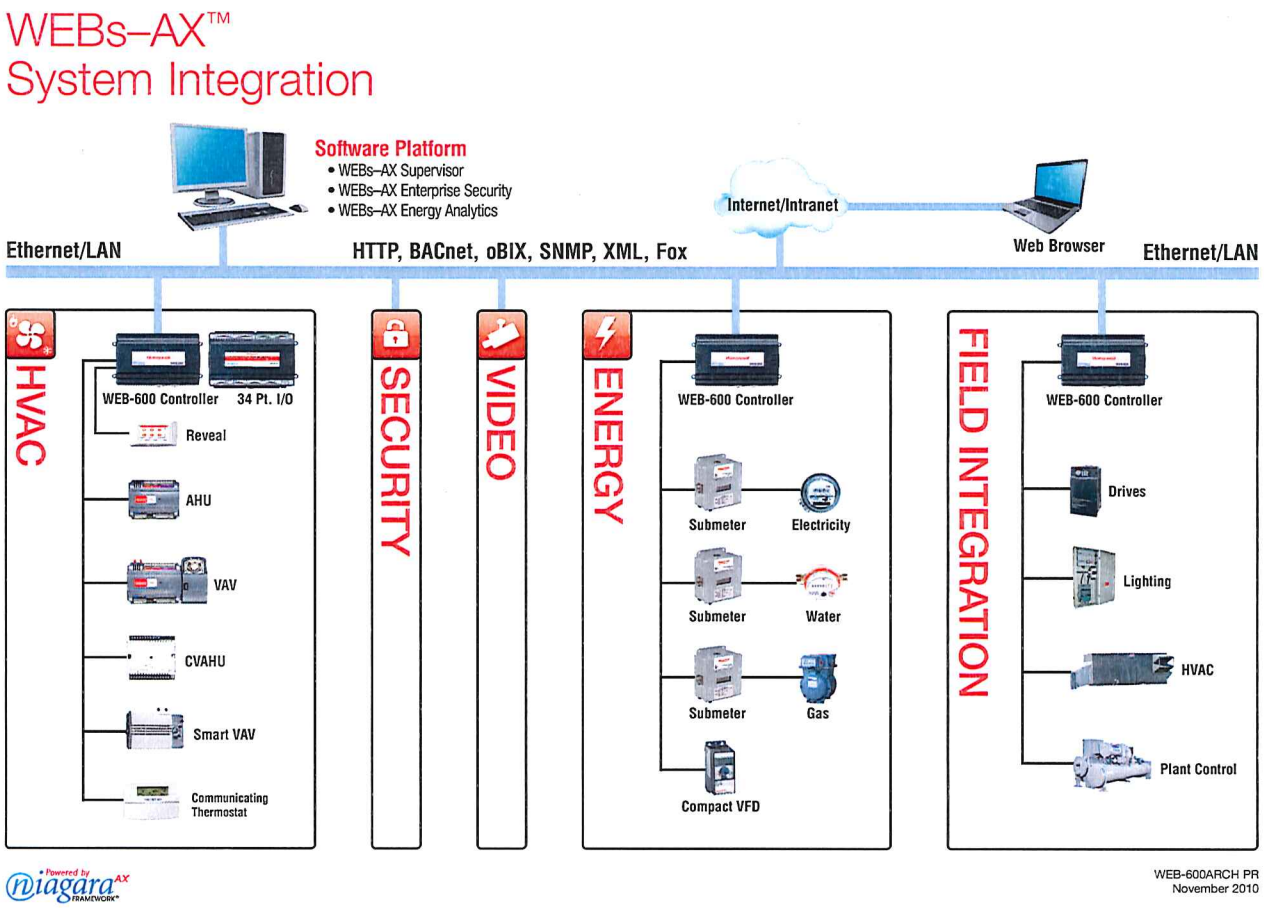
- Type 3 (10K) Thermistors; Thermistor Sensor Range -10° to +240° F (23° to +116° C). Input accuracy is in the range of +/-1% of span. Others may be supported by entering custom non-linear curve interpolation points for each unique non-linear input.
- 0 to 10 volt; accuracy is +/- 2% of span, without user calibration; uses an external resistor for current input (four provided, mounted by installer on terminal connections) 4/20 mA current loop; accuracy is +/- 2% of span, without user calibration; self-powered or board-powered sensors accepted.
- Dry contact; V open circuit, 300-uA short-circuit current.
- Pulsing dry contact at a rate of up to 20 Hz; 50% duty cycle.

Digital Outputs (4 ea.) Pilot Duty.

- Form A relay contacts suitable for on/off control only; floating control not supported.
- Maximum voltage - 30V DC or AC.
- 1/2 Amp maximum current rating.

Analog Outputs:

- 0 -10 Volt DC.
- Minimum load supported per output is 2500 ohms minimum or 4 mA drain maximum.



Automation and Control Solutions
Honeywell International Inc.
1985 Douglas Drive North
Golden Valley, MN 55422

Honeywell Limited-Honeywell Limitée
35 Dynamic Drive
Toronto, Ontario M1V 4Z9
customer.honeywell.com

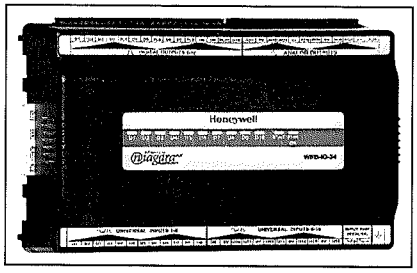
Honeywell

74-4067—02 T.D. Rev. 11-10
Printed in U.S.A.

Honeywell

WEB-IO-34 Input/Output Module

INSTALLATION INSTRUCTIONS



GENERAL

This document covers the mounting, wiring, and initial start-up of WEB-IO-34 expansion module. It assumes that you are an engineer, technician, or service person who is performing control system installation using the Niagara Framework®. Please read this entire document before beginning the installation procedures.

This document does not discuss software installation or station configuration. For more information on these topics, refer to the documents listed in the RELATED DOCUMENTATION section.

PRODUCT DESCRIPTION

The Honeywell WEB-IO-34 is a compact direct WEB-IO module for auxiliary monitoring and control when used with a WEB-201 series controller or other controller platforms as identified in their respective data sheets. This option expands the controller an additional 34 logic-controlled points. Included are 16 universal inputs, 10 form "A" (SPST) relay outputs and 8 analog (voltage only) outputs. This greatly expands the controller monitoring and control capabilities with fast, reliable, direct inputs and outputs for monitoring power, temperature, humidity and status. In addition, the WEB-IO-34 provides power to the attached controller using either an externally-supplied 24 Vac transformer or 24 Vc power supply.

The on-board I/O can be used to monitor pulse contacts from power/demand meters, analog sensors, or transducers, as well as to control energy-consuming devices such as fans, lights or pumps with digital relay outputs. Also included are 8 analog outputs to proportionally control dampers, valves and other devices.

A maximum of one WEB-IO-34 module may be used per WEB-201 controller. However, 2 additional WEB-IO-16 modules can also be used, to provide a total of 32 UIs, 18 relay outputs, and 16 analog output points.

BEFORE INSTALLATION

1. Unpack the WEB-IO-34 Compact Direct Expansion Module.
2. Inspect contents of the package for damaged or missing components.
3. Check the equipment and report any damage to a Honeywell representative at once and return any damaged components for immediate repair or replacement. See RETURNING A DEFECTIVE UNIT section.
4. Read all of these instructions and ensure they are understood.

Included in this Package

Included in this package you should find the following items:

- One WEB-IO-34 module, with grounding wire having a quick-disconnect 0.187 in. (4.75 mm) female connector.
- WEB-IO-34 INSTALLATION INSTRUCTIONS, literature no. 95-7724.
- One 15-position terminal plug and three 12-position terminal plugs, for I/O wiring.
- One 2-position terminal plug, for 24 Vac power.
- Sixteen 499-ohm resistors for 4-20 mA inputs.

Materials and Tools Required

The following tools and supplies are required for installation:

- A suitable power source, as one of the following:
  - UL listed, Class 2, 24 Vac transformer, rated a minimum of 8.5 VA to 20 VA (approximate range of WEB-201 with WEB-IO-34 alone, to fully-expanded unit with 2 additional WEB-IO-16 modules and other option boards). A *dedicated* transformer is required (cannot power additional equipment).
  - 24 Vdc power supply, capable of supplying at least 1 A (24 W).
- DIN rail, type NS35/7.5 (35 mm x 7.5 mm) recommended for mounting with WEB-201 controller. The DIN rail should be sufficient length to accommodate both the WEB-201 controller and WEB-IO-34 module. See Fig. 2.
- Suitable screws and screwdriver for mounting DIN rail, or if DIN rail not used, for mounting bases of WEB-201 controller and WEB-IO-34 module.
- Small flat-blade screwdriver: used for mounting or removing the WEB-IO-34 module from DIN rail, also for screw terminals on I/O connectors and 24 V power connector.

CE c UL us

95-7724

SAFETY INSTRUCTIONS

NOTES REGARDING DEVICE DESCRIPTION

These instructions include guidelines for use and mounting of the device. In case of questions that cannot be answered with these instructions, please consult the product supplier or manufacturer. It is the responsibility of the equipment installer to ensure that all federal, state and local codes are followed.

SAFETY INSTRUCTIONS

- Keep these Installation Instructions for industrial safety and the prevention of accidents.
- The information in these instructions must be read and understood by every person using this device.
- The following items share warnings of a general nature relating to the installation and start-up of the WEB-201 series controller.
- Be sure to heed these warnings to prevent personal injury or equipment damage.

⚠ WARNING

- **A 24 Vac or 24 Vdc circuit powers the WEB-IO-34 module and attached WEB-201 controller. Disconnect power before installation or servicing to prevent electrical shock or equipment damage.**
- **Make all connections in accordance with national and local electrical codes. Use copper conductors only.**
- **To reduce the risk of fire or electrical shock, install in a controlled environment relatively free of contaminants.**
- **WEB controllers and I/O modules are only intended for use as monitoring and control devices. To prevent data loss or equipment damage, do not use for any other purposes.**

Static Discharge Precautions

The following items are cautionary notes that will help prevent equipment damage or loss of data caused by static discharge.

⚠ CAUTION

- **Static charges produce voltages high enough to damage electronic components. The microprocessors and associated circuitry within WEB-IO-34 modules are sensitive to static discharge. Follow these precautions when installing, servicing or operating the system:**
- **Work in a static free area.**
- **Discharge any static electricity you may have accumulated. Discharge static electricity by touching a known securely grounded object.**
- **Do not handle the printed circuit board (PCB) without proper protection against static discharge. Use a wrist strap when handling PCBs, with the wrist strap clamp secured to earth ground.**

I/O Module Connection Precautions

⚠ CAUTION

- **Avoid "hot" plug-in or removal of any WEB-IO module from the controller (or other accessory module), meaning first remove power from the unit. If the unit switches to battery operation, wait for all LEDs to go out.**
- **Plugging or unplugging a WEB-IO module from a powered WEB controller should not cause damage to either the controller or WEB-IO module hardware. However, note that all WEB-IO modules are initialized upon station startup and if not (continuously) present following a power cycle, will be inoperable.**
- **Do not plug in more than (2) WEB-IO-16 modules into a single WEB-201 controller. Doing so will have unexpected effects on the software, and may overload the power supply.**
- **WEB-IO modules are designed to be directly plugged into the WEB-201 controller or directly attached modules. Do not use a ribbon cable or extend the length of the I/O cable as this will increase radiated signal noise, decreasing analog stability, and may introduce communication problems.**

INSTALLATION AND START-UP OUTLINE

NOTE: If installing the WEB-201 controller and WEB-IO-34 module at the same time, refer to the WEB-201 INSTALLATION INSTRUCTIONS guide literature no. 95-7722 to install the WEB-201 controller. In this case, the WEB-IO-34 module is typically the "approved power source", used *in place* of a WEB-NPB-PWR module. A maximum of 2 additional WEB-IO-16 modules are supported. See Fig. 2.

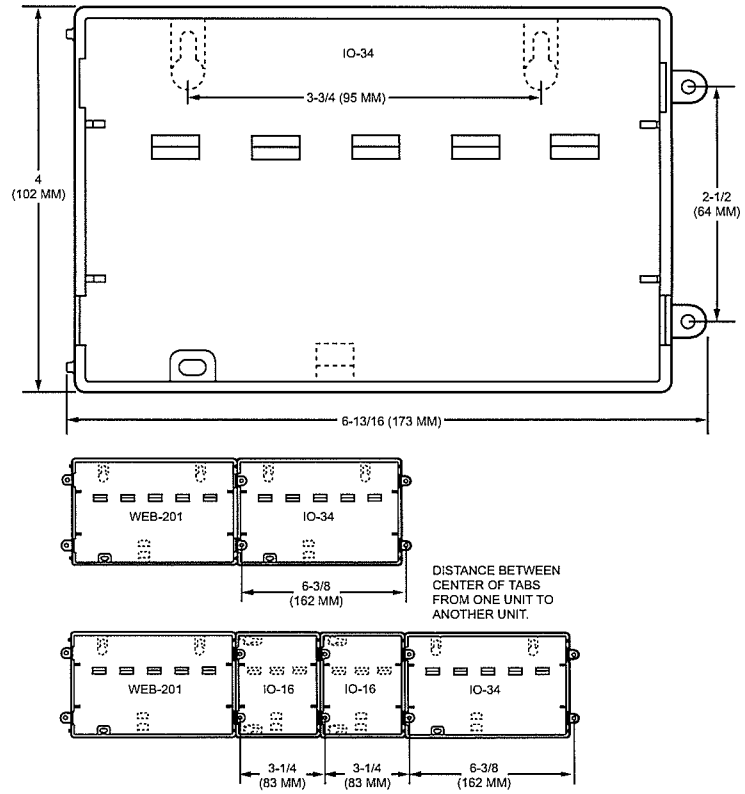
The major steps to installing and starting the WEB-IO-34 module are outlined as follows:

1. Physically mount the WEB-IO-34 module with the WEB-201 controller. See MOUNTING section. Make sure that the I/O input connector is properly seated into the I/O connector on the WEB-201 controller (or if used, another WEB-IO-16 module). Refer to the previous I/O Module Connector Precautions section.
2. Make wiring connections for earth ground, 24 Vac power and I/O wiring. See WIRING section.
3. Apply power and perform an initial checkout. See POWER UP AND INITIAL CHECKOUT section.

MOUNTING

The following applies to mounting a WEB-IO-34 module with a WEB-201 controller:

- The units may be mounted in any orientation. It is not necessary to remove the covers before mounting.
- Mounting on a 1.4 in. (35 mm) wide DIN rail is recommended. Both the WEB-201 unit base and the WEB-IO-34 unit base have a molded DIN rail slot and locking clip as does the WEB-IO-16 expansion module. Mounting a DIN rail ensures accurate alignment of connectors between all modules.
- If DIN rail mounting is impractical, screws in mounting tabs may be used on the WEB-201 controller and then in the WEB-IO-34 module. Mounting tab dimensions are shown in Fig. 1.



NOTES: ELECTRONIC AND PRINTED VERSIONS OF THIS GUIDE MAY NOT SHOW THE DIMENSIONS TO SCALE.

VERIFY ALL MEASUREMENTS DRILLING.

DIN MOUNTING IS RECOMMENDED OVER TAB MOUNTING. SEE FIGURE 2.

M23283

Fig. 1. Tab mounting dimensions in inches (mm).

Procedure 1 provides step by step mounting instructions for the WEB-IO-34 module on an existing installed DIN rail.

NOTES: If the WEB-201 controller is already in use:

a. Back up its configuration to your PC using Niagara AX™ Workbench 3.n.nn. This is done using a platform connection to the controller, using the backup command in the **Platform Administration** view.

b. Turn off the power to the controller and disconnect the power cord. Be sure that all of the LEDs are off. Make sure that the controller is not running off of battery power.

c. Remove any other power source: NPB-WPM-US (wall mount) or WEB-NPB-PWR (DIN mount) module. **Do not reconnect a NPB-WPM-US** (wall mount module) after installing and powering the WEB-IO-34 module. The WEB-IO-34 should be the only power source for the WEB-201 controller.

Procedure 1. Din rail mount.

Step 1	Remove the bottom I/O connector plug(s) that cover the plastic DIN locking clip.
Step 2	Position the WEB-IO-34 module on the rail, tilting to hook DIN rail tabs over one edge of the DIN rail. (See Fig. 2)
Step 3	Use a screwdriver to pry down the plastic locking clip, and push down and in on the WEB-IO-34, to force the clip to snap over the edge of the DIN rail.
Step 4	Slide the WEB-IO-34 module along the DIN rail to connect its 20-position plug into WEB-201 controller (or if used, another WEB-IO-16 module). With all modules connected, the WEB-IO-34 module is at one end. Make sure that all modules are firmly seated.
Step 5	To keep this assembly from sliding on the DIN rail, secure the WEB-IO-34 (last module) with clips provided by the DIN rail vendor, or place a screw in one of the mounting tabs in the base of the WEB-IO-34 module.

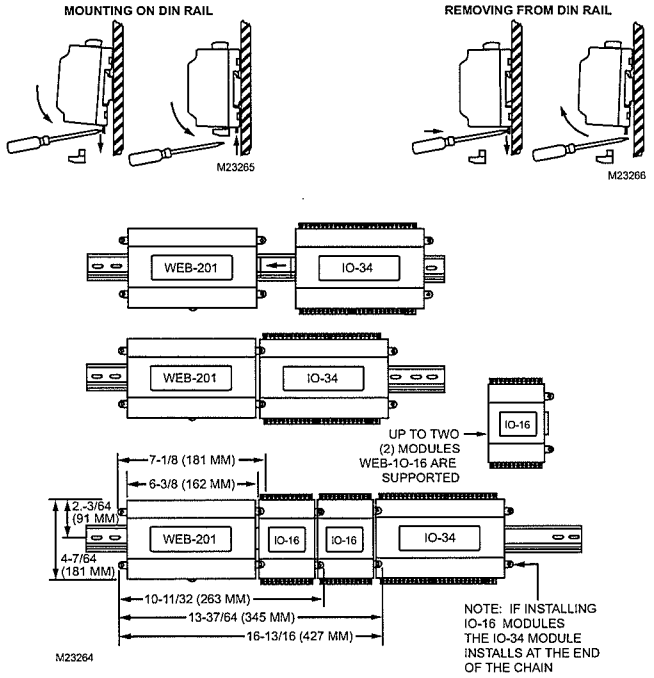


Fig. 2. WEB-IO-34 Module mounting details.

NOTE: To remove WEB-IO-34 module from DIN rail, slide it away from other modules. Insert a screwdriver in the center plastic locking tab and pull downwards, then lift the unit outwards. It may be necessary to remove an I/O connector plug as shown at the top of Fig 2.

BOARD LAYOUT AND TERMINAL LOCATIONS

The WEB-IO-34 module provides 16 universal inputs supporting analog inputs (temperature, resistance, voltage and current) and digital inputs (contact closure, pulse count) and 18 outputs: 10 relay (24 Vac/cd, 0.5 A max.) outputs and 8 analog outputs (0-10 Vdc). Wiring terminal positions are shown in Fig. 3 along with LED locations.

WIRING

See Fig. 3 to locate connectors and other components on the controller.

Make connections to the WEB-IO-34 controller in the following order.

1. Connect the earth ground wire (with spade connector) from the earth ground lug on the WEB-IO-16 module to a nearby earth ground point. See GROUNDING section for details.
2. Prepare power wiring (leave the unit powered off). See Power Wiring section for details.
3. Connect I/O wiring. See Inputs and Outputs sections.
4. Apply power to the unit. See POWER UP AND INITIAL CHECKOUT sections.

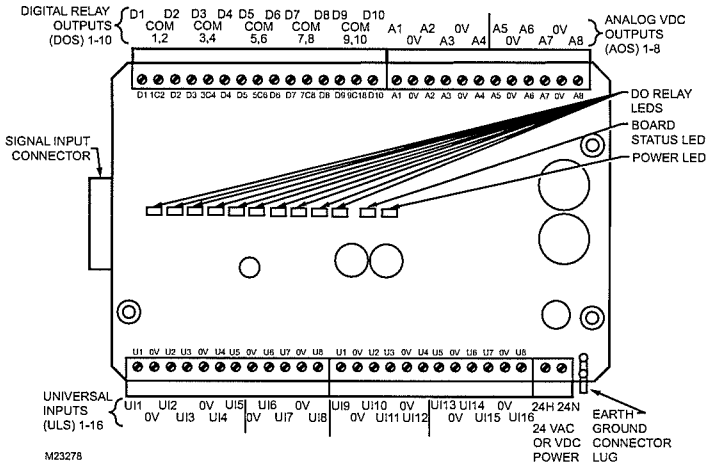


Fig. 3. WEB-IO-34 Wiring terminal locations.

Grounding

An earth ground spade lug 0.187 in. (4.75 mm) is provided on the base of the WEB-IO-34 module (as well as the WEB-201, WEB-IO-16 controller) for connection to earth ground. For maximum protection from electrostatic discharge or other forms of EMI, connect each earth ground using a #16 AWG or larger wire. Keep these wires as short as possible.

See Fig. 4 for the location of the earth grounding wire for WEB-IO-34.

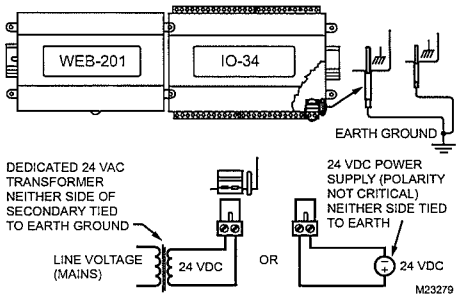


Fig. 4. WEB-IO-34 earth ground connection.

Power Wiring

The WEB-IO-34 module can be powered by wiring to a **dedicated** Class 2, 24 V transformer, or to a 24 Vdc power source. The WEB-IO-34 provides power to the attached WEB-201 controller and up to two attached WEB-IO-16 modules (if used).

NOTE: If powering from a 24 V transformer, do not power other equipment with it. Otherwise, conducted noise problems may result. Also, do not ground either side of the transformer's 24 V secondary.

Power consumption depends on installed accessories and option cards, and may vary from:

- WEB-201 controller with WEB-IO-34 module alone: approximately 8.5 VA (AC) or 8.5 W (DC)
- WEB-201 with WEB-IO-34, 2 additional WEB-IO-16 modules, plus option boards: up to 20 VA (AC) or 20 W (DC).

As shown in Fig. 4, the WEB-IO-34 module's 2-position power connector is located at the lower corner of the unit. Unplug the connector from the module and make connections to it as shown.

NOTE: Do not apply 24 V power (reinsert connector plug into the WEB-IO-34) until all other wiring is completed, including WEB-IO-34 inputs and outputs. See POWER UP AND INITIAL CHECKOUT section.

Inputs

Each of the 8 universal inputs (UI) can support any one of the following:

- Type-3 10K ohm Thermistor (also see Note in Resistive 0-100k ohms section)
- Resistive 0-100K ohms
- 0-10 Vdc
- 4-20 mA
- Binary Input

Thermistor

The inputs support 10K Thermistor temperature sensors using a **ThermistorInputPoint**. Input accuracy is in the range of ±1% of span. By default, conversion is for standard Type 3 thermistor sensor, with a sensor range of -10° to 135° F (23.3° to 57.2° C). Using a conversion type of "Tabular Thermistor", a different thermistor response curve can be specified by importing a thermistor curve.xml file. Currently, the Ndio module contains an xml folder with thermistor curves for a Radio Shack sensor model 271-0110 and TE-6300 10K type sensor. Customized thermistor xml files may be edited or exported (for reuse). See the Niagara AX Ndio Guide for more details. Fig. 5 shows the wiring diagram.

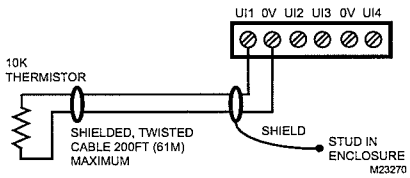


Fig. 5. Thermistor wiring.

Resistive 0-100K ohms

The inputs can read a resistive signal within a range from 0 to 100,000 ohms. Wiring is the same as shown for a Thermistor temperature sensor. See Fig. 5.

Resistive signals require a **ResistiveInputPoint**.

NOTE: UI inputs are optimized to provide the best resolution around the 10K ohm range. For a sensor with a range far from 10K ohms (such as 100-ohm type), resolution will be poor. To use such a sensor, it is recommended a transmitter that produces a Vdc or mA signal be installed. Wire the transmitter to the UI according to the 0-10 Vdc or 4-20 mA instructions.

0-10 Vdc

The inputs support self-powered 0-10 Vdc sensors. Input impedance is greater than 5K ohms. 0-10 volt accuracy is ±2% of span, without user calibration. Fig. 6 shows the wiring diagram. 0-10 Vdc sensors requires a **VoltageInputPoint**.

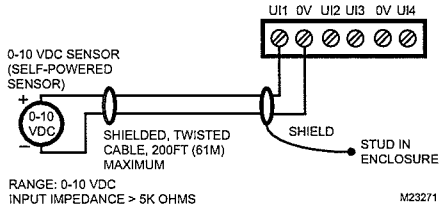


Fig. 6. 0-10 Vdc wiring.

4-20 mA

The inputs support self-powered 4-20 mA sensors. Input accuracy is ±2% of span, without user calibration. Fig. 7 shows the wiring diagram, which requires a 499 ohm resistor wired across the input terminals. 4-20 mA sensors also require the **VoltageInputPoint**.

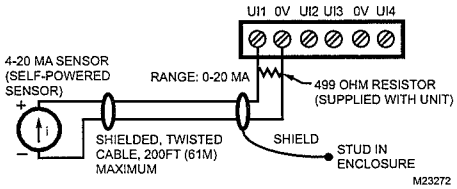


Fig. 7. 4-20 mA wiring.

Binary Input

The universal inputs support both pulse contacts and normal dry (equipment status) contacts.

- Pulse contacts may have a change-of-state (COS) frequency of up to 20 Hz with a 50% duty cycle.

NOTE: Minimum dwell time must be >25 ms. (Contacts must remain open at least 25 ms and be closed at least 25 ms)

- Standard dry contacts must have a 1 Hz (or less) COS frequency, with minimum dwell time >500 ms. (Contacts must remain open at least 500 ms and be closed at least 500 ms)

Both types of dry contacts support 3.3 Vdc open circuits or 330 µA short-circuit current.

Fig. 8 shows the wiring diagram. For a pulse diagram contact use the **CounterInputPoint** in the station database. For other dry contacts, use the **BooleanInputPoint**.

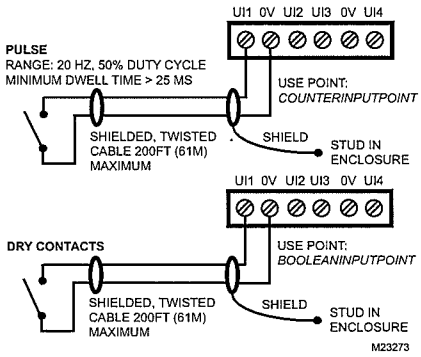


Fig. 8. Binary input wiring.

Outputs

The WEB-IO-34 module has 10 digital relay outputs and 8 0-10 volt analog outputs.

Relay Outputs

Each relay output is rated at 24 Vac or Vdc at 0.5 A. Relay outputs have MOV (metal oxide varistor) suppressors to support inductive type loads such as heavy duty relay coils.

⚠ WARNING

Relays are not rated for AC mains (line level) powered loads (instead, 24 V maximum). Never use the controllers power transformer to power I/O loads. Using controller transformer introduces potentially damaging switching transients into the controller.

Use a **BooleanOutputWritable** in the station for each output. Fig. 9 shows an example wiring diagram.

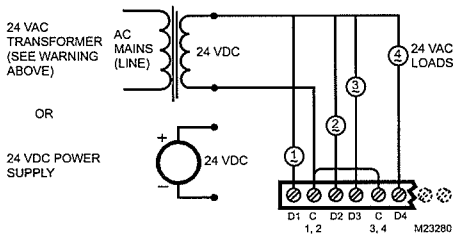


Fig. 9. Relay output wiring diagram.

NOTE: 15-position DO connector plug has 5 common terminals "C" (1 -2, 3 - 4, 5 - 6, 7 - 8, 9 - 10), which are isolated from each other. This can be useful when powering loads from different 24 Vac sources.

A yellow LED status indicator for each relay (D1 - D10) is located on the board (Fig. 3), and also visible through the cover. Under normal operation, each digital status LED indicates activity as follows:

- **Off** - relay open/no current flows.
- **On** - relay closed/load current flows.

Therefore, an **On** status indicates that the load is powered.

Analog Outputs

Analog Outputs (AO) are referenced by the terminals labeled A*n* and 0 V (ground). Each AO can supply a maximum of 4 mA over the entire 0 to 10 Vdc range. The minimum input impedance of a device controlled by an AO must be greater than 2500 ohms. Typical wiring for an AO is shown in Fig. 10.

For each AO, use a **VoltageOutputWritable** in the station database.

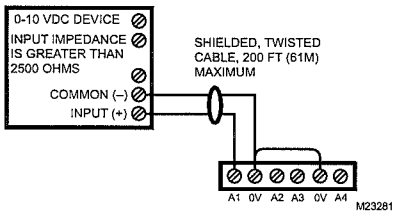


Fig. 10. Analog output wiring diagram.

SOFTWARE DESCRIPTION

In the Niagara station interface to the WEB-201 controller, each I/O module appears as one **NdioBoard** under the station's **NdioNetwork**. If a WEB-201 controller has only one WEB-IO-34 module, the NdioNetwork has a single **NdioBoard** component, where the "Io Port" property of the **NdioBoard** is 1. See Fig. 10, top.

Upon discovery, if the WEB-201 controller has multiple WEB-IO-16 modules, the module closest to the WEB-201 controller is the first **NdioBoard** (property Io Port **1**), the next module in the chain is **NdioBoard1** (property Io Port **2**), and the third module is **NdioBoard2** (property Io Port **3**). See Fig. 11, bottom.

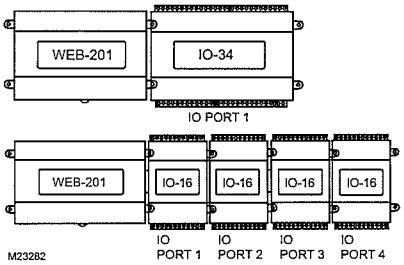


Fig. 11. WEB-201 controller NdioBoard (port) assignment.

Once the operating system identifies the NDIO processors, the I/O board status LED on each WEB-IO module turns green. The green status LED means that the controller is able to communicate with the I/O. It does not indicate anything about the status of the Niagara station or its Ndio components.

NOTE: Any time a powered WEB-IO module's status LED is not lit, all outputs are in "failsafe" state (all relay outputs OFF, and all AOs are at a 0-volt level). See Fig. 3 for location of the WEB-IO-16 status LED.

Each type input or output used requires a special Niagara Direct Input/Output (Ndio) point to be added in the station database. These components act as the station interface to the physical I/O points. The Ndio points needed for each input or output type are noted in previous wiring sections in **boldface**.

For Ndio component details, see the Ndio Guide in Niagara AX online Help, or the same document in PDF.

POWER UP AND INITIAL CHECKOUT

1. Plug in the 24 V connector plug to apply power. The WEB-IO-34 board and status LED will initially be Off (Fig. 3), but the Power LED on the WEB-IO-34 should be lit. Allow the controller sufficient time to boot (at least 2 minutes).
2. Upgrade the controller firmware if necessary (if controller has a Niagara build earlier than the Workbench). Using a Workbench, open a platform connection to the controller. Use the **Commissioning Wizard** to do this. For more details, see the JACE® Niagara AX Install and Startup Guide, also available in the Workbench online HELP (doc Jace Startup). Make sure to install the Ndio software module.
3. Verify that the WEB-IO-34 board status LED is now lit to green.
4. Using WorkBench, open the station (if running), or open a platform connection and start the station using **Station Director**.
5. If not already present, add an NdioNetwork component to the station's Drivers Container and use "Manager" views and "Learn Mode" to discover and add Ndio components to the station database. See SOFTWARE DESCRIPTION section. For more details about Ndio components, refer to the Ndio Guide, also available in Workbench online Help (doc Ndio).

RELATED DOCUMENTATION

For more information on configuring and using WEB-201 series controllers, consult the following documents:

- WEB-201 Installation Instructions.
- JACE Niagara AX Install and Startup Guide
- Niagara AX Ndio Guide
- Niagara AX User Guide
- WEB-IO-16 Installation Instructions

REPLACEMENT PARTS

Servicing the WEB-IO-34 modules may call for replacement parts. There are two categories of parts:

- Standard Replacement Parts
- New Replacement Units

Standard Replacement Parts

Standard replacement parts are listed in Table 1 and can be ordered from stock without restriction. Standard replacement parts cannot be returned for credit and should be disposed of in an appropriate manner.

Table 1. Standard replacement parts.

Part Number	Description
10149	Resistor, 499 ohm, 1%, 0.6 w
10600	Connector plug, 15-position screw terminal, 180 deg. (1 used for DOs)
10599	Connector plug, 12-position screw terminal, 180 deg. (3 used: 2 for UIs, 1 for AOs)
10598	Connector plug, 2-position screw terminal, 180 deg. (1 used for 24 V power)
10370	Grounding wire with quick-disconnect 0.187 in. (4.75 mm) female connector

New Replacement Units

To replace a faulty unit, order and install a new WEB-IO-34 accessory module.

NOTE: WEB-201 series products do not have special "field replacement units", or FRU's, with separate part numbers.

If the faulty WEB-IO-34 module is still in warranty credit may be received by returning it to Honeywell. Be sure to contact Honeywell for a return authorization (RA) number before shipping an item for return credit. See RETURNING A DEFECTIVE UNIT section for details.

NOTE: Before ordering a new WEB-IO-34 module, it is strongly recommended that normal technical support resource be used to eliminate the possibility of a software issue or mis-configuration problem.

MAINTENANCE

Module Replacement

⚠ CAUTION

Before handling circuit boards, discharge any accumulated static by touching the nearby earth grounding point. For details, see Static Discharge Precaution section.

To replace the WEB-IO-34 accessory module in the field, proceed as follows:

Procedure 2. Accessory Module Replacement.

Step 1	Using the appropriate Niagara software tool, back up the controller configuration to your PC.
Step 2	Remove power to the WEB-IO-34 controller. The unit should power down automatically.
Step 3	Record positions of all I/O wiring going to the WEB-IO-34. If necessary, label connectors to avoid mis-connection later (after WEB-IO-34 module is replaced).
	NOTE: The software that runs on the WEB-201 controller expects the terminal positions to be the same in the replacement WEB-IO-34 module, in order to collect data from or to control the attached devices.
Step 4	If any I/O points have voltage, turn the devices off, or disconnect power to them.
Step 5	Unplug all connectors from the WEB-IO-34 module, including all I/O connectors and earth ground wire.
Step 6	Remove any screws or DIN rail clips securing the WEB-IO-34 module, removing it from its mounting.
Step 7	Mount the replacement WEB-IO-34 module as it was previously, using the same DIN rail location and/or screws.
Step 8	Reconnect the earth ground wire to the grounding lug.
Step 9	Reconnect all I/O connectors to the WEB-IO-34 module.
Step 10	If any of your I/O points have voltage, turn the devices back on, or reconnect power to them.
Step 11	Restore power to the WEB-IO-34 module and perform a checkout using Niagara AX Workbench (see POWER UP AND INITIAL CHECKOUT section).
Step 12	For more details, see the Niagara AX Ndio Guide and JACE Niagara AX Install and Startup Guide.

RETURNING A DEFECTIVE UNIT

NOTES: If the defective unit is under warranty, follow return instructions provided in this section. If the unit is out of warranty, discard the unit.

— Do not return an out-of-warranty WEB-IO-34 module to Honeywell.

— There is no "return for repair-and-return" service available for any of the WEB-201 series products.

For proper credit on an in-warranty unit, ship the defective unit to Honeywell within 30 days.

Prior to returning the unit, contact one of the Honeywell offices to obtain a return authorization (RA) number and other instructions. See last page of document for Honeywell contact information. Please provide:

- Product model
- Serial number
- Number of the defect
- Nature of defect

Automation and Control Solutions

Honeywell International Inc.
1985 Douglas Drive North
Golden Valley, MN 55422
customer.honeywell.com

Honeywell Limited-Honeywell Limitée
35 Dynamic Drive
Scarborough, Ontario M1V 4Z9

Honeywell

95-7724 J.I. 03-06

Honeywell

Stryker™ Lon Configurable VAV/CVAHU Controllers

INSTALLATION INSTRUCTIONS

APPLICATION

The Stryker™ configurable, direct digital controllers are used for either pressure-independent or pressure single-duct VAV terminal units OR constant volume, air-handling unit control solutions. VAV controllers feature preprogrammed heat/cooling or reheat algorithms for VAV box control applications and can be configured to match a wide range of VAV applications. The CVAHU controller is designed to control a wide range of air-handling units including single-zone and heat pump air handlers. All Stryker™ controllers use Echelon LONWORKS communication technology and the Free Topology Transceiver (FTT) for great installation flexibility.

One model of the CUL controller (CUL6438SR-CV1) and two models of the CVL controller (CVL4022AS-VAV1 and CVL4024NS-VAV1) are available. The CVL4022AS-VAV1 model consists of a VAV controller and a floating actuator. The CVL4024NS-VAV1 VAV controller model does not include an actuator. Both models contain an integral microbridge air flow sensor that provides flow measurement for pressure independent applications.

The CUL controller controls space temperature in a given zone by regulating heating and cooling equipment in the air handler delivering air to that space.

The CVL controller controls the space temperature in a given zone by modulating a damper and/or regulating a reheat coil in a Variable Air Volume Box that delivers air to one space.

The controllers are capable of stand-alone operation; however, optimum functional benefits are achieved when the network communication capabilities are used.

The Zio (TR71/75) wall modules are used in conjunction with the CUL and CVL controllers. Zio is an LCD Wall Module to communicate via a two-wire, polarity insensitive bus with the Honeywell Spyder and Stryker™ controller families. The CUL and CVL controllers can be configured in Zio.

Table 1. Controller Configurations

Controller Model	Communication Protocol	Application	UI (Universal Input	DI (Digital Input)	AO (Analog Output)	DO (Digital Output)	Velocity Pressure Sensor (Microbridge)	Series 60 Floating Actuator
CVL4022AS-VAV1	LonWorks	VAV	4	0	2	2	YES	YES
CVL4024NS-VAV1	LonWorks	VAV	4	0	2	4	YES	NO
CUL6438SR-CV1	LonWorks	CVAHU	6	4	3	8 Relays	NO	NO

Sylk™ Enabled
Easy 2-wire installation

62-2029—02

Specifications

Electrical
Rated Voltage: 20-30 Vac; 50/60 Hz
Power Consumption:
100 VA for controller and all connected loads
Controller only Load: 5 VA maximum for models CUL6438SR-CV1 and CVL4024NS-VAV1
Controller and Actuator Load: 9 VA maximum, model CVL4022AS-VAV1
External Sensors Power Output: 20 Vdc ±10% @ 75 mA maximum

Environmental
VAV Operating & Storage Temperature Ambient Rating (models CVL4022AS-VAV1 and CVL4024NS-VAV1):
Minimum 32° F (0° C); Maximum 122° F (50° C)
CVAHU Operating & Storage Temperature Ambient Rating (model CUL6438SR-CV1)
Minimum -40° F (-40 °C); Maximum 150° F (65.5° C)

Relative Humidity: 5% to 95% non-condensing

Approval Bodies
UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
CSA (LR95329-3) listed.
Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
Meets Canadian standard C108.8 (radiated emissions).
Conforms to the following requirements per European Consortium standards:
- EN 61000-6-1; 2001 (EU Immunity).
- EN 61000-6-3; 2001 (EU Emissions)

Velocity Pressure Sensor (models CVL4022AS-VAV1 and CVL4024NS-VAV1)
Operating Range: 0 to 1.5 in. H2O (0 to 374 Pa)

Series 60 Floating Actuator (model CVL4022AS-VAV1)
Rotation Stroke: 95° ± 3° for CW or CCW opening dampers
Torque Rating: 44 lb-in. (5 Nm)
Run Time for 90° rotation: 90 seconds at 60 Hz

Hardware
CPU: Each controller uses a Texas Instruments MSP430 family microprocessor. The processor contains on-chip FLASH program memory, FLASH information memory, and RAM.

Memory Capacity
Flash Memory: 116 kilobytes with 8 kilobytes available for user program. The controller is able to retain FLASH memory settings for up to ten (10) years.
RAM: 8 kilobytes

Dimensions
CUL6438SR-CV1: H/W/D: 5.45 x 6.85 x 2.26 in. (13.84 x 17.40 x 5.74 cm)
CVL4022AS-VAV1: H/W/D: 6.60 x 8.28 x 2.26 in. (16.7 x 21.1 x 5.7 cm)
CVL4024NS-VAV1: H/W/D: 6.60 x 4.75 x 2.26 in. (15.9 x 12.1 x 5.7 cm)

Real Time Clock
Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic daylight savings time adjustment to occur at 2:00 a.m. local time on configured start and stop dates.
Power Failure Backup: 24 hours at 32 to 100° F (0 to 38° C), 22 hours at 100 to 122° F (38 to 50° C)
Accuracy: ±1 minute per month at 77° F (25° C)

Inputs and Outputs
CVL4022AS-VAV1 has four universal input (UI) circuits, two analog outputs (AO), and two digital Triac outputs (DO). Two Digital Outputs are reserved for the actuator.
CVL4024NS-VAV1 has four universal input (UI) circuits, two analog outputs (AO), and four digital Triac outputs (DO).
CUL6438SR-CV1 has six universal inputs (UI), four digital inputs (DI), three analog outputs (AO), and eight digital relay outputs (DO).

Universal Input (UI) Circuits
See Table 2 for the UI specifications.

Table 2. Universal Input Circuit Specifications

Input Type	Sensor Type	Operating Range
Room/Zone Discharge Air Outdoor Air Temperature	20K Ohm NTC	-40° F to 199° F (-40° C to 93° C)
Outdoor Air Temperature	C7031G[a]	-40° to 120°F (-40° to 49°C)
	C7041F[a]	-40° to 250°F (-40° to 121°C)
	PT1000 (IEC751 3850)	-40° F to 199° F (-40° C to 93° C)
TR23 Setpoint Potentiometer	500 Ohm to 10,500 Ohm	-4° DDC to 4° DDC (-8° DDF to 7° DDF) or 50° F to 90° F (10° C to 32° C)
Resistive Input	Generic	100 Ohms to 100K Ohms
Voltage Input	Transducer, Controller	0–10 Vdc
Discrete Input	Dry Contact closure	Open Circuit ≥ 3000 Ohms Closed Circuit < 3000 Ohms

[a] C7031G and C7041F are recommended for use with these controllers, due to improved resolution and accuracy when compared to the PT1000.

Analog Output (AO) Circuits
ANALOG CURRENT OUTPUTS:
Current Output Range: 4.0 to 20.0 mA
Output Load Resistance: 550 Ohms maximum
ANALOG VOLTAGE OUTPUTS:
Current Output Range: 4.0 to 20.0 mA
Output Load Resistance: 550 Ohms maximum
Digital Triac Output (DO) Circuits (CVL4022AS-VAV1 and CVL4024NS-VAV1 only)
Voltage Rating: 20 to 30 Vac @ 50-60Hz
Current Rating: 25 mA to 500 mA continuous, 800 mA (AC rms) for 60 milliseconds
Digital Relay Output (DO) Circuits (CUL6438SR-CV1 only)
Voltage Rating: 20 to 30 Vac @ 50-60Hz
Current Rating: 0 mA to 1 A continuous, 3.5 A inrush (AC rms) for 100 milliseconds

Status Information

The LED on the front of the controller provides a visual indication of the status of the device. When the controller receives power, the LED appears in one of the following allowable states, as described in Table 3.

Table 3. Status LED States.

LED State	Blink Rate	Status or Condition
OFF	not applicable	No power to processor, LED damaged, low voltage to board, or controller damaged.
ON	ON steady; not blinking	Processor and/or controller is not operating.
Very slow blink (continuous)	1 second ON, 1 second OFF	Controller is operating normally.
Slow blink (continuous)	0.5 second ON, 0.5 second OFF	Controller alarm is active, controller in process of download, or controller lost its configuration.
Medium blink (continuous)	0.25 second ON, 0.25 second OFF	Controller firmware is loading.
Fast blink (continuous)	0.10 second ON, 0.10 second OFF	Controller is in manual mode under control of the PC-based software tool.

Communications

Each controller uses an FTT transformer-coupled communications port. The controller's Manchester encoded data is presented to other controllers and devices on the LONWORKS® Bus at 78 kilobits per second (kbs) via Echelon® communication protocol. The transformer-coupled communications interface offers a much higher degree of common mode-noise rejection while assuring dc isolation. The LONWORKS® Bus is polarity insensitive, eliminating installation errors due to miswiring.

Sylk™ Bus

Sylk is a two wire, polarity insensitive bus that provides both 18 Vdc power and communications between Sylk-enabled devices. Using Sylk-enabled devices saves I/O on the controller and is faster and cheaper to install since only two wires are needed and the bus is polarity insensitive.

LONMARK® Functional Profile

The CVL Controllers support the LONMARK® Functional Profile number 8010 VAV Controller, version 1.0.

Network Variables Profile

Network variables, as described in Fig. 1 and 2, are communicated over the LONWORKS® Bus. The controller's built-in functions provide for the selection of variables, which are available from/to the network.

In Fig. 1 and 2 the network variable prefixes have the following meaning:

- nvi - Network Variable Input
- nvo - Network Variable Output

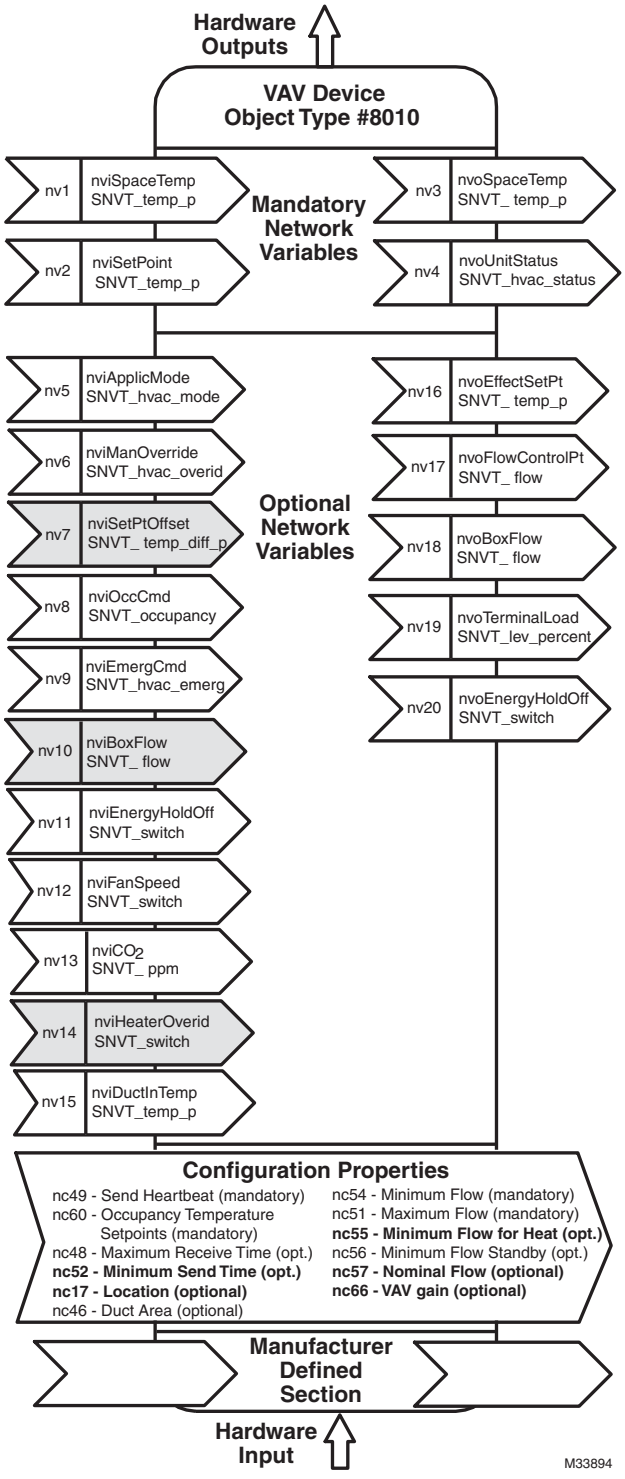


Fig. 1. Object Variables List for VAV controllers.

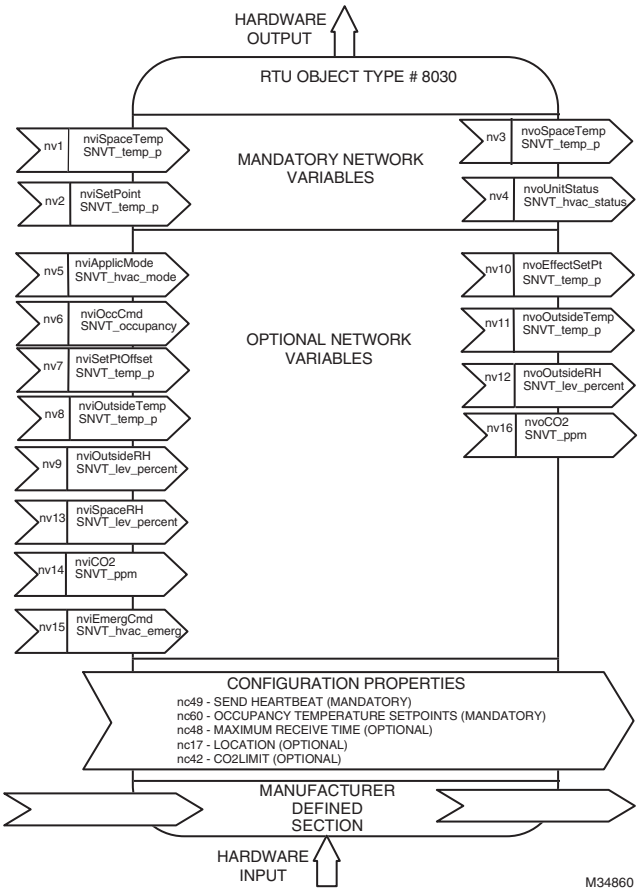


Fig. 2. Object variables for CVAHU controllers.

Accessories

- 201052A, B, C Auxiliary Switches (one, two or three switches)
- 209541B Termination Module
- C7041B, C, D, P, R Air Temperature Sensor (indoor)
- C7770A Air Temperature Sensor (indoor/plenum)
- C7031G Air Temperature Sensor (outdoor)
- C7041F Air Temperature Sensor (outdoor)
- Q7751A,B Router (configured as a repeater)
- Q7752A,B Serial Interface Adapter
- TR7X Wall Module
- TR2X Wall Module
- C7400A Enthalpy Sensor
- P7640 Pressure Transducer Family
- C7262 CO2 Sensor Family
- C7600 Humidity Sensor Family
- H7625, H7635, and H7655 Humidity and Temperature Sensors

Refer to the "Sensors Product Overview," form 63-9285, for additional accessories.

BEFORE INSTALLATION

Review the power, input, and output specifications on page "2" before installing the controller.

— Hardware driven by Triac outputs must have a minimum current draw, when energized, of 25 mA and a maximum current draw of 500 mA.

— Hardware driven by the analog current outputs must have a maximum resistance of 550 Ohms, resulting in a maximum voltage of 11 volts when driven at 20 mA.

If resistance exceeds 550 Ohms, voltages up to 18 Vdc are possible at the analog output terminal.

INSTALLATION

The controller must be mounted in a position that allows clearance for wiring, servicing, removal, connection of the LonWorks® Bus Jack, and access to the Neuron® Service Pin (see Fig. 16 on page 14). The controller may be mounted in any orientation.

IMPORTANT NOTE:

Avoid mounting in areas where acid fumes or other deteriorating vapors can attack the metal parts of the controller, or in areas where escaping gas or other explosive vapors are present (see Fig. 4-Fig. 5 on page 6 for mounting dimensions).

Mount Actuator onto Damper Shaft (CVL4022AS-VAV1 only)

The CVL4022AS-VAV1 controller includes the direct-coupled actuator with Declutch mechanism, which is shipped hard-wired to the controller. The actuator mounts directly onto the VAV box damper shaft and has up to 44 lb-in. (5 Nm) torque, 90-degree stroke, and 90 second timing at 60 Hz. The actuator is suitable for mounting onto a 3/8 to 1/2 in. (10 to 13 mm) square or round VAV box damper shaft. The minimum VAV box damper shaft length is 1-9/16 in. (40 mm).

The two mechanical end-limit set screws control the amount of rotation from 12° to 95°. These set screws must be securely fastened in place. To ensure tight closing of the damper, the shaft adapter has a total rotation stroke of 95° (see Fig. 1).

NOTE: The actuator is shipped with the mechanical end-limit set screws set to 95 degrees of rotation. Adjust the two set screws closer together to reduce the rotation travel. Each "hash mark" indicator on the bracket represents approximately 6.5° of rotation per side.

NOTE: The Declutch button, when pressed, allows you to rotate the universal shaft adapter (see Fig. 3).

IMPORTANT:

Determine the damper rotation and opening angle prior to installation. See Fig. 4 and 4 on page 5 for examples.

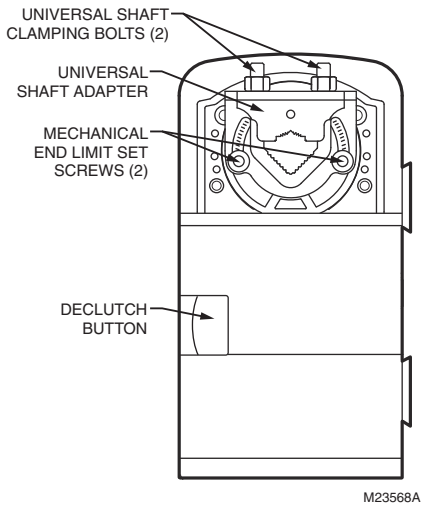


Fig. 3. Series 60 Floating Actuator

IMPORTANT: Mount actuator flush with damper housing or add a spacer between the actuator mounting surface and damper box housing.

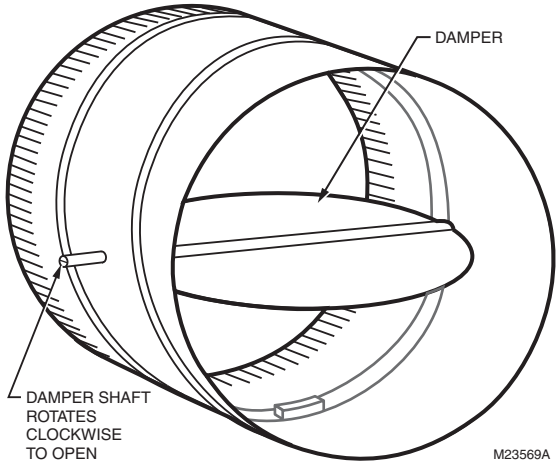


Fig. 4. Damper with 90 degree CW rotation to open.

Before Mounting Actuator onto Damper Shaft (CVL4022AS-VAV1 only)

Tools required:
- Phillips #2 screwdriver - end-limit set screw adjustment
- 8 mm wrench - centering clamp

Before mounting the actuator onto the VAV box damper shaft, determine the following:

1. Determine the damper shaft diameter. It must be between 3/8 in. to 1/2 in. (10 to 13 mm).
2. Determine the length of the damper shaft. If the length of the VAV box damper shaft is less than 1-9/16 in. (40 mm), the actuator cannot be used.
3. Determine the direction the damper shaft rotates to open the damper (CW or CCW) (see Fig. 4). Typically, there is an etched line on the end of the damper shaft that indicates the position of the damper. In Fig. 2, the indicator shows the damper open in a CW direction.
4. Determine the damper full opening angle (45, 60, or 90 degrees). In Fig. 4, the damper is open to its full open position of 90 degrees.

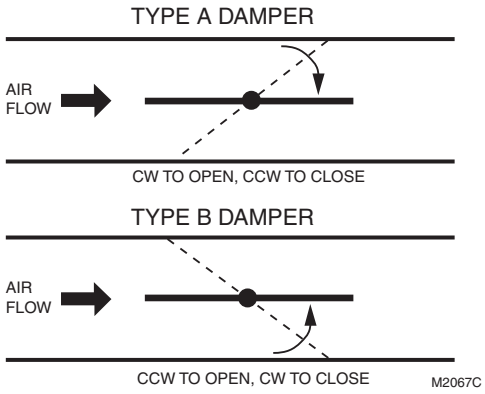


Fig. 5. Determining the rotation direction (CW or CCW) for damper opening.

Mounting Actuator onto Damper Shaft (CVL4022AS-VAV1 only)

The unit is shipped with the actuator set to rotate open in the clockwise (CW) direction to a full 95 degrees. The extra 5 degrees ensures a full opening range for a 90 degree damper. The installation procedure varies depending on the damper opening direction and angle:

1. If the damper rotates clockwise (CW) to open, and the angle of the damper open-to-closed is 90 degrees:
   a. Manually open the damper fully (rotate clockwise).
   b. Using the Declutch button, rotate the universal shaft adapter fully clockwise.
   c. Mount the actuator to the VAV damper box and shaft.
   d. Tighten the two bolts on the centering clamp (8 mm wrench; 70.8-88.5 lb-in. [8-10 Nm] torque). When the actuator closes, the damper rotates CCW 90 degrees to fully close.
2. If the damper rotates clockwise (CW) to open, and the angle of the damper open-to-closed is 45 or 60 degrees:
   a. Manually open the damper fully (rotate clockwise).
   b. The actuator is shipped with the mechanical end-limits set at 95 degrees. Adjust the two mechanical end-limit set screws to provide the desired amount of rotation. Adjust the two set screws closer together to reduce the rotation travel.
   c. Tighten the two mechanical end-limit screws (Phillips #2 screwdriver; (26.5-31 lb-in. [3.0-3.5 Nm] torque).
   d. Using the Declutch button, rotate the universal shaft adapter fully clockwise.
   e. Mount the actuator to the VAV damper box and shaft.
   f. Tighten the two bolts on the centering clamp (8 mm wrench; 70.8-88.5 lb-in. [8-10 Nm] torque).
   g. When the actuator closes, the damper rotates CCW either 45 or 60 degrees to fully close.

3. If the damper rotates counterclockwise (CCW) to open, and the angle of the damper open-to-closed is 90 degrees:
   a. Manually open the damper fully (rotate counter-clockwise).
   b. Using the Declutch button, rotate the universal shaft adapter fully counterclockwise.
   c. Mount the actuator to the damper box and shaft.
   d. Tighten the two bolts on the centering clamp (8 mm wrench; 70.8-88.5 lb-in. [8-10 Nm] torque). When the actuator closes, the damper rotates CW 90 degrees to fully close.
4. If the damper rotates counterclockwise (CCW) to open, and the angle of the damper open-to-closed is 45 or 60 degrees:
   a. Manually open the damper fully (rotate counter-clockwise).
   b. The actuator is shipped with the mechanical end-limits set at 95 degrees. Adjust the two mechanical end-limit set screws to provide the desired amount of rotation. Adjust the two set screws closer together to reduce the rotation travel.
   c. Tighten the two mechanical end-limit screws (Phillips #2 screwdriver; (26.5-31 lb-in. [3.0-3.5 Nm] torque).
   d. Using the Declutch button, rotate the universal shaft adapter fully counter-clockwise.
   e. Mount the actuator to the VAV damper box and shaft.
   f. Tighten the two bolts on the centering clamp (8 mm wrench; 70.8-88.5 lb-in. [8-10 Nm] torque).
   g. When the actuator closes, the damper rotates CW either 45 or 60 degrees to fully close.

Mount Controller

NOTE: The controller may be wired before mounting to a panel or DIN rail. Terminal blocks are used to make all wiring connections to the controller. Attach all wiring to the appropriate terminal blocks (See “Wiring” on page 7). See Fig. 6 and 7 for panel mounting dimensions. See Fig. 8 on page 7 for DIN rail mounting.

Panel Mounting

NOTE: The controller enclosure is constructed of a plastic base plate and a plastic factory-snap-on cover.

The controller is designed so that the cover does not need to be removed from the base plate for either mounting or wiring. The controller mounts using four screws inserted through the corners of the base plate. Fasten securely with four No. 6 or No. 8 machine or sheet metal screws.

The controller can be mounted in any orientation. Ventilation openings are designed into the cover to allow proper heat dissipation, regardless of the mounting orientation.

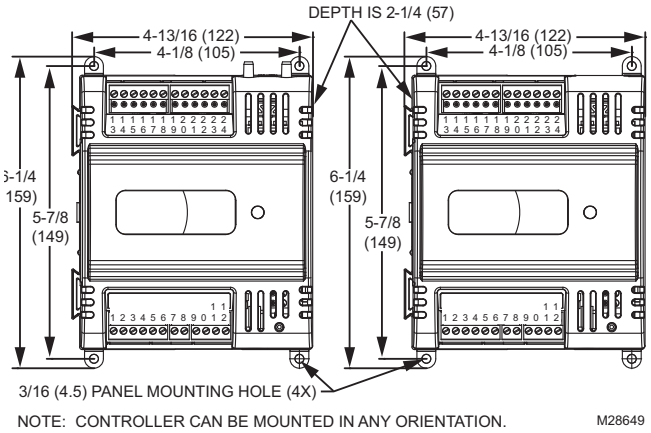


Fig. 6. Panel mounting - controller dimensions in inches (mm) for CVL4024NS-VAV1 only.

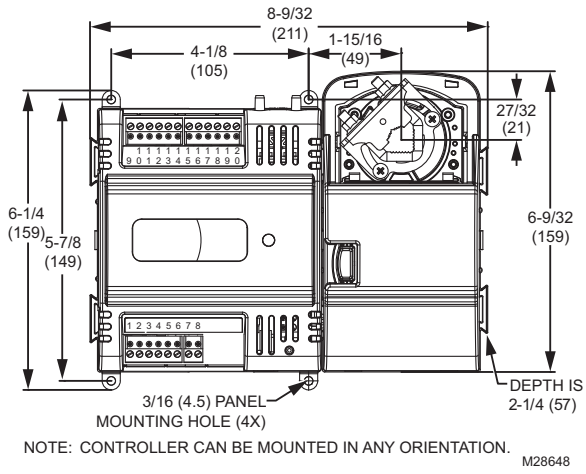


Fig. 7. Panel mounting - controller and actuator dimensions in inches (mm) for CVL4022AS-VAV1 only.

DIN Rail Mounting (CUL6438SR-CV1 and CVL4024NS-VAV1)

To mount the CUL6438SR-CV1 or CVL4024NS-VAV1 controller on a DIN rail [standard EN50022; 1-3/8 in. x 9/32 in. (7.5 mm x 35 mm)], refer to Fig. 8 and perform the following steps:

1. Holding the controller with its top tilted in towards the DIN rail, hook the two top tabs on the back of the controller onto the top of the DIN rail.
2. Push down and in to snap the two bottom flex connectors of the controller onto the DIN rail.

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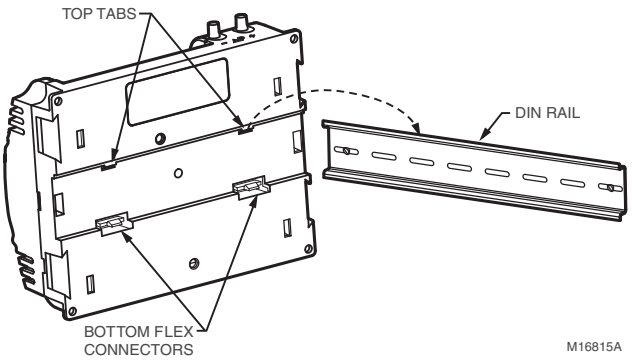

Fig. 8. Controller DIN rail mounting (CVL4024NS-VAV1 is shown here).

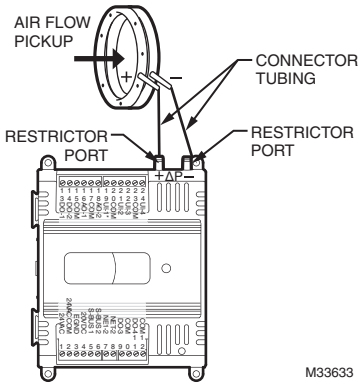

Fig. 9. Air flow pickup connections

IMPORTANT NOTE:
To remove the controller from the DIN rail, perform the following:

1. Push straight up from the bottom to release the top tabs.
2. Rotate the top of the controller out towards you and pull the controller down and away from the DIN rail to release the bottom flex connectors.

Piping (CVL4022AS-VAV1 and CVL4024NS-VAV1 only)

Air flow Pickup

Connect the air flow pickup to the two restrictor ports on the controller (see Fig. 9).

NOTES:

— Use 1/4 inch (6 mm) outside diameter, with a 0.040 in. (1 mm) wall thickness, plenum-rated1219 FR (94V-2) tubing.

— Always use a fresh cut on the end of the tubing that connects to the air flow pickups and the restrictor ports on the controller.

Connect the high pressure or upstream tube to the plastic restrictor port labeled (+), and the low pressure or downstream tube to the restrictor port labeled (-). See labeling in Fig. 9. When twin tubing is used from the pickup, split the pickup tubing a short length to accommodate the connections.

NOTES:

— If controllers are mounted in unusually dusty or dirty environments, an inline, 5-micron disposable air filter (use 5-micron filters compatible with pneumatic controls) is recommended for the high pressure line (marked as +) connected to the air flow pickup.

— The tubing from the air flow pickup to the controller should not exceed three feet (0.914 m). Any length greater than this will degrade the flow sensing accuracy.

— Use caution when removing tubing from a connector.

Always pull straight away from the connector or use diagonal cutters to cut the edge of the tubing attached to the connector. Never remove by pulling at an angle.

Wiring

All wiring must comply with applicable electrical codes and ordinances, or as specified on installation wiring diagrams.

Controller wiring is terminated to the screw terminal blocks located on the top and the bottom of the device.

WARNING

Electrical Shock Hazard. Can cause severe injury, death or property damage.

Disconnect power supply before beginning wiring or making wiring connections, to prevent electrical shock or equipment damage.

Power Wiring

GUIDELINES FOR POWER WIRING
For multiple controllers operating from a single transformer, the same side of the transformer secondary must be connected to the same power input terminal in each device. The earth ground terminal must be connected to a verified earth ground for each controller in the group (see Fig. 12 on page 9). Controller configurations are not necessarily limited to two devices, but the total power draw, including accessories, cannot exceed 100 VA when powered by the same transformer (U.S. only).

- See Fig. 11 on page 8 for controller power wiring used in UL 1995 equipment (U.S. only).
- Many controllers require all loads to be powered by the same transformer that powers the controller.
- Keep the earth ground connection wire run as short as possible (refer to Fig. 10-Fig. 12 beginning on page 8).
- Do not connect earth ground to the controller's digital or analog ground terminals (refer to Fig. 10 and Fig. 12).
- Do not connect the universal input COM terminals, analog output COM terminals or the digital input/output COM terminals to earth ground. Refer to Fig. 10-12 for wiring examples. The 24 Vac power from an energy limited Class II power source must be provided to the controller. To conform to Class II restrictions (U.S. only), the transformer must not be larger than 100 VA. Fig. 10 depicts a single controller using one transformer.

- Unswitched 24 Vac power wiring can be run in the same conduit as the LONWORKS® Bus cable.
- Maintain at least a 3 in. (76 mm) separation between Triac outputs and LONWORKS® Bus wiring throughout the installation.

IMPORTANT

Power must be off prior to connecting to or removing connections from the 24 Vac power (24 Vac/24 Vac COM), earth ground (EGND), and 20 Vdc power (20 Vdc) terminals.

IMPORTANT

Use the heaviest gauge wire available, up to 14 AWG (2.0 sq mm), with a minimum of 18 AWG (1.0 sq mm), for all power and earth ground wiring. Screw-type terminal blocks are designed to accept up to one 14 AWG (2.0 sq mm) conductor or up to two 18 AWG (1.0 sq mm) conductors. More than two wires that are 18 AWG (2.0 sq mm) can be connected with a wire nut. Include a pigtail with this wire group and attach the pigtail to the terminal block.

IMPORTANT

*If the controller is used on **Heating and Cooling Equipment (UL 1995, U.S. only)** and the transformer primary power is more than 150 volts, connect terminal 2, (the 24 Vac common [24 VAC COM] terminal) to earth ground (see Fig. 11). For these applications, only one controller can be powered by each transformer.*

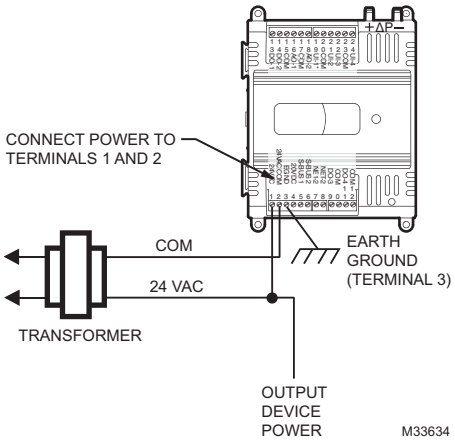

Fig. 10. Power wiring details for one controller per transformer

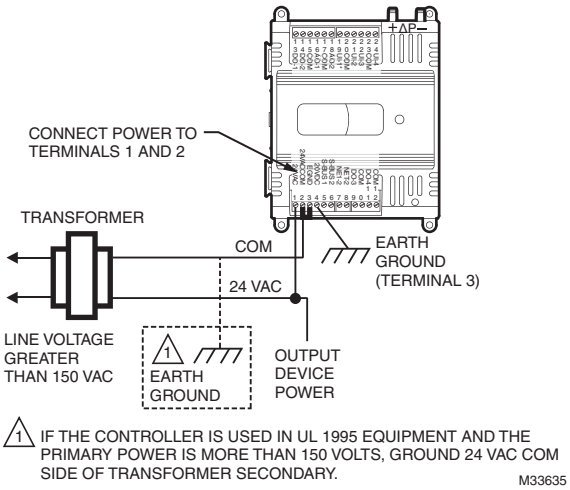

Fig. 11. Transformer power wiring details for one controller used in UL 1995 equipment (U.S. only).

NOTE: More than one controller can be powered by a single transformer. Fig. 12 shows power wiring details for multiple controllers.Controller configurations are not necessarily limited to three devices, but the total power draw, including accessories, cannot exceed 100 VA when powered by the same transformer (U.S. only). For power wiring recommendations, see "Power" below.

Power

Before wiring the controller, determine the input and output device requirements for each controller used in the system. Select input and output devices compatible with the controller and the application. Consider the operating range, wiring requirements, and the environment conditions when selecting input/output devices. When selecting actuators for modulating applications, consider using floating control. In direct digital control applications, floating actuators will generally provide control action equal to or better than an analog input actuator for lower cost.

Determine the location of controllers, sensors, actuators and other input/output devices and create wiring diagrams. Refer to Fig. 18 and 19 beginning on page 14 for illustrations of typical controller wiring for various configurations.

The application engineer must review the control job requirements. This includes the sequences of operation for the controller, and for the system as a whole. Usually, there are variables that must be passed between the controllers that are required for optimum system wide operation. Typical examples are the TOD, Occ/Unocc signal, the outdoor air temperature, the demand limit control signal, and the smoke control mode signal.

It is important to understand these interrelationships early in the job engineering process, to ensure proper implementation when configuring the controllers.

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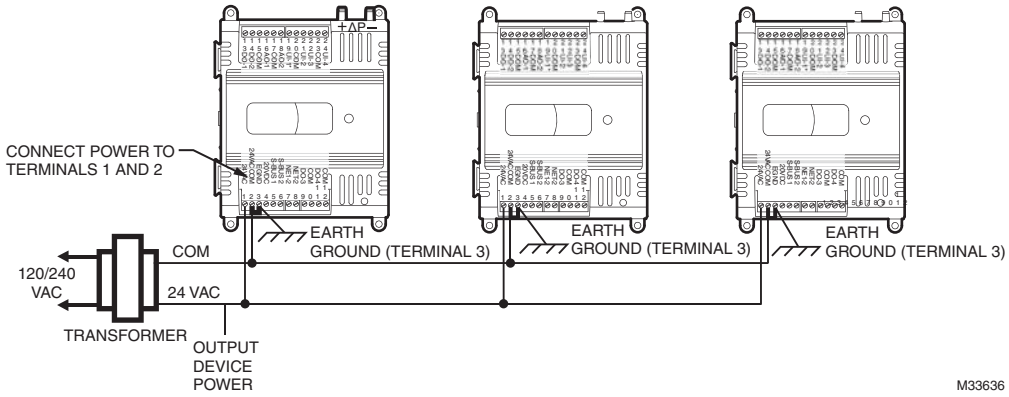

Fig. 12. Power wiring details for two or more controllers per transformer

Power Budget

A power budget must be calculated for each device to determine the required transformer size for proper operation. A power budget is simply the summing of the maximum power draw ratings (in VA) of all the devices to be controlled. This includes the controller itself and any devices powered from the controller, such as equipment actuators (ML6161 or other motors) and various contactors and transducers.

IMPORTANT

- If a controller is used on Heating and Cooling Equipment (UL 1995, U.S. only) and transformer primary power is more than 150 volts, connect the transformer secondary common to earth ground (see Fig. 11 on page 8).
- When multiple controllers operate from a single transformer, connect the same side of the transformer secondary to the same power input terminal in each device. The earth ground terminal (terminal 3) must be connected to a verified earth ground for each controller in the group (see Fig. 12).

POWER BUDGET CALCULATION EXAMPLE

Table 4 is an example of a power budget calculation for a typical CVL controller.

The system example above requires 30.7 VA of peak power. Therefore, a 100 VA AT92A transformer could be used to power one controller of this type. Because the total peak power is less than 50 VA, this same transformer could be on page 11 for illustrations of controller power wiring. See Table 6 for VA ratings of various devices.

For contactors and similar devices, the in-rush power ratings should be used as the worst case values when performing power budget calculations. Also, the application engineer must consider the possible combinations of simultaneously energized outputs and calculate the VA ratings accordingly. The worst case, which uses the largest possible VA load, should be determined when sizing the transformer. Each controller requires 24 Vac power from an energy-limited Class II power source. To conform to Class II restrictions (U.S. only), transformers must not be larger than 100 VA. A single transformer can power more than one controller.

Table 4. Power budget calculation example

Device	VA Information	Obtained From
CVL4022AS-VAV1 controller (include Series 60 Floating Damper Actuator)	9.0	See “Specifications” on page 2.
R8242A Contactor fan rating	21.0	TRADELINE® Catalog inrush rating
D/X Stages	0.0	For example, assume cooling stage outputs are wired into a compressor control circuit and have no impact on the budget.
M6410A Steam Heating Coil Valve	0.7	TRADELINE® Catalog, 0.32A 24 Vac
TOTAL	30.7	

Table 5. VA ratings for transformer sizing.

Device	Description	VA
CVL4022AS-VAV1 controllers and Series 60 Floating Damper Actuator	Controller and Actuator	9.0
CVL4024NS-VAV1	Controller	5.0
ML684	Versadrive Valve Actuator	12.0
ML6161	Damper Actuator, 35 lb-in.	2.2
ML6185	Damper Actuator SR 50 lb-in	12.0
ML6464	Damper Actuator, 66 lb-in.	3.0
ML6474	Damper Actuator, 132 lb-in.	3.0
R6410A	Valve Actuator	0.7
R8242A	Contactor	21.0

Line-Loss

Controllers must receive a minimum supply voltage of 20 Vac. If long power or output wire runs are required, a voltage drop due to Ohms Law (I x R) line-loss must be considered. This line-loss can result in a significant increase in total power required and thereby affect transformer sizing. The following

example is an I x R line-loss calculation for a 200 ft. (61m) run from the transformer to a controller drawing 37 VA and using two 18 AWG (1.0 sq mm) wires.

The formula is:

Loss = [length of round-trip wire run (ft.)] x [resistance in wire (ohms per ft.)] x [current in wire (amperes)]

From specification data:

18 AWG twisted pair wire has a resistance of 6.52 ohms per 1000 feet.

Loss = [(400 ft.) x (6.52/1000 ohms per ft.)] x [(37 VA)/(24V)] = 4.02 volts

This means that four volts are going to be lost between the transformer and the controller. To assure the controller receives at least 20 volts, the transformer must output more than 24 volts. Because all transformer output voltage levels depend on the size of the connected load, a larger transformer outputs a higher voltage than a smaller one for a given load.

Fig. 13 shows this voltage load dependence.

In the preceding I x R loss example, even though the controller load is only 37 VA, a standard 40 VA transformer is not sufficient due to the line-loss. Looking at Fig. 13 a 40 VA transformer is just under 100 percent loaded (for the 37 VA controller) and has a secondary voltage of 22.9 volts. (Use the lower edge of the shaded zone in Fig. 13 that represents the worst case conditions.) When the I x R loss of four volts is subtracted, only 18.9 volts reaches the controller. This is not enough voltage for proper operation. In this situation, the engineer has three alternatives:

1. Use a larger transformer. For example, if an 80 VA model is used, an output of 24.4 volts, minus the four volt lineloss, supplies 20.4V to the controller (see Fig. 13).

Although acceptable, the four-volt line-loss in this example is higher than recommended.

IMPORTANT

No installation should be designed where the line-loss is greater than two volts. This allows for nominal operation if the primary voltage drops to 102 Vac (120 Vac minus 15 percent).

2. Use heavier gauge wire for the power run. 14 AWG (2.0 sq mm) wire has a resistance of 2.57 ohms per 1,000 ft. Using the preceding formula results in a lineloss of only 1.58 volts (compared with 4.02 volts). This would allow a 40 VA transformer to be used. 14 AWG (2.0 sq mm) wire is the recommended wire size for 24 Vac wiring.
3. Locate the transformer closer to the controller. This reduces the length of the wire run, and the line-loss. The issue of line-loss is also important in the case of the output wiring connected to the Triac digital outputs. The same formula and method are used. Keep all power and output wire runs as short as practical. When necessary, use heavier gauge wire, a bigger transformer, or install the transformer closer to the controller.

To meet the National Electrical Manufacturers Association (NEMA) standards, a transformer must stay within the NEMA limits. The chart in Fig. 13 shows the required limits at various loads. With 100 percent load, the transformer secondary must supply between 23 and 25 volts to meet the NEMA standard. When a purchased transformer meets the NEMA standard DC20-1986, the transformer voltage regulating ability can be considered reliable. Compliance with the NEMA standard is voluntary.

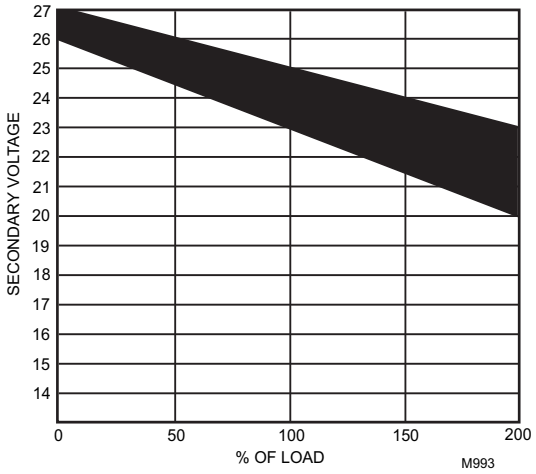

Fig. 13. NEMA Class 2 transformer voltage output limits

The Honeywell transformers listed in Table 5 meet the NEMA standard DC20-1986.

Table 6. Honeywell transformers that meet NEMA standard DC20-1986

Transformer Type	VA Rating
AT40A	40
AT72D	40
AT87A	50
AK3310 Assembly	100

NOTE: The AT88A and AT92A transformers do not meet the voluntary NEMA standard DC20-1986.

Bus Communication Wiring

The maximum LONWORKS® Bus network length is 4,600 ft. (1,400 m). For LONWORKS® Bus network lengths greater than the above, see "LONWORKS® Bus Wiring Guidelines," form no. 74-2865. The theoretical limit for each LONWORKS® Bus segment is 60 controllers. Up to 120 controllers can be configured when the Q7751A,B Router (configured as a repeater) is used, and the bus must be either singly or doubly terminated. Each network segment can have a maximum of one repeater. Actual installations may have a lower limit, depending on the devices connected.

Honeywell provided cable types for LONWORKS® Bus communications wiring are Level IV 22 AWG (0.34 sq mm) plenum or non-plenum rated unshielded, twisted pair, stranded conductor wire.

- For non-plenum areas, U.S. part AK3798 (single-pair stranded) can be used.
- In plenum areas, U.S. part AK3797 (single-pair stranded) or U.S. part AK3799 (two-pair stranded) can be used.

Contact Echelon Corp. Technical Support for the recommended vendors of Echelon approved cables.

Communications wiring can be run in a conduit, if needed, with non-switched 24 Vac or sensor wiring.

Pull the cable to each controller on the LONWORKS® Bus and connect to the controller's communication terminals 7 and 8. (See Table 7 on page 12 and Table 8 on page 13, and Fig. 16 on page 13 for location of terminals 7 and 8.)

NOTE: Connection for operator access to the LONWORKS® Bus is provided by plugging the Serial LONTALK® Adapter (SLTA) connector into the LONWORKS® Bus jack (see Fig. 16 and Fig. 17 on page 13).

IMPORTANT

Notes on communications wiring:

- All field wiring must conform to local codes and ordinances (or as specified on installation drawings).
- Do not bundle device output wires with sensor, digital input or communications LONWORKS® Bus wires.
- Do not use different wire types or gauges on the same LONWORKS Bus segment. The step change in line impedance characteristics causes unpredictable reflections on the LONWORKS® Bus.
- In noisy (high EMI) environments, avoid wire runs parallel to noisy power cables, motor control centers, or lines containing lighting dimmer switches. Keep at least 3 in. (76 mm) of separation between noisy lines and the LONWORKS® Bus cable.

The theoretical limit for each LONWORKS® Bus segment is 60 controllers. Up to 120 controllers can be configured when a repeater is used, and the bus must be either singly or doubly terminated. Actual installations may have a lower limit depending on the devices connected.

- The singly terminated bus must have one 209541B Excel 10 FTT Termination Module for T tap or Star configurations.
- The doubly terminated bus must have two 209541B Excel 10 FTT Termination Modules, one at each end of the daisy chain (Bus style) wiring run. Note that the Q7751A,B router (configured as a repeater) has onboard terminating networks that can be jumper selected on each segment.
- Make sure that neither of the LONWORKS® Bus wires are grounded.

NOTE: If a 209541B Termination Module is required at the controller, connect two of the three termination module wires to the LONWORKS® Bus terminals 7 and 8, which are labeled Net-1 and Net-2, on the controller. Selecting the appropriate two wires depends on the LONWORKS® Bus network topology. Refer to the "LONWORKS® Bus Wiring Guidelines," form 74-2865, and the "Excel 10 FTT Termination Module Installation Instructions," form 95-7554. For example, on a doubly terminated daisy-chained bus topology, where controllers are on either end of an LONWORKS® Bus wire run, mount the termination module on the appropriate terminals, as shown in Fig. 14.

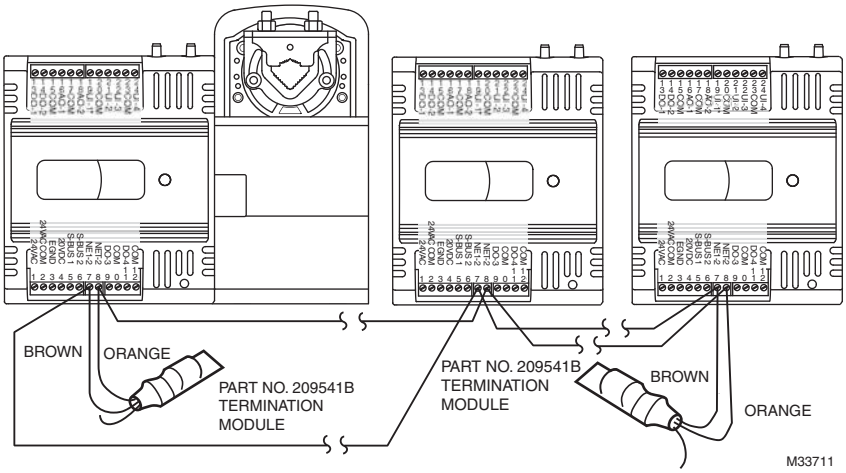

Fig. 14. Termination Modules (LONWORKS® daisy chain connections)

Wiring Method

NOTE: When attaching two or more wires to the same terminal, other than 14 AWG (2.0 sq mm), be sure to twist them together. Deviation from this rule can result in improper electrical contact (see Fig. 15). Each terminal can accommodate the following gauges of wire:

- Single wire: from 22 AWG to 14 AWG solid or stranded
- Multiple wires: up to two 18 AWG stranded, with 1/4 watt wire-wound resistor

Prepare wiring for the terminal blocks, as follows:

1. 1. Strip 1/2 in. (13 mm) insulation from the conductor.
2. 2. Cut a single wire to 3/16 in. (5 mm). Insert the wire in the required terminal location and tighten the screw.
3. 3. If two or more wires are being inserted into one terminal location, twist the wires together a minimum of three turns before inserting them (see Fig. 15).
4. 4. Cut the twisted end of the wires to 3/16 in. (5 mm) before inserting them into the terminal and tightening the screw.
5. 5. Pull on each wire in all terminals to check for good mechanical connection.

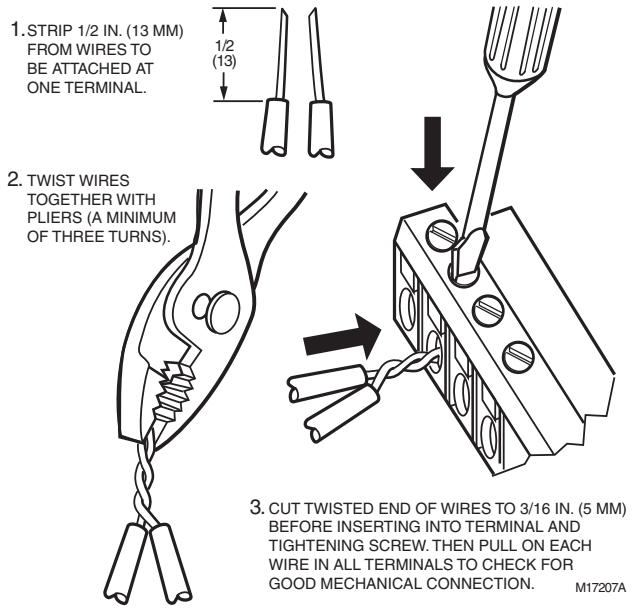

Fig. 15. Attaching two or more wires at terminal blocks.

Wiring Details

Each controller is shipped with the digital outputs, which switch the 24 Vac to the load (High Side). The three analog outputs (AO) are used to control modulating heating, cooling and economizer equipment. Any AO may be used as a digital output, as follows:

- False (0%) produces 0 Vdc, (0 mA)
- True (100%) produces the maximum 11 Vdc (22 mA)

The wiring connection terminals described in Table 7 and 8 are shown in Fig. 18-22 starting on page 14.

IMPORTANT

If the controller is not connected to a good earth ground, the controller's internal transient protection circuitry is compromised and the function of protecting the controller from noise and power line spikes cannot be fulfilled. This could result in a damaged circuit board and require replacement of the controller.

NEURON® SERVICE PIN

The NEURON® Service Pin pushbutton (when pressed) transmits the Service Message to the network, regardless of the controller's current mode of operation (see Fig. 16 and 17 on page 13).

Table 7. Description of CVL4022AS-VAV1 and CVL4024NS-VAV1 wiring terminal connections.

Terminal	Label	Connection
INPUT POWER & GROUND		
1	24 Vac	24 Vac Power
2	24 Vac COM	24 Vac Power
3	EGND	Earth Ground
4	20Vdc	20 Vdc Power
5	SBUS 1	Sylk
6	SBUS 2	Sylk
NETWORK CONNECTIONS		
7	NET-1	LONWORKS® communications
8	NET-2	LONWORKS® communications
DIGITAL OUTPUTS[a]		
9	DO-3	Digital Output
10	COM	Digital Output
11	DO-4	Digital Output
12	COM	Common
13	DO-1	Digital Output
14	DO-2	Digital Output
15	COM	Common
ANALOG OUTPUTS[b]		
16	AO-1	Analog Output
17	COM	Common
18	AO-2	Analog Output
UNIVERSAL INPUTS		
19	UI-1	Universal Input
20	COM	Common
21	UI-2	Universal Input
22	UI-3	Universal Input
23	COM	Common
24	UI-4	Universal Input

[a] For the CVL4022AS controller ONLY, terminals 9-12 (DO3, DO4, & COM) are not present. The actuator is internally hardwired to these terminals.

[b] Analog outputs may be configured as digital outputs and operate as follows:
– False (0%) produces 0 Vdc, (0 mA)
– True (100%) produces the maximum 11 Vdc (22 mA)

⚠ CAUTION

Equipment Damage Hazard.
Can cause controller damage or failure.

Do not use any metal object to press the NEURON® Service Pin. Use a plastic rod or wood device (such as a pencil with the lead broken off) to press the pin. Using a metal object can damage the circuitry of the controller.

LONWORKS BUS CONVENIENCE JACK

The LONWORKS Bus connection is provided by plugging the Serial LONTALK Adapter (SLTA) connector into the LONWORKS® Bus Jack (see Fig. 16 and Fig. 17 on page 13).

Table 8. Description of CUL6438SR-CV1 wiring terminal connections.

Terminal	Label	Connection
INPUT POWER & GROUND		
1	24 Vac	24 Vac Power
2	24 Vac COM	24 Vac Power
3	EGND	Earth Ground
4	SHLD	Shield
5	SBUS 1	Sylk
6	SBUS 2	Sylk
NETWORK CONNECTIONS		
7	NET-1	LONWORKS® communications
8	NET-2	LONWORKS® communications
DIGITAL OUTPUTS		
9	24 Vac Out	24 Vac Power
10	COM-A	Common
11	COM-B	Common
12	COM-C	Common
13	DO-C1	Digital Output
14	DO-A1	Digital Output
15	DO-A2	Digital Output
16	DO-A3	Digital Output
17	DO-B1	Digital Output
18	DO-B2	Digital Output
19	DO-B3	Digital Output
20	DO-B4	Digital Output
ANALOG OUTPUTS[a]		
21	AO-1	Analog Output
22	COM	Common
23	AO-2	Analog Output
24	AO-3	Analog Output
25	COM	Common
DIGITAL INPUTS[b]		
26	DI-1	Digital Input
27	DI-2	Digital Input
28	COM	Common
29	DI-3	Digital Input
30	DI-4	Digital Input
ATTACHED DEVICE(S) POWER		
31	20 Vdc	20 Vdc Power
UNIVERSAL INPUTS		
32	UI-1	Universal Input
33	COM	Common
34	UI-2	Universal Input
35	UI-3	Universal Input
36	COM	Common
37	UI-4	Universal Input
38	UI-5	Universal Input
39	COM	Common
40	UI-6	Universal Input

[a] Analog outputs may be configured as digital outputs and operate as follows:
– False (0%) produces 0 Vdc, (0 mA)
– True (100%) produces the maximum 11 Vdc (22 mA)

[b] Digital inputs: Open circuit = False; Closed circuit = True

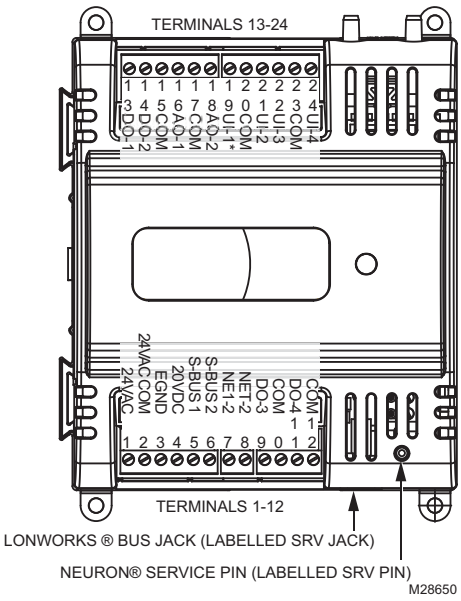

Fig. 16. Controller terminal connections, NEURON® Service Pin and LONWORKS® Bus Jack for the CVL4022AS-VAV1, and CVL4024NS-VAV1 (CVL4024NS-VAV1 shown).

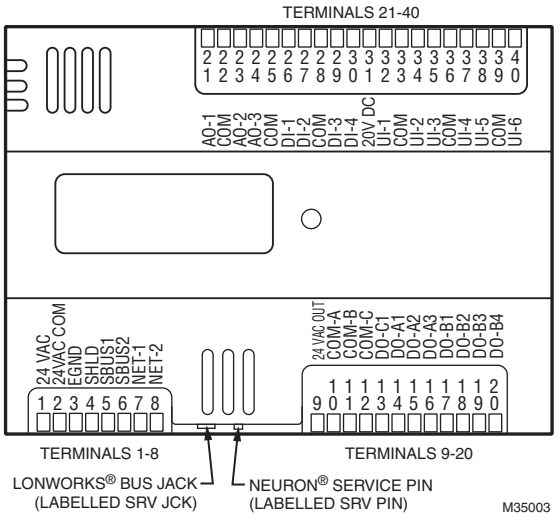

Fig. 17. Controller terminal connections, NEURON® service pin and LONWORKS® bus jack for CUL6438SR-CV1.

Wiring Applications (Examples)

Typical controller wiring for VAV applications (see Fig. 18 and Fig. 19 beginning page 14).

Typical controller wiring for CVAHU applications (see Fig. 20-22 beginning page 16).

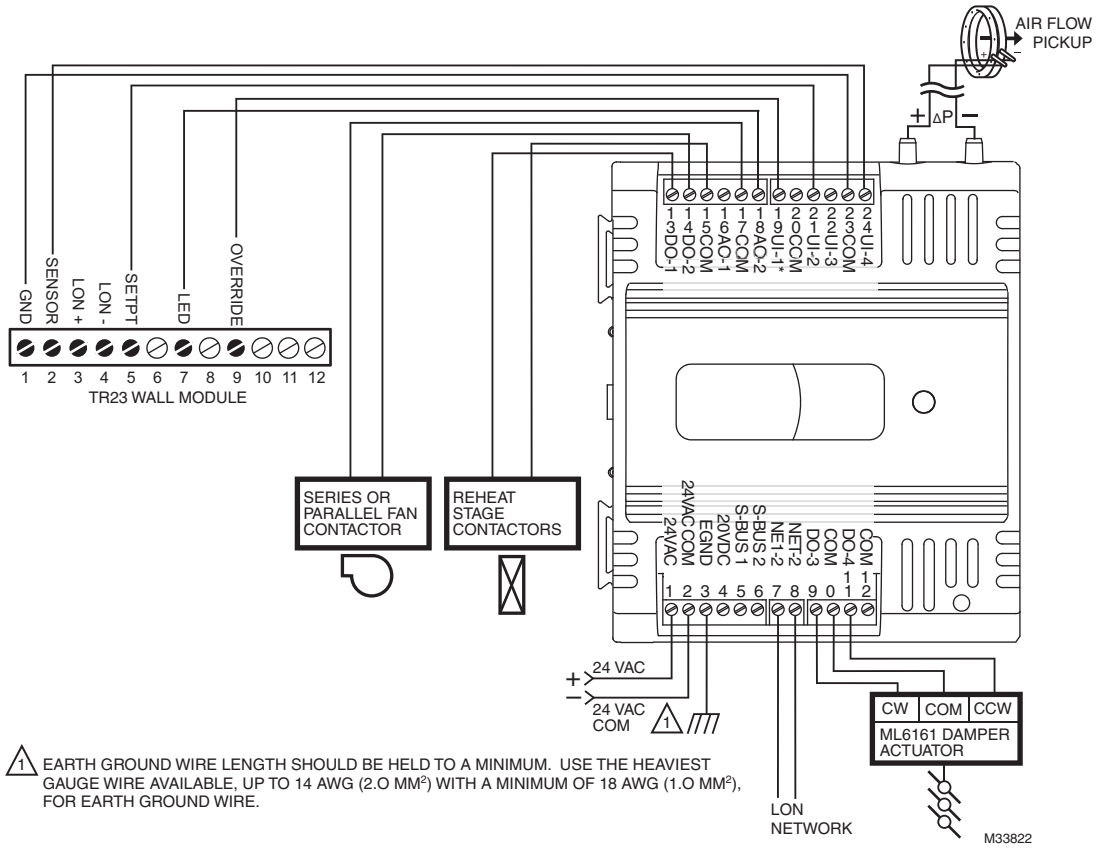

Fig. 18. Controller wiring diagram for typical VAV application, using the TR23 wall module.

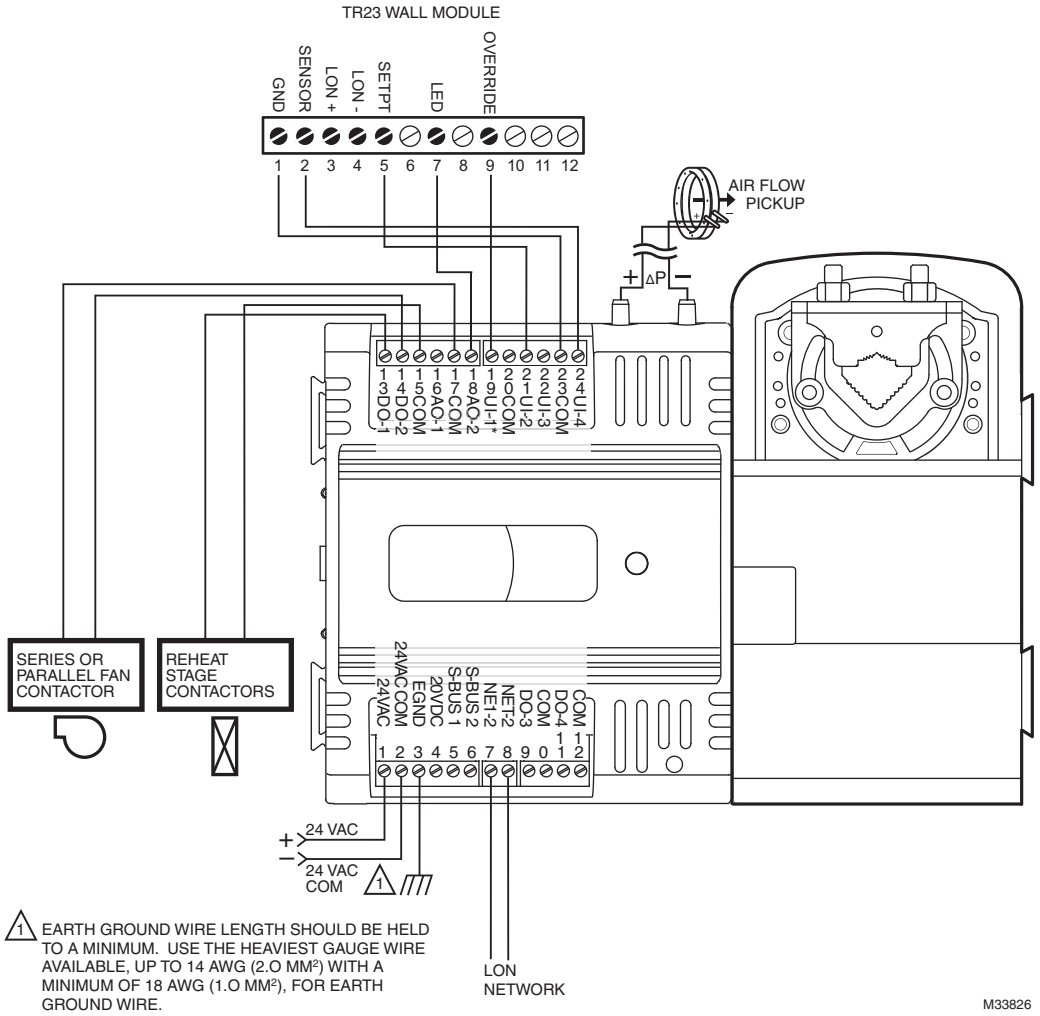

Fig. 19. Controller wiring diagram for typical VAV application with staged reheat.

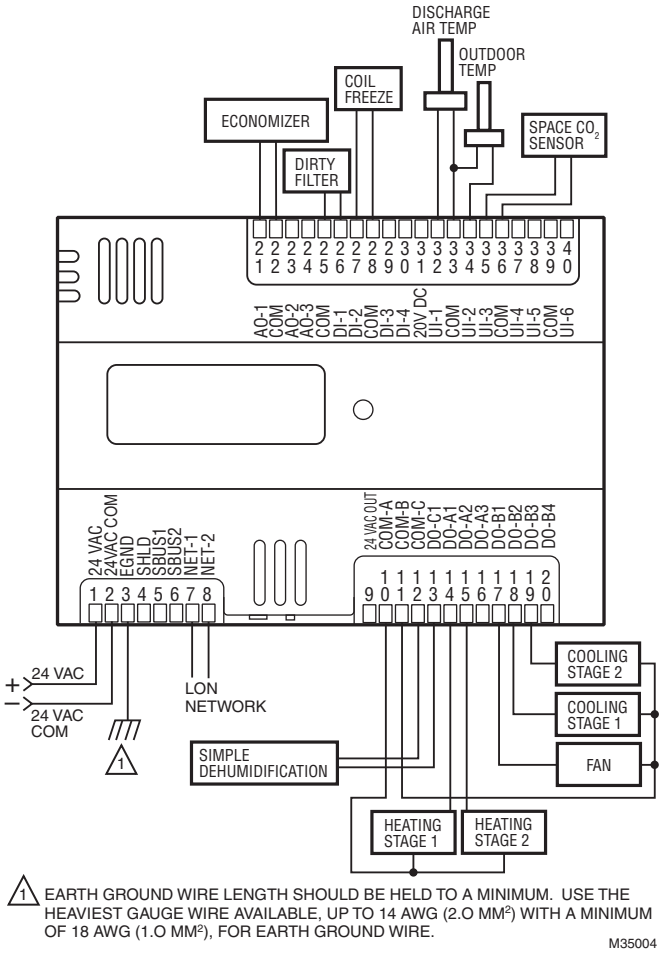

Fig. 20. Controller wiring diagram for a typical 2H/2C conventional system with a modulating economizer and dehumidification.

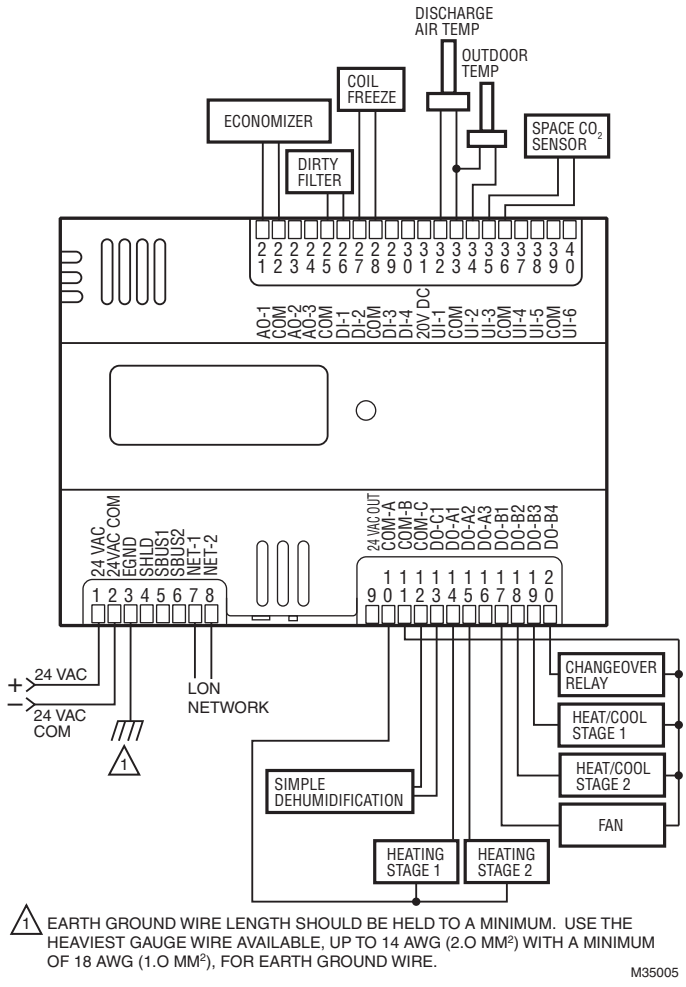

Fig. 21. Controller wiring diagram for a typical 2H/2C heat pump system with auxilliary heat, modulating economizer and dehumidification.

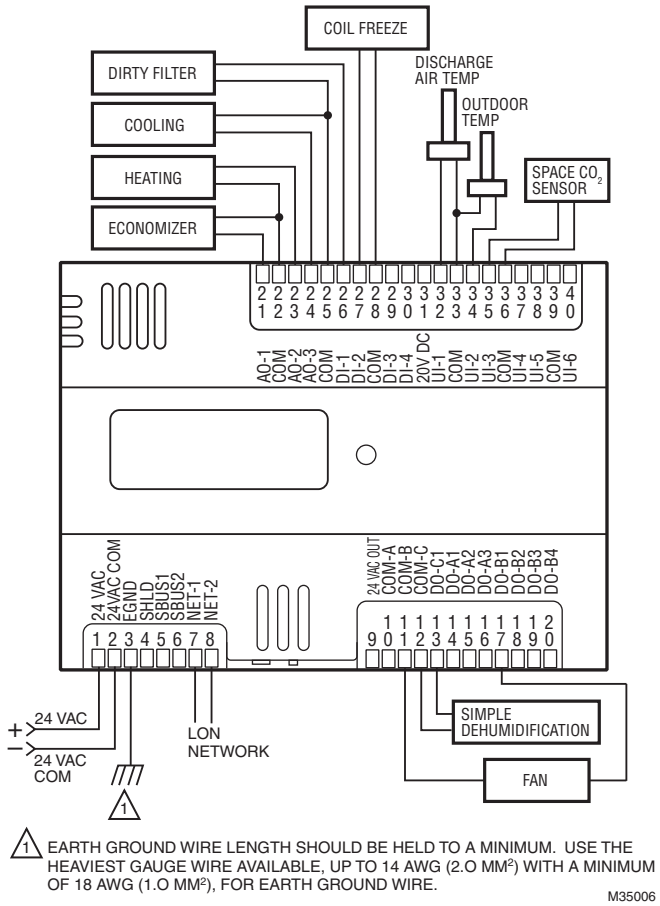

Fig. 22. Controller wiring diagram for a typical modulating heat/cool system with modulating economizer and dehumidification.

CHECKOUT

Step 1. Check Installation and Wiring

Inspect all wiring connections at the controller terminals, and verify compliance with installation wiring diagrams. If any wiring changes are required, first be sure to remove power from the controller before starting work. Pay particular attention to:

- 24 Vac power connections. Verify that multiple controllers being powered by the same transformer are wired with the transformer secondary connected to the same input terminal numbers on each controller. Use a meter to measure 24 Vac at the appropriate terminals (see Fig. 10 on page 8). Controller configurations are not necessarily limited to three devices, but the total power draw, including accessories, cannot exceed 100 VA when powered by the same transformer (U.S. only).
- Be sure that each controller has terminal 3 wired to a verified earth ground, using a wire run as short as possible with the heaviest gauge wire available, up to 14 AWG (2.0 sq mm) with a minimum of 18 AWG (1.0 sq mm) for each controller in the group (see Fig. 12 on page 9).
- Verify that Triac wiring of the digital outputs to external devices uses the proper load power and 24 Vac common terminal (digital output common terminals) for High-Side switching.

NOTE: All wiring must comply with applicable electrical codes and ordinances or as specified on installation wiring diagrams. For wiring run length and power budget guidelines, see "Power" on page 8".

VERIFY TERMINATION MODULE PLACEMENT (MULTIPLECONTROLLERS ONLY)

The installation wiring diagrams should indicate the locations for placement of the 209541B termination module(s). See Fig. 14 on page 11 and refer to the "LONWORKS® Bus Wiring Guidelines," form 74-2865. Correct placement of the termination module(s) is required for proper LONWORKS® Bus communications.

Step 2. Startup

Refer to Fig. 23 and the following text for startup information.

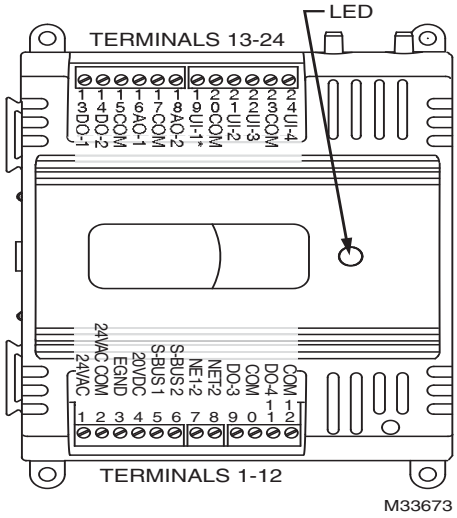

Fig. 23. LED location.

BROADCAST THE SERVICE MESSAGE

The Service Message allows a device on the LONWORKS® Bus to be positively identified. The Service Message contains the controller's Neuron® ID number and node type. This is used to confirm the physical location of a particular Stryket device in a building.

- To send the Service Message from the controller, press the NEURON® Service Pin pushbutton on the controller (see Fig. 23 and Fig. 16 and 17 on page 13). This button sends out the Service Message when it is pressed, regardless of the controller's current mode of operation

⚠ CAUTION

Equipment Damage Hazard.
Can cause controller damage or failure.
Do not use any metal object to press the NEURON® Service Pin. Use a plastic rod or wood device (such as a pencil with the lead broken off) to press the pin. Using a metal object can damage the circuitry of the controller.

CONTROLLER STATUS LED:

The LED on the front of the controller provides a visual indication of the status of the device. When the controller receives power, the LED appears in one of the following allowable states, as described in Table 9.

Table 9. Status LED States

LED State	Blink Rate	Status or Condition
OFF	not applicable	No power to processor, LED damaged, low voltage to board, or controller damaged.
ON	ON steady; not blinking	Processor and/or controller is not operating.
Very slow blink (continuous)	1 second ON, 1 second OFF	Controller is operating normally.
Slow blink (continuous)	0.5 second ON, 0.5 second OFF	Controller alarm is active, controller in process of download, or controller lost its configuration.
Medium blink (continuous)	0.25 second ON, 0.25 second OFF	Controller firmware is loading.
Fast blink (continuous)	0.10 second ON, 0.10 second OFF	Controller is in manual mode under control of the PC-based software tool.

Step 3. Checkout Completion

At this point the controller is installed and powered. To complete the checkout, the NIAGARA FRAMEWORK® application (run on a PC) is used to configure the I/O and functions of the controller. Refer to the Programming Tool User Guide, form no. 63-2662, for controller configuration and programming details.

⚠ WARNING

Fire, Explosion, or Electrical Shock Hazard. Can cause severe injury, death or property damage.
Do not attempt to modify the physical or electrical characteristics of this device in any way. Replace the controller if troubleshooting indicates a malfunction.

⚠ WARNING

Electrical Shock Hazard. Can cause severe injury, death or property damage.
Disconnect power supply before beginning controller replacement to prevent electrical shock or equipment damage.

Terminal Block Removal

To simplify controller replacement, all terminal blocks are designed to be removed with the wiring connections intact and then re-installed on the new controller. See Fig. 24 and refer to the following procedure.

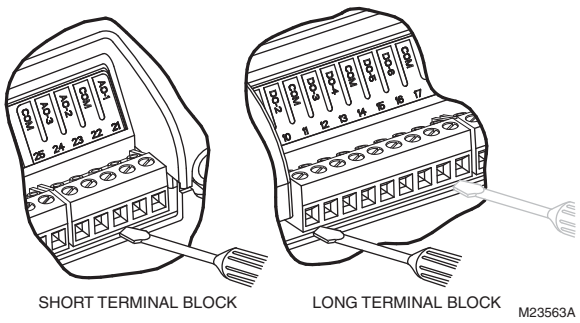

Fig. 24. Removing terminal blocks

IMPORTANT

To prevent bending or breaking the alignment pins on longer terminal blocks, insert the screwdriver at several points to evenly and gradually lift up the terminal block. Insert the screwdriver blade no more than 1/8 in. (3 mm) to prevent damage to the terminal block alignment pins on the controller circuit board.

1. Use a thin-bladed screwdriver to evenly raise the terminal block from its alignment pins:
   a. For short terminal blocks (1 to 5 terminals), insert screwdriver blade in the center of the terminal block and use a back and forth twisting motion to gently raise the terminal block from its alignment pins 1/4 in. (6.35 mm).
   b. For long terminal blocks (6 or more terminals), insert screwdriver blade on one side of the terminal block and gently rotate the blade 1/4 turn. Then, move to the other side of the terminal block and do the same. Repeat until the terminal block is evenly raised 1/4 in. (6.35 mm) from its alignment pins.
2. Once the terminal block is raised 1/4 in. (6.35 mm) from its alignment pins, grasp the terminal block at its center (for long terminal blocks grasp it at each end) and pull it straight up.

Controller Replacement

Perform the following to replace the controller:
1. Remove all power from the controller.
2. Remove the terminal blocks (See Fig. 24).
3. Remove the old controller from its mounting.

IMPORTANT

(FOR CONTROLLERS MOUNTED TO A DIN RAIL):
1. Push straight up from the bottom to release the top pins.
2. Rotate the top of the controller outwards to release the bottom flex connectors.
3. Mount the new controller (See ""“Mount Controller” on page 6).
4. Replace the terminal blocks:
   a. Insert each terminal block onto its alignment pins.
   b. Press straight down to firmly seat it.
   c. Repeat for each terminal block.
5. Restore power to the controller.
6. Perform "Checkout.”

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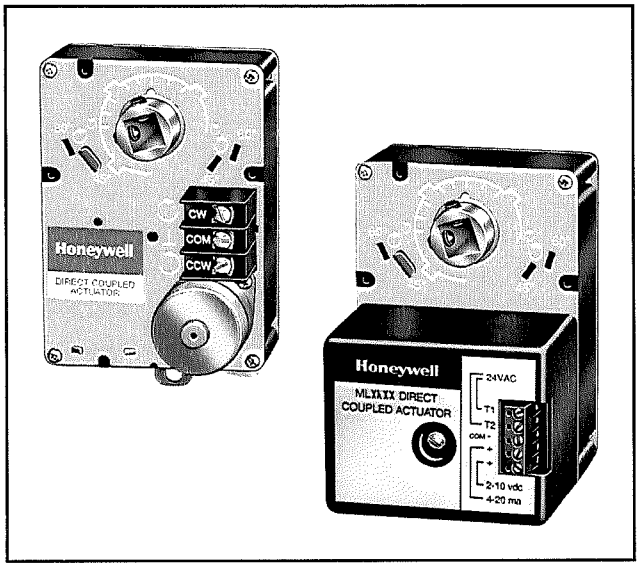
62-2029—02 KK Rev. 09-13
Printed in United States

Honeywell

35 and 70 lb-in. Non-Spring Return Direct Coupled Actuators

ML6161, ML7161, ML6174, ML7174

PRODUCT DATA



FEATURES

- **Selectable 45°, 60°, or 90° stroke in both clockwise (cw) or counterclockwise (ccw) directions.**
- **0° to 30° minimum position adjustment (cw or ccw direction) on all models.**
- **Magnetic coupling eliminates the need for mechanical stops.**
- **Two field-addable auxiliary switches.**
- **Auxiliary feedback potentiometer field-addable on select models.**
- **Manual declutch on all models.**
- **ML7161 and ML7174 models include standard reverse/direct acting rotation switch on outside cover.**
- **W7620 Terminal Unit Controller compatibility.**
- **Commercial zone damper in W7600 Commercial Zone System compatibility.**

APPLICATION

The 35 and 70 lb-in. (4 Nm and 8 Nm) Non-Spring Return Direct Coupled Actuators (DCA) are control actuators that provide floating or proportioning control for valves and dampers. The proportioning actuators accept a current or voltage signal from a controller to position the damper or valve at any chosen point between fully open and fully closed.

Floating actuators are suitable for use with single pole double throw (spdt) floating thermostats or two-position control systems.

Two-position control requires installation of the 201052B Auxiliary Switch.

Contents

63-2209—9

SPECIFICATIONS

Models: See Table 1.

Dimensions: See Figures 1, 1A, and 1B.

Electrical Ratings:
Power Input: 24 Vac ±20%, 50/60 Hz.
Impedance:
2-10 Vdc: 45k ohms.
4-20 mA: 536 ohms.
Power Consumption: See Table 2.
Auxiliary Switch Ratings:
Electrical: Selective NO or NC, not simultaneous.
Pilot Duty: 50 VA, 24 Vac.
Switch Differential: Three angular degree maximum.

Torque Ratings (at Rated Voltages): See Table 3.

Actuator Stroke:
Selectable: 45°, 60°, and 90°.
Rotation: Clockwise (cw) and counterclockwise (ccw).

NOTE: Reversing drive rotation of the ML7161 and ML7174 requires changing the control signal from 2-10 Vdc to 10-2 Vdc.

Device Weight: 1.3 lb (0.58 kg).

Actuator Timing for 90° Stroke: See Table 4.

Mounting: Mounts directly on 3/8 in. to 1/2 in. (10 to 13 mm) round or square shaft. Can be mounted with shaft in any position with two 1/4 in. (6 mm) 28 NF Allen screws. Minimum Shaft Length Required: 1-3/4 in. (45 mm).

Temperature Ratings:
Ambient: 20° F to 125° F (-18° C to 50° C).
Derated Timing to: -20° F (-29° C).
Shipping and Storage: -20° F to 130° F (-29° C to 54° C).
Humidity Ratings: 5% to 95% RH noncondensing.

Actuator Minimum Design Life: See Table 5.

Noise Output: 45 dBA at 1 meter maximum.

Feedback Potentiometer Ratings:
Electrical Rating (200976A,C Potentiometer): 24 Vac, 50/60 Hz, 2.25W.
Resistance Output (Resistance Linear as Measured Between Terminals R-B):
0 ohms (at 0°, cw stroke).
250 ohms (at 45°, cw stroke).
333 ohms (at 60°, cw stroke).
500 ohms (at 90°, cw stroke).

Environmental Protection Ratings:
NEMA1.
ML6161E, ML6174E, ML7161E, ML7174E *only*: IP54.

Approvals:
Underwriter's Laboratories Inc. Component Recognized: File No. E4436; Guide No. XAPX2.
UL94-5V: Meets plenum requirements.
Canadian Standards Association Certified (includes Auxiliary Switch).
ML6161E, ML6174E, ML7161E, ML7174E *only*: CE.

Accessories:
200976A Auxiliary Potentiometer (0 to 500 ohm).
200976C Auxiliary Potentiometer (0 to 2000 ohm).
201052A Auxiliary Switch (one).
201052B Auxiliary Switch (two).
201391 Shaft Adapter (included).
4074ENJ Bag Assembly—includes stop pin, shaft adapter, and two minimum-position screws.
4074ENY Bag Assembly—includes stop pin and shaft adapter.
4074EVK Short Shaft Extender.
7640QW Metal Enclosure—for attaching conduit to actuator.
T641 Floating Thermostat—for use with seven-minute models.
T6984 Floating Thermostat—for use with 90-second and seven-minute models.
T7984 Modulating Thermostat—for use with ML7161 or ML7174.

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the TRADELINE® Catalog or price sheets for complete ordering number.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Honeywell Automation and Control Products Sales Office (check white pages of your phone directory).
2. Honeywell Customer Care
   1885 Douglas Drive North
   Minneapolis, Minnesota 55422-4386

In Canada—Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Toronto, Ontario M1V 4Z9.
International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

Table 1. 35 lb-in. and 75 lb-in. DCA models.

ML	Motor Linkage					
	61	Floating Control				
	71	4-20 mA/2-10 Vdc Control				
		61	35 lb-in. (4 Nm), Non-Spring Return			
		74	70 lb-in. (8 Nm), Non-Spring Return			
			A	Includes output for feedback potentiometer.		
			B	Standard (includes minimum-position setscrews).		
			C	Includes output for feedback potentiometer and cover with conduit connections.		
			D	Includes cover with conduit connections.		
			E	Standard with European ratings.		
				1	Standard.	
				2	Includes declutch function.	
ML	**61**	**61**	**B**	**1**	**XXX**	**Varies by model**

Table 2. Power Consumption.

Model	Power Consumption
ML6161A,B,C,D	1.8 VA
ML7161A	4.8 VA
ML6174A,B	2.4 VA
ML7174A	5.4 VA

Table 3. Torque Ratings.

	35 lb-in. DCA lb-in. (Nm)	70 lb-in. DCA lb-in. (Nm)
Running	35 (4)	70 (8)
Breakaway		
Stall Minimum	45 (5)	
Stall Maximum	70 (8)	130 (14)

Table 4. Actuator 90° Stroke Timing.

	At 50 Hz	At 60 Hz
90 Second Models	108 sec	90 sec
Three-Minute Models	216 sec	180 sec
Seven-Minute Models	504 sec	420 sec

Table 5. Actuator Minimum Design Life.

	35 lb-in. (4 Nm) DCA	70 lb-in. (8 Nm) DCA
Cycles	50,000	40,000
Repositions	1,500,000	1,500,000

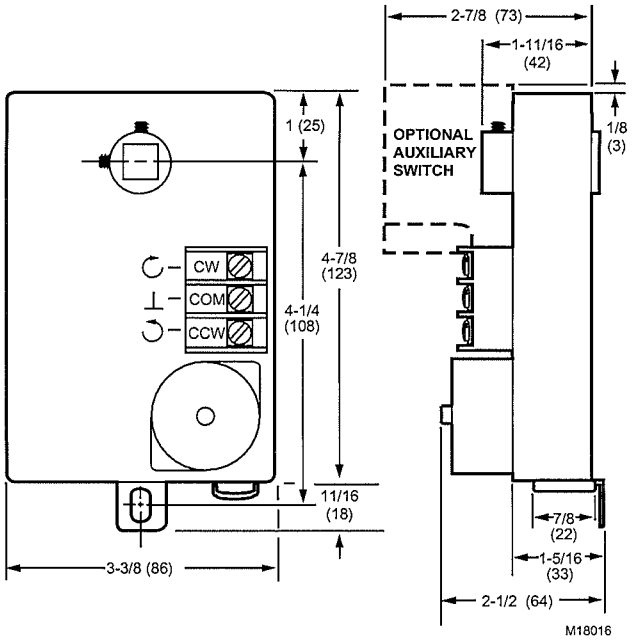


Fig. 1a. Approximate dimensions of ML6161A,B,E and ML6174A,B,E DCA in inches (mm).

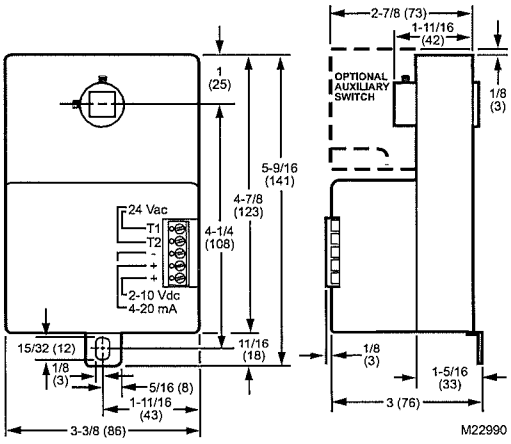


Fig. 1b. Approximate dimensions of ML7161, ML7174 DCA in inches (mm).

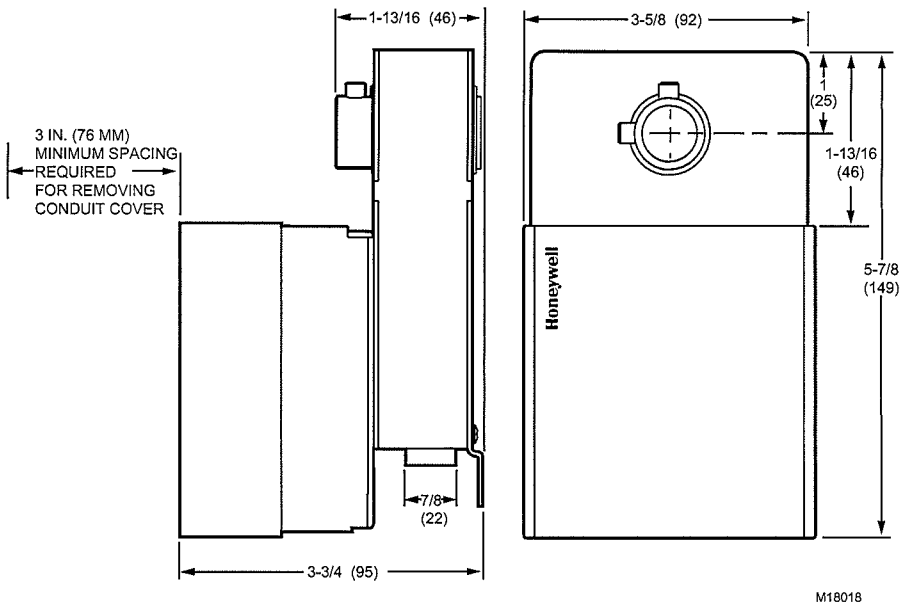


Fig. 1c. Approximate dimensions of ML6161C,D and ML6174C,D DCA in inches (mm).

INSTALLATION

When Installing this Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

IMPORTANT

All wiring must agree with applicable codes, ordinances and regulations.

⚠ WARNING

Explosion Hazard.
A spark from the actuator or attached accessories can result in serious injury or death.
Install the actuator in areas free of escaping gas and other explosive vapors.

⚠ CAUTION

Electrical Shock or Equipment Damage Hazard.
Can shock individuals or short equipment circuitry.
Disconnect all power supplies before installation. Actuators with auxiliary switches can have more than one disconnect.

⚠ CAUTION

Actuator Damage Hazard.
Deteriorating vapors and acid fumes can damage the actuator metal parts.
Install actuator in areas free of acid fumes and deteriorating vapors.

Location

Choose a location for the actuator that allows enough clearance for mounting accessories and for servicing.

Mounting

These actuators are designed to open a damper or valve by driving the shaft in either the clockwise (cw) or counterclockwise (ccw) direction. The actuator has a mounting tab on the bottom that secures it to a damper box or valve linkage. When mounted correctly, this tab allows the actuator to float without rotating relative to the shaft. The tab is sized for 1/4 in. (6 mm) screw or pin (not included).

⚠ CAUTION

Equipment Damage Hazard.
Tightly securing mounting tab to damper housing can damage actuator.
Once mounted, the actuator must be allowed to float; do not fully tighten the screw.

These actuators are shipped in the fully clockwise 90° position as viewed from the end of the damper shaft.

⚠ CAUTION

Equipment Damage Hazard.
Mounting actuator unevenly with damper housing can damage actuator.
Mount actuator flush with damper housing or add spacer between mounting tab and damper box housing (see Fig. 2).

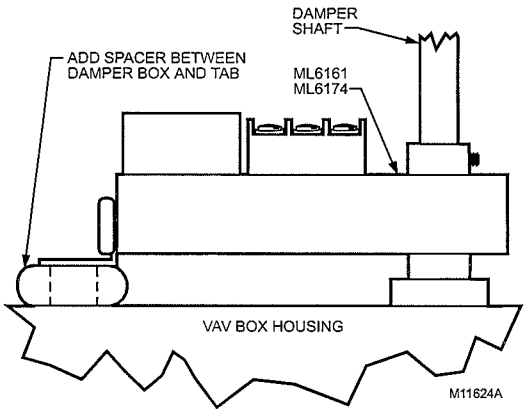


Fig. 2. Mounting actuator to VAV box when actuator is not flush with box.

Preparation

Before mounting the actuator onto the shaft, determine the following:

1. Size of the shaft [3/8 in. to 1/2 in. (10 mm to 13 mm)].
2. Direction the shaft rotates to open the device (cw or ccw). See Fig. 4.
3. Degrees of actuator stroke for opening device (45°, 60°, or 90°).

If the shaft is 3/8 in. (10 mm) round or square, use part number 201391 Shaft Adapter provided inside the bag assembly shipped with the actuator. Place the adapter opposite the setscrews (see Fig. 3).

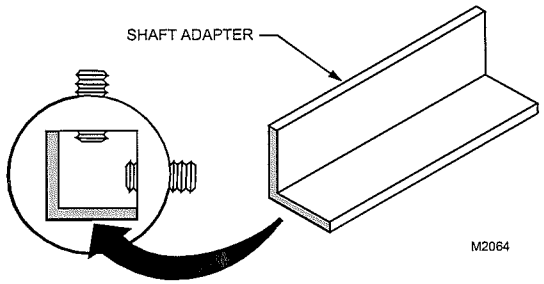


Fig. 3. Using shaft adapter for 3/8 in. (10 mm) shafts.

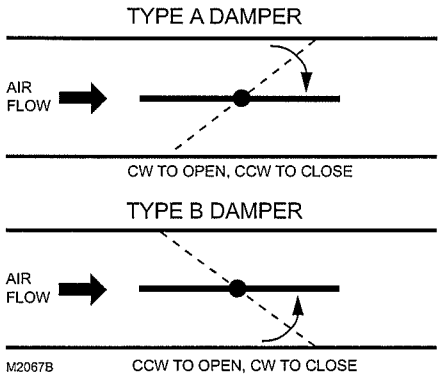


Fig. 4. Determining direction damper shaft rotates when opening.

Manual Operation (Declutch)

⚠ CAUTION

Product Damage Hazard.
Do not use manual declutch without supporting the load.
Support actuator load independently immediately before and during use of manual declutch lever.

Manual declutch capability is available on some actuators. Use the manual declutch lever to manually adjust the actuator setting. Fig. 5 shows the location of the manual declutch lever. To operate, push the lever in the direction of the arrow on the lever cover.

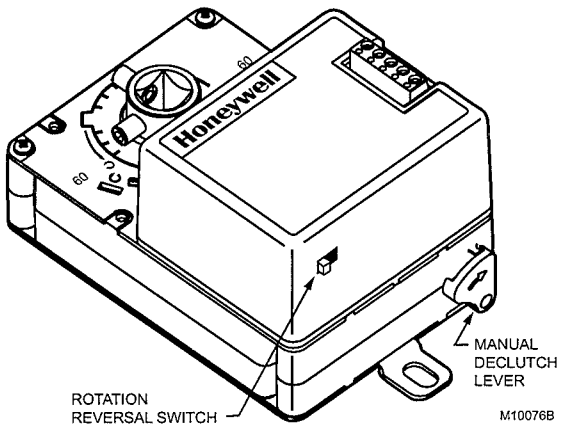


Fig. 5. Location of manual declutch lever.

Installation

After determining the direction of the shaft rotation (cw or ccw), install the device. For valve linkage mounting, refer to the instructions shipped with the linkage. For damper mounting, proceed as follows:

1. Place the actuator onto the damper shaft.

⚠ CAUTION

Equipment Damage Hazard.
Improper range stop selection can damage light-duty dampers.
Be sure to select the proper range stop.

2. If the angle of the damper opening is either 45° or 60°, close the actuator using the manual declutch:
   a. Disengage the hub using the declutch lever; see Manual Operation (Declutch) section.
   b. Rotate the hub until the actuator gear train passes the proper 45° or 60° setting. (Do not insert the pin until after the actuator passes this point.)
   c. Release the declutch lever.

   NOTE: Dampers with 90° stroke do not require the range stop pin.

3. Insert the range stop pin into the appropriate (cw or ccw) 45° or 60° slot. The range stop pin clips into its final position only after the pin passes through both actuator plates (see Fig. 7). The range stop pin should snap into position and not be removable manually (see Fig. 8).

IMPORTANT

Do not fully tighten the mounting screw; the actuator must be allowed to float.

4. With the actuator placed in its final position, fix the mounting tab in position with a 1/4 in. (6 mm) screw or pin. See Fig. 6.
5. Position the damper in the open position and securely tighten the Allen screws into the damper shaft.

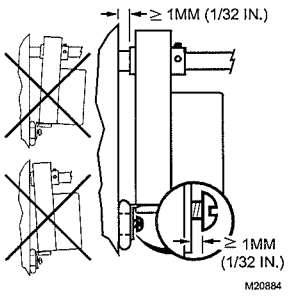
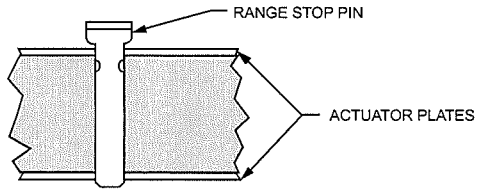


Fig. 6. Proper actuator mounting to prevent rotation.



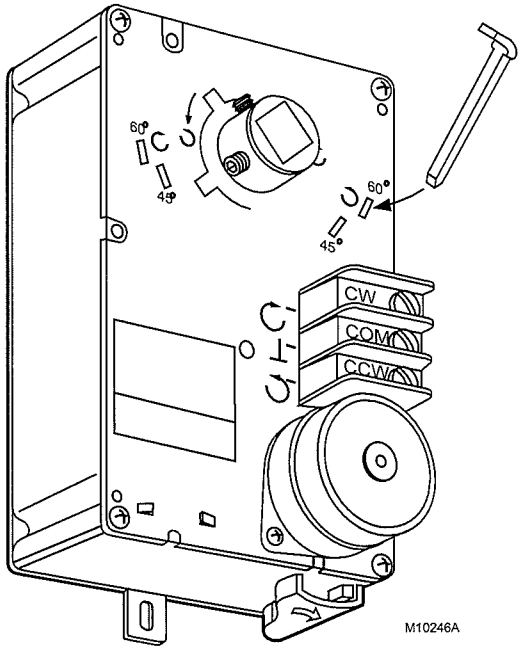


Fig. 7. Range stop pin properly inserted.

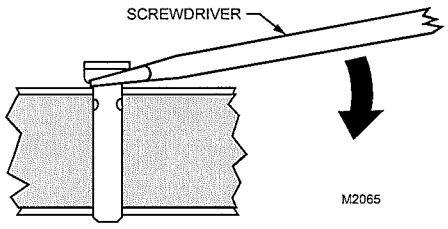


Fig. 8. Lifting range stop pin out of its slot.

Minimum Position Setscrew

Certain ML6161, ML6174 and all ML7161, ML7174 models are equipped with two tapped holes located in the plastic housing at the top of the actuator. These holes can be used with the minimum position setscrew and locknut inside the 4074ENJ Bag Assembly (see Fig. 9). The setscrew provides for a 0° to 30° minimum position adjustment.

NOTE: Before starting operation, note that the 1/4 in. (6 mm) minimum position setscrew limits closing motion, while the range stop pin limits opening motion.

1. Determine the direction of the desired closing rotation.
2. Move the actuator to the position fully opposite the desired closing rotation (if cw closing rotation is desired, move the actuator to the full ccw position).
3. Determine the correct hole for the setscrew using Fig. 9 and the results of step 1.

⚠ CAUTION

Equipment Damage Hazard.
Improper hub positioning or hole selection can permanently damage the device.
Avoid backdriving the actuator with the setscrew.

4. Remove the red cap from the desired hole. Leave the other cap in position. The caps ensure that dust and other impurities do not enter the gear train through unused holes.
5. Thread the locknut fully onto the 1/4 in. (6 mm) setscrew.
6. Insert the setscrew into the desired hole, turning clockwise until resistance is encountered or the locknut contacts the housing.
7. If resistance is met before the setscrew is fully inserted, stop and review the initial setup procedures as detailed in steps 1 through 3.
8. Determine the angle of minimum position required for the application. With the setscrew fully inserted, the minimum position is 30°. With the setscrew fully out, the minimum position is 0°.
9. Using the conversion of approximately 1.7 angular degrees per turn of the setscrew, back the screw out of the housing and stop slightly short of the calculated position. This allows the setscrew to be set accurately while taking air flow measurements.

IMPORTANT

After initiating step 10, the setscrew cannot be turned into the housing without returning the actuator to the fully open position (as determined in step 1). The actuator follows the setscrew without damaging the housing only when backed out of the housing (turned ccw).

10. Rotate the actuator to minimum position using the manual declutch; see Manual Operation (Declutch) section.
11. With the actuator at minimum position, adjust the position more accurately using air flow measurements.

NOTES:

1. After each adjustment, ensure the actuator is completely stopped before proceeding with the next adjustment.
2. To reduce the minimum position, turn out the setscrew (ccw). The actuator then drives toward the closed position.
3. Turning the setscrew in (cw) damages the actuator housing.
4. If the device is too far closed, return to step 1.

12. When proper air flow is achieved, loosen the locknut from the setscrew until it contacts the actuator housing, then turn it an additional 1/8 turn to lock the setscrew in place.

IMPORTANT

Run an entire check of the operation after completing this procedure.

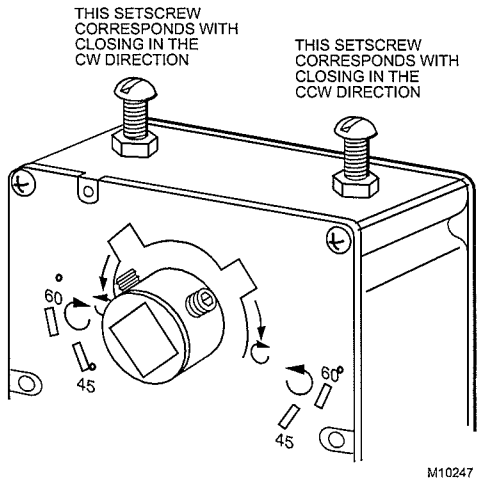


Fig. 9. Setscrew location for ML6161 and ML6174.

Wiring

⚠ CAUTION

Electrical Shock or Equipment Damage Hazard.
Can shock individuals or short equipment circuitry.
Disconnect all power supplies before installation. Actuators with auxiliary switches can have more than one disconnect.

All wiring must comply with local electrical codes, ordinances and regulations. Voltage and frequency of the transformer used with the actuator must correspond with the characteristics of both the power supply and the actuator. Screw terminals are provided for easy hookup. See Figures 11 through 14 for typical wiring hookups.

Connecting Wiring to Conduit Cover Actuators (Fig. 10)

1. Remove the cover from the actuator by lifting the top and pivoting the cover to the rear of the actuator.
2. Remove the conduit knockouts with a flat-bladed screwdriver. Discard the knockouts.
3. Install the conduit connector.
4. Run the connecting wire through the conduit connector, strip the wire ends (if necessary) and connect to the CW, COM and CCW terminals using Figures 11 through 14, Figures 16 through 20, or the control manufacturer instructions.
5. Apply power to the actuator.
6. After operational checkout, replace the cover by reversing the procedure outlined in step 1.

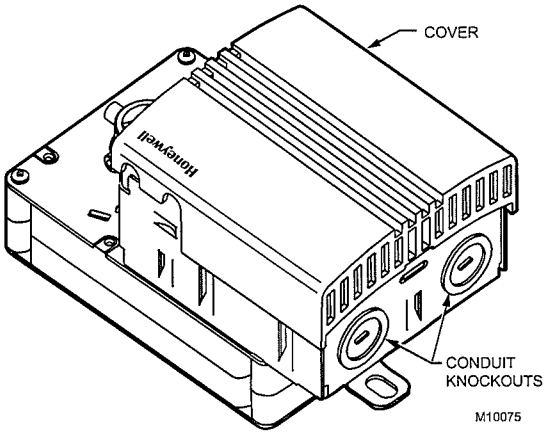


Fig. 10. Conduit cover for ML6161C,D and ML6174C,D DCA.

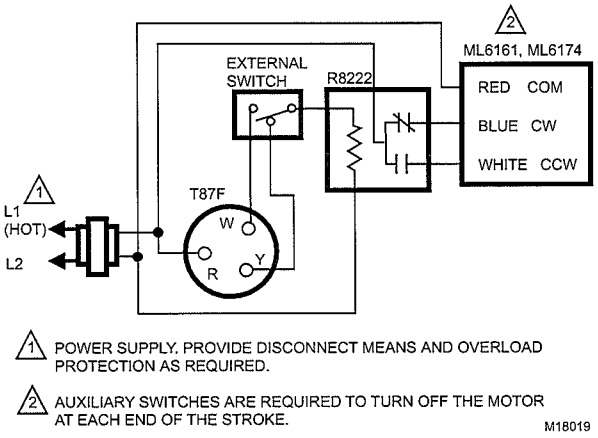


Fig. 11. ML6161 or ML6174 used with T87F in heating-only or cooling-only application.

NOTE: See Fig. 12 for the 201052B Auxiliary Switch wiring.

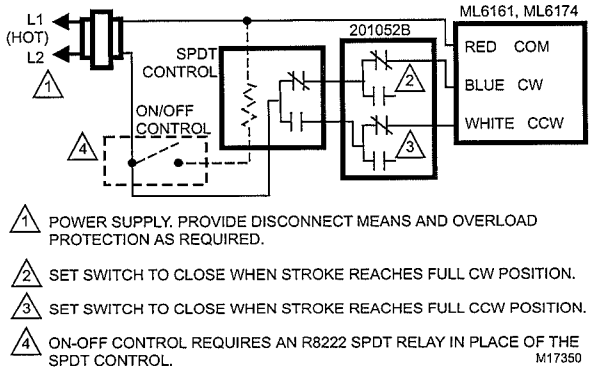


Fig. 12. 201052B Auxiliary Switch wiring.

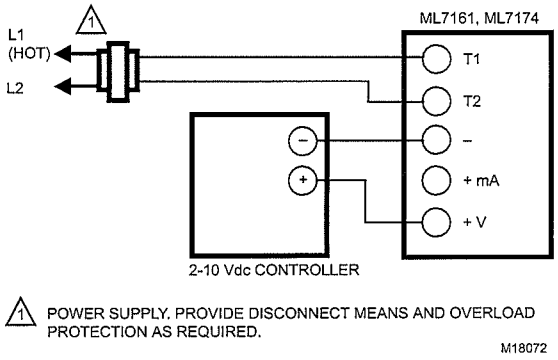


Fig. 13. ML7161 or ML7174 used with 2-10 Vdc control.

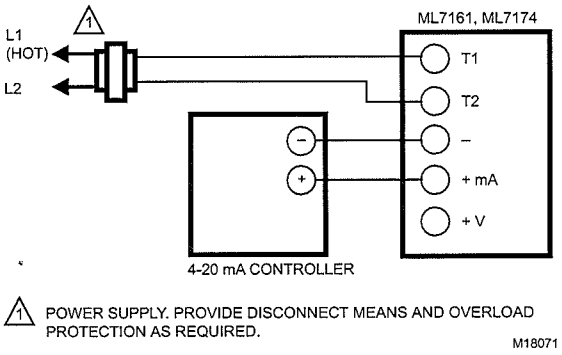


Fig. 14. ML7161 or ML7174 used with 4-20 mA control.

Auxiliary Switches

The 201052A or B Auxiliary Switch is used in conjunction with the actuator. It allows for control of equipment external to the actuator (for example, electric reheat coils and fan) at an adjustable point in the stroke (0° to 90°) of the actuator.

The 201052A and B Auxiliary Switches are field-addable. For mounting instructions, see form 63-2218, provided with the device.

IMPORTANT

When operating an ML6161 or ML6174 from a two-position controller, a 201052B Auxiliary Switch is required for proper operation. See Fig. 12.

Auxiliary Potentiometers

The 200976A,C Auxiliary Potentiometers mount on the face of the ML6161A,C or ML6174A,C (as shown in Fig. 15). The potentiometer shaft has a slipping collar. If one of the two limits of the potentiometer is exceeded, the collar continues to rotate, causing no damage to the potentiometer itself. To mount the potentiometer on the actuator:

1. Turn the potentiometer to align the shaft key with the slot in the potentiometer drive.
2. Tilt the potentiometer slightly so the key faces down toward the slot.
3. Insert the potentiometer into the slot, and push down so the potentiometer is flush with the actuator body and the bracket is aligned over the screw hole.

4. Insert the screw provided into the hole and fasten securely.

IMPORTANT

Failure to follow the calibration procedures can result in improper resistance values at desired stroke.

AUXILIARY POTENTIOMETER

MOTOR POSITION	RW RESISTANCE	RB RESISTANCE
FULLY CW 24V (COM-CW)	0 OHMS	500 OR 2000 OHMS
FULLY CCW 24V (COM-CCW)	500 OR 2000 OHMS	0 OHMS

MOTOR ROTATION	AUXILIARY POTENTIOMETER LEADS	
	RW OHMS	RB OHMS
CCW	INCREASE	DECREASE
CW	DECREASE	INCREASE

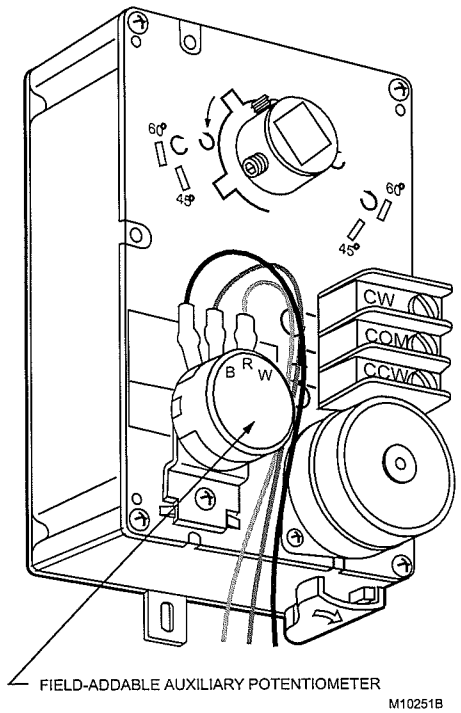


Fig. 15. ML6161A,C, ML6174A,C with field-addable potentiometer.

To Calibrate the 200976A,C:

IMPORTANT

Remove the range stop pins and minimum position setscrews prior to calibration.

1. Drive the actuator fully closed (0°) to fully open (90°) and back again to the fully closed position. This must be done to receive the correct resistance readings at the appropriate degree of stroke.
2. Check the resistance values of the potentiometer with an ohmmeter at intervals in the stroke while referring to the table in Fig. 15 and resistance information provided in the Specifications section.
3. Replace the range stop pins and/or the minimum position setscrews using the appropriate procedures.

OPERATION

VAV Systems

VAV systems control the temperature within a space by varying the volume of supply air temperature. The system delivers air to the space at a fixed temperature. The space thermostat controls the volume of supply air by modulating the supply air damper. When full heating and cooling flexibility is required in a zone, it is handled by the air temperature system, or with reheat capability in the air terminal units. As individual zones shut down, a central duct static pressure controller regulates the total air flow in the system. The fan system is sized to handle an average peak load, not the sum of the individual peaks. As each zone peaks at a different time of day, extra air is borrowed from the off-peak zones. This transfer of air from low-load to high-load zones occurs only in true VAV systems.

In pressure independent systems, individual zone airflow sensors maintain the zone air flow rate independent of fluctuation in the total system pressure. Pressure independent systems, when used with controllers such as the W7620, can react faster to changes in air flow demand; therefore, these systems can use the faster 90-second models.

Pressure dependent systems do not incorporate an individual zone air flow sensor and depend on a stable system pressure to maintain flow. These systems require slower actuators such as the seven-minute models that are typically controlled by spdt floating wall thermostats.

The T641 is a mercury bulb floating-control type thermostat designed for use with the seven-minute model on pressure-dependent systems (see Figures 16 and 17).

The T6984 is an electronic floating-control thermostat designed for use with the 90-second and seven-minute models (see Fig. 18).

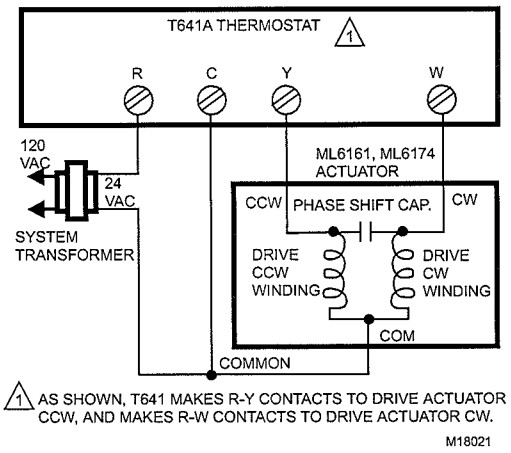


Fig. 16. T641A controlling ML6161 or M6174 Actuator.

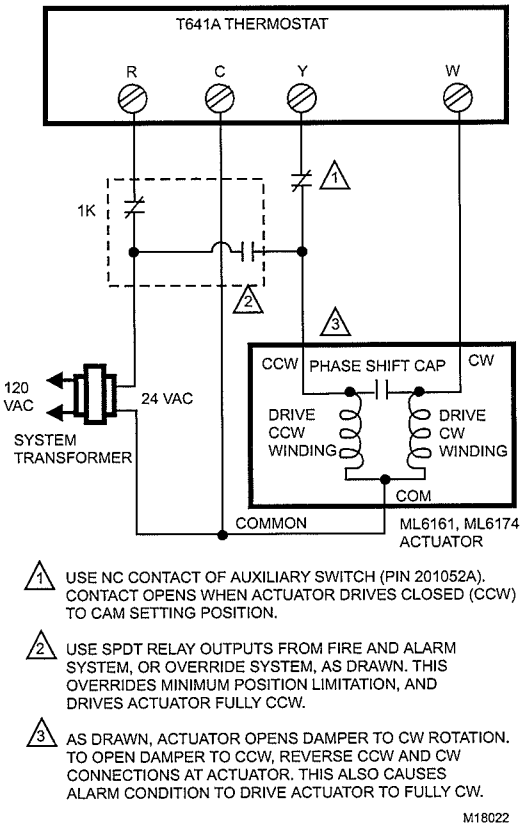


Fig. 17. Minimum position set with auxiliary switch contacts, override provided by fire and alarm contacts.

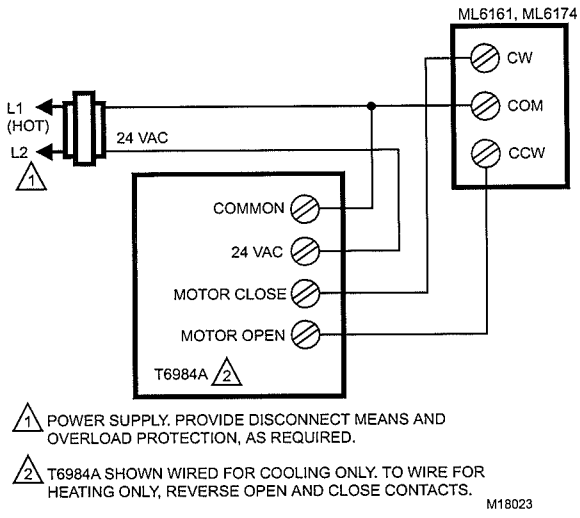


Fig. 18. T6984A controlling ML6161 or ML6174 Actuator for cooling or heating application.

Rotation Reversal Switch (ML7161, ML7174)

Use the rotation reversal slide switch to reverse the actuator rotation. The switch is located on the bottom of the actuator housing (see Fig.5). To change rotation to counterclockwise (ccw) ↶, change the slide switch. In direct, 2 volts is fully ccw and 10 volts is fully clockwise (cw); in reverse, 2 volts is fully cw and 10 volts is fully ccw.

IMPORTANT

When reversing the rotation, make sure the switch is fully to one side or the other. If the switch is left in the middle, the actuator will not operate properly.

Parallel Actuators

IMPORTANT

Over time, parallel-driving actuators can become out of sync with each other. Normally, driving all actuators to the fully-open or fully-closed position puts them back in sync.

ML6161, ML6174 Actuators

Using Fig. 19, parallel the CW, COM and CCW terminals. Make certain the total connected load does not exceed the current capacity of the controller or thermostat.

ML7161, ML7174 Actuators

VOLTAGE INPUT (2 TO 10 VDC)

Wire the (+Vdc) and (-) terminals of each actuator in parallel. Make certain the total connected load does not exceed the current capacity of the input signal source.

CURRENT INPUT (4 TO 20 MA)

When using a current controller (such as the W7600), wire the ML7161, ML7174 voltage input terminals (+Vdc) and (-) in parallel. Use a bridging resistor in parallel with the 4 to 20 mA signal. See Fig. 20 for resistor values.

NOTE: The actuator has 45,000 ohm impedance.

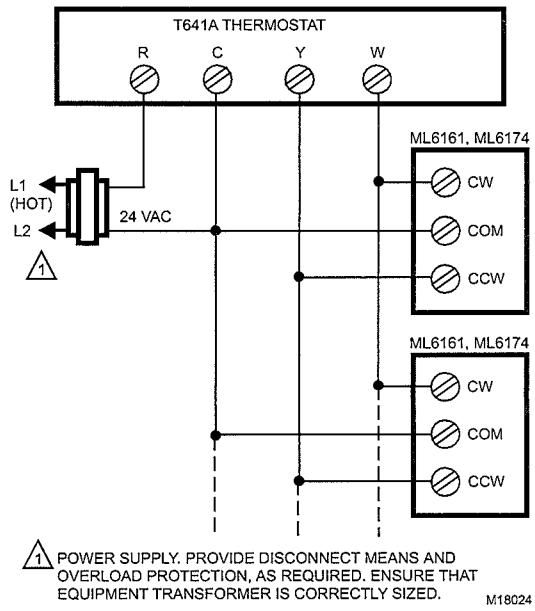


Fig. 19. Spdt control of parallel ML6161 or ML6174 Actuators.

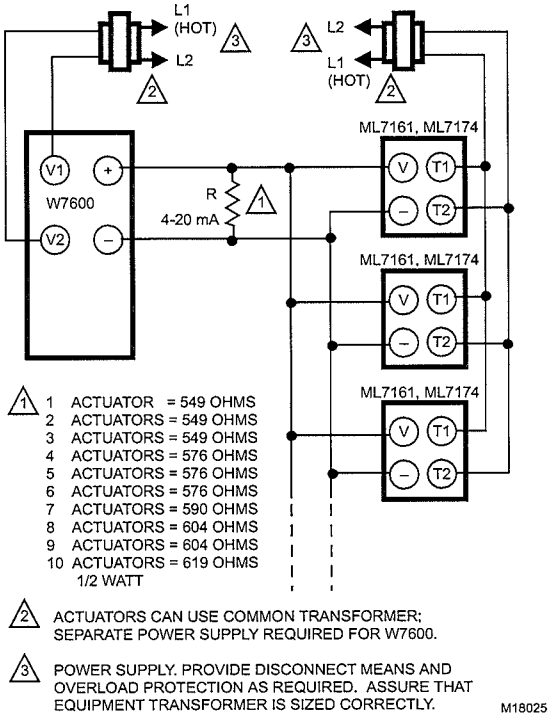


Fig. 20. 4-20 mA signal control of parallel ML7161 or ML7174 Actuators.

CHECKOUT

ML6161, ML6174

To check out ML6161, ML6174 Actuators controlled by electronic control systems, such as the W7620, override the control system by programming the controller to open or close the zone damper, as appropriate.

NOTE: Using a seven-minute actuator results in a longer response time before noticeable damper movement.

To check out the ML6161 or ML6174:

1. Determine the direction the shaft moves to open the device (cw or ccw). See Fig. 3.
2. Place 24 volts across the appropriate common cw or common ccw terminals to energize the actuator. The actuator should begin to open the device.
3. If the actuator does not run, try switching the 24 volts across the opposite common cw or ccw terminals to determine if the device begins to close.
4. If the actuator does not run in either direction, replace the actuator.

For ML6161 or ML6174 issued with a spdt floating wall thermostat (for pressure dependent systems), use the following checkout procedure:

1. Adjust the setpoint of the thermostat to call for cooling.
2. Observe the operation of the actuator; if the device is closed, it should begin to open.
3. If not, adjust the setpoint of the thermostat higher to determine if the wiring is correct.
4. If no movement is observed, check for the presence of 24 volts.
5. If using the T641 Thermostat, check that 24 volts are present between terminals C and Y during a call for cooling. With proper wiring and 24 volts present, the actuator should operate correctly.
6. If not, replace the actuator.

ML7161, ML7174

Check input impedance on the actuator with an ohmmeter.

IMPORTANT

Be sure to disconnect all wiring to the actuator before connecting the ohmmeter.

1. Verify resistance readings are as follows:
   - 45K ohms ±5K ohms, across the (+Vdc) and (-) terminals.
   - 536 ohms ±10 ohms, across the (+mA) and (-) terminals.
2. If the resistance readings are correct, reconnect the actuator and check for 24 Vac at terminals T and T2. With the correct power present at T and T2, check the motion of the shaft/actuator by ramping the setpoint up and down. This causes the actuator to move from one limit to the other and back (from fully ccw to fully cw and back to fully ccw).

   NOTE: Remember that the actuator takes 90 seconds to move from one limit to the other.

3. When the actuator is used with electronic control systems such as the W7600 Commercial Zone System, override the control system by programming the controller to open or close the damper, as appropriate.
4. If the actuator continues to operate incorrectly, check Table 6 for the proper input signal/actuator drive relationship at the (+Vdc) and (-) terminals.
5. If the actuator does not operate according to Table 6 values, replace the actuator.

Table 6. Input Signal/Actuator Drive Relationship.

Input Signal	Actuator Drive Relationship
1.50 ±0.2 Vdc	Actuator drives to extreme ccw position.
2.00 ±0.2 Vdc	Actuator remains at ccw position.
3.00 ±0.2 Vdc	Actuator leaves ccw position.
10.70 ±0.7 Vdc	Actuator drives to extreme cw position.
10.00 ±0.7 Vdc	Actuator remains at cw position.
8.50 ±0.6 Vdc	Actuator leaves cw position.

Automation and Control Solutions

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63-2209—9 J.I. Rev. 12-06

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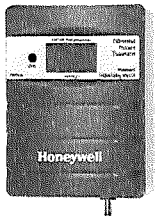
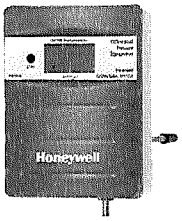
P7640A,B,U

DIFFERENTIAL PRESSURE SENSORS

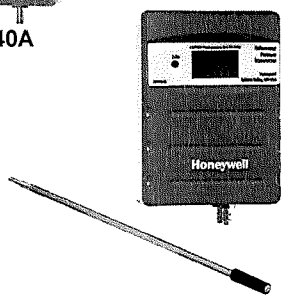
SPECIFICATION DATA



P7640A



P7640B



P7640U

GENERAL

The P7640A Panel Mount, P7640B Duct Mount, and P7640U Universal Differential Pressure Sensors provide reliable, accurate measurement and control. Proper applications include measurement of extremely low pressure applications such as: building/room pressure, air flow, variable air volume, filter status, and duct pressure. They are ideal for clean rooms, hospitals, fume hoods, and computer rooms.

FEATURES

- **Temperature-compensated transmitter with advanced ceramic capacitive sensing element designed for very low pressure differentials provides a stable, reliable, maintenance-free operation.**
- **The P7640 Pressure Sensors are designed with field-selectable 4-20 mA, 0-5 Vdc, or 0-10 Vdc output.**
- **All models offer jumper selectable inches w.c. or pascal scale.**
- **All models offer uni- or bi-directional output.**
- **All models offer jumper selectable fast or standard response time.**
- **The P7640A,B offer four configurable pressure ranges, selectable between *0-1" w.c/0-250 Pa or 0-10" w.c/0-2500 Pa* with an easy to set rotary switch. No jumpers, no guessing.**
- **The P7640U offers configurable pressure ranges between 0-10 in. w.c/0-2500 Pa with an easy to set rotary switch.**
- **Duct model comes with factory installed duct probe. The Universal model comes with attachable duct probe and can be used in either panel or duct mounting application.**
- **All models offer both pushbutton and digital input to zero the output. A microprocessor algorithm prevents accidental zero adjustment during normal operation.**

SPECIFICATIONS

Models:
Refer to Table 1.

Dimensions:
Refer to Fig. 1.

Fittings:
Brass barb; 0.24 in. (6.1 mm) O.D.

Electrical Ratings:
Supply Voltage: 12-30 Vdc or 24 Vac (±15%) nominal.
Maximum Supply Current (Vac): 60 mA.
Maximum Supply Current (Vdc): 25 mA.
Maximum Output Current: 25 mA.

Operating Environment:
32° to 140° F (0° to 60° C).
0 to 90% RH.
Dry air or inert gas only.

63-1306-04

Zero Adjust:
Pushbutton auto-zero and digital input on terminal block.

Mode:
Unidirectional (default) or bidirectional, jumper selectable.

Proof Pressure:
3 psid.

Burst Pressure:
5 psid.

Accuracy:
+/- 1% full scale (combined linearity and hysteresis).

Temperature Effect:
1 in. models: 0.05% per ° C.
10 in. models: 0.01% per ° C (relative to 25° C) 0-50° C.

Zero Drift (1 year):
1 in. models: 2.0% max.
10 in. models: 0.5% max.

Accessories:
32003169-001 4 in. Duct Pressure Pick-up Probe.

IMPORTANT:
The selectable pascal scale and selectable response time features do not apply to models with date code prior to 0816.

Table 1. P7640 Models.

Model	Mounting	Pressure Ranges (in. w.c.)	Pressure Ranges (pascal)	Display
P7640A1000	panel	0-.1, 0-.25, 0-.5, 0-1	0-25, 0-50, 0-100, 0-250	yes
P7640A1018	panel	0-.1, 0-.25, 0-.5, 0-1	0-25, 0-50, 0-100, 0-250	no
P7640A1026	panel	0-1, 0-2.5, 0-5, 0-10	0-250, 0-500, 0-1000, 0-2500	yes
P7640A1034	panel	0-1, 0-2.5, 0-5, 0-10	0-250, 0-500, 0-1000, 0-2500	no
P7640B1008	duct	0-.1, 0-.25, 0-.5, 0-1	0-25, 0-50, 0-100, 0-250	yes
P7640B1016	duct	0-.1, 0-.25, 0-.5, 0-1	0-25, 0-50, 0-100, 0-250	no
P7640B1024	duct	0-1, 0-2.5, 0-5, 0-10	0-250, 0-500, 0-1000, 0-2500	yes
P7640B1032	duct	0-1, 0-2.5, 0-5, 0-10	0-250, 0-500, 0-1000, 0-2500	no
P7640U1040	Universal	0-.1, 0-.25, 0-.5, 0-1, 0-2.5, 0-5, 0-10	0-25, 0-50, 0-100, 0-250, 0-500, 0-1000, 0-2500	no
P7640U1052	Universal	0-.1, 0-.25, 0-.5, 0-1, 0-2.5, 0-5, 0-10	0-25, 0-50, 0-100, 0-250, 0-500, 0-1000, 0-2500	yes

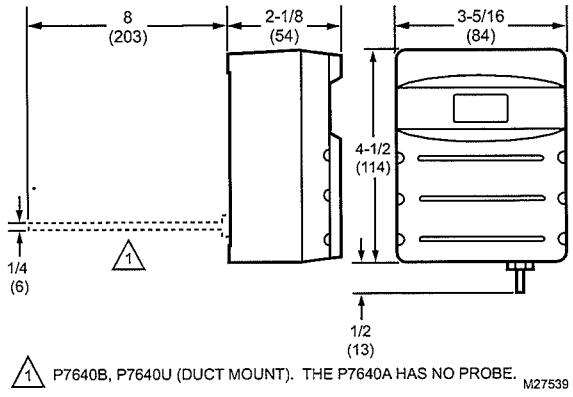


Fig. 1. P7640A,B,U dimensions in in. (mm).

TYPICAL SPECIFICATION

1. Sensor shall have four switch selectable ranges: 0.1, 0.25, 0.5, 1.0 in. w.c. for 1 in. models, and 1.0, 2.5, 5, 10 in. w.c. for 10 in. models.
2. Sensor shall have provision for zeroing by pushbutton or digital input.
3. Sensor shall have field selectable outputs of 0-5 Vdc, 0-10 Vdc, and 4-20 mA.
4. Sensor shall have jumper to select unidirectional or l-directional mode.
5. Sensor shall have brass-barb fittings.
6. Sensor shall operate from 12-30 Vdc or 24 Vac. AC power applies to operation in voltage mode only.
7. Sensor housing dimensions shall be 4-1/2 in. x 4-1/2 in. x 2 in.
8. Sensor shall have LCD display.
9. Sensor accuracy shall be ±1% FS selected range.
10. Sensor overpressure rating shall be 3 PSID proof, and 5 PSID burst.

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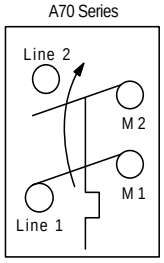
63-1306—04 M.S. Rev. 07-08

JOHNSON CONTROLS

Controls Group 507 E. Michigan Street
P.O. Box 423, Milwaukee, WI 53202
Code No. LIT-1927140

A70 Series

Four-Wire, Two-Circuit Temperature Control



Action on Increase on Temperature

A70GA-1

Features

- long-life, snap-acting contacts
- automatic or manual reset models

Applications

Typical applications include energizing an indicator light after a low temperature cutout on a ventilating system.

Replacement Covers

Code Number	Description
CVR17A-620R	Automatic reset
CVR17A-621R	Manual reset

Description

The A70 Series temperature control incorporates a vapor-charged sensing element. The A70G, A70H, and A70K have a 4-wire, 2-circuit contact block that contains two isolated sets of contacts.

The contacts are designed so that when the main contact opens, the auxiliary contact closes.

To Order

Specify the code number from the following selection chart.

Selection Chart

Code Number	Switch Action		Range °F (°C)	Diff F° (C°)	Bulb and Capillary	Max Bulb Temp °F (°C)	Range Adjuster
	Main Contacts	Auxiliary Contacts					
A70GA-1C[a]	Open Low	Close Low	15 to 55 (-10 to 15)	5 (2.8)	20 ft of 1/8 in. O.D. Tubing	400 (260)	Screwdriver slot
A70GA-2C			35 to 80 (0 to 25)	3 to 30, set at 12	3/8 in. x 3 in. 6 ft Cap.	250 (121)	Screwdriver slot
A70HA-1C[a]			15 to 55 (-10 to 15)	Manual reset	20 ft. of 1/8 in. O.D. Tubing	400 (260)	Screwdriver slot
A70HA-2C			35 to 80 (0 to 25)	Manual reset	3/8 in. x 3 in. 6 ft cap.	250 (121)	Screwdriver slot
A70KA-1C	Open High	Close High	100 to 170 (38 to 77)	Manual reset	3/8 in. x 10 in. 6 ft cap.	240 (116)	Screwdriver slot

(a) The low cutout stop is set and sealed at 35°F (1.6°C). The control responds only to the lowest temperature along any one ft. of the entire 20 ft. element or bellows cup.

Electrical Ratings

Pole Number	LINE-M2 (Main)				LINE-M1 (Auxiliary)			
Motor Ratings VAC	**120**	**208**	**240**	**277**	**120**	**208**	**240**	**277**
AC Full Load Amp	16.0	9.2	8.0	–	6.0	3.3	3.0	–
AC Locked Rotor Amp	96.0	55.2	48.0	–	36.0	19.8	18.0	–
AC Non-Inductive Amp	16.0	9.2	8.0	7.2	6.0	6.0	6.0	6.0
Pilot Duty – Both Poles	125 VA, 24 to 600 VAC							
	57.5 VA, 120 to 300 VDC							

WAGNER MANUFACTURING
A Division of DiversiTech

WET SWITCH

FLOOD DETECTOR

Model No. WS-1 U.S. Pat. # 4787212

The Wet Switch is a solid state device designed to detect the presence of condensate water overflow. Upon sensing moisture, the Wet Switch will turn the system off to help prevent damage to carpets, walls, woodwork, ceilings and other property. The covered area can be expanded by connecting one or more Wet Switches in series.

The Wet Switch also provides isolated relay contacts. This adds flexibility in installations with electronic control boards where breaking one lead from the transformer is not possible.

Installation

- Turn off power to the system.
- Place the wet switch with the padded side down on the surface to be monitored.
- Route the cable from the wet switch to cooling control voltage transformer as shown in the wiring diagram. Wire can be extended if necessary.
- Cut common wire of transformer.
- Connect black wire from wet switch to same wire on transformer where common was cut.
- Connect green wire from wet switch to common wire that was cut from transformer in step 4.
- Connect red wire from wet switch to 24VAC of transformer.
- Connect orange wire to the common wire that was cut going to the system.
- Do not connect to the white wire.
- Restore power to the system.

NOTE: Red light (LED) on wet switch will light if control is tripped by the presence of water, and remain lit even after water has dried up.

TO RESET

- Turn power off to system.
- Solve water leak problem.
- Wipe up any standing water around the wet switch.
- Dry the sensor pad on the wet switch thoroughly with a paper towel, uses of a blow drier (on low) can speed up drying.
- When wet switch is dry turn power on to system, the LED will be off and the system will run, if red light comes back on then pad is not dry.

CONTROLLING SELECTED COMPONENTS

To stop selected components of a system such as compressors, electric valves, condenser pumps, chill water pumps or other 24VAC controls, wire the wet switch to break the common to just that control.

Specifications:

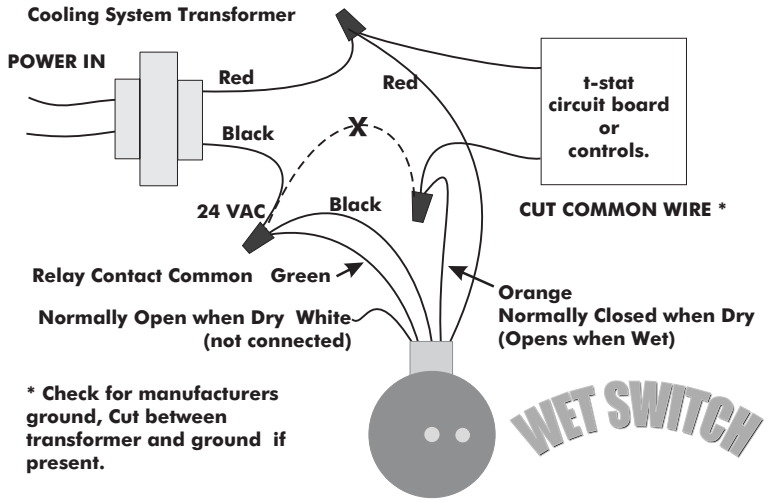
Indicators:
- Green LED - Power
- Red LED - Moisture Detected

Power Requirements:
- 24 VAC 50/60 HZ
- 1.5 Watts Max (wet) < 0.5 Watts (dry)

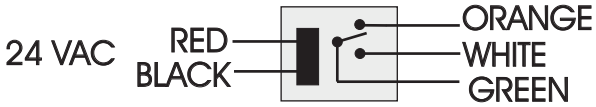
Relay:
- Isolated Contacts
- 2 Amps - Normally Closed Contact
- 2 Amps - Normally Open Contact

Latching Operation Reset:
- Remove power
- Dry sensor plates
- Re-apply power

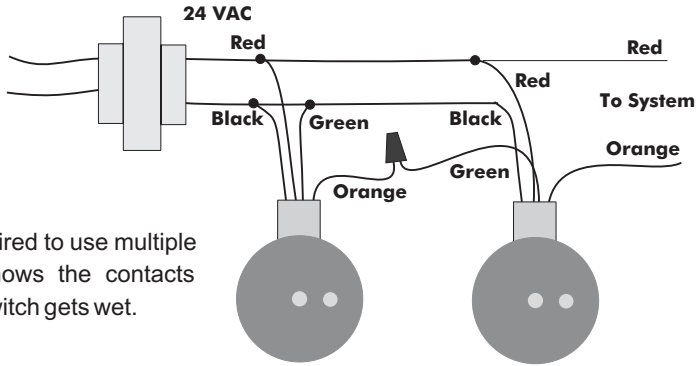
Typical Connection



Wet Switch Schematic



Connection showing two or more wet switches in series



The contacts of the Wet Switch's relay may be wired to use multiple Wet Switches. The Drawing to the right shows the contacts interrupting the 24 VAC signal when either wet switch gets wet.

DiversiTech Corporation
2530 Lantrac Court
Decatur, GA 30035 USA
800.995.2222
770.593.8600 FAX
www.wetswitch.com

Functional Devices, Inc. • p: 800.888.5538 • f: 765.883.7505 • www.functionaldevices.com • sales@functionaldevices.com

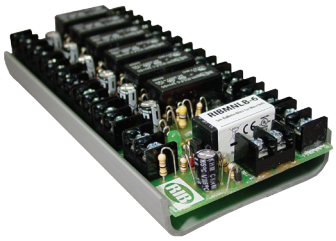
RIBMNLB-6/-4/-2

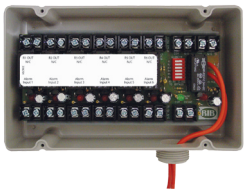
2.75″ Track Mount AHU Fan Safety Alarm and General Purpose Logic Circuit, 24 Vac Power Input

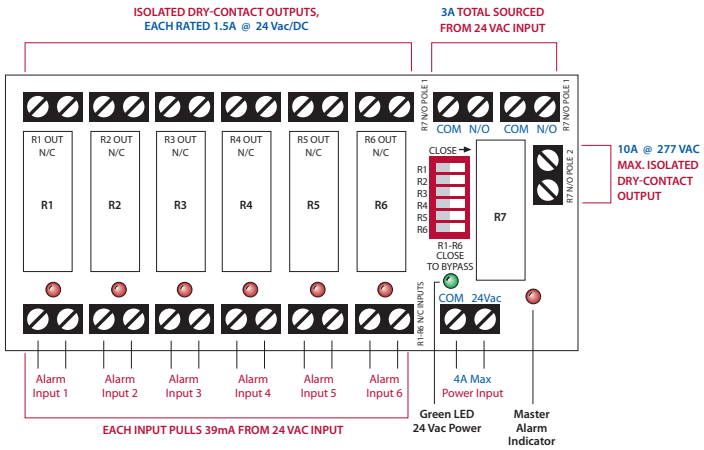
RIBLB-6/-4/-2

Enclosed AHU Fan Safety Alarm and General Purpose Logic Circuit, 24 Vac Power Input

Fan Safety Alarm Circuits







Specifications

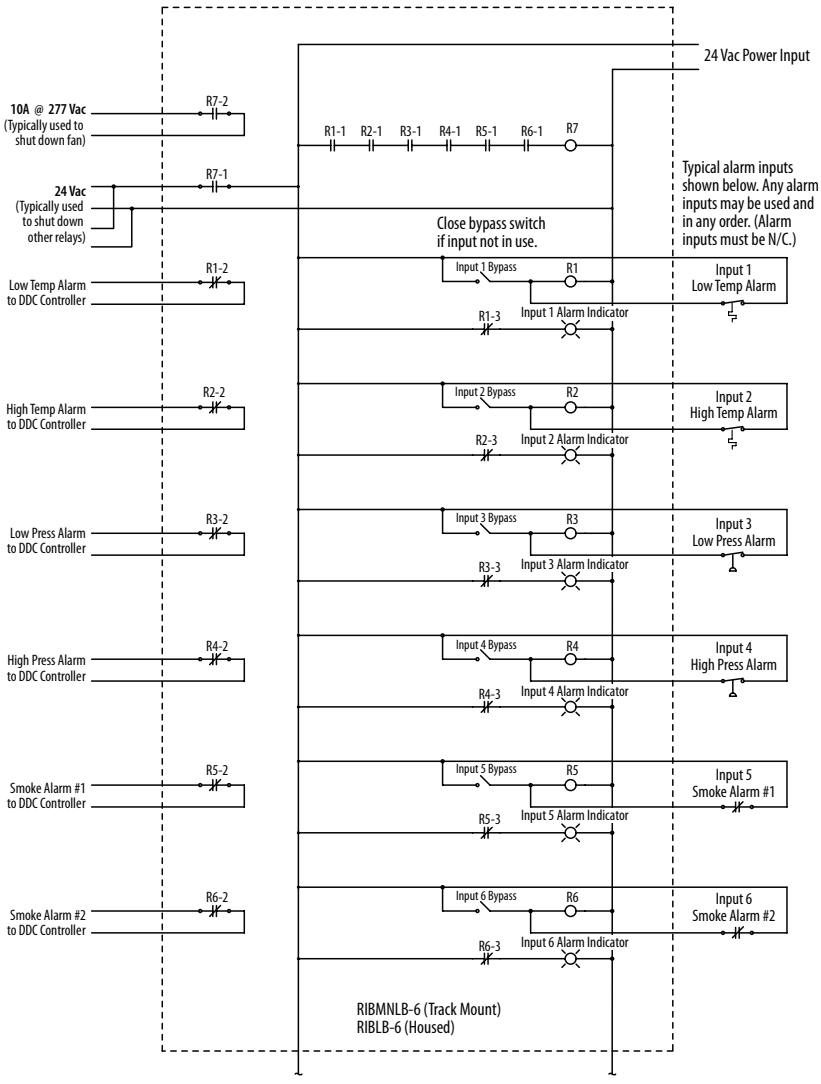
Expected Relay Life: 10 million cycles minimum mechanical
Operating Temperature: -30 to 140° F
Humidity Range: 5 to 95% (noncondensing)
Operate Time: 8mS
Power Input: 4 Amp @ 24 Vac ; 50-60 Hz
Alarm Status: LED On = Activated
Dimensions: 6.000″ x 2.750″ x 1.750″ (RIBMNLB-6)
4.740″ x 2.750″ x 1.750″ (RIBMNLB-4)
3.200″ x 2.750″ x 1.750″ (RIBMNLB-2)
4.28″ x 7.00″ x 2.00″ with .75″ NPT Nipple (RIBLB-6/-4/-2)
Track Mount: MT212-6 Mounting Track Provided
Approvals: UL Listed, UL916, UL864, C-UL, CE, RoHS
Housing Rating: UL Listed, NEMA 1, C-UL, CE Approved, UL Accepted for Use in Plenum, Also available NEMA 4 / 4X
Gold Flash: No
Override Switch: No

Notes:
- RIBMNLB-6 and RIBLB-6 shown above.
- RIBMNLB-4 and RIBLB-4 have four Alarm Inputs and one Master Alarm.
- RIBMNLB-2 and RIBLB-2 have two Alarm Inputs and one Master Alarm.

Models RIBMNLB-6, RIBMNLB-4, and RIBMNLB-2; and RIBLB-6, RIBLB-4, and RIBLB-2 are simply devices that combine a common relay-logic function into a small, easy-to-install, and less expensive form.

A master relay will open if any one of the normally-closed (N/C) inputs opens. There are six, four, or two inputs depending on the model chosen. LED status of all inputs, the master relay, and power input is provided. Bypass of un-used inputs is also provided. The RIBMNLB series is provided with mounting track for mounting in user-provided electrical enclosures. The RIBLB series is enclosed in a NEMA-1, 4″ x 7″ enclosure with a clear lid to allow viewing of the status LEDs. The master relay has three general-purpose outputs: two 24 Vac output terminals and one dry-contact output rated up to 10 Amp 277 Vac (terminals on RIBMNLB series, wires on RIBLB series.)
The most common application is an Air Handling Unit (AHU) fan-safety-shutdown where the master relay is used to shut-down the fan. Contact closure outputs are provided so that a DDC controller can determine the cause of a shutdown.

Selection Guide		
Model#	**Inputs**	
RIBMNLB-6	6	MT212 Mounting Track
RIBMNLB-4	4	MT212 Mounting Track
RIBMNLB-2	2	MT212 Mounting Track
RIBLB-6	6	PE6020 Enclosure
RIBLB-4	4	PE6020 Enclosure
RIBLB-2	2	PE6020 Enclosure



JOHNSON CONTROLS

Controls Group 507 E. Michigan Street
P.O. Box 423, Milwaukee, WI 53202
Code No. Lit-1920657

A19

Hot Water Temperature Control With Strap-On Mount

A19DAC-1

Description

SPDT, strap-on, surface type hot water control for direct or reverse action. May be used as either an open high control or as an open low control.

Features

- terminals are color coded to simplify installation
- may be mounted on either horizontal or vertical rise pipe
- insulated back portion of case minimizes the effects of ambient temperature
- SPDT switch action for high or low temperature detection
- supplied with convertible range adjuster, which provides either knob or screwdriver adjustment

Applications

- automatic changeover control for fan coil systems

Specifications

- maximum case ambient temperature: 140°F (60°C)
- maximum sensing element temperature: 250°F (121°C)

To Order

Specify the code number from the following selection chart.

Selection Chart

Code Number	Switch Action	Range °F (°C)	Diff F° Fixed (C°)	Mounting
♦**A19DAC-1C**	SPDT	100 to 240 (38 to 116)	10 (5.6)	Clamp-on Strap Supplied

Note: Replaces White-Rodgers 1127-2. A19DAC-1 not for use as a limit control.

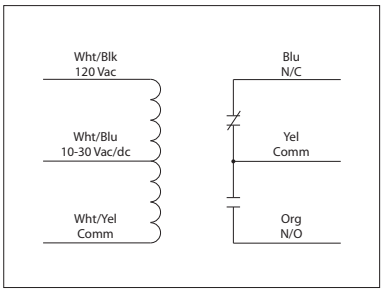
Electrical Ratings

Motor Ratings VAC	120	240
AC Full Load Amp	10.0	6.0
AC Locked Rotor Amp	60.0	36.0
Pilot Duty–125 VA, 24 to 600 VAC		

Functional Devices, Inc. • p: 800.888.5538 • f: 765.883.7505 • www.functionaldevices.com • sales@functionaldevices.com

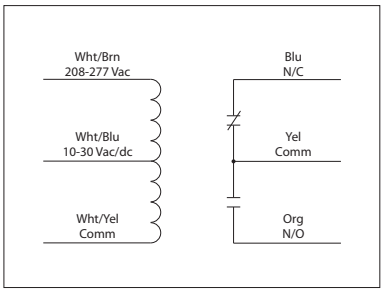
RIBU1C

Enclosed Relay 10 Amp SPDT with
10-30 Vac/dc/120 Vac Coil



RIBH1C

Enclosed Relay 10 Amp SPDT with
10-30 Vac/dc/208-277 Vac Coil



10 Amp Pilot Control Relays

RIBU1C-RD
RIBH1C-RD
• Red housing

RIBU1C-N4
RIBH1C-N4
• NEMA 4X housing, UL508 only

c UL us LISTED

Made in USA
Meets
"Buy American"
of ARRA 2009

Specifications

 # Relays & Contact Type: One (1) SPDT Continuous Duty Coil
Expected Relay Life: 10 million cycles minimum mechanical
Operating Temperature: -30 to 140° F
Humidity Range: 5 to 95% (noncondensing)
Operate Time: 20mS
Relay Status: LED On = Activated
Dimensions: 1.70˝ x 2.80˝ x 1.50˝ with .50˝ NPT nipple
Wires: 16˝, 600V Rated
Approvals: UL Listed, UL916, UL864, C-UL
California State Fire Marshal, CE, RoHS
Housing Rating: UL Accepted for Use in Plenum, NEMA 1
Gold Flash: Yes
Override Switch: No

Contact Ratings:
10 Amp Resistive @ 277 Vac
10 Amp Resistive @ 28 Vdc
480 VA Pilot Duty @ 240-277 Vac
480 VA Ballast @ 277 Vac
600 Watt Tungsten @ 120 Vac N/O
240 Watt Tungsten @ 120 Vac N/C
1/3 HP for N/O @ 120-240 Vac
1/6 HP for N/C @ 120-240 Vac
1/4 HP for N/O @ 277 Vac
1/8 HP for N/C @ 277 Vac

Coil Current:

33 mA @ 10 Vac	13 mA @ 10 Vdc
35 mA @ 12 Vac	15 mA @ 12 Vdc
46 mA @ 24 Vac	18 mA @ 24 Vdc
55 mA @ 30 Vac	20 mA @ 30 Vdc

28 mA @ 120 Vac (RIBU1C)
39 mA @ 208-277 Vac (RIBH1C)

Coil Voltage Input:
10-30 Vac/dc ; 120 Vac ; 50-60 Hz (RIBU1C)
10-30 Vac/dc ; 208-277 Vac ; 50-60 Hz (RIBH1C)
Drop Out = 2.1 Vac / 2.8 Vdc
Pull In = 9 Vac / 10 Vdc

IDEC GENERAL-PURPOSE RELAYS

RH, RJ, RR SERIES

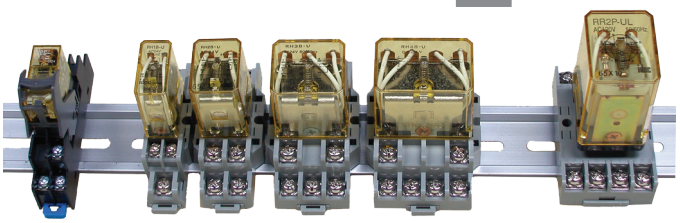
DESCRIPTION

IDEC general-purpose relays are available in the **RH Series** blade-style relays and the **RR Series** pin-style relays and the **RJ Series** compact relays.

The **RH Series** features a 10A switching capacity. They are available in SPDT, DPDT, 3PDT, and 4PDT contact configurations, driven by AC or DC coils, and they have blade terminals for socket mounting.

The **RR Series** has a 10A contact rating. The **RR Series** relays are available in SPDT, DPDT, and 3PDT configurations driven by AC or DC coils, and they have pin or blade terminals for socket mounting.

The **RJ Series** is compact to reduce space requirements. They are available in a 12A SPDT version and an 8A DPDT version. They are driven by AC or DC coils and have blade terminals for socket mounting.



RJ Series RH Series RR Series

FEATURES

- ***Blade style, pin style, and compact models***
- ***Indicator light and/or check button available***
- ***Surface or DIN rail mount***
- ***UL recognized, CSA certified***

SPECIFICATIONS

COIL RATINGS

RH SERIES

RATED VOLTAGE		RATED CURRENT (mA) ±15% @ 20°C								COIL RESISTANCE (Ω) ±10% @ 20°C			
		60 Hz				50 Hz							
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT
AC	12	75	100	140	165	86	121	165	196	165	39.3	25.3	21.2
	24	37	50	70	83	42	60.5	81	98	83	153	103	84.5
	120	7.5	–	14.2	16.5	8.6	–	16.4	19.5	16.5	–	10,800	7,360
	240	4.3	–	7.1	8.3	4.9	–	8.2	9.8	8.3	–	12,100	9,120
		SPDT		DPDT		3PDT		4PDT		SPDT	DPDT	3PDT	4PDT
DC	12	64		75		120		125		188	160	100	96
	24	32		36.9		60		62		750	650	400	388

RR Series

RATED VOLTAGE		Rated Current (mA) ±15% @ 20°C		COIL RESISTANCE (Ω) ±10% @ 20°C
		60 Hz	50 Hz	
AC	12	210	245	365
	24	105	121	182
	120	20.5	24	35
	240	10.5	12.1	18
DC	12	120		–
	24	60		–

RJ Series

	MODELS	Rated Current (mA) ±15% @ 20°C					COIL RESISTANCE (Ω) ±10% @ 20°C
			WITHOUT LED[1]		WITH LED[1]		
			60 Hz	50 Hz	60 Hz	50 Hz	
AC	BLADE & PCB	24V	37.5	43.9	41.1	47.5	243
		120V	7.5	8.8	7.4	8.7	6,400
DC	BLADE	24V	22.1		25.7		1,080
	PCB	24V	22.1		–		1,080

1. LED indicator is only available on Blade relays.

Maximum continuous applied voltage
- **RH, RR**: 110% of rated voltage
- **RJ**: 140% of rated voltage

Pull-in voltage
- **RH, RR, RJ/AC**: 80% of rated voltage
- **RJ, RJ/DC**: 70% of rated voltage

Drop-out voltage
- **AC**: 30% or more of rated voltage
- **DC**: 10% or more of rated voltage

Contact material
- **RH**: Silver cadmium oxide
- **RR**: Silver
- **RJ**: Silver nickel alloy

CONTACT RATINGS

RH SERIES (UL ratings)

VOLTAGE	RESISTIVE			GENERAL USE			HORSEPOWER RATING		
	RH1 RH2	RH3	RH4	RH1 RH2	RH3	RH4	RH1 RH2	RH3	RH4
240V AC	10A	7.5A	7.5A	7A	6.5A	5A	1/3 hp	1/3 hp	–
120V AC	–	10A	10A	–	7.5A	7.5A	1/6 hp	1/6 hp	–
30V DC	10A	10A	–	7A	–	–	–	–	–
28V DC	–	–	10A	–	–	–	–	–	–

RR SERIES (UL ratings)

VOLTAGE	RESITIVE (A)	INDUCTIVE (A) cosΘ= 0.3	MOTOR LOAD (hp)
240 AC	10	7	1/3
120 AC	10	7.5	1/4
30 DC	10	7	–

RJ Series (UL ratings)

	CONTACT	RJ1S	RJ2S
Resistive Load (Maximum)	N.O.	12A @ 250 VAC/30 VDC	8A @ 250 VAC/30 VDC
	N.C.	12A @ 250 VAC; 6A @ 30 VDC	8A @ 250 VAC; 4A @ 30 VDC
Inductive Load (Maximum)	N.O.	7.5A @ 250 VAC; 6A @ 30 VDC	4A @ 250 VAC; 4A @ 30 VDC
	N.C.	7.5A @ 250 VAC; 3A @ 30 VDC	4A @ 250 VAC; 2A @ 30 VDC

Contact resistance
- **RH**: 50 mΩ maximum
- **RR**: 30 mΩ maximum
- **RJ**: 50 mΩ maximum

Operate time
- **RH, RR**: 25 ms maximum
- **RJ**: 15 ms maximum

Release time
- **RH, RR**: 25 ms maximum
- **RJ**: 10 ms maximum

Min load
- **RH**: 24 VDC/30 mA, 5 VDC/100 mA
- **RR**: 24 VDC/10 mA, 5 VDC/20 mA
- **RJ**: 5 VDC/100 mA

Operating temp: -22° to 158°F (-30° to 70°C)

Agency approvals: UL-recognized component, **(RH, RR):** File #E66043, **(RJ):** File #E55996, CSA certified, File #LR35144; CE certified (not RR blade style)

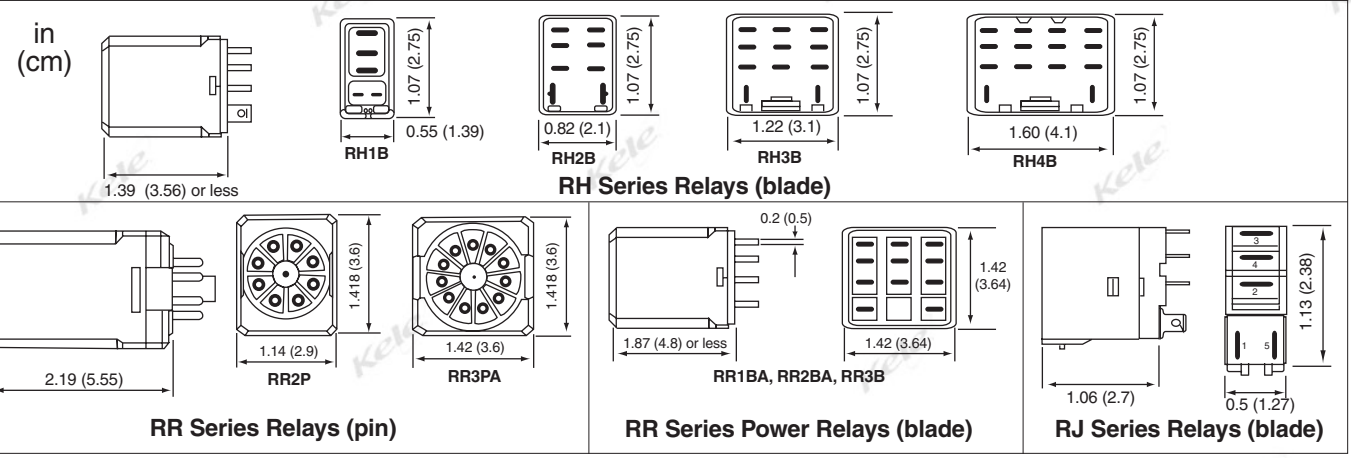
Warranty: 1 year

RELAYS & CONTACTORS

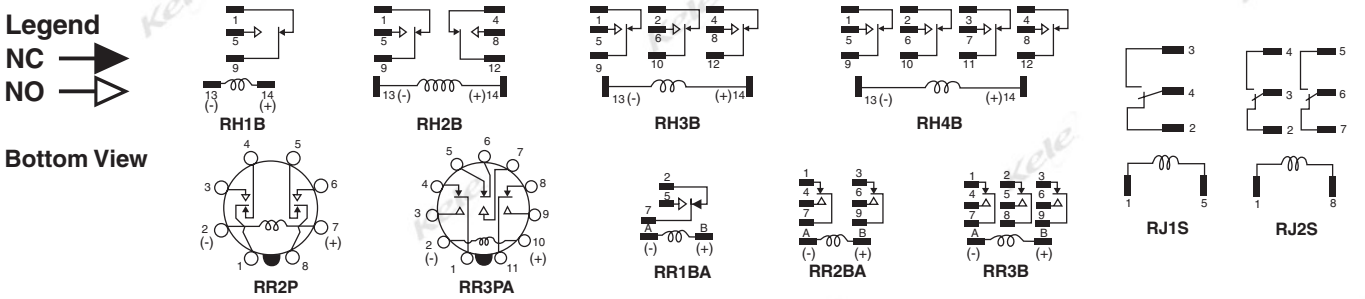
IDEC GENERAL-PURPOSE RELAYS

RH, RJ, RR SERIES

DIMENSIONS



WIRING



ORDERING INFORMATION

MODEL	DESCRIPTION
RH1B	Relay, SPDT, blade (use SH1B-05 socket)
RH2B	Relay, DPDT, blade (use SH2B-05 socket)
RH3B	Relay, 3PDT, blade (use SH3B-05 socket)
RH4B	Relay, 4PDT, blade (use SH4B-05 socket)

U	Standard relay
UL	Indicator light
ULC	Indicator light and check button

AC12V	12 VAC coil voltage
AC24V	24 VAC coil voltage
AC120V	120 VAC coil voltage
AC240V	240 VAC coil voltage
DC12V	12 VDC coil voltage
DC24V	24 VDC coil voltage

RH1B	U	AC24V

MODEL	DESCRIPTION
RR2P	Relay, DPDT, 8 pin (use SR2P-05 or SR2P-06)
RR3PA	Relay, 3PDT, 11 pin (use SR3P-06 socket)
RR1BA	Relay, SPDT, 11 blade (use SR3B-05 socket)
RR2BA	Relay, DPDT, 11 blade (use SR3B-05 socket)
RR3B	Relay, 3PDT, 11 blade (use SR3B-05 socket)

U	Standard relay
UL	Indicator light
ULC	Indicator light and check button

AC12V	12 VAC coil voltage
AC24V	24 VAC coil voltage
AC120V	120 VAC coil voltage
AC240V	240 VAC coil voltage
DC12V	12 VDC coil voltage
DC24V	24 VDC coil voltage

RR2P	U	AC24V

Example: **RR2PUAC24V** DPDT relay 8 pin with 24VAC coil

MODEL	DESCRIPTION
RJ1S	Relay, SPDT (use SJ1S-05B socket)
RJ2S	Relay, DPDT (use SJ2S-05B socket)

C	No options
CL	LED indicator

A24	24 VAC coil voltage
A120	120 VAC coil voltage
D24	24 VDC coil voltage

RJ1S	C	A24

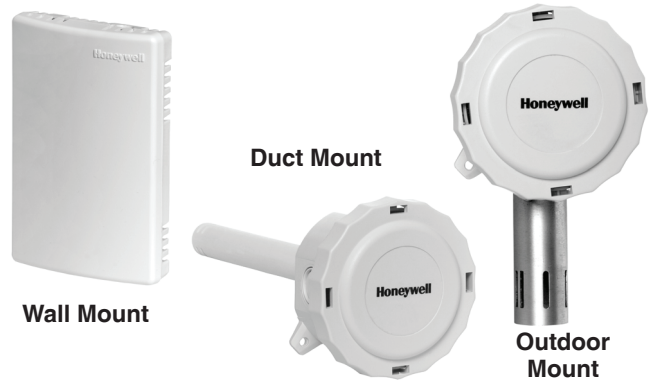
RELATED PRODUCTS

		PAGE
DIN-3F	35 mm DIN rail, steel, 39.4" (1m), RoHS compliant	**860**
DIN-3F, BAM-1000	DIN rail	**860**
SH, SR, SJ Series	Relay sockets	**1123**

Honeywell

H7625, H7635, H7655 Series 2000
Humidity/Temperature Sensors

SPECIFICATION DATA



The H7625, H7635, and H7655 are highly accurate, stable humidity transducers designed for use with HVAC controllers such as the T7350 Thermostat, H775 Remote Humidity Controller, and W7760 Direct Digital Controllers. The Ceramic Technology humidity sensor is not affected by condensation and provides excellent long-term stability.

FEATURES

- **Ceramic Technology overcomes the limitations of other resistance based humidity sensors that use water soluble polymer coatings.**
- **Ceramic Technology allows sensors to recover fully from condensation, fog, and high humidity.**
- **Highly accurate, repeatable, stable output with negligible hysteresis.**
- **Temperature compensated output**
- **Zero and span trimmers, and increment/decrement recalibration feature.**
- **All units have selectable 4-20mA, 0-10Vdc, or 0-5Vdc output.**
- **NIST traceable 2%, 3%, and 5% calibration, every sensor calibrated at 3 different points.**

SPECIFICATIONS

Operating RH Range:
❑ 0 to 95% RH non-condensing.

RH Measurement Range:
❑ 0-100% RH

Humidity Accuracy:
❑ ±2%, ±3% or ±5% from 20 to 95% RH.

1K Ohm Temperature Accuracy:
❑ ± (0.15 + 0.002t) C t = actual temperature in C

20K Ohm Temperature Accuracy:
❑ ±0.4°F at 77°F (±0.2°C at 25°C)

1K Ohm Temperature Output Range:
❑ Room: 32 to 122°F (0 to 50°C).
❑ Duct: -58 to 572°F (-50 to 300°C).

20K Ohm Temperature Output Range:
❑ Room: 40° to 110°F (4° to 43°C).
❑ Duct/Outdoor: -40° to 240°F (-40° to 116°C).

Hysteresis:
❑ Less than ±0.5% RH.

Supply Voltage:
❑ 4-20mA Output: 250 Ohm Load 15 – 40 VDC / 18 - 28 VAC
❑ 4-20mA Output: 500 Ohm Load 18 – 40 VDC / 18 - 28 VAC (500 Ohm Load Max)
❑ 0-5 VDC Output: 12 - 40 VDC / 18 - 28 VAC (10K Load Minimum)
❑ 0-10 VDC Output: 18 - 40 VDC / 18 – 28 VAC (10K Load Minimum)

Maximum Supply Current:
❑ Current Mode: 24 mA.
❑ Voltage Mode: 8 mA.

Finish:
❑ Room Enclosure: ABS Plastic (UL94-VO rated).
❑ Duct Enclosure: ABS Plastic (UL94-5VA rated).
❑ Outdoor Enclosure: ASA Plastic (UL-94V0 rated).

Compensated Temperature Range: Full RH Range
❑ Room: 32 to 122°F (-0 to 50°C).
❑ Duct/Outdoor: -10 to 140°F (-23 to 60°C)

Humidity Response Time:
❑ 200 seconds.

CE

63-4521-03

Saturation Response Time:
❑ 10 minutes.

Sensitivity:
❑ 0.1%RH.

Interchangeability:
❑ Less than ±3% RH nominal.

Repeatability:
❑ 0.5% RH.

Long term drift:
❑ Less than 2% RH drift/5 years.

Table 1. Model Description

MODEL NUMBER	REPLACES	RH ACCURACY	MOUNTING	TEMPERATURE SENSOR	OUTPUT SIGNAL	USED WITH
H7625A2010	H7625A1008	2%	ROOM	20K ohm at 77F, reference 206598"	Selectable 4-20mA, 0-10Vdc, or 0-5Vdc	T7350, H775, XL50, XL500, XFC, W7750B/C, W7753, W7760A/C, W7761"
H7635A2012	H7635A1006	3%				
H7625B2006	H7625B1006	2%	DUCT			
H7635B2018	H7635B1004	3%				
H7655B2014	H7655B1009	5%				
H7635C2015	H7635C1002	3%	OUTDOOR			
H7626A2020		2%	ROOM	1097 ohm at 77F		T775
H7636A2022		3%				
H7626B2024		2%	DUCT			
H7636B2026		3%				
H7656B2029		5%				

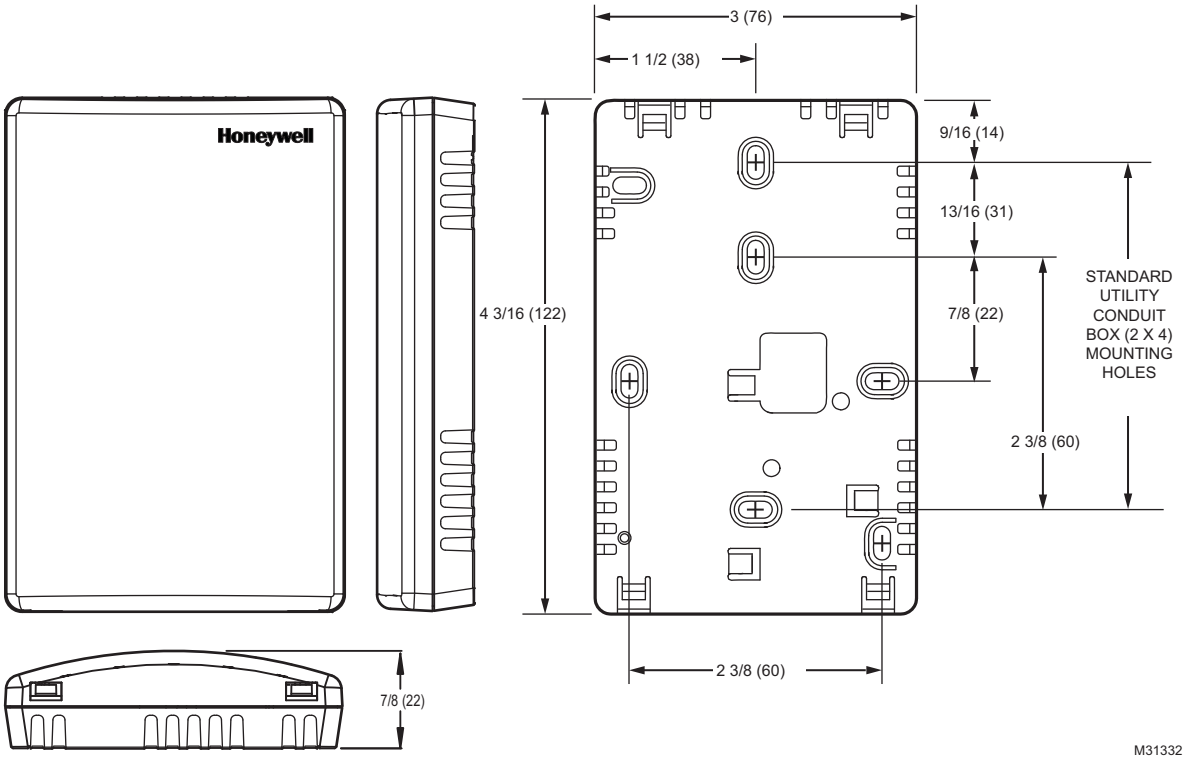


Fig. 1. Wall-mount sensor dimensions in in. (mm).

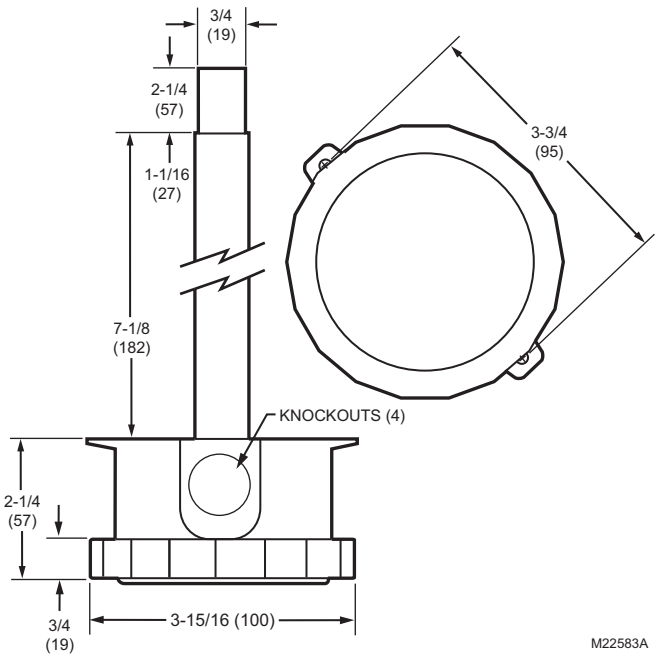


Fig. 2. Duct-mount sensor dimensions in in. (mm).

TYPICAL SPECIFICATION

Humidity transducer shall be accurate to ±2%, ±3%, or ±5% RH (whichever is specified) across the relative humidity range from 20-95%, NIST traceable calibration.

Humidity transducers shall be calibrated at three different points across the RH range.

Interchangeability of output between humidity transducers shall be within ±3%.

Each humidity transducer shall have selectable 4 to 20 mA, 0 to 10 Vdc, or 0 to 5 Vdc output.

Each humidity transducer shall have the option for field calibration using zero and span potentiometers, and toggle switches to increment or decrement the RH value in steps of 0.5% RH.

Accuracy of the humidity transducers shall not be adversely affected by condensation.

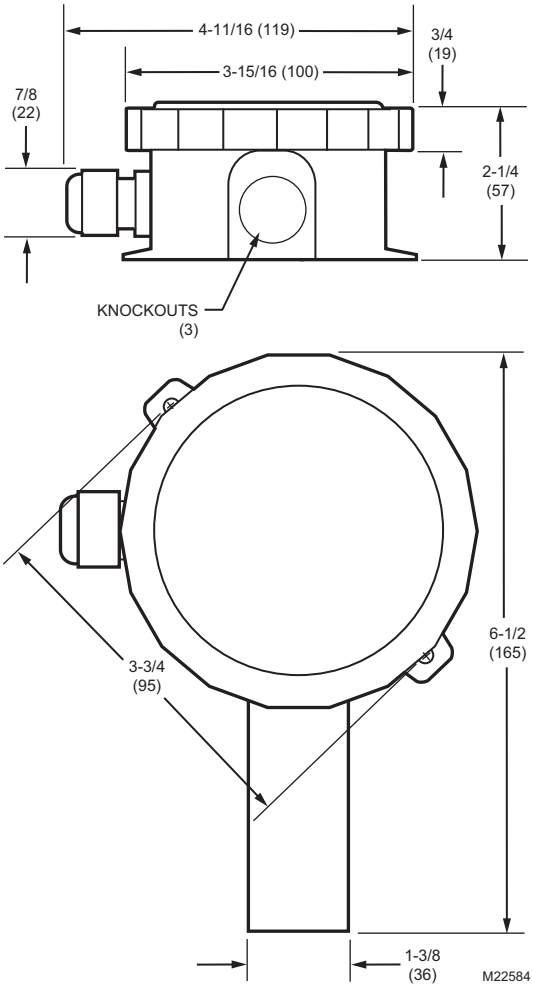


Fig. 3. Outdoor-mount sensor dimensions in in. (mm).

Automation and Control Solutions
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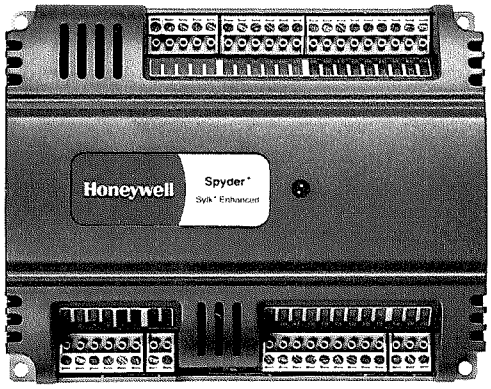
63-4521—03 M.S. Rev. 10-14
Printed in United States

Honeywell

Spyder® Lon Programmable, Unitary/VAV Controllers

SPECIFICATION DATA



GENERAL

The PUL1012S, PUL4024S, PUL6438S, PVL0000AS, PVL4022AS, PVL4024NS, PVL6436AS, and PVL6438NS controllers are part of the Spyder family. The eight controllers are Free Topology Transceiver (FTT) LONMARK®-compliant devices designed to control HVAC equipment. These controllers provide many options and advanced system features that allow state-of-the-art commercial building control. Each controller is programmable and configurable using the NIAGARA FRAMEWORK® software.

The Spyder Lon controllers require the Spyder Programmable Feature to be licensed in the WEBpro workbench tool and the WEBS AX JACE Controller for programming and downloading. The eight Spyder Lon Models are also available as Individually Licensed Controllers (ILC). The ILC versions are identical in design and capability in every detail except for the licensing. The Individual Licensing of the Spyder ILCs (The License is built in) allows them to be programmed and downloaded with any brand of the Niagara Workbench or JACE controller. The Spyder ILCs are identified with a suffix on the Part Number of -ILC. Example: PUL6438S-ILC follows all the same Installation Instructions information as the PUL6438S.

The controllers are for use in VAV (Variable Air Volume) and Unitary HVAC control applications. Each controller contains a host microcontroller to run the main HVAC application and a second microcontroller for LONWORKS® network communications. Each controller provides flexible, universal inputs for external sensors, digital inputs, and a combination of analog outputs and digital Triac outputs.

The photo above is of the PUL6438S.

FEATURES

- **Uses the Echelon® LONWORKS® network protocol.**
- **Free Topology Transceiver (FTT) high-speed 78 kilobit communications network.**
- **Capable of stand-alone operation, but can also use LONWORKS® Bus network communications.**
- **Sylk™ bus for use with Sylk-enabled sensors.**
- **120 controllers per Q7751A,B Router when configured as a repeater.**
- **Field configurable and programmable for control, input, and output functions using the NIAGARA FRAMEWORK® software.**
- **User-defined network variables.**
- **Function Block engine, which allows the application designer to program the controller to perform a wide variety of HVAC applications.**
- **Significant Event Notification, Periodic Update capability, and Failure Detect (FD) when network inputs fail to be detected within their configurable time frame.**
- **Built-in Zone Control functions include a remote wall module interface and a scheduler.**
- **Pressure-independent or pressure-dependent single or dual duct Variable Air Volume (VAV) control as well as Unitary equipment control.**
- **Microbridge air flow sensor with dual integral restrictor design (PVL0000AS, PVL4022AS, PVL4024NS, PVL6436AS, and PVL6438NS only).**
- **Easy user access to air flow sensor inputs.**
- **Actuator (PVL0000AS, PVL4022AS, and PVL6436AS only) mounts directly onto VAV box damper shaft and has up to 44 lb-in. (5 Nm) torque, 90-degree stroke, and 90 second timing at 60 Hz.**
- **All wiring connections are made to removable terminal blocks to simplify controller installation and replacement.**
- **Both controller housing and actuator are UL plenum rated.**

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63-1325-05

DESCRIPTION

The programmable VAV/Unitary controllers are available in eight models, as described in Table 1.

Table 1. Controller Configurations.

Controller Model	Programmable Type	Universal Inputs (UI)	Digital Inputs (DI)	Analog Outputs (AO)	Digital Outputs (DO)	Velocity Pressure Sensor (Microbridge)	Series 60 Floating Actuator
PUL1012S	Unitary	1[a]	0	1	2	NO	NO
PUL4024S	Unitary	4[a]	0	2	4	NO	NO
PUL6438S	Unitary	6	4	3	8	NO	NO
PVL0000AS	VAV	0	0	0	0	YES	YES
PVL4022AS	VAV	4[a]	0	2	2	YES	YES
PVL4024NS	VAV	4[a]	0	2	4	YES	NO
PVL6436AS	VAV	6	4	3	6	YES	YES
PVL6438NS	VAV	6	4	3	8	YES	NO

[a] One Universal Input (UI-1*) is user selectable as a fast digital pulse meter

Each controller is programmable because the user chooses which function blocks to use and how to connect them. It is configurable because each Function Block has user-defined behavior.

The PUL1012S, PUL4024S, and PUL6438S models are Unitary controllers, and the PVL0000AS, PVL4022AS, PVL4024NS, PVL6436AS, and PVL6438NS models are Variable Air Volume (VAV) controllers.

Unitary Equipment Control (Models PUL1012S, PUL4024S, and PUL6438S)

Unitary equipment includes natural convection units, radiant panels, unit heaters, unit ventilators, fan coil units, and heat pumps. Unitary equipment does not require a central fan. Depending on the design, unitary equipment may perform one or all of the functions of HVAC—ventilation, filtration, heating, cooling, humidification and distribution. Unitary equipment frequently requires a distribution system for steam or hot and or chilled water.

VAV Equipment Control (Models PVL0000AS, PVL4022AS, PVL4024NS, PVL6436AS, and PVL6438NS)

VAV controllers provide pressure-independent air flow control and pressure-dependent damper control. VAV systems generally provide cool air only to zones. However, each controller has additional programmable inputs and outputs that may be used to control devices, such as a fan or VAV box reheat coils. Heaters can be staged electric or modulating hot water. Supply and exhaust pressurization control are provided on a zone basis.

SPECIFICATIONS

Electrical

Rated Voltage: 20-30 Vac; 50/60 Hz

Power Consumption:
100 VA for controller and all connected loads (including the actuator on models PVL0000AS, PVL4022AS, and PVL6436AS)

Controller only Load: 5 VA maximum; models PUL1012S, PUL4024S, PUL6438S, PVL4024NS, and PVL6438NS

Controller and Actuator Load: 9 VA maximum; models PVL0000AS, PVL4022AS, and PVL6436AS.

External Sensors Power Output: 20 Vdc ±10% @ 75 mA maximum

Environmental

VAV Operating & Storage Temperature Ambient Rating (models PVL0000AS, PVL4022AS, PVL4024NS, PVL6436AS, and PVL6438NS):
Minimum 32° F (0° C); Maximum 122° F (50° C)

Unitary Operating & Storage Temperature Ambient Rating (models PUL1012S, PUL4024S, and PUL6438S):
Minimum -40° F (-40° C); Maximum 150° F (65.5° C)

Relative Humidity: 5% to 95% non-condensing

Dimensions (H/W/D)

See Fig. 1 to Fig. 4 beginning on page 6, for dimensions drawings.

Approval Bodies

UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.

CSA (LR95329-3) listed.

Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.

Meets Canadian standard C108.8 (radiated emissions).

Conforms to the following requirements per European Consortium standards:
— EN 61000-6-1; 2001 (EU Immunity).
— EN 61000-6-3; 2001 (EU Emissions)

Real Time Clock

Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic daylight savings time adjustment to occur at 2:00 a.m. local time on configured start and stop dates
Power Failure Backup: 24 hours at 32 to 100° F (0 to 38° C), 22 hours at 100 to 122° F (38 to 50° C)
Accuracy: ±1 minute per month at 77° F (25° C)

Velocity Pressure Sensor (Models PVL0000AS, PVL4022AS, PVL4024NS, PVL6436AS, and PVL6438NS only)

Operating Range: 0 to 1.5 in. H_2O (0 to 374 Pa)

Series 60 Floating Actuator (Models PVL0000AS, PVL4022AS, and PVL6436AS only)

Rotation Stroke: 95° ± 3° for CW or CCW opening dampers
Torque Rating: 44 lb-in. (5 Nm)
Run Time for 90° rotation: 90 seconds at 60 Hz

Inputs and Outputs

Each controller has a combination of universal inputs (UI), digital inputs (DI), analog outputs (AO), and digital Triac outputs (DO) as listed in Table 1.

Digital Input (DI) Circuits

Voltage Rating: 0 to 30 Vdc open circuit
Input Type: Dry contact to detect open and closed circuit
Operating Range: Open circuit = False; Closed circuit = True
Resistance: Open circuit > 3,000 Ohms; Closed circuit < 500 Ohms

Digital Triac Output (DO) Circuits

Voltage Rating: 20 to 30 Vac @ 50-60Hz
Current Rating: 25 mA to 500 mA continuous, 800 mA (AC rms) for 60 milliseconds

Analog Output (AO) Circuits

Analog outputs can be individually configured for current or voltage.

ANALOG CURRENT OUTPUTS:
Current Output Range: 4.0 to 20.0 mA
Output Load Resistance: 550 Ohms maximum

ANALOG VOLTAGE OUTPUTS:
Voltage Output Range: 0 to 10.0 Vdc
Maximum Output Current: 10.0 mA

Analog outputs may be configured as digital outputs and operate as follows:
– False (0%) produces 0 Vdc, (0 mA)
– True (100%) produces the maximum 11 Vdc, (22 mA)

Universal Input (UI) Circuits

See Table 2 for the UI specifications

Table 2. Universal Input Circuit Specifications.

Input Type	Sensor Type	Operating Range
Room/Zone Discharge Air Outdoor Air Temperature	20K Ohm NTC	-40° F to 199° F (-40° C to 93° C)
Outdoor Air Temperature	C7031G[a]	-40° to 120°F (-40° to 49°C)
	C7041F[a]	-40° to 250°F (-40° to 121°C)
	PT1000 (IEC751 3850)	-40° F to 199° F (-40° C to 93° C)
TR23 Setpoint Potentiometer	500 Ohm to 10,500 Ohm	-4° DDC to 4° DDC (-8° DDF to 7° DDF) or 50° F to 90° F (10° C to 32° C)
Resistive Input	Generic	100 Ohms to 100K Ohms
Voltage Input	Transducer, Controller	0–10 Vdc
Discrete Input	Dry Contact closure	OpenCircuit ≥ 3000Ohms ClosedCircuit < 3000Ohms
Pulse Input[b]	Counter/Meter	Max. frequency: 15 Hz Min. pulse width: 20 ms

[a] C7031G and C7041F are recommended for use with these controllers, due to improved resolution and accuracy when compared to the PT1000.

[b] One Universal Input (UI-1*) on the PUL1012S, PUL4024S, PVL4022AS, and PVL4024NS is user selectable as a fast digital pulse meter

Hardware

CPU

Each controller uses a Texas Instruments MSP430 family microprocessor. The processor contains on-chip FLASH program memory, FLASH information memory, and RAM.

Memory Capacity

Flash Memory: 116 kilobytes with 8 kilobytes available for user program. The controller is able to retain FLASH memory settings for up to ten (10) years.

RAM: 8 kilobytes

Status Information

The LED on the front of the controller provides a visual indication of the status of the device. When the controller receives power, the LED appears in one of the following allowable states, as described in Table 3.

Table 3. Status LED States.

LED State	Blink Rate	Status or Condition
OFF	not applicable	No power to processor, LED damaged, low voltage to board, or controller damaged.
ON	ON steady; not blinking	Processor and/or controller is not operating.
Very slow blink (continuous)	1 second ON, 1 second OFF	Controller is operating normally.
Slow blink (continuous)	0.5 second ON, 0.5 second OFF	Controller alarm is active, controller in process of download, or controller lost its configuration.
Medium blink (continuous)	0.25 second ON, 0.25 second OFF	Controller firmware is loading.
Fast blink (continuous)	0.10 second ON, 0.10 second OFF	Controller is in manual mode under control of the PC-based software tool.

Communications

Each controller uses an FTT transformer-coupled communications port. The controller's Manchester encoded data is presented to other controllers and devices on the LONWORKS® Bus at 78 kilobits per second (kbs) via Echelon® communication protocol. The transformer-coupled communications interface offers a much higher degree of common mode-noise rejection while assuring dc isolation. The LONWORKS® Bus is polarity insensitive, eliminating installation errors due to miswiring.

The maximum LONWORKS® Bus network length is 4,600 ft. (1,400 m). For LONWORKS® Bus network lengths greater than the above, see "LONWORKS® Bus Wiring Guidelines," form no. 74-2865.

The theoretical limit for each LONWORKS® Bus segment is 60 controllers. Up to 120 controllers can be configured when the Q7751A,B Router (configured as a repeater) is used, and the bus must be either singly or doubly terminated. Actual installations may have a lower limit, depending on the devices connected.

Honeywell-provided cable types for LONWORKS® Bus communications wiring are Level IV 22 AWG (0.34 sq. mm) plenum or non-plenum rated unshielded, twisted pair, stranded conductor wire.

- For non-plenum areas, U.S. part AK3798 (single-pair stranded) can be used.
- For plenum areas, U.S. part AK3797 (single-pair stranded) or U.S. part AK3799 (two-pair stranded) can be used.

Contact Echelon Corp. Technical Support for the recommended vendors of Echelon approved cables.

Refer to the "LONWORKS® Bus Wiring Guidelines," form 74-2865, for a complete description of LONWORKS® Bus network topology rules and approved cable types.

If a longer LONWORKS® Bus network is required, the Q7751A,B Router (configured as a repeater) can be added to extend the length of the LONWORKS® Bus. Each network segment can have a maximum of one repeater.

NOTE: Connection for operator access to the LONWORKS® Bus is provided by plugging the Serial LONTALK® Adapter (SLTA) connector into the LONWORKS® Bus jack on the controller.

Sylk™ Bus

Sylk is a two wire, polarity insensitive bus that provides both 18 Vdc power and communications between a Sylk-enabled sensor and a Sylk-enabled controller. Using Sylk-enabled sensors saves I/O on the controller and is faster and cheaper to install since only two wires are needed and the bus is polarity insensitive. Sylk sensors are configured using the latest release of the Spyder® Tool for WEBPro and WEBStation.

Network Variables Profile

Network variables, as described in Table 4 on page 5, are communicated over the LONWORKS® Bus. User-defined variables provide for customized configurations. The controller's built-in functions provide for the selection of variables, which are available from/to the network. Each network variable is named and configured using the NIAGARA FRAMEWORK® software.

Each controller supports a range of network variables, depending on the byte count (storage requirements) of each variable. In most typical installations, a maximum of 30–37 variables are configured.

NOTE: The maximum number of variables that a controller supports is 62, and the maximum byte count per variable is 31.

The controller is capable of supporting up to 1,922 separate data values.

In Table 4 on page 5, the network variable prefixes have the following meaning:

- nvi — Network Variable Input
- nvo — Network Variable Output
- nci — Configuration Property Network Variable Input stored in Non-Volatile Memory
- nro — Network Variable Output stored in Non-Volatile memory

Table 4. Network Object Variables List.

Network Object Variables	
→ Input **Mandatory**	**Output** →
nviNodeRequest * [a]	nvoNodeStatus *
→ Input **Optional**	**Output** →
nviTimeSet *	nvoFileStatus *
nviFileRequest	
nviFilePos *	
→ Input **Manufacturer Defined**	**Output** →
nviDebugIndx *	nvoTime *
nviInUse *	nvoConfigError *
nviManVal *	nvoDebug1 *
	nvoDebug2 *
	nvoAlarmH *
	nvoAlarmStatus *
	nvoError *
	nvoIO1 *
	nvoIO2 *
	nvoIO3 *
→ Input **Configuration (Manufacturer Defined)**	**Output** →
nciApplVerNew *	nroPgmVer *
nciDeviceName *	
nciSendHrtBt *	
nciRcvHrtBt *	
nciUICalOffset *	
→ Input **User-defined (Examples of)** [b]	**Output** →
nviSpaceTemp	nvoSpaceTemp
nviSetPoint	nvoEffectSetPt
nviManOverride	nvoUnitStatus
nviEmergCmd	nvoTerminalLoad
nviEnergyHoldOff	nvoEnergyHoldOff
nviFanSpeed	nvoBoxFlow

[a] Network variables marked with an asterisk (*) are fixed. All network variables, other than those that are user-defined, are fixed and not configurable.

[b] User-defined network variables are created using the NIAGARA FRAMEWORK® software. The variables listed in the table are a few examples. A wide range of variables are user-definable.

Accessories

— 201052A,B,C Auxiliary Switches (one, two or three switches)
— 205979 Connector Cable from the Q7752A Serial Interface Adapter to Controller or Wall Module
— 209541B Termination Module
— C7041B,C,D,P,R Air Temperature Sensor (indoor)
— C7770A Air Temperature Sensor (indoor/plenum)
— C7031G Air Temperature Sensor (outdoor)
— C7041F Air Temperature Sensor (outdoor)
— Q7751A,B Router (configured as a repeater)
— Q7752A,B Serial Interface Adapter
— TR23 Wall Module
— C7400A Enthalpy Sensor
— P7640 Pressure Transducer Family
— C7232 CO_2 Sensor Family
— C7600 Humidity Sensor Family
— H7625, H7635, and H7655 Humidity and Temperature Sensors

Refer to the "Sensors Product Overview," form 63-9285, for additional accessories.

Mounting

The controller enclosure is constructed of a plastic base plate and a plastic factory-snap-on cover. The cover does not need to be removed from the base plate for either mounting or wiring. Removable terminal blocks are used for all wiring connections, which allow the controller to be wired before or after mounting.

The controller can be mounted in any orientation. Ventilation openings are designed into the cover to allow proper heat dissipation regardless of the mounting orientation.

NOTE: The controller must be mounted in a position that allows clearance for wiring, servicing, removal, connection of the LONWORKS® Bus Jack, and access to the NEURON® Service Pin.

NOTE: For complete mounting information, refer to the "Installation Instructions," form 62-0287.

PVL0000AS, PVL4022AS, and PVL6436AS Mounting

The PVL0000AS, PVL4022AS, and PVL6436AS controllers include the direct-coupled actuator with Declutch mechanism, which is shipped hard-wired to the controller.

The actuator mounts directly onto the VAV box damper shaft and has up to 44 lb-in. (5 Nm) torque, 90-degree stroke, and 90 second timing at 60 Hz. The actuator is suitable for mounting onto a 3/8 to 1/2 in. (10 to 13 mm) square or round VAV box damper shaft. The minimum VAV box damper shaft length is 1-9/16 in. (40 mm).

After the actuator is mounted onto the damper shaft, the controller mounts to a panel by using four No. 6 or No. 8 machine or sheet metal screws inserted through the corners of the base plate.

PUL1012S, PUL4024S, PUL6438S, PVL4024NS, and PVL6438NS Mounting

These controllers mount to either a panel or DIN rail (standard EN50022; 7.5 mm x 35 mm).

- For panel mounting, use four No. 6 or No. 8 machine or sheet metal screws inserted through the corners of the base plate.
- For DIN rail mounting, refer to the "Installation Instructions," form 62-0287.

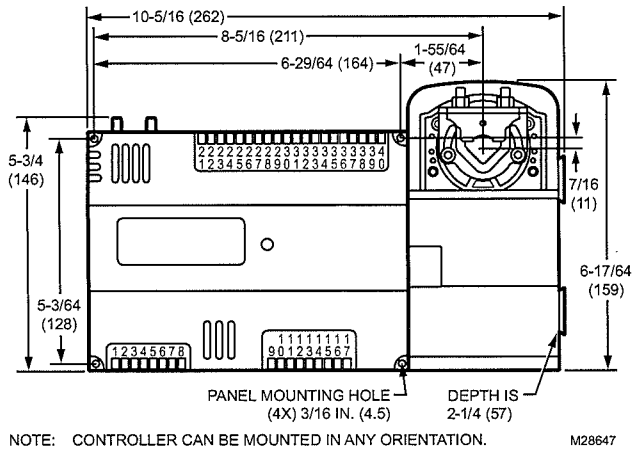

Fig. 1. Panel mounting — controller and actuator dimensions in inches (mm) for model PVL6436AS only.

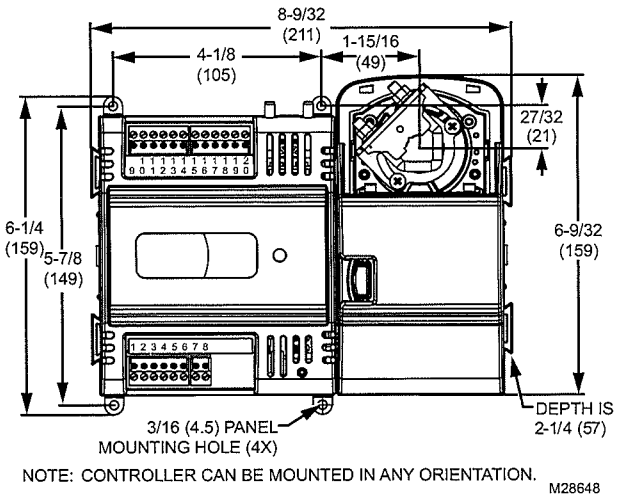

Fig. 2. Panel mounting — controller and actuator dimensions in inches (mm) for PVL0000AS and PVL4022AS only (PVL4022AS shown).

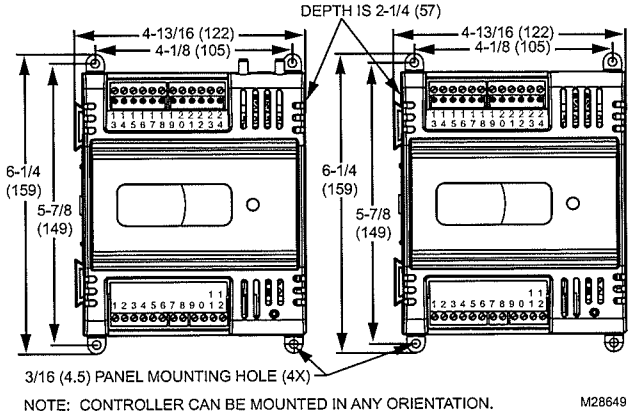

Fig. 3. Panel mounting — controller dimensions in inches (mm) for PUL1012S, PUL4024S, and PVL4024NS only (PUL4024S and PVL4024NS shown).

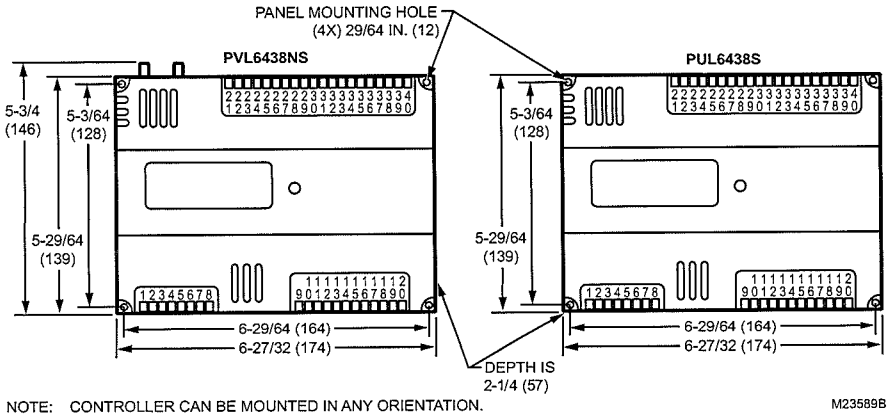

Fig. 4. Panel mounting — controller dimensions in inches (mm) for models PVL6438NS and PUL6438S.

SPYDER® LON PROGRAMMABLE, UNITARY/VAV CONTROLLERS

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63-1325—05 M.S. Rev. 11-09
Printed in U.S.A.

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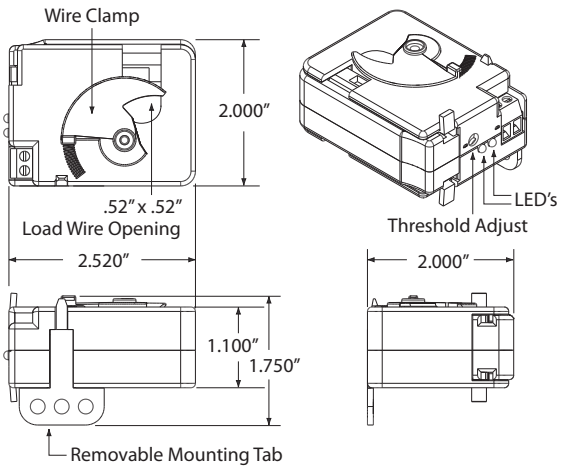
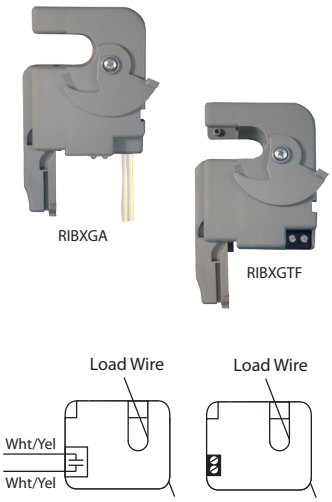




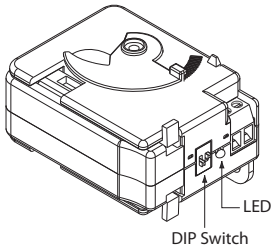
Made in USA
Meets "Buy American" of ARRA 2009

Specifications

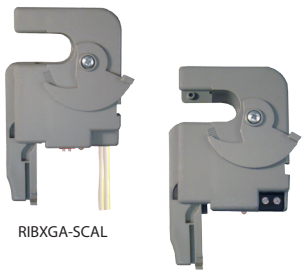
Operating Temperature: -30 to 140° F
Humidity Range: 5 to 95% (noncondensing)
Max Sense Voltage: 600 Vac
Approvals: UL Listed, UL916, UL864, C-UL, California State Fire Marshal, CE, RoHS
Mounting/Installation: Removable mounting tab provided. The wire clamp locks against the load wire, securing the unit in place.

Sensor Output:
- Solid State Contact
- 30 Vac/dc, .4 Amp Max.
- When current sensor status is off (open), leakage <30 uA @ 30Vac/dc
- When current sensor status is on (closed), voltage drop
  < .3 Vac/dc @ .1 Amp
  < 1.6 Vac/dc @ .4 Amp

Self-Calibrating AC Sensors (Models with -SCAL Suffix)



-SCAL LED Table	
LED Off	No Current
Two Winks	Current Below Range
Three Winks	Current In Range
Four Winks	Current Above Range
Continuous Winks	Calibration in Progress



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The SCAL unit begins the 30 second self-calibration process the first time current is applied in the operating range. The threshold is permanently set. Subsequent calibrations may be performed by moving SW1 to the position opposite of its current position with or without current applied (hands can be safely away from live voltage). Once current begins flowing, or if it already is, the calibration process will begin. At the end of the 30 seconds, amperage will be read and set as the threshold. SW2 in the ON position provides a 15% (+/-3%) differential, in the OFF position it provides a 25% (+/-3%) differential. SW2 can be selected at anytime and does not affect the threshold setting. Current in-range closes the status contacts. Current above or below range opens the status contacts. Ex. With a current of 10 amps set as the threshold and a 15% differential, status contacts will be closed between 8.5 amps and 11.5 amps and open outside of this range. A small amount of hysteresis is provided to prevent dithering near the differential limits.

RIBXG Series Selection Guide

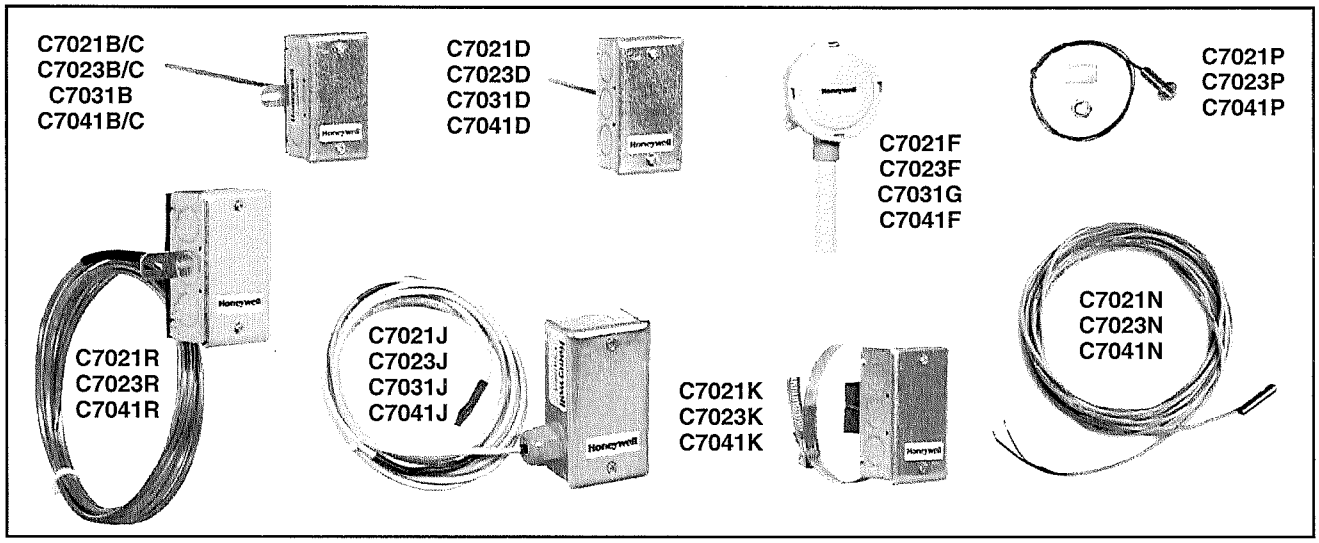
Model#	Range	Type	Threshold	Output	LED 1	LED 2
RIBXGF	.35-150 Amp	Split Core	Fixed, .35 Amp	Solid State Switch SPST ; 30 Vac/dc ; .4 Amps Max (Wht/Yel 16˝ 18 AWG Wire Leads)		
RIBXGFL*	.75-150 Amp	Split Core	Fixed, .75 Amp	Solid State Switch SPST ; 30 Vac/dc ; .4 Amps Max (Wht/Yel 16˝ 18 AWG Wire Leads)	Over Trip Point	
RIBXGTF	.35-150 Amp	Split Core	Fixed, .35 Amp	Solid State Switch SPST ; 30 Vac/dc ; .4 Amps Max (Terminal Strip, Accepts #14-22 AWG Wire)		
RIBXGTFL*	.75-150 Amp	Split Core	Fixed, .75 Amp	Solid State Switch SPST ; 30 Vac/dc ; .4 Amps Max (Terminal Strip, Accepts #14-22 AWG Wire)	Over Trip Point	
RIBXGA	.75-150 Amp	Split Core	Adjustable	Solid State Switch SPST ; 30 Vac/dc ; .4 Amps Max (Wht/Yel 16˝ 18 AWG Wire Leads)	Over Trip Point	Under Trip Point
RIBXGTA	.75-150 Amp	Split Core	Adjustable	Solid State Switch SPST ; 30 Vac/dc ; .4 Amps Max (Terminal Strip, Accepts #14-22 AWG Wire)	Over Trip Point	Under Trip Point
RIBXGA-SCAL	3-150 Amp	Split Core	Self-Cal.	Solid State Switch SPST ; 30 Vac/dc ; .4 Amps Max (Wht/Yel 16˝ 18 AWG Wire Leads)	See -SCAL Table	
RIBXGTA-SCAL	3-150 Amp	Split Core	Self-Cal.	Solid State Switch SPST ; 30 Vac/dc ; .4 Amps Max (Terminal Strip, Accepts #14-22 AWG Wire)	See -SCAL Table	

* = Not approved by California State Fire Marshal

Honeywell

Series 2000
Electronic Temperature Sensors

PRODUCT DATA



APPLICATION

The Series 2000 C7021, C7023, C7031 and C7041 Electronic Temperature Sensors are designed for use with electronic controllers in domestic or commercial heating and cooling systems.

FEATURES

- **C7021D, C7023D, C7031D, C7041D for immersion mounting sense water temperature.**
- **C7021F, C7023F, C7031G, C7041F sense outdoor air temperature and are weatherproof for outdoor use (knockouts allow for 1/2 in. conduit connection).**
- **C7021J/R, C7023J/R, C7031J, C7041J/R sense average duct air temperature.**
- **C7021B/C, C7023B/C, C7031B, C7041B/C sense duct air temperature.**
- **C7021K, C7023K, C7041K with strap-on mounting senses water temperature.**
- **C7021N, C7023N, C7041N probe senses water or air temperature.**
- **C7021P, C7023P, C7041P senses air temperature.**
- **Solid state components not affected by dust or dirt.**

Contents

63-2590-06

SPECIFICATIONS

See Table 1 for additional specifications.

Compatability:

Use Series 2000 C7031, C7041 Temperature Sensors with Excel 10, 15, 80, 100, and 500 controllers.

Series 2000 C7031B,D,G,J sensors are compatible with various Honeywell controllers. The C7031G2014 is compatible with the T7350 Commercial Thermostat.

Series 2000 C7021 temperature sensors are compatible with TB7600, TB7300 and TB7200 communicating thermostats.

Series 2000 C7023 temperature sensors are compatible with WEBs-AX I/O modules.

Dimensions:

See Fig. 1 through Fig. 11.

Sensor Accuracy:

±0.36°F at 77°F (±0.2°C at 25°C) for 20K ohm NTC sensors and 10K ohm NTC Type II and Type III sensors.

Long-term Temperature Sensor Drift (for C7041 models only): Maximum sensor drift is nominally +/-0.13°F after 5 years of operation, no appreciable drift thereafter. No calibration of the device is possible. Long term drift calibration/maintenance through controller software is typically not necessary.

Accessories:

32006523-001 20K Probe: to allow replacement of old style C7031D1062-1 with non-threaded well.

50001774-001 Stainless Steel 304 Well Assembly: 1/2 in. external and internal NPT threading. Use with C7021D/C7023D/C7031D/C7041D.

50001775-001 Well Adapter: Used with C7021D/C70231D/C7031D/C7041D to allow threading sensor into previously installed Series 1000 32005960-001 Well.

Table 1. Sensor Selection and Application Guide

Model	Control Application	Element Insertion Length	Element Operating Range	Element Max Ambient Temperature	Sensor Resistance in Ohms	Sensitivity[a]
C7021B	Duct discharge air	6 in. (152) or 12		250°F (121°C)	10K Ohms NTC @ 77° F Type II	—
C7021C	Duct discharge air	18 in. (457 mm)				
C7021D	Hot or chilled water [b]	5 in. (127 mm)				
C7021F	Outdoor air	—	-40° to 158°F (-40° to 70°C)			
C7021J	Duct discharge air (averaging sensor with 4 elements)	12 ft (3.7m)	-40° to 250°F (-40° to 121°C)			
C7021K	Hot water (strap-on mounting)[f]					
C7021N	Water / Air (bullet probe)					
C7021P	Space air temperature (button probe)					
C7021R	Duct discharge air (rigid copper averaging sensor)	12 ft (3.7m) or 24 ft (7.3m)				

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the TRADELINE® Catalog or price sheets for complete ordering number.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Honeywell Automation and Control Products Sales Office (check white pages of your phone directory).
2. Honeywell Customer Care
   1885 Douglas Drive North
   Minneapolis, Minnesota 55422-4386

International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

Table 1. Sensor Selection and Application Guide

Model	Control Application	Element Insertion Length	Element Operating Range	Element Max Ambient Temperature	Sensor Resistance in Ohms	Sensitivity[a]
C7023B	Duct discharge air	6 in. (152) or 12 in. (305 mm)	-40° to 250°F (-40° to 121°C)	250°F (121°C)	10K Ohms NTC @ 77° F Type III	—
C7023C	Duct discharge air	18 in. (457 mm)				
C7023D	Hot or chilled water[b]	5 in. (127 mm)				
C7023F	Outdoor air		-40° to 158°F (-40° to 70°C)	250°F (121°C)	10K Ohms NTC @ 77° F Type III	—
C7023J	Duct discharge air (averaging sensor with 4 elements)	12 ft (3.7m)	-40° to 250°F (-40° to 121°C)			
C7023K	Hot water (strap-on mounting)[f]					
C7023N	Water / Air (bullet probe)					
C7023P	Space air temperature (button probe)					
C7023R	Duct discharge air (rigid copper averaging sensor)	12 ft (3.7m) or 24 ft (7.3m)	-40° to 250°F (-40° to 121°C)			
C7031B	Duct discharge air	6 in. (152 mm)	-40° to 250°F (-40° to 121°C)	250°F (121°C)	1097 at 77° (25°C)[c]	2.1 (3.9)
C7031D	Hot or chilled water	5 in. (127 mm)	40° to 350°F (4° to 115°C)	370°F (187°C)	1097 at 77° (25°C)[c]	2.1 (3.9)
C7031G -2006	Outdoor air	—	-40° to 120°F (-40° to 49°C)	120°F (49°C)	1715 at 90°F (32°C)[c]	2.2 (3.4)
C7031G -2014[d]	Outdoor air	—	-40° to 120°F (-40° to 49°C)	120°F (49°C)	3484 at 77°F (25°C)[c]	2.1 (3.9)
C7031J	Duct discharge air (averaging sensor with 4 elements)	12 ft (3.7m)	40° to 180°F (4° to 82°C)	250°F (121°C)	1097 at 77° (25°C)[c]	2.1 (3.9)
C7041B	Duct discharge air	6 in. (152 mm) or 12 in. (305 mm)	-40° to 250°F (-40° to 121°C)	250°F (121°C)	20K Ohms NTC at 77°F (25°C)[e]	—
C7041C	Duct discharge air	18 in. (457 mm)				
C7041D	Hot or chilled water[b]	5 in. (127 mm)				
C7041F	Outdoor air	—	-40° to 158°F (-40° to 70°C)			
C7041J	Duct discharge air (averaging sensor with 4 elements)	12 ft (3.7m)	-40° to 250°F (-40° to 121°C)			

Table 1. Sensor Selection and Application Guide

Model	Control Application	Element Insertion Length	Element Operating Range	Element Max Ambient Temperature	Sensor Resistance in Ohms	Sensitivity[a]
C7041K	Hot water (strap-on mounting)[f]	—				
C7041N	Water / Air (bullet probe)					
C7041P	Space air temperature (button probe)	—				
C7041R	Duct discharge air (rigid copper averaging sensor)	12 ft (3.7m) or 24 ft (7.3m)				

[a]Control sensitivity in ohms per degree F (per degree C) for element operating range.
[b] Order immersion well separately (50001774-001)
[c] Resistance increases as temperature increases.
[d] Use with T7350 Commercial Thermostat.
[e] Nonlinear resistance decreases as temperature increases.
[f] Not equipped with well; temperature sensed at surface of pipe.

Sensor Resistance

Table 2. Typical Resistance of Sensor Models.

	Typical Resistance (in ohms)			
	C7021 Sensors (10K Ohm NTC Type II)	C7023 Sensors (10K Ohm NTC Type III)	C7031 Sensors (1097 Ohms PTC)	C7041 Sensors (20K ohm NTC)
At 41°F (5°C)	25,392	23,467	1,020	54,200
At 50°F (10°C)	19,901	18,789	1,039	41,758
At 59°F (15°C)	15,712	15,137	1,059	32,427
At 68°F (20°C)	12,493	12,268	1,078	25,370
At 77°F (25°C)	10,000	10,000	1,097	20,000
At 86°F (30°C)	8,057	8,196	1,117	15,856
At 95°F (35°C)	6,531	6,754	1,136	12,654

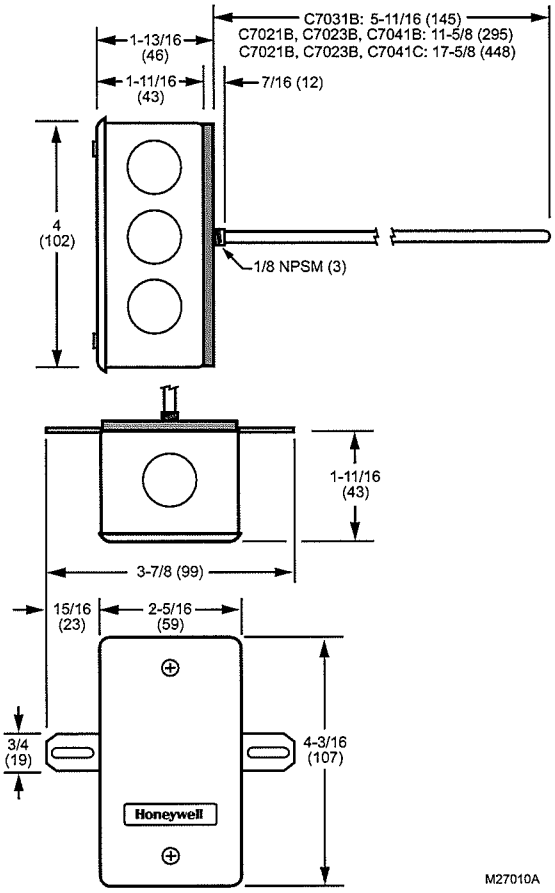


Fig. 1. C7021B/C, C7023B/C, C7041B/C dimensions in in. (mm).

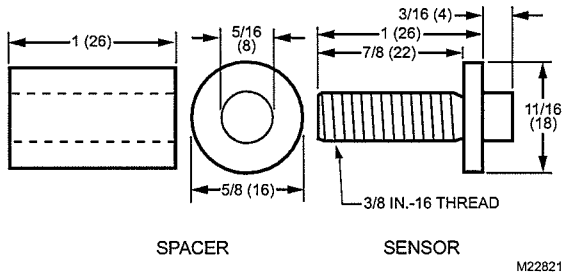


Fig. 2. Dimensions of C7021P, C7023P, C7041P in in. (mm)

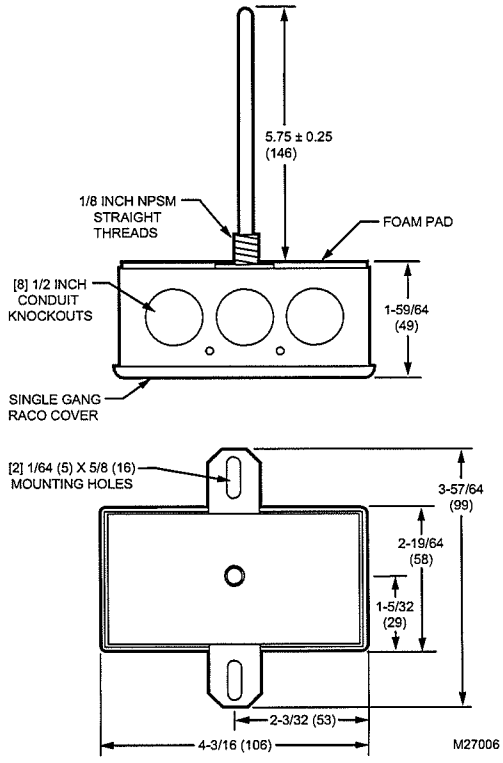


Fig. 3. C7031B dimensions in in. (mm)

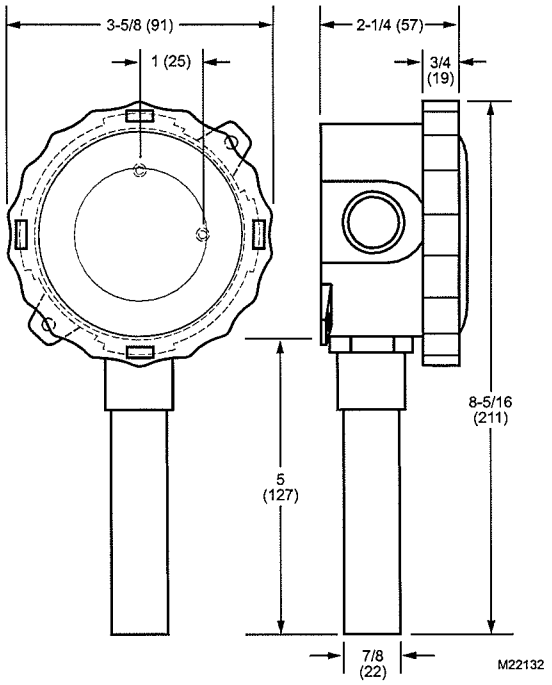


Fig. 4. C7031G, C7021F, C7023F, C7041F dimensions in in. (mm).

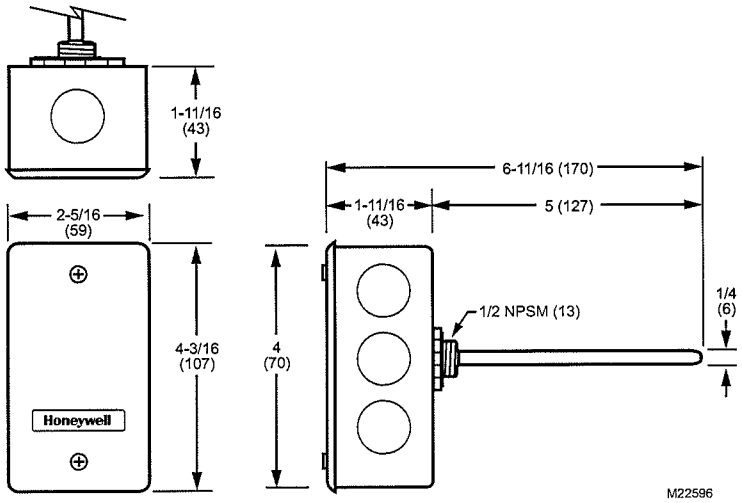


Fig. 5. C7021D, C7023D, C7031D, C7041D dimensions in in. (mm)

NOTE: The C7021D, C7023D, C7041D uses the 50001774-001 Well Assembly. See Fig. 4 for dimensions.

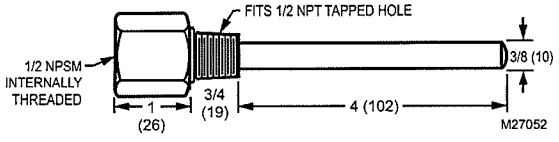


Fig. 6. 50001774-001 Immersion Well dimensions in in. (mm)

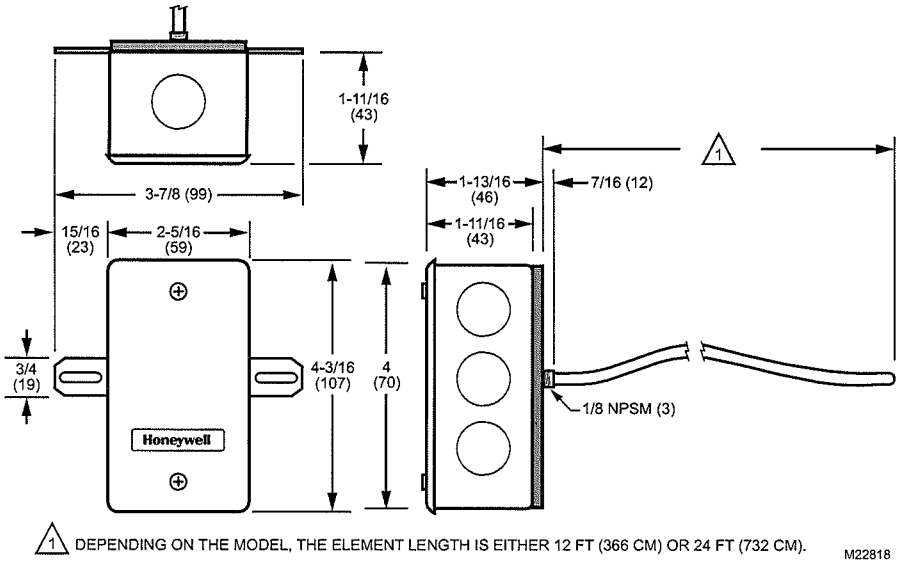


Fig. 7. C7021R, C7023R, C7041R dimensions in. (mm).

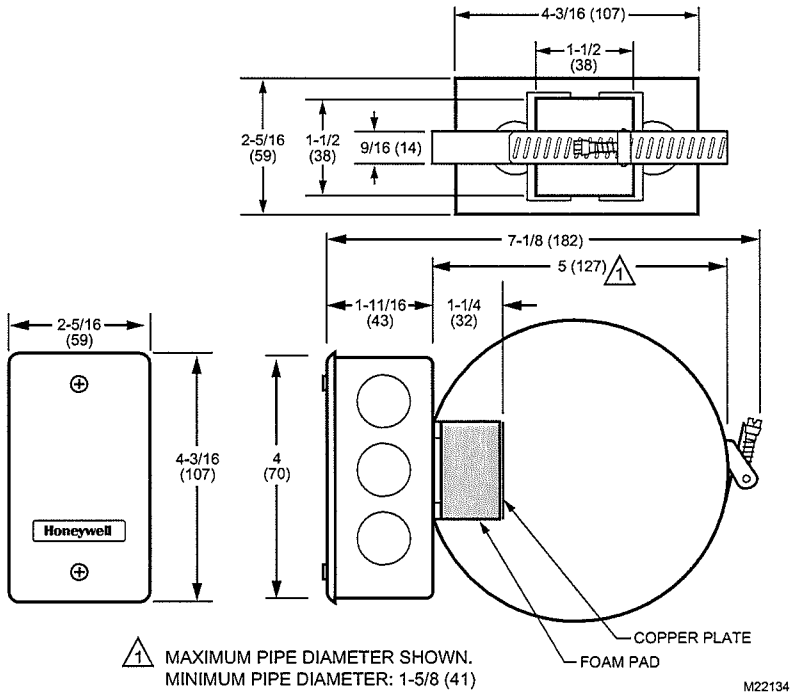


Fig. 8. C7021K, C7023K, C7041K dimensions in. (mm).

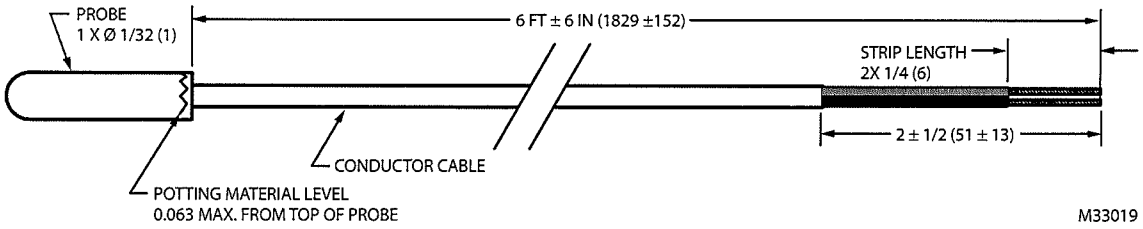


Fig. 9. C7021N, C7023N, C7041N dimensions in in. (mm).

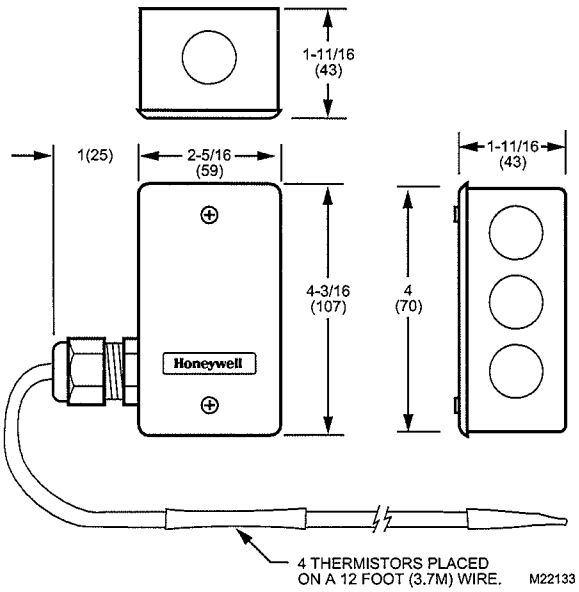


Fig. 10. C7021J, C7023J, C7031J, C7041J dimensions in in. (mm).

INSTALLATION

When Installing this Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

⚠ CAUTION

Electrical Shock or Equipment Damage Hazard. Can shock individuals or short equipment circuitry.

Disconnect power supply before installation.

Mounting

The method of mounting depends on the particular application of the temperature sensor. The following procedures include outdoor, duct, immersion well and strap-on applications. Also refer to the instructions for the electronic control.

Outdoor Mounting (C7031G, C7021F, C7023F, C7041F)

The C7031G, C7021F, C7023F and C7041F sense outdoor air temperature. Mount this control where it can sense average outdoor air temperature. Normally, the north side of a building provides a suitable location.

NOTE: These sensors are weatherproof for outdoor use. Knockouts allow for 1/2 in. conduit connection.

1. Remove and set aside the wiring box cover.
2. Mount the sensor to standard 1/2 in. conduit.

   NOTE: Mount sensor so that the element points down.
3. Make wiring connections using two wire nuts.
4. Reattach the wiring box cover.

Duct Mounting

The C7031B, C7031J, C7021B/C/J, C7023B/C/J, C7041B/C/J can be mounted in a duct to sense air temperature.

IMPORTANT

Select a spot for the sensor where it will be exposed to average duct air temperature. Avoid locations where stratification can cause sensing errors.

C7021B,C/C7023B/C, C7041B/C MOUNTING

1. Cut a hole in the duct just large enough to accept the sensing element.
2. Use the sensor case to mark the locations of the pilot holes for the mounting screws.
3. Drill the pilot holes and fasten the sensor to the duct.

C7021J, C7023J, C7031J, C7041J MOUNTING

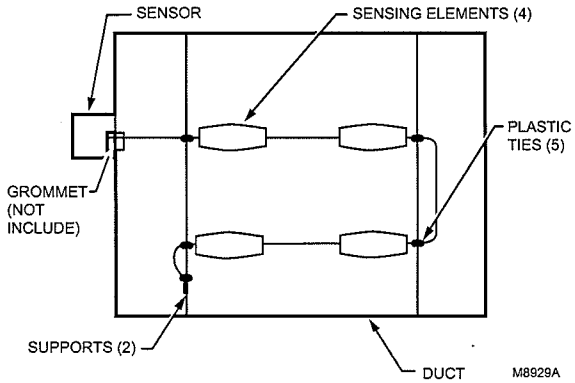


Fig. 11. Duct cross section showing method of installing C7021J, C7023J, C7031J, C7041J Averaging Electronic Sensor.

1. Install two supports inside the duct to hold the averaging element.
2. Cut a 7/8 in. (22 mm) hole in the side of the duct to insert the averaging element.
3. Fasten the terminal box to the outside of the duct and thread the element through the hole and into the duct.
4. Use plastic wire ties to fasten the element to supports. Seal the hole around the element with a rubber grommet.
5. Secure the end of the element to the duct on the support to prevent continuous flexing or abrasion.

IMPORTANT

To assure that the C7021J, C7023J, C7031J, C7041J senses average duct temperature, position the temperature elements approximately as shown in Fig. 11. Do not allow the elements to touch or be close to the duct sides.

NOTE: When the sensor is used as a deck sensor in a multizone system, be sure to space the elements equally in the duct midstream as shown in Fig. 12.

Install one C7021J, C7023J, C7031J, C7041J just upstream from the cold deck zone dampers and the other C7021J, C7023J, C7031J, C7041J upstream from the hot deck zone dampers. Position the thermistors to sense the average deck temperature.

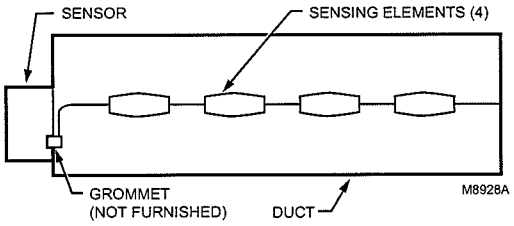


Fig. 12. Duct cross section showing method of installing C7021J, C7023J, C7031J, C7041J in a multizone system.

C7021R, C7023R, C7041R MOUNTING

1. Install two supports inside the duct to hold the averaging element.
2. Cut a 7/8 in. (22 mm) hole in the side of the duct.
3. Insert the averaging element into the duct through the hole.
4. Fasten the terminal box to the outside of the duct and thread the element through the hole and into the duct.
5. Use plastic wire ties to fasten the element to the supports. Seal the hole around the element with a rubber grommet.
6. Secure the end of the element to the duct on the support to prevent continuous flexing or abrasion.

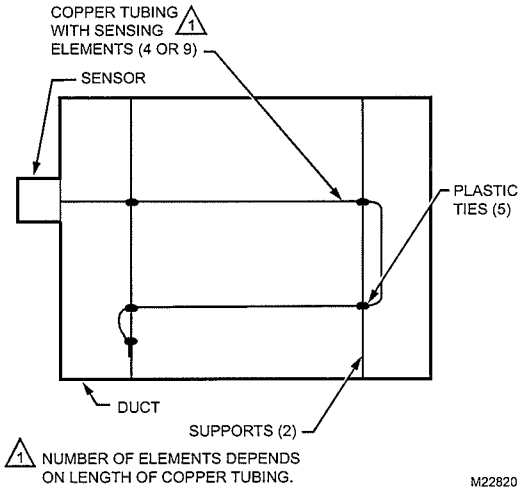


Fig. 13. Duct cross section showing method of installing C7021R, C7023R, C7041R Averaging Electronic Sensor.

IMPORTANT

To ensure that the C7021R, C7023R, C7041R senses average duct temperature, position the temperature elements approximately as shown in Fig. 13. Do not allow the elements to touch or be close to the duct sides.

NOTE: When the sensor is used as a deck sensor in a multizone system, be sure to space the elements equally in the duct midstream as shown in Fig. 14.

Install one C7021R, C7023R, C7041R just upstream from the cold deck zone dampers and the other C7021R, C7023R, C7041R upstream from the hot deck zone dampers. Position the thermistors to sense the average deck temperature.

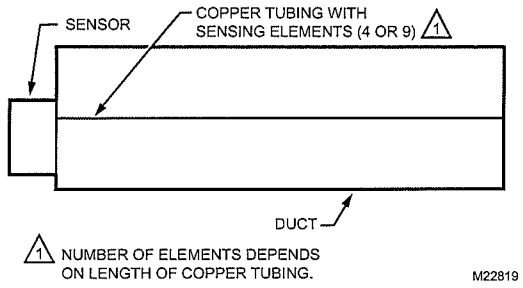


Fig. 14. Duct cross section showing method of installing C7021R, C7023R, C7041R in a multizone system.

Immersion Well Mounting (C7021D, C7023D, C7031D, C7041D)

The C7031D Sensor includes an immersion well. The C7021D, C7023D, and C7041D sensors do not include a well. For the C7021D, C7023D, and C7041D, order the well as an accessory (part no.: 50001774-001).

When used on a boiler, follow the manufacturer instructions for location. If a tapped hole is not provided for the immersion well, provide one as follows:

1. Drain boiler and drill a 23/32 in. (18 mm) hole at the selected location.
2. Cut threads in the hole with a 1/2 in. (13 mm) by 14 NPT tap.

In other installations, mount the immersion well in an elbow with a heel outlet as shown in Fig. 15.

1. Drain the system, if you have not already done it, and open the tapped hole.
2. Put pipe joint compound on the threads of the immersion well and screw it into the tapped hole or elbow, tightening it securely.
3. Refill the system and check for leaks.

Mount the C7021D, C7023D, C7031D and C7041D into the well:

NOTE: Mounting using previously installed Honeywell wells (part no.: 32005960-001) requires an adapter (part no.: 50001775-001).

1. When an adapter is required, first thread it into the well no more than one or two turns.
2. Slide the sensor into the well.
3. Rotate the sensor to thread it tightly into the adapter and the adapter tightly into the well.

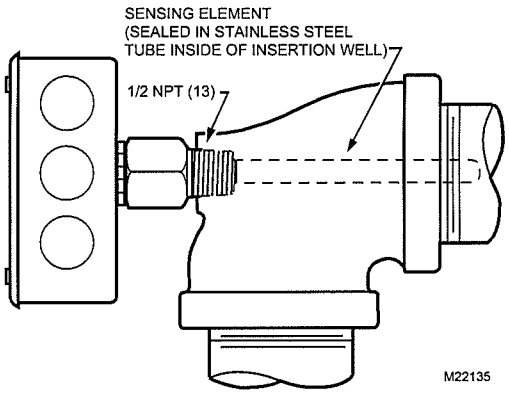


Fig. 15. Method of mounting C7021D, C7023D, C7031D, C7041D Sensor.

Strap-On Mounting (C7021K, C7023K, C7041K)

Strap-on mounting is well-suited for retrofit applications where installation costs can be reduced by not draining the system. The C7021K, C7023K, C7041K Sensor mounts on metal pipes from 1-5/8 inch to five inches in diameter using the straps supplied. Clean the surface of the pipe where the sensor makes contact before mounting (remove insulation from the pipe at the point of installation if necessary). Thermal compound is recommended with the strap-on C7021K, C7023K, C7041K Sensor. Locate the sensor on the discharge pipe within 3 feet (0.9m) of the boiler. See Fig. 16.

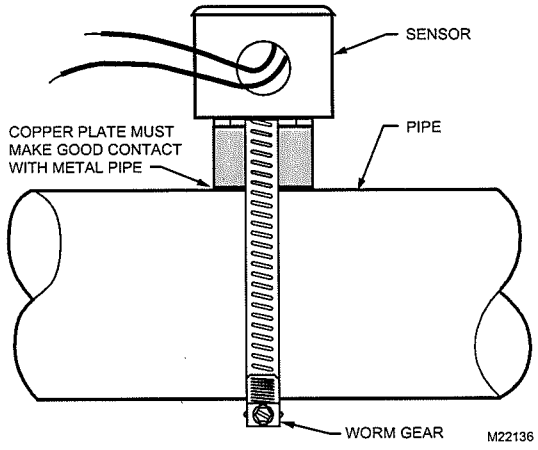


Fig. 16. Strap-on mounting of C7021K, C7023K, C7041K Sensor.

NOTE: Insulation around the contact area increases sensor accuracy.

Button Probe Mounting

The C7021P, C7023P, C7041P Button Probe Sensor design simplifies mounting into a variety of standard structural materials.

The locking nut can be used to secure the probe. See Fig. 18.

The plastic spacer helps insulate the probe from drywall, wood, or other material in which the probe is mounted. The spacer is sized to fit snugly into 1/2 in. metal conduit. See Fig. 17.

NOTES:
- — The plastic spacer is threaded for easy installation.
- — Use of both the locking nut and spacer requires cutting spacer to shorter length.

C7041P MOUNTING RECOMMENDATIONS

Determine the proper location based upon the following:
- — Mount the probe to an inside wall approximately 54 in. (1372 mm) from the floor (or in the specified location) to allow exposure to the average zone temperature.
- — Do not mount the probe to an outside wall, a wall containing waterpipes, or near air ducts.
- — Avoid locations exposed to register discharge air, or radiation from lights, appliances, or the sun.

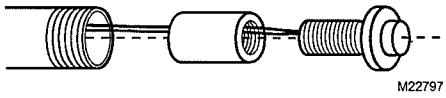


Fig. 17. Mounting sensor in conduit.

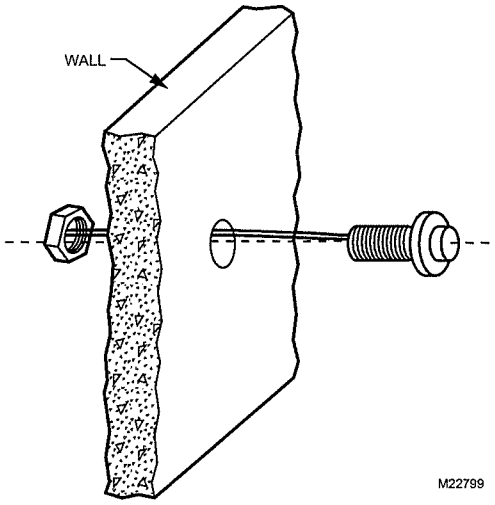


Fig. 18. Mounting sensor in wall with nut only.

Bullet Probe Sensor Mounting (C7021N, C7023N, C7041N)

The bullet probe sensor is a water-resistant sensor that provides a cost-effective solution for surface contact temperature measurement of conditioned water pipes, low pressure steam or refrigerant lines. These sensors are ideal for applications where immersion wells are not practical to install. These sensors can also be use to sense air temperature.

WIRING

CAUTION

Erratic System Operation Hazard.
Failure to follow proper wiring practices can introduce disruptive electrical interference (noise).

Keep wiring at least one foot away from large inductive loads such as motors line starters, lighting ballasts, and large power distribution panels.

Shielded cable is required in installations where these guidelines cannot be met.

Ground shield only to grounded controller case.

CAUTION

Electrical Shock or Equipment Damage Hazard.
Can shock individuals or short equipment circuitry.

Disconnect power supply before installation.

IMPORTANT

1. *All wiring must agree with applicable codes, ordinances and regulations.*
2. *Do not mount sensor in incorrect environment.*
3. *Wire according to the applicable controller instructions.*

OPERATION AND CHECKOUT

Operation

The C7041 Temperature Sensors are designed for use with XL500, XL100, XL50, XL15, XL10, and Honeywell LCBS Controllers or any controller requiring 20K ohm NTC non-linear input. As the temperature at the C7041 Sensor increases, the resistance of the sensor decreases, causing the controller to operate and offset the temperature change.

The C7021 Temperature Sensors are designed for use with the TB7600, TB7300, and TB7200 Series Communicating Thermostats or any controller requiring a 10K ohm NTC Type II input.

The C7023 Temperature Sensors are designed for use with WEBs-AX I/O Modules or any controller requiring a 10K ohm NTC Type III input.

Checkout

Refer to the applicable controller instructions when checking out the complete heating and cooling systems.

To check out the sensors, move the thermostat or remote setpoint potentiometer below the temperature of the cooling or heating medium. Watch the motor, valve or damper for the correct movement.

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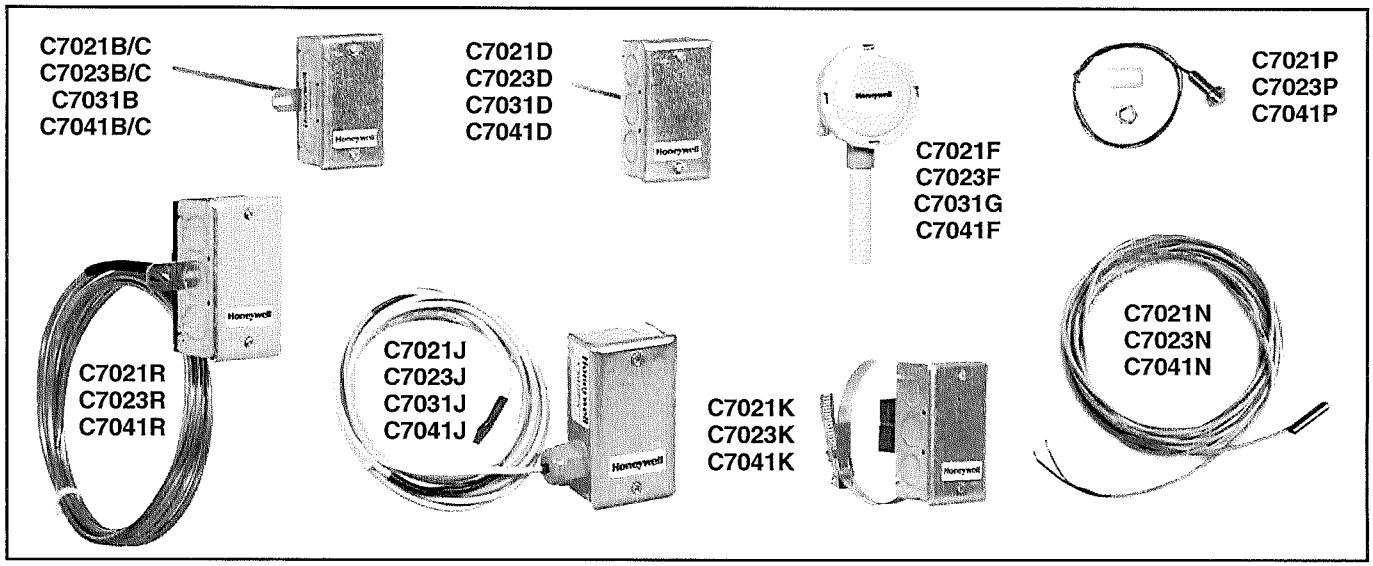
63-2590—06 M.S. Rev. 01-12
Printed in United States

Honeywell

Honeywell

Series 2000 Electronic Temperature Sensors

PRODUCT DATA



APPLICATION

The Series 2000 C7021, C7023, C7031 and C7041 Electronic Temperature Sensors are designed for use with electronic controllers in domestic or commercial heating and cooling systems.

FEATURES

- **C7021D, C7023D, C7031D, C7041D for immersion mounting sense water temperature.**
- **C7021F, C7023F, C7031G, C7041F sense outdoor air temperature and are weatherproof for outdoor use (knockouts allow for 1/2 in. conduit connection).**
- **C7021J/R, C7023J/R, C7031J, C7041J/R sense average duct air temperature.**
- **C7021B/C, C7023B/C, C7031B, C7041B/C sense duct air temperature.**
- **C7021K, C7023K, C7041K with strap-on mounting senses water temperature.**
- **C7021N, C7023N, C7041N probe senses water or air temperature.**
- **C7021P, C7023P, C7041P senses air temperature.**
- **Solid state components not affected by dust or dirt.**

Contents

63-2590-06

SPECIFICATIONS

See Table 1 for additional specifications.

Compatability:

Use Series 2000 C7031, C7041 Temperature Sensors with Excel 10, 15, 80, 100, and 500 controllers.

Series 2000 C7031B,D,G,J sensors are compatible with various Honeywell controllers. The C7031G2014 is compatible with the T7350 Commercial Thermostat.

Series 2000 C7021 temperature sensors are compatible with TB7600, TB7300 and TB7200 communicating thermostats.

Series 2000 C7023 temperature sensors are compatible with WEBs-AX I/O modules.

Dimensions:

See Fig. 1 through Fig. 11.

Sensor Accuracy:

±0.36°F at 77°F (±0.2°C at 25°C) for 20K ohm NTC sensors and 10K ohm NTC Type II and Type III sensors.

Long-term Temperature Sensor Drift (for C7041 models only): Maximum sensor drift is nominally +/-0.13°F after 5 years of operation, no appreciable drift thereafter. No calibration of the device is possible. Long term drift calibration/maintenance through controller software is typically not necessary.

Accessories:

32006523-001 20K Probe: to allow replacement of old style C7031D1062-1 with non-threaded well.

50001774-001 Stainless Steel 304 Well Assembly: 1/2 in. external and internal NPT threading. Use with C7021D/C7023D/C7031D/C7041D.

50001775-001 Well Adapter: Used with C7021D/C70231D/C7031D/C7041D to allow threading sensor into previously installed Series 1000 32005960-001 Well.

Table 1. Sensor Selection and Application Guide

Model	Control Application	Element Insertion Length	Element Operating Range	Element Max Ambient Temperature	Sensor Resistance in Ohms	Sensitivity[a]
C7021B	Duct discharge air	6 in. (152) or 12		250°F (121°C)	10K Ohms NTC @ 77° F Type II	—
C7021C	Duct discharge air	18 in. (457 mm)				
C7021D	Hot or chilled water [b]	5 in. (127 mm)				
C7021F	Outdoor air	—	-40° to 158°F (-40° to 70°C)			
C7021J	Duct discharge air (averaging sensor with 4 elements)	12 ft (3.7m)	-40° to 250°F (-40° to 121°C)			
C7021K	Hot water (strap-on mounting)[f]					
C7021N	Water / Air (bullet probe)					
C7021P	Space air temperature (button probe)					
C7021R	Duct discharge air (rigid copper averaging sensor)	12 ft (3.7m) or 24 ft (7.3m)				

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the TRADELINE® Catalog or price sheets for complete ordering number.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Honeywell Automation and Control Products Sales Office (check white pages of your phone directory).
2. Honeywell Customer Care
   1885 Douglas Drive North
   Minneapolis, Minnesota 55422-4386

International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

Table 1. Sensor Selection and Application Guide

Model	Control Application	Element Insertion Length	Element Operating Range	Element Max Ambient Temperature	Sensor Resistance in Ohms	Sensitivity[a]
C7023B	Duct discharge air	6 in. (152) or 12 in. (305 mm)	-40° to 250°F (-40° to 121°C)	250°F (121°C)	10K Ohms NTC @ 77° F Type III	—
C7023C	Duct discharge air	18 in. (457 mm)				
C7023D	Hot or chilled water [b]	5 in. (127 mm)				
C7023F	Outdoor air		-40° to 158°F (-40° to 70°C)	250°F (121°C)	10K Ohms NTC @ 77° F Type III	—
C7023J	Duct discharge air (averaging sensor with 4 elements)	12 ft (3.7m)	-40° to 250°F (-40° to 121°C)			
C7023K	Hot water (strap-on mounting)[f]					
C7023N	Water / Air (bullet probe)					
C7023P	Space air temperature (button probe)					
C7023R	Duct discharge air (rigid copper averaging sensor)	12 ft (3.7m) or 24 ft (7.3m)	-40° to 250°F (-40° to 121°C)			
C7031B	Duct discharge air	6 in. (152 mm)	-40° to 250°F (-40° to 121°C)	250°F (121°C)	1097 at 77° (25°C)[c]	2.1 (3.9)
C7031D	Hot or chilled water	5 in. (127 mm)	40° to 350°F (4° to 115°C)	370°F (187°C)	1097 at 77° (25°C)[c]	2.1 (3.9)
C7031G -2006	Outdoor air	—	-40° to 120°F (-40° to 49°C)	120°F (49°C)	1715 at 90°F (32°C)[c]	2.2 (3.4)
C7031G -2014[d]	Outdoor air	—	-40° to 120°F (-40° to 49°C)	120°F (49°C)	3484 at 77°F (25°C)[c]	2.1 (3.9)
C7031J	Duct discharge air (averaging sensor with 4 elements)	12 ft (3.7m)	40° to 180°F (4° to 82°C)	250°F (121°C)	1097 at 77° (25°C)[c]	2.1 (3.9)
C7041B	Duct discharge air	6 in. (152 mm) or 12 in. (305 mm)	-40° to 250°F (-40° to 121°C)	250°F (121°C)	20K Ohms NTC at 77°F (25°C)[e]	—
C7041C	Duct discharge air	18 in. (457 mm)				
C7041D	Hot or chilled water [b]	5 in. (127 mm)				
C7041F	Outdoor air	—	-40° to 158°F (-40° to 70°C)			
C7041J	Duct discharge air (averaging sensor with 4 elements)	12 ft (3.7m)	-40° to 250°F (-40° to 121°C)			

Table 1. Sensor Selection and Application Guide

Model	Control Application	Element Insertion Length	Element Operating Range	Element Max Ambient Temperature	Sensor Resistance in Ohms	Sensitivity[a]
C7041K	Hot water (strap-on mounting)[f]	—				
C7041N	Water / Air (bullet probe)					
C7041P	Space air temperature (button probe)	—				
C7041R	Duct discharge air (rigid copper averaging sensor)	12 ft (3.7m) or 24 ft (7.3m)				

[a]Control sensitivity in ohms per degree F (per degree C) for element operating range.
[b] Order immersion well separately (50001774-001)
[c] Resistance increases as temperature increases.
[d] Use with T7350 Commercial Thermostat.
[e] Nonlinear resistance decreases as temperature increases.
[f] Not equipped with well; temperature sensed at surface of pipe.

Sensor Resistance

Table 2. Typical Resistance of Sensor Models.

	Typical Resistance (in ohms)			
	C7021 Sensors (10K Ohm NTC Type II)	C7023 Sensors (10K Ohm NTC Type III)	C7031 Sensors (1097 Ohms PTC)	C7041 Sensors (20K ohm NTC)
At 41°F (5°C)	25,392	23,467	1,020	54,200
At 50°F (10°C)	19,901	18,789	1,039	41,758
At 59°F (15°C)	15,712	15,137	1,059	32,427
At 68°F (20°C)	12,493	12,268	1,078	25,370
At 77°F (25°C)	10,000	10,000	1,097	20,000
At 86°F (30°C)	8,057	8,196	1,117	15,856
At 95°F (35°C)	6,531	6,754	1,136	12,654

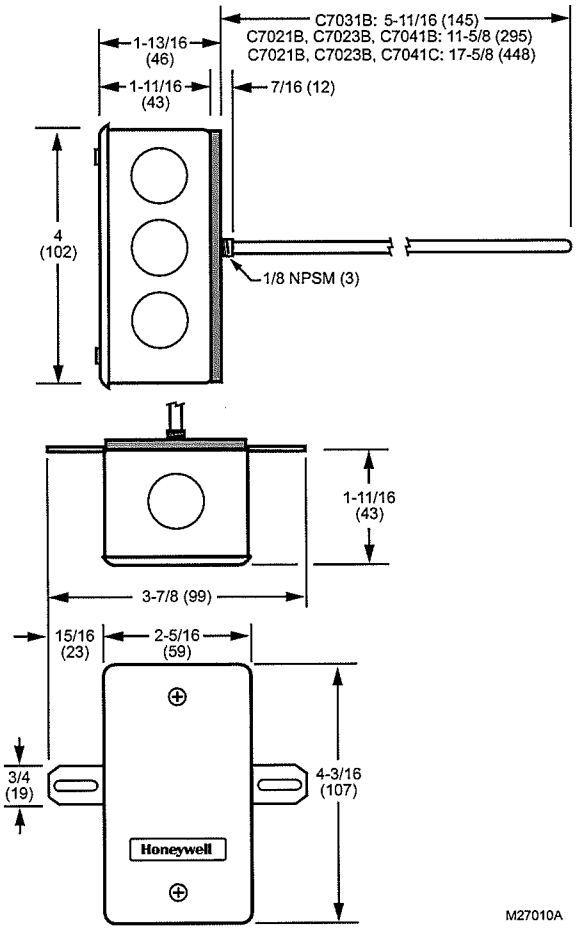


Fig. 1. C7021B/C, C7023B/C, C7041B/C dimensions in in. (mm).

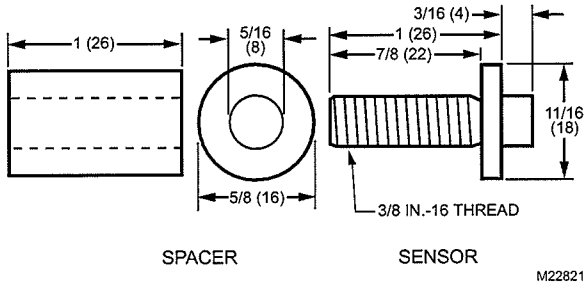


Fig. 2. Dimensions of C7021P, C7023P, C7041P in in. (mm)

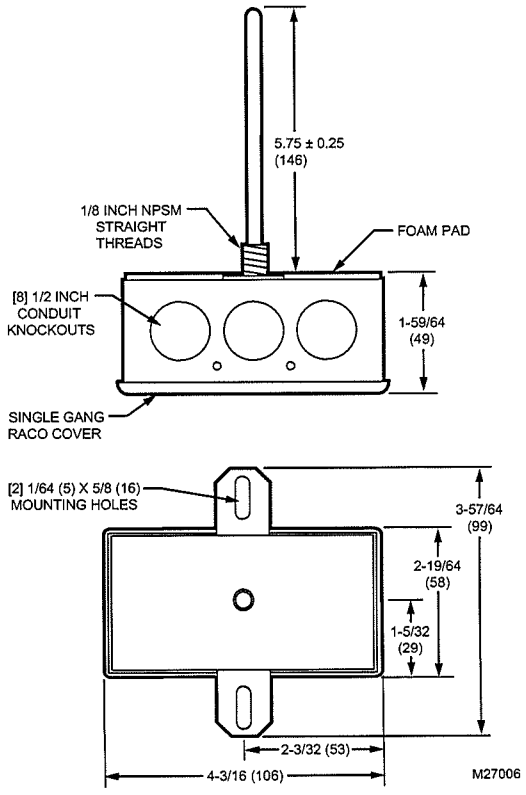


Fig. 3. C7031B dimensions in in. (mm)

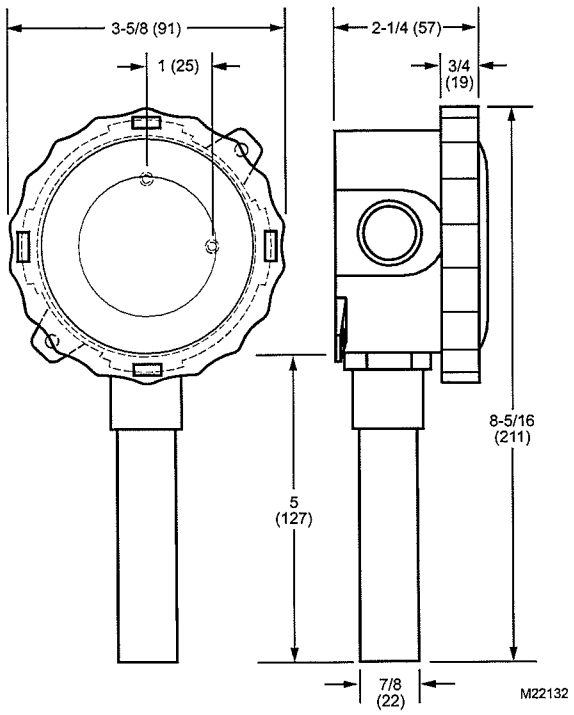


Fig. 4. C7031G, C7021F, C7023F, C7041F dimensions in in. (mm).

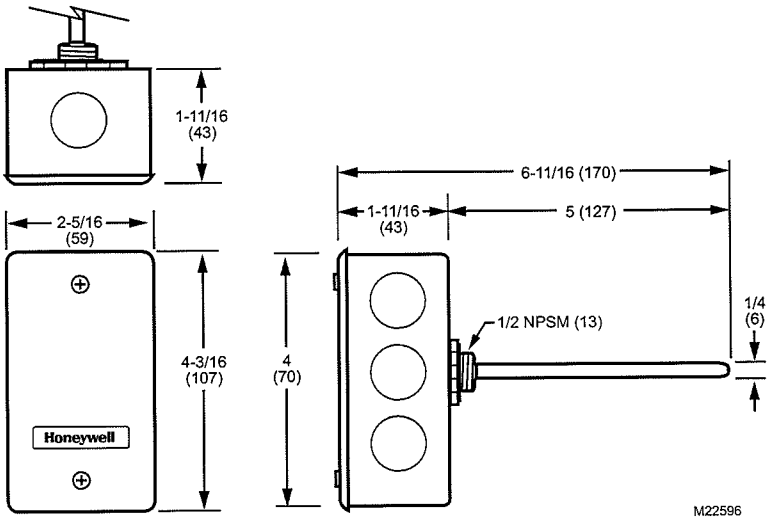


Fig. 5. C7021D, C7023D, C7031D, C7041D dimensions in in. (mm)

NOTE: The C7021D, C7023D, C7041D uses the 50001774-001 Well Assembly. See Fig. 4 for dimensions.

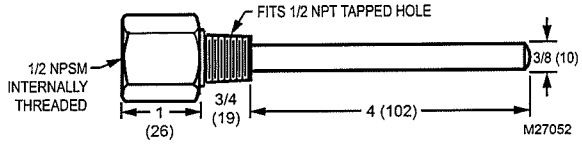


Fig. 6. 50001774-001 Immersion Well dimensions in in. (mm)

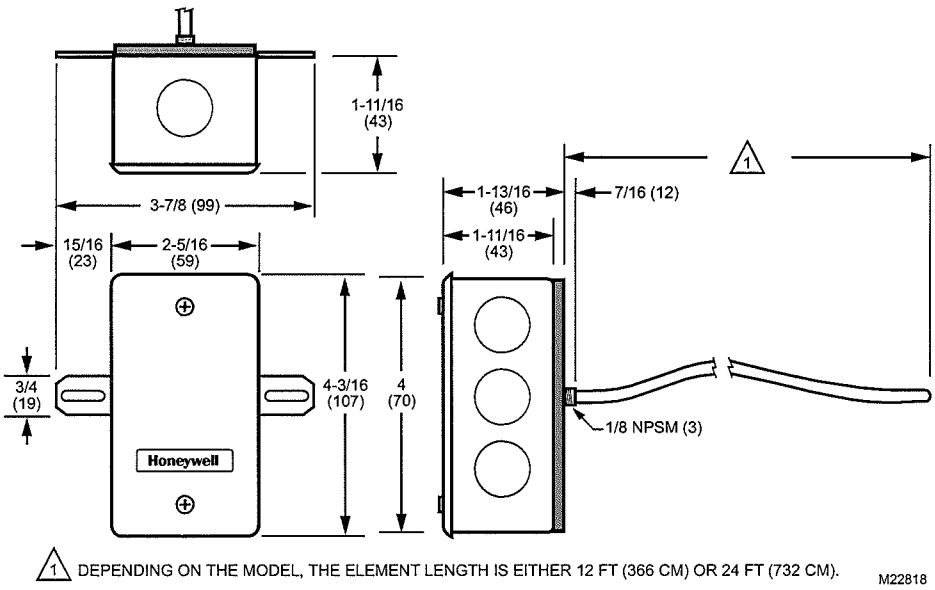


Fig. 7. C7021R, C7023R, C7041R dimensions in in. (mm).

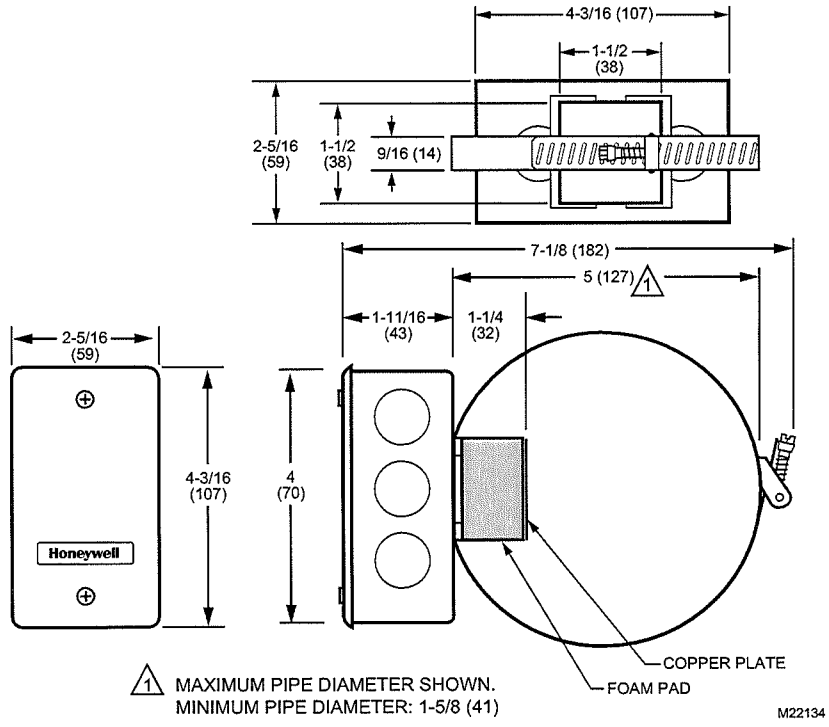


Fig. 8. C7021K, C7023K, C7041K dimensions in in. (mm).

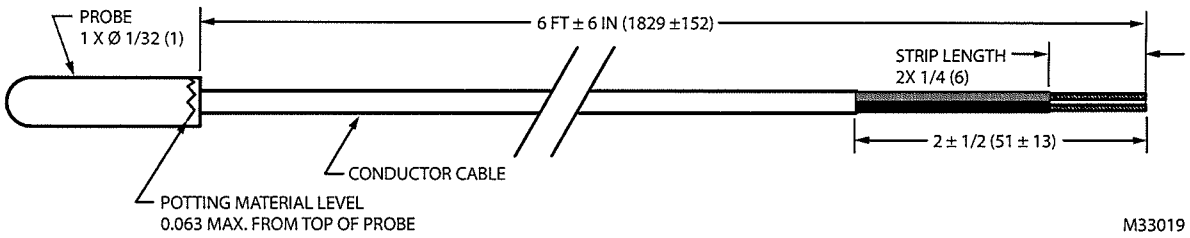


Fig. 9. C7021N, C7023N, C7041N dimensions in in. (mm).

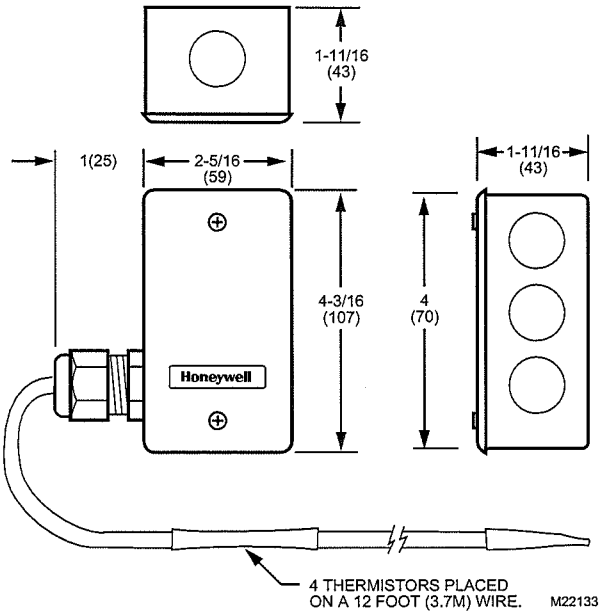


Fig. 10. C7021J, C7023J, C7031J, C7041J dimensions in in. (mm).

INSTALLATION

When Installing this Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

⚠ CAUTION

Electrical Shock or Equipment Damage Hazard. Can shock individuals or short equipment circuitry.

Disconnect power supply before installation.

Mounting

The method of mounting depends on the particular application of the temperature sensor. The following procedures include outdoor, duct, immersion well and strap-on applications. Also refer to the instructions for the electronic control.

Outdoor Mounting (C7031G, C7021F, C7023F, C7041F)

The C7031G, C7021F, C7023F and C7041F sense outdoor air temperature. Mount this control where it can sense average outdoor air temperature. Normally, the north side of a building provides a suitable location.

NOTE: These sensors are weatherproof for outdoor use. Knockouts allow for 1/2 in. conduit connection.

1. Remove and set aside the wiring box cover.
2. Mount the sensor to standard 1/2 in. conduit.

   NOTE: Mount sensor so that the element points down.
3. Make wiring connections using two wire nuts.
4. Reattach the wiring box cover.

Duct Mounting

The C7031B, C7031J, C7021B/C/J, C7023B/C/J, C7041B/C/J can be mounted in a duct to sense air temperature.

IMPORTANT

Select a spot for the sensor where it will be exposed to average duct air temperature. Avoid locations where stratification can cause sensing errors.

C7021B,C/C7023B/C, C7041B/C MOUNTING

1. Cut a hole in the duct just large enough to accept the sensing element.
2. Use the sensor case to mark the locations of the pilot holes for the mounting screws.
3. Drill the pilot holes and fasten the sensor to the duct.

C7021J, C7023J, C7031J, C7041J MOUNTING

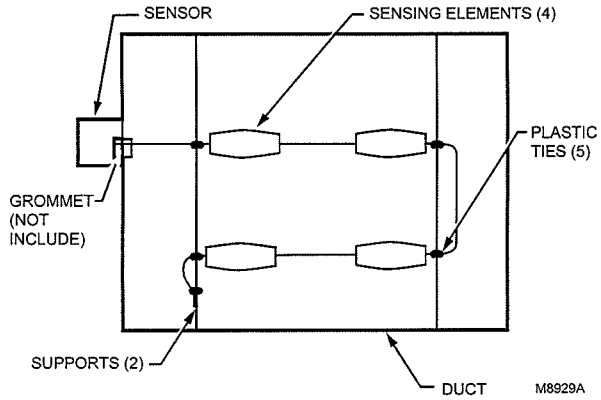


Fig. 11. Duct cross section showing method of installing C7021J, C7023J, C7031J, C7041J Averaging Electronic Sensor.

1. Install two supports inside the duct to hold the averaging element.
2. Cut a 7/8 in. (22 mm) hole in the side of the duct to insert the averaging element.
3. Fasten the terminal box to the outside of the duct and thread the element through the hole and into the duct.
4. Use plastic wire ties to fasten the element to supports. Seal the hole around the element with a rubber grommet.
5. Secure the end of the element to the duct on the support to prevent continuous flexing or abrasion.

IMPORTANT

To assure that the C7021J, C7023J, C7031J, C7041J senses average duct temperature, position the temperature elements approximately as shown in Fig. 11. Do not allow the elements to touch or be close to the duct sides.

NOTE: When the sensor is used as a deck sensor in a multizone system, be sure to space the elements equally in the duct midstream as shown in Fig. 12.

Install one C7021J, C7023J, C7031J, C7041J just upstream from the cold deck zone dampers and the other C7021J, C7023J, C7031J, C7041J upstream from the hot deck zone dampers. Position the thermistors to sense the average deck temperature.

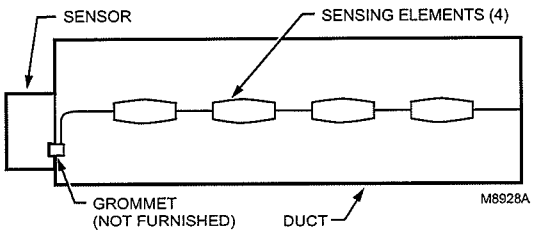


Fig. 12. Duct cross section showing method of installing C7021J, C7023J, C7031J, C7041J in a multizone system.

C7021R, C7023R, C7041R MOUNTING

1. Install two supports inside the duct to hold the averaging element.
2. Cut a 7/8 in. (22 mm) hole in the side of the duct.
3. Insert the averaging element into the duct through the hole.
4. Fasten the terminal box to the outside of the duct and thread the element through the hole and into the duct.
5. Use plastic wire ties to fasten the element to the supports. Seal the hole around the element with a rubber grommet.
6. Secure the end of the element to the duct on the support to prevent continuous flexing or abrasion.

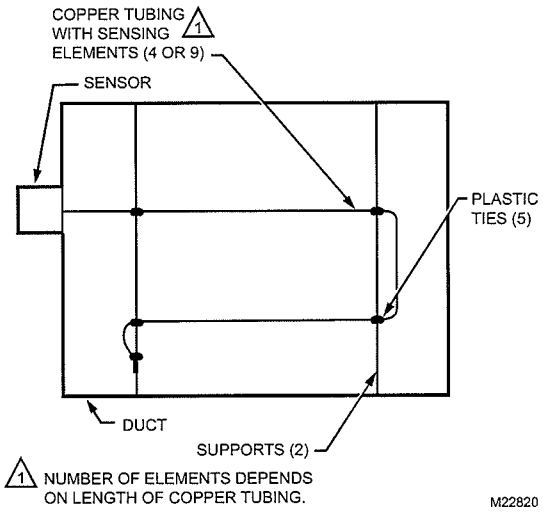


Fig. 13. Duct cross section showing method of installing C7021R, C7023R, C7041R Averaging Electronic Sensor.

IMPORTANT

To ensure that the C7021R, C7023R, C7041R senses average duct temperature, position the temperature elements approximately as shown in Fig. 13. Do not allow the elements to touch or be close to the duct sides.

NOTE: When the sensor is used as a deck sensor in a multizone system, be sure to space the elements equally in the duct midstream as shown in Fig. 14.

Install one C7021R, C7023R, C7041R just upstream from the cold deck zone dampers and the other C7021R, C7023R, C7041R upstream from the hot deck zone dampers. Position the thermistors to sense the average deck temperature.

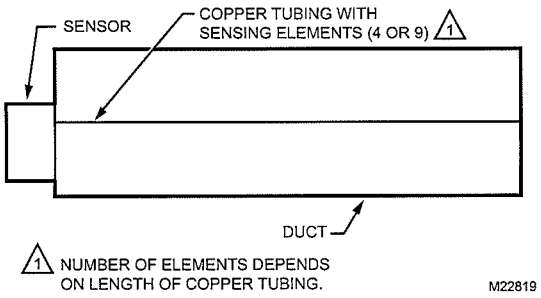


Fig. 14. Duct cross section showing method of installing C7021R, C7023R, C7041R in a multizone system.

Immersion Well Mounting (C7021D, C7023D, C7031D, C7041D)

The C7031D Sensor includes an immersion well. The C7021D, C7023D, and C7041D sensors do not include a well. For the C7021D, C7023D, and C7041D, order the well as an accessory (part no.: 50001774-001).

When used on a boiler, follow the manufacturer instructions for location. If a tapped hole is not provided for the immersion well, provide one as follows:

1. Drain boiler and drill a 23/32 in. (18 mm) hole at the selected location.
2. Cut threads in the hole with a 1/2 in. (13 mm) by 14 NPT tap.

In other installations, mount the immersion well in an elbow with a heel outlet as shown in Fig. 15.

1. Drain the system, if you have not already done it, and open the tapped hole.
2. Put pipe joint compound on the threads of the immersion well and screw it into the tapped hole or elbow, tightening it securely.
3. Refill the system and check for leaks.

Mount the C7021D, C7023D, C7031D and C7041D into the well:

NOTE: Mounting using previously installed Honeywell wells (part no.: 32005960-001) requires an adapter (part no.: 50001775-001).

1. When an adapter is required, first thread it into the well no more than one or two turns.
2. Slide the sensor into the well.
3. Rotate the sensor to thread it tightly into the adapter and the adapter tightly into the well.

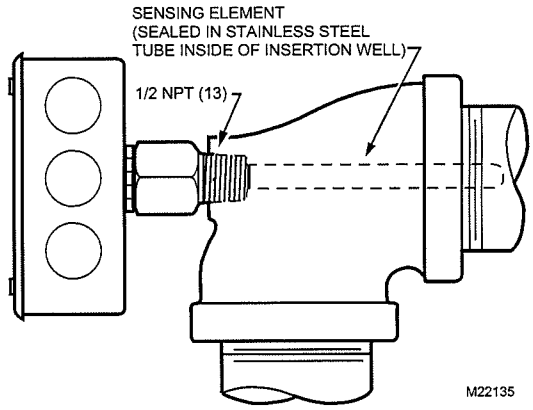


Fig. 15. Method of mounting C7021D, C7023D, C7031D, C7041D Sensor.

Strap-On Mounting (C7021K, C7023K, C7041K)

Strap-on mounting is well-suited for retrofit applications where installation costs can be reduced by not draining the system. The C7021K, C7023K, C7041K Sensor mounts on metal pipes from 1-5/8 inch to five inches in diameter using the straps supplied. Clean the surface of the pipe where the sensor makes contact before mounting (remove insulation from the pipe at the point of installation if necessary). Thermal compound is recommended with the strap-on C7021K, C7023K, C7041K Sensor. Locate the sensor on the discharge pipe within 3 feet (0.9m) of the boiler. See Fig. 16.

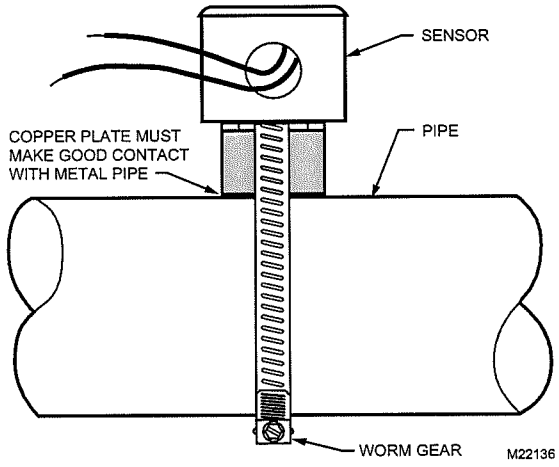


Fig. 16. Strap-on mounting of C7021K, C7023K, C7041K Sensor.

NOTE: Insulation around the contact area increases sensor accuracy.

Button Probe Mounting

The C7021P, C7023P, C7041P Button Probe Sensor design simplifies mounting into a variety of standard structural materials.

The locking nut can be used to secure the probe. See Fig. 18.

The plastic spacer helps insulate the probe from drywall, wood, or other material in which the probe is mounted. The spacer is sized to fit snugly into 1/2 in. metal conduit. See Fig. 17.

NOTES:
- — The plastic spacer is threaded for easy installation.
- — Use of both the locking nut and spacer requires cutting spacer to shorter length.

C7041P MOUNTING RECOMMENDATIONS

Determine the proper location based upon the following:
- — Mount the probe to an inside wall approximately 54 in. (1372 mm) from the floor (or in the specified location) to allow exposure to the average zone temperature.
- — Do not mount the probe to an outside wall, a wall containing waterpipes, or near air ducts.
- — Avoid locations exposed to register discharge air, or radiation from lights, appliances, or the sun.

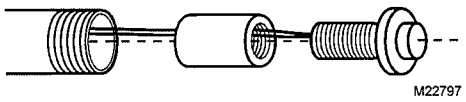


Fig. 17. Mounting sensor in conduit.

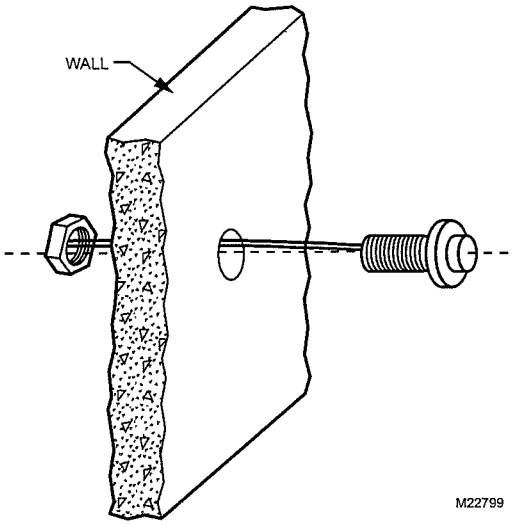


Fig. 18. Mounting sensor in wall with nut only.

Bullet Probe Sensor Mounting (C7021N, C7023N, C7041N)

The bullet probe sensor is a water-resistant sensor that provides a cost-effective solution for surface contact temperature measurement of conditioned water pipes, low pressure steam or refrigerant lines. These sensors are ideal for applications where immersion wells are not practical to install. These sensors can also be use to sense air temperature.

WIRING

⚠ CAUTION

Erratic System Operation Hazard.
Failure to follow proper wiring practices can introduce disruptive electrical interference (noise).

Keep wiring at least one foot away from large inductive loads such as motors line starters, lighting ballasts, and large power distribution panels.

Shielded cable is required in installations where these guidelines cannot be met.

Ground shield only to grounded controller case.

⚠ CAUTION

Electrical Shock or Equipment Damage Hazard.
Can shock individuals or short equipment circuitry.

Disconnect power supply before installation.

IMPORTANT

1. *All wiring must agree with applicable codes, ordinances and regulations.*
2. *Do not mount sensor in incorrect environment.*
3. *Wire according to the applicable controller instructions.*

OPERATION AND CHECKOUT

Operation

The C7041 Temperature Sensors are designed for use with XL500, XL100, XL50, XL15, XL10, and Honeywell LCBS Controllers or any controller requiring 20K ohm NTC non-linear input. As the temperature at the C7041 Sensor increases, the resistance of the sensor decreases, causing the controller to operate and offset the temperature change.

The C7021 Temperature Sensors are designed for use with the TB7600, TB7300, and TB7200 Series Communicating Thermostats or any controller requiring a 10K ohm NTC Type II input.

The C7023 Temperature Sensors are designed for use with WEBs-AX I/O Modules or any controller requiring a 10K ohm NTC Type III input.

Checkout

Refer to the applicable controller instructions when checking out the complete heating and cooling systems.

To check out the sensors, move the thermostat or remote setpoint potentiometer below the temperature of the cooling or heating medium. Watch the motor, valve or damper for the correct movement.

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63-2590—06 M.S. Rev. 01-12
Printed in United States

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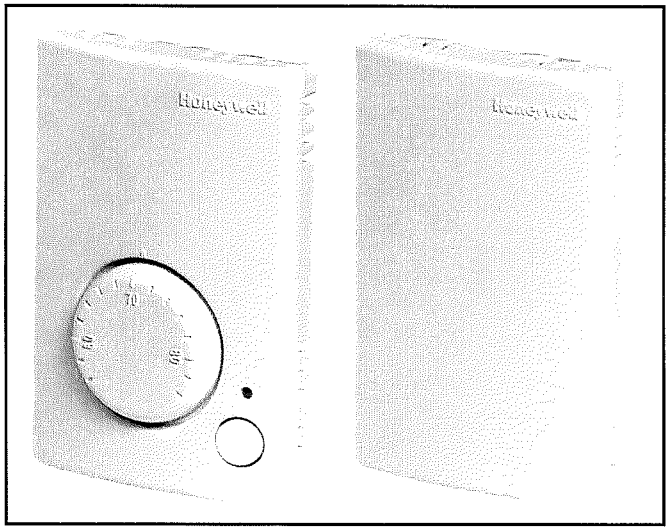
TR21, TR22, TR23, and TR24 Wall Modules

INSTALLATION INSTRUCTIONS



FEATURES

The TR21, TR22, TR23, and TR24 family of wall modules include:

- **Models with setpoint adjustment.**
- **Models with humidity output.**
- **Models with occupied/unoccupied override (bypass) with LED.**
- **Models with 3-position (auto/0/1) or 5-position (auto/0/1/2/3 speed) fan switch.**
- **LONWORKS® bus jack on all models except the TR21 and TR21-A models.**
- **Locking cover on all models.**
- **Operating range 45° to 99° F (7° to 37° C).**
- **Models (TR22 and TR23) with user-selectable temperature setpoint dials in Fahrenheit, Celsius, and Relative (- to +).**

PRODUCT DESCRIPTION

The TR21, TR22, TR23, and TR24 are a family of direct-wired wall modules for use with:

- — Honeywell Excel 800, 600, 500, 100, and 80 (all fully programmable) controllers
- — Excel 10 W7750, W7751[a], W7752, and W7753 controllers
- — W7761 Controller
- — Spyder Unitary Controllers: PUL, PVL
- — ComfortPoint LON Controllers: CP-UL, CP-VL

All models have a space temperature sensor. Some models have a temperature dial, setpoint adjustment, LONWORKS bus jack, override (bypass) with LED, and fan switch.

NOTE: Refer to the *TR21, TR22, TR23, and TR24 Wall Modules – Specification Data*, form 63-1321, for specific model features and additional information.

[a] The TR21, TR22, TR23, and TR24 wall modules are not compatible with W7751A,C,E,G Controllers.

SPECIFICATIONS

Models: For specific model information, see *TR21, TR22, TR23, and TR24 Wall Modules – Specification Data*, form 63-1321.

Environmental Ratings:

- Operating Temperature: 45° to 99° F (7° to 37° C).
- Shipping Temperature: -40° to 150° F (-40° to 65.5° C).

Accessories: 50007298-001 (pack of 12) medium, cover plate; 6-7/8 x 5 in. (175 x 127 mm).

Approvals: CE; UL94 plastic enclosure; FCC Part 15, Class B

Temperature Sensor

TR21, TR22, TR23, and TR24 20K Ohm Nonlinearized Sensor:
All models are furnished with a 20K Ohm nonlinear NTC temperature sensor that follows a specific temperature resistance curve. See Fig. 1 on page 2.

NOTE: The TR21-A wall module model has two (2) 20K Ohm nonlinear NTC temperature sensors in parallel, which provide 10K NTC temperature sensing necessary for averaging.

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62-0267-07

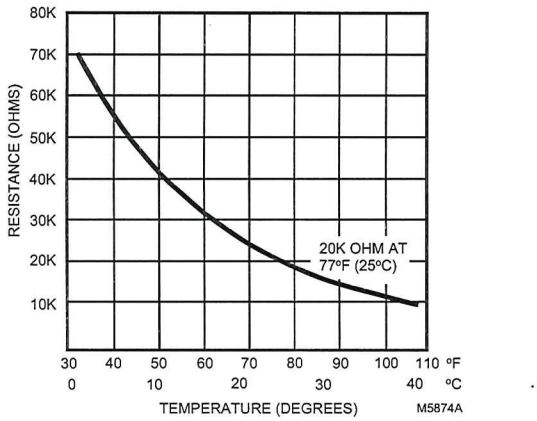


Fig. 1. Temperature vs. Resistance for Nonlinear Sensor.

Communications

All wall modules (except the TR21 and TR21-A models) have a LONMARK® bus communications port. If needed, the jack plug must be removed in the field, and terminals 3 and 4 wired according to the installation instructions.

The recommended wire size for the LONMARK® bus is Level IV, 22 AWG (0.34 sq.mm) plenum or non-plenum rated, non-shielded, twisted pair, solid conductor wire.

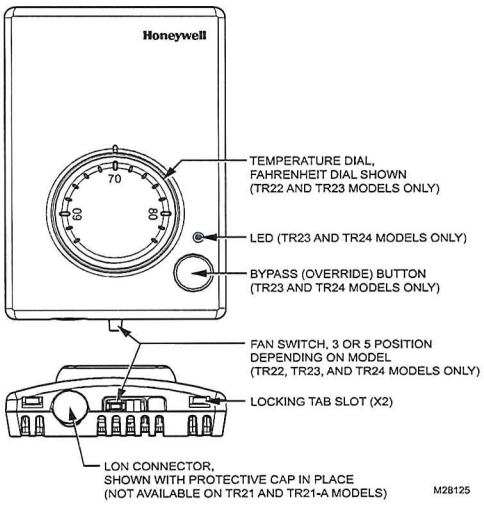


Fig. 2. Wall Module Features (TR23-F Shown).

TR22 and TR23 Setpoint Adjustment

For models TR22 and TR23 with a setpoint adjustment, the controller must be programmed for the values in Table 1.

Table 1. Wall Module Setpoint Configuration

Model	Setpoint	Resistance (Ohms)
F Absolute	55° F	9574
	85° F	1426
Relative	-9° F offset from 70° F	9574
	+9° F offset from 70° F	1426
C Absolute	12° C	9945
	30° C	1150

BEFORE INSTALLATION

⚠ CAUTION

Erratic System Operation Hazard.
Failure to follow proper wiring practices can introduce disruptive electrical interference (noise).
Keep wiring at least one foot away from large inductive loads such as motors, line starters, lighting ballasts, and large power distribution panels.
Shielded cable is required in installations where these guidelines cannot be met.
Ground shield only to grounded controller case.

IMPORTANT

All wiring must comply with local electrical codes and ordinances or as specified on installation wiring diagrams.

— Wall module wiring can be sized from 16 to 22 AWG (1.31 to 0.33 sq. mm) depending on the application.
— The maximum length of wire from a device to a wall module is 1000 ft. (305 m).
— Twisted pair wire is recommended for wire runs longer than 100 ft. (30.5 m).

INSTALLATION

Mount the wall module on an inside wall approximately 54 in. (1372 mm) from the floor (or in the specified location) to allow exposure to the average zone temperature. Do not mount the wall module on an outside wall, on a wall containing water pipes, or near air ducts. Avoid locations that are exposed to discharge air from registers or radiation from lights, appliances, or the sun. See “Cover Disassembly” on page 3.

The wall module can be mounted on a wall, on a standard utility conduit box using No. 6 (3.5 mm) screws or on a 60 mm wall outlet box (see Fig. 3). When mounting directly on a wall, use the type of screws appropriate for the wall material.

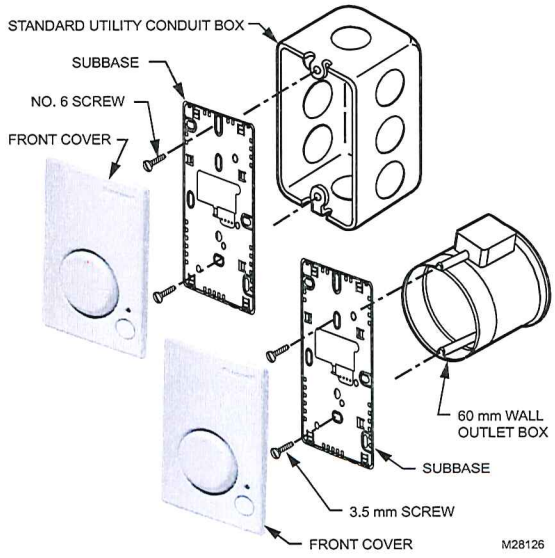


Fig. 3. Mounting on Standard Utility Conduit Box or 60 mm Wall Outlet Box (TR23 Shown).

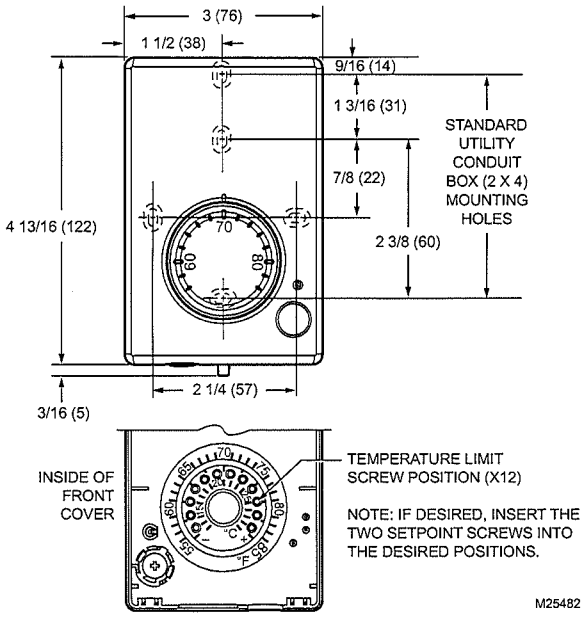


Fig. 4. Wall Module Subbase Dimensions in Inches (mm) and Temperature Limit Set Screw Locations (TR23 Shown).

Cover Disassembly

A snap-fit locking mechanism is used to attach the cover of the wall module to its subbase. To disassemble the cover from the subbase:

1. Insert a thin, flat blade screwdriver into each of the two slots at the bottom of the module to release the two locking tabs. See Fig. 2 on page 2.
2. Tilt the cover out and away from the subbase to release the top two locking tabs.
3. To change the dial (e.g. from Fahrenheit to Celsius) release the two tabs on the inside of the front cover and remove the old dial.

Wiring

Attach the wires from the device sensor terminals to the appropriate wall module terminals. See Table 2 on page 4.

⚠ CAUTION

Improper Electrical Contact Hazard.
Screw type terminal blocks are designed to accept no more than one 16 AWG (1.31 sq. mm) conductor.
Connect multiple wires that are 16-18 AWG (1.31-0.82 sq. mm) with a wire nut. Include a pigtail with this wire group and attach the pigtail to the individual terminal block.

Wiring Wall Modules

Wire the terminal block as follows:

1. For single wires, strip 3/16 in. (5 mm); for multiple wires going into one terminal, strip 1/2 in. (13 mm) insulation from the conductor.
2. If two or more wires (20 to 22 AWG only) are being inserted into one terminal, twist the wires together before inserting. See Fig. 5.
3. Insert the wire in the required terminal location and tighten the screw to complete the termination.
4. Review and verify the terminal connection wiring and DIP switch settings illustrated in Table 2 on page 4.

NOTE: Wire the Lon connection (terminals 3 and 4) using Level IV 22 AWG (0.34 mm^2) plenum or non-plenum rated, unshielded, twisted pair, solid conductor wire.

Wiring Examples

Table 2 on page 4 illustrates DIP switch settings and terminal connections for the wall modules. Refer to the *TR21, TR22, TR23, and TR24 Wall Modules – Specification Data*, form 63-1321, for additional DIP Switch information.

IMPORTANT

SW 2 on DIP Switch S2 is used for factory calibration of the temperature setpoint potentiometer. Depending on calibration, this switch may be set in either the On or Off position.
***DO NOT** change the position of this switch.*

NOTES:

1. The TR21 and TR22 models do **not** use DIP Switch S1 and S3.
2. DIP Switch S1 is used **only** on the humidity models, TR21-H and TR23-H.
3. Models TR21 and TR21-A use terminals 1 and 2 only. Model TR21-J uses terminals 1, 2, 3, and 4 only.

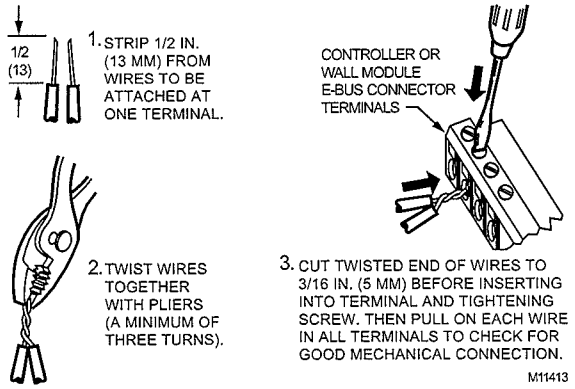


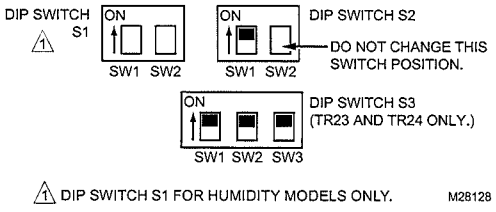
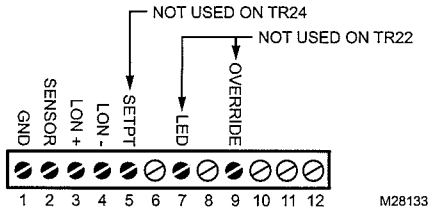
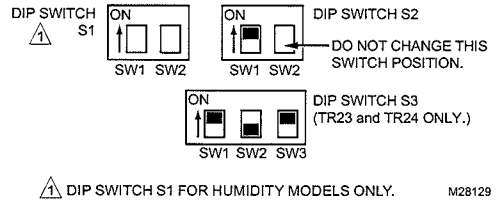
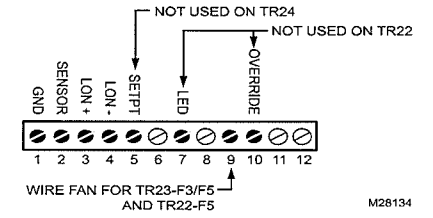
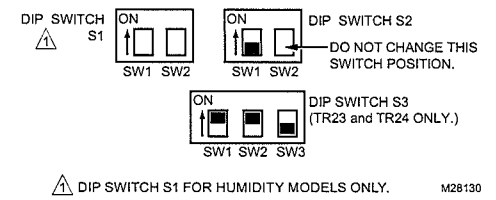
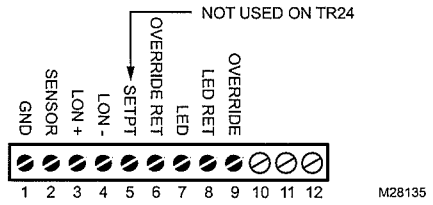
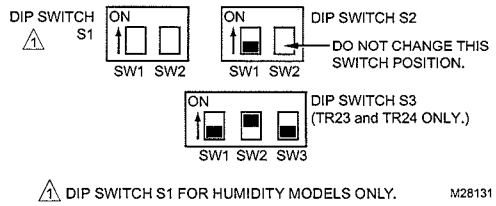
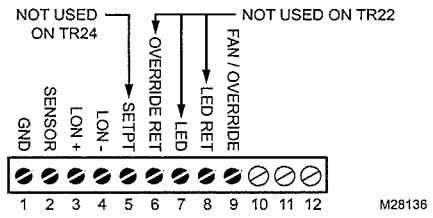
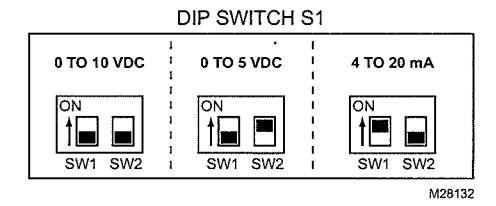
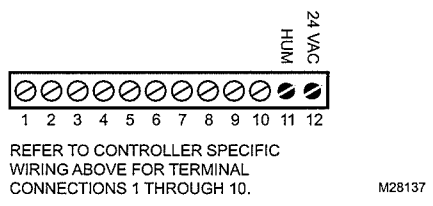
Fig. 5. Attaching Two Wires (20 to 22 AWG) to Wall Module Terminals.

Attaching the Cover

When all wiring is complete, attach the cover of the Wall Module as follows:

1. *Optional*: For models with a temperature dial, insert the two setpoint screws into the inside of the cover to set the desired temperature range limit. See Fig. 4.
2. Press the cover straight down onto the subbase until it snaps into place.
3. For models with a temperature dial, insert the desired dial through the opening in the cover. Align the keyed shaft on the knob with the keyed slot into the fitting on the subbase, then press down until it snaps into place.

Table 2. DIP Switch Settings and Terminal Connections.

Controller Model(s)	TR23-TR24 DIP Switch Settings	TR22-TR24 Terminal Connections
No fan switching from sensor W7750, W7751, and W7752 Spyder: PUL, PVL T7350: Use +/- offset knob only!	 NOTE: These switch positions are the factory **default** settings for non-fan models.	
Fan switching from sensor. W7753 Spyder: PUL, PVL		
Excel 600/500/100/80 • Used with TR23 and TR24 models **without fan**.		
Excel 600/500/100/80 • Used with TR22-F5, TR23-F3, and TR23-F5 models **with fan**.		
Any controller noted above. For humidity models – TR21-H and TR23-H only!		

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62-0267—07 K.K. Rev. 08-08

Honeywell

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TR21, TR22, TR23, and TR24 Wall Modules

SPECIFICATION DATA

GENERAL

The TR21, TR22, TR23, and TR24 are a family of direct wired wall modules for use with:

— Honeywell Excel 600, 500, 100, and 80 (all fully programmable) controllers
— Excel 10 W7750, W7751[a], W7752, and W7753 controllers
— W7761 Controller
— Spyder Unitary Controllers: PUL, PVL

All models have a space temperature sensor. Some models have a temperature dial, setpoint adjustment, LONWORKS® bus jack, override (bypass) with LED, and fan switch. The figure above is the TR23 model.

[a] The TR21, TR22, TR23, and TR24 wall modules are not compatible with W7751A,C,E,G Controllers.

FEATURES

The TR21, TR22, TR23, and TR24 family of wall modules include:

- **Models with setpoint adjustment.**
- **Models with occupied/unoccupied override (bypass) with LED.**
- **Models with 3-position (auto/0/1) or 5-position (auto/0/1/2/3 speed) fan switch.**
- **LONWORKS bus jack on all models except the TR21 and TR21-A models.**
- **Operating range 45° to 99° F (7° to 37° C).**
- **Models (TR22 and TR23) with user-selectable temperature setpoint dials in Fahrenheit, Celsius, and Relative (- to +).**

SPECIFICATIONS

Models: Refer to Table 1 on page 2.

Construction: Two-piece construction, cover and internally wired subbase. Field wiring 16 to 22 AWG (1.31-0.33 sq. mm) connects to a terminal block in the subbase.

Mounting Options: All modules can be mounted on a standard two by four inch junction box or on a 60 mm diameter junction box.

Dimensions (H/W/D): Refer to Fig. 2 on page 3.

Environmental Ratings:
- Operating Temperature: 45° to 99° F (7° to 37° C).
- Shipping Temperature: -40° to 150° F (-40° to 66° C).

Relative Humidity: 5% to 95% non condensing.

Temperature Sensor Operating Range: 45° to 99° F (7° to 37° C).

Temperature Setpoint Ranges (TR22 and TR23 only): The setpoint range is determined by the temperature knob installed:
- 55° to 85° F
- 13° to 29° C
- Relative (- to +)

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Accessories: 50007298-001 (pack of 12) medium, cover plate; 6-7/8 x 5 in. (175 x 127 mm).

Approvals: CE; UL94 plastic enclosure; FCC Part 15, Class B.

Temperature Sensor

TR21, TR22, TR23, and TR24 20K Ohm Non-linearized Sensor:
All models are furnished with a 20K Ohm non-linear NTC temperature sensor that follows a specific temperature resistance curve (See Fig. 1).

Honeywell controllers used with the TR21, TR22, TR23, and TR24 models employ an algorithm that provides readings close to the actual temperature. Sensor accuracy across the range of 55° to 85° F (13° to 29° C) is better than ± 0.36° F (± 0.2° C).

NOTE: The TR21-A wall module model has two 20K Ohm non-linear NTC temperature sensors in parallel, which provide 10K NTC temperature sensing necessary for averaging.

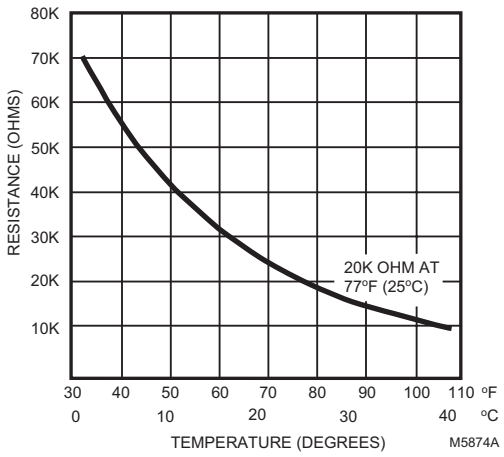


Fig. 1. Temperature vs. Resistance for Non-linear Sensor.

Wall Module Features

Table 1 illustrates the TR21, TR22, TR23, and TR24 wall module features and lists the existing Honeywell models that they replace.

Table 1. TR21 - TR24 Wall Module Features.[a]

Model Number		Sensor Element Type	Sensor Type		Selectable Setpoint Adjustment: 55° to 85° F, 13° to 30° C, or Relative (- to +)	Override Button with LED	LON Jack	Fan Switching
Honeywell Wall Module Model	Replaces Honeywell Model		Temp	Humidity				
TR21	T7770A1006	20K ohms non-linear	✓					n/a
TR21-A	T7770A3002	10K ohms non-linear for averaging only	✓					
TR21-H	n/a	20K ohms non-linear	✓	✓			✓	
TR21-J	T7770A2004		✓				✓	
TR22	T7770B1004 T7770B1020 T7770B1046		✓		✓		✓	
TR23	T7770C1002 T7770C1028 T7770C1044		✓		✓	✓	✓	
TR23-H	n/a		✓	✓	✓	✓	✓	
TR23-N [b]	T7770C1051		✓		✓	✓	✓	
T24	T7770D1000		✓			✓	✓	
TR22-F5	n/a		✓		✓		✓	5 position
TR23-F3	T7770E1023		✓		✓	✓	✓	3 position
TR23-F5	T7770F1005		✓		✓	✓	✓	5 position

[a] A check mark (✓) indicates the feature is included with the wall module.

[b] The TR23-N has no Honeywell logo on the cover.

NOTE: Refer to the *TR21, TR22, TR23, and TR24 Wall Modules – Installation Instructions*, form 62-0267, for wiring diagrams. Some features may not be available with all controllers.

Module Dimensions

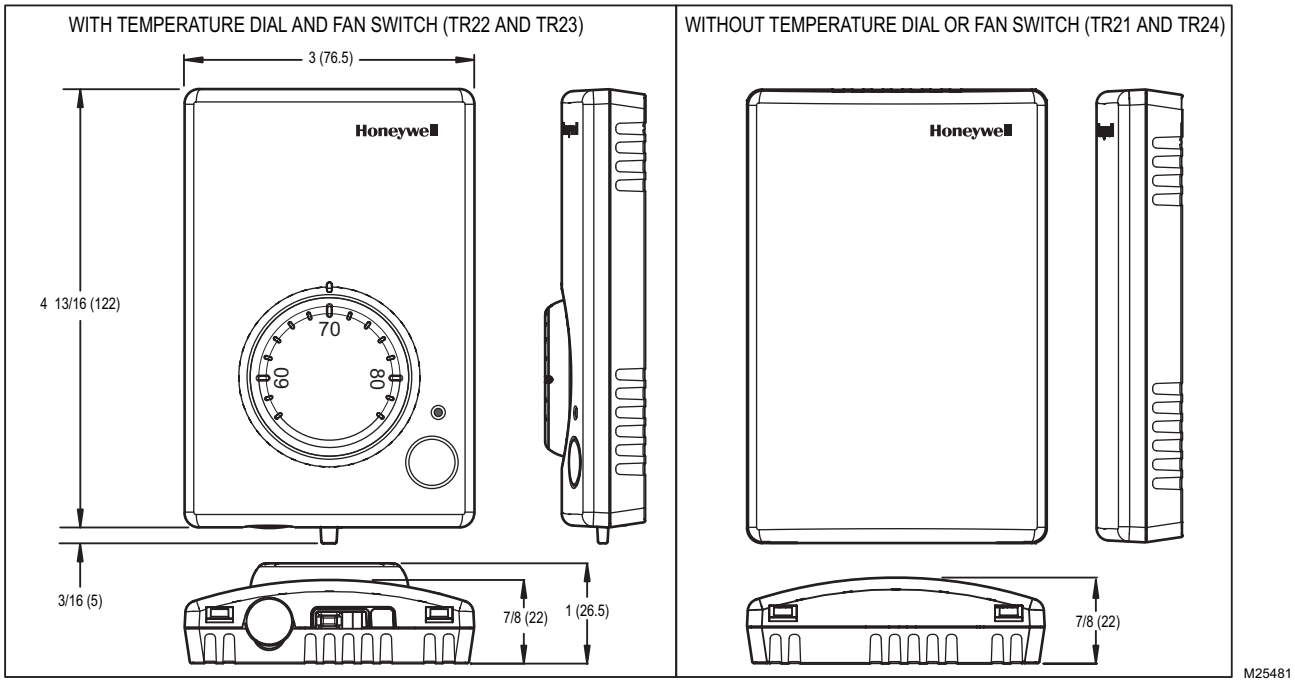


Fig. 2. Wall Module Dimensions in inches (mm).

Circuit Board

Fig. 3 illustrates the location of the terminal block and other features on the TR21, TR22, TR23, and TR24 models' circuit board. Table 2 on page 4 describes the terminal connections by model number.

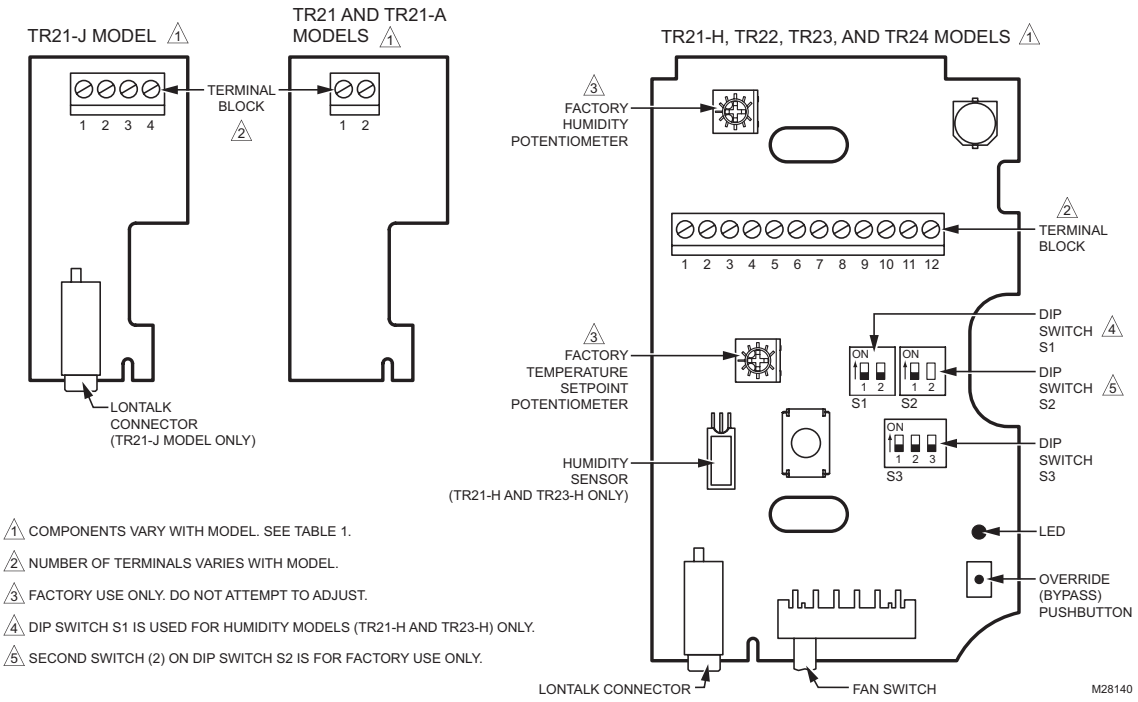


Fig. 3. Wall Module Circuit Board Components.

Table 2. TR21, TR22, TR23, and TR24 Wall Module Terminal Connections.[a]

Wall Module Model	When Used With Controller Model(s)	Terminal Usage and Number (See Fig. 3 on page 3)											
		GND [b]	Sensor	LON +[c]	LON –	SETPT (Setpoint)	Override Return	LED	LED Return	Override / Fan	Override	Humidity	18-24 Vac[d]
		1	2	3	4	5	6	7	8	9	10	11	12
TR21	W7761	✓	✓										
TR21-A		✓	✓										
TR21-H		✓	✓	✓	✓							✓	✓
TR21-J		✓	✓	✓	✓								
TR22-F5	• W7750, W7751, W7752, and W7753 • Excel 600, 500, 100, and 80	✓	✓	✓	✓	✓				Fan			
TR23		✓	✓	✓	✓	✓							
TR23-N		✓	✓	✓	✓	✓							
T24		✓	✓	✓	✓								
TR23	W7753	✓	✓	✓	✓	✓		✓			✓		
TR23-F3		✓	✓	✓	✓	✓		✓		Fan	✓		
TR23-F5		✓	✓	✓	✓	✓		✓		Fan	✓		
TR23-H		✓	✓	✓	✓	✓		✓			✓	✓	✓
T24		✓	✓	✓	✓			✓			✓		
TR23	• W7750, W7751, and W7752 • Spyder: PUL, PVL	✓	✓	✓	✓	✓		✓		Override			
TR23-F3		✓	✓	✓	✓	✓		✓		Override / Fan			
TR23-F5		✓	✓	✓	✓	✓		✓		Override / Fan			
TR23-H		✓	✓	✓	✓	✓		✓		Override		✓	✓
T24		✓	✓	✓	✓			✓		Override			
TR23-F3	Excel 600, 500, 100, and 80 **with Fan**	✓	✓	✓	✓	✓		✓	✓	Override / Fan			
TR23-F5		✓	✓	✓	✓	✓	✓	✓	✓	Override / Fan			
TR23	Excel 600, 500, 100, and 80 **without Fan**	✓	✓	✓	✓	✓	✓	✓	✓	Override			
TR23-H		✓	✓	✓	✓	✓	✓	✓	✓	Override		✓	✓
T24		✓	✓	✓	✓		✓	✓	✓	Override			

[a] A check mark (✓) indicates the terminal is used in this wall module and controller configuration.

[b] Earth Ground.

[c] LonWorks terminals (+ and –) are polarity insensitive.

[d] Power coming from the controller to power the humidity sensor.

Communications

All wall modules (except the TR21 and TR21-A models) have a LONMARK® bus communications port. If needed, the jack plug must be removed in the field, and terminals 3 and 4 wired according to the installation instructions.

LONMARK bus communication is not applicable when the wall modules are used with Excel 600/500/100/80 Controllers. The LONMARK bus is insensitive to polarity, minimizing installation errors due to mis-wiring.

The recommended wire size for the LONMARK bus is Level IV, 22 AWG (0.34 sq. mm) plenum or non-plenum rated, unshielded, twisted pair, solid conductor wire.

TR22 and TR23 Setpoint Adjustment

For the TR22 and TR23 Wall Modules with a setpoint adjustment, the controller must be programmed for the values in Table 3.

Table 3. Setpoint Values.

Setpoint Value	Program Setting
55° F (13° C)	2.773 V
65° F (18° C)	2.148 V
75° F (24° C)	1.345 V
85° F (29° C)	0.43 V

Humidity Settings (DIP switch S1)

The humidity sensing control mode is set with this 2-position DIP switch. Refer to Fig. 3 on page 3 for location of DIP switch S1.

NOTE: These switch settings apply only to the TR21-H and TR23-H models.

To change the setting, first disconnect the power, then set **SW1** and **SW2** according to Table 4.

The switch settings are used to indicate the sensing control between the humidity sensor on the wall module and the connected controller model.

Table 4. DIP Switch S1 Settings.

Wall Module Model	Sensing Control	Individual Switches	
		1	2
TR21-H TR23-H	0-10 Vdc	OFF	OFF
	0-5 Vdc	OFF	ON
	4-20 mA	ON	OFF

DIP Switches S2 and S3

Refer to Fig. 3 on page 3 for location of these DIP switches. To set these DIP switches, refer to the TR21, TR22, TR23, and TR24 Wall Modules – Installation Instructions, form 62-0267.

TR23 and TR24 Wall Module Override (Bypass) Pushbutton and LED Operation

When Used With Excel 10 Controllers:

The Excel 10 controllers (W7750, W7751, W7752, and W7753) provide timed occupied and unoccupied temperature setpoints for the Wall Module, see Fig. 4. The override pushbutton is used to change the controller into the modes shown in Table 5 and illustrated in Fig. 5 on page 6. The override (bypass) LED displays the override status of the controller.

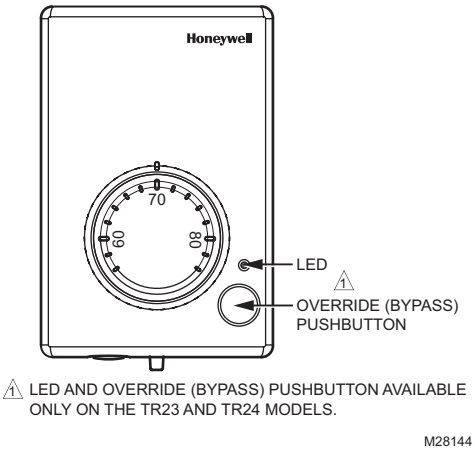


Fig. 4. LED and Override Pushbutton Locations (TR23-F Wall Module shown).

Table 5. Wall Module Operation.

Pushbutton Held Down	Controller Model	LED Status
0 to 1 second	No override	Off
1 to 4 seconds	Timed occupied override	On
4 to 7 seconds	Unoccupied override	Single blink per second
Longer than 7 seconds	No override	Off
not applicable	Continuous occupied override[a]	Two blinks per second

[a] Remote function, which is generated from the network.

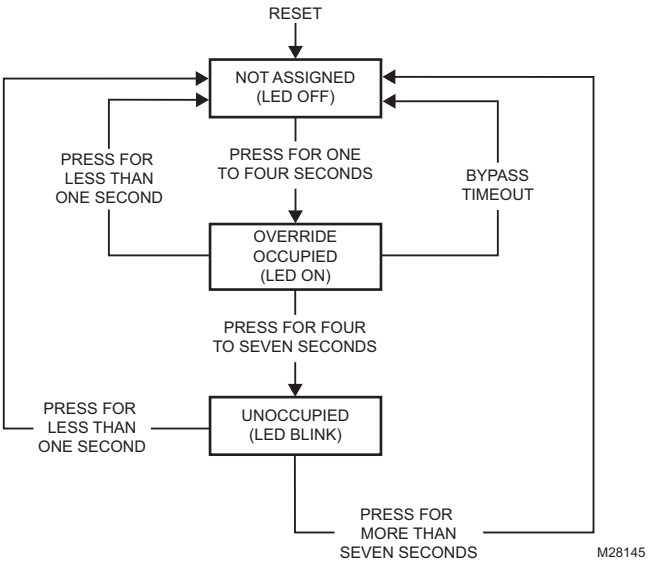


Fig. 5. Override Pushbutton Operation.

When Used With Excel 600/500/100/80 Controllers:

The application engineer/programmer can program the override (bypass) and LED to operate in any manner desired. The override (bypass) input is a dry contact, normally open, momentary digital input when the wall module does not have a fan switch. When a fan speed switch (basically a series of resistances based on fan switch position) is present, the override button is an analog input. See Table 7 for resistances.

When Used With T7350 Thermostat:

TR21, TR21-A, TR21-H, TR22, TR23, and TR24 are the models compatible with the T7350 thermostat. When using with the T7350 thermostat be sure to use the relative +/- offset knob only. The Celsius and Fahrenheit knobs will not work properly with the T7350 Thermostat.

TR22-F5, TR23-F3, and TR23-F5 Wall Module Fan Switch

With the switch in the far left position (Auto), the fan automatically runs at the speed determined by the controller temperature control algorithm.

With the switch in the 0 position, the fan is off. Position 1 is fan speed 1, etc.

The wall module fan speed switch overrides the temperature control algorithm.

When Used With Excel 10 Controllers:

The Excel 10 Controllers (W7750, W7751, W7752, and W7753) can be programmed so that the fan speed switch and override button function the way that the application engineer/programmer wants. See Table 6 for controller-programming resistances. Switch 1 on Dip Switch S2 adds 10k Ohms resistance when OPEN (for Excel 600-80 controllers) and removes it when CLOSED (for Excel 10 controllers).

Table 6. Program Settings for Wall Module with Fan Switch using Excel 10 Controllers.

For Switch Position	Resistance (Ohms)	Comment
Auto	1861 ±119	Left most position
0	2686 ±127	Fan Off position
1	3866 ±139	
2	304 ±130	
3	460 ±146	Right most position
Override button closed	Closed circuit	

When Used With Excel 600/500/100/80 Controllers:

Excel 600/500/100/80 Controllers can be programmed so that the fan speed switch and override button function the way that the application engineer/programmer wants. See Table 7 for controller-programming resistances. Switch 1 on Dip Switch S2 adds 10k Ohms resistance when OPEN (for Excel 600-80 controllers) and removes it when CLOSED (for Excel 10 controllers).

Table 7. Program Setting for Wall Module with Fan Switch using Excel 600/500/100/80 Controllers.

For Switch Position	Resistance (Ohms)	Comment
Auto	11.861K ±119	Left most position
0	12.686K ±127	Fan Off position
1	13.866K ±139	
2	13.04K ±130	
3	14.60K ±146	Right most position
Override button closed	10K ±100	

Automation and Control Solutions

Honeywell International Inc.
1985 Douglas Drive North
Golden Valley, MN 55422
customer.honeywell.com

Honeywell Limited-Honeywell Limitée
35 Dynamic Drive
Toronto, Ontario M1V 4Z9

63-1321—1 J.I. Rev. 01-08

Honeywell

CONNCAT CULINARY ARTS
4 Science Park, 1st Floor
New Haven, CT

Honeywell Direct Digital Control System

For: Eastern Mechanical Services
Danbury, CT

Control Wizards
Control Wizards, Inc.

89 Taylor Avenue
Norwalk, CT 06854
Phone: 203-274-5284

REV.	DATE	DESCRIPTION
1	08/22/2015	SUBMITTAL DRAWING
2	9/20/2016	As-Built

PROJECT NAME: **CONNCAT**

DESCRIPTION: **COVER PAGE**

PROJ MGR:	PROJ ENG:	DRAWN BY:	DRAWING No:
CB	CB	ZJ	1 OF 10

DWG. NO.	PAGE NAME	REVISION LEVEL	DESCRIPTION
-01	COVER PAGE	1	DRAWING COVER PAGE
-02	DRAWING INDEX	1	THIS PAGE
-03	REVISIONS & ABBREVIATIONS	1	DRAWING REVISION DETAILS & CONTROL ABBREVIATIONS
-04	NETWORK LAYOUT	1	NETWORK LAYOUT
-05	COOLING ONLY VAV BOX	1	COOLING ONLY VAV BOX
-06	VAV BOX WITH HEAT	1	VAV BOX WITH HEAT
-07	AHU-1	1	AHU-1
-08	DDC PANEL	1	DDC PANEL
-09	DDC POINTS	1	DDC POINTS
-10	1ST FLOOR DDC CONTROLLER	1	1ST FLOOR DDC CONTROLLER

REV.	DATE	DESCRIPTION
1	08/22/2015	SUBMITTAL DRAWING
2	9/20/2016	As-Built

PROJECT NAME:
CONNCAT

DESCRIPTION:
DRAWING INDEX

PROJ MGR:	PROJ ENG:	DRAWN BY:	DRAWING No:
CB	CB	ZJ	2 OF 10

REVISIONS

REV	DRAWING REVISIONS	DATE	BY	CHECKED BY
1	SUBMITTAL DRAWING	08/22/2015	JZ	CB
2	As=Built	9/20/2016	CB	CB

ABBREVIATIONS

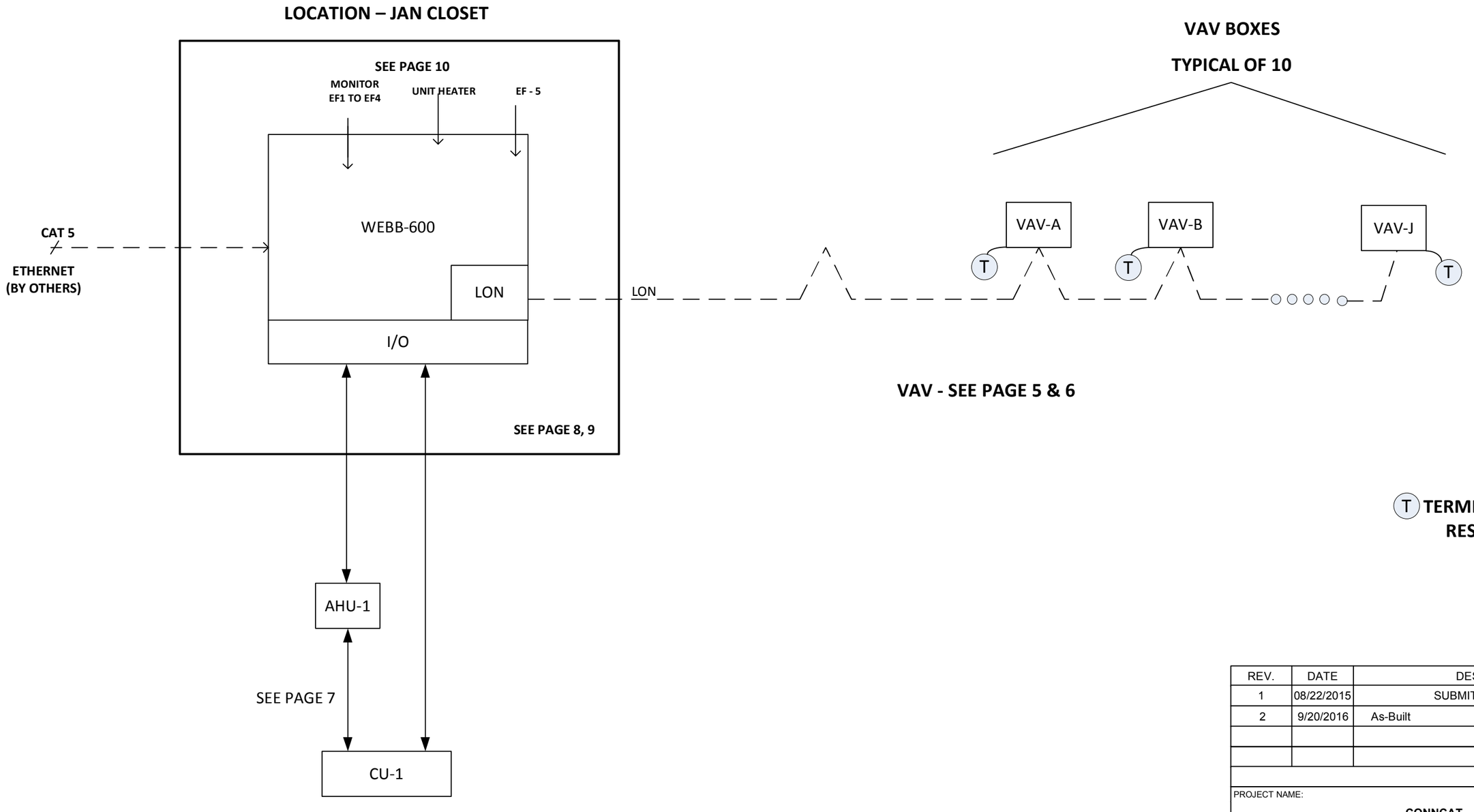
ABBREVIATION	COMPLETE NAME
AHU	AIR HANDLER UNIT
CUH	CABINET UNIT HEATER
CT	CURRENT SWITCH
EF	EXHAUST FAN
ERV	ENERGY RECOVERY VENTILATOR
FCU	FAN COIL UNIT
HOA	HAND – OFF – AUTOMATIC SELECTOR SWITCH
J	JUMPER WIRE
J BOX	JUNCTION BOX
PHT	PRE-HEAT AIR TEMPERATURE
PS	POWER SUPPLY
RAT	RETURN AIR TEMPERATURE
RHT	RE-HEAT AIR TEMPERATURE
SAT	SUPPLY AIR TEMPERATURE
TR-X	TRANSFORMER (X) = NUMBER
VAC	VOLTS A/C
VDC	VOLTS D/C
VRV	VARIABLE REFRIGERANT FLOW

REV.	DATE	DESCRIPTION
1	08/22/2015	SUBMITTAL DRAWING
2	9/20/2016	As-Built

PROJECT NAME:
CONNCAT

DESCRIPTION:
REVISIONS & ABBREVIATIONS

PROJ MGR:	PROJ ENG:	DRAWN BY:	DRAWING No:
CB	CB	ZJ	3 OF 10



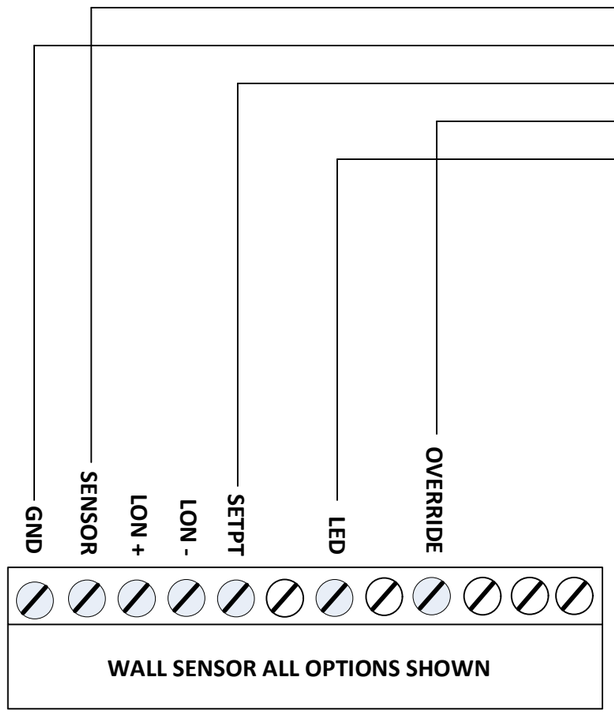
REV.	DATE	DESCRIPTION
1	08/22/2015	SUBMITTAL DRAWING
2	9/20/2016	As-Built

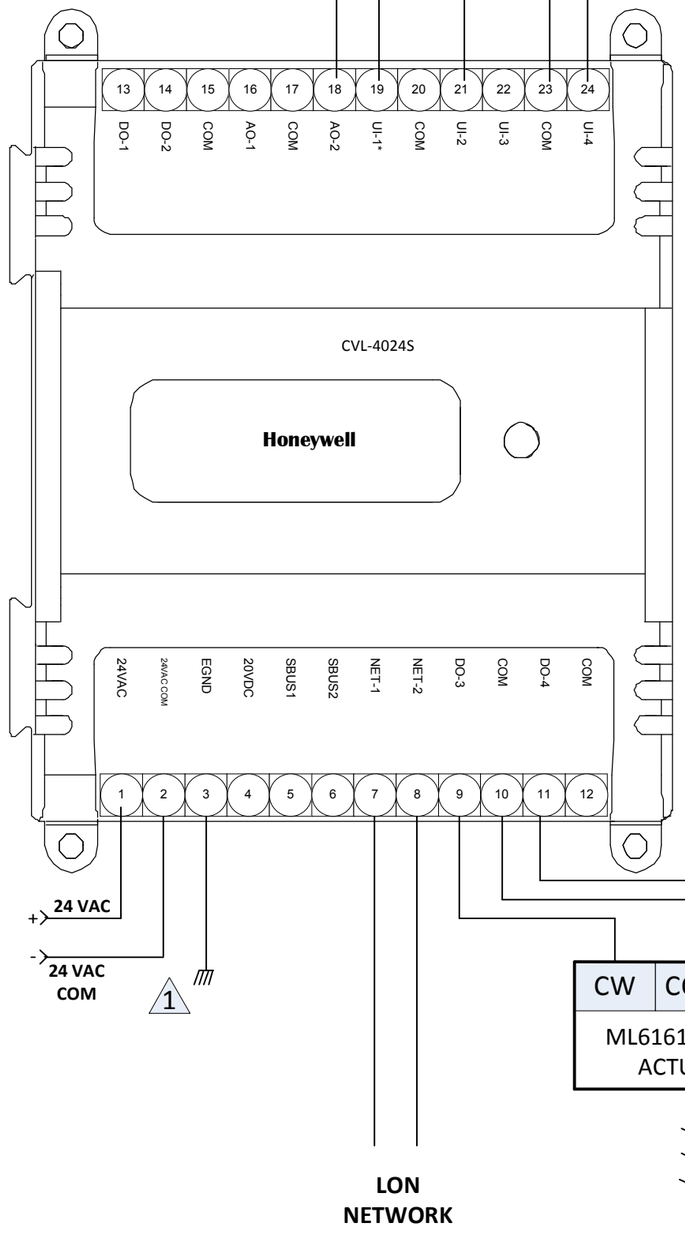
PROJECT NAME: **CONNCAT**

DESCRIPTION: **NETWORK LAYOUT**

PROJ MGR:	PROJ ENG:	DRAWN BY:	DRAWING No:
CB	CB	ZJ	4 OF 10

COOLING ONLY VAV BOX
TYPICAL OF 2 VAV-B & VAV-D





POINTS

UI-1	FUTURE OVERRIDE BUTTON
UI-2	FUTURE SET POINT BUTTON
UI-3	SPARE
UI-4	SPACE TEMP
DO-1	SPARE
DO-2	SPARE
DO-3	DAMPER-OPEN
DO-4	DAMPER-CLOSED
AO-1	SPARE
AO-2	FUTURE LED @ SENSOR

Wall Sensor: TR-23 with Sensor, Setpoint wheel, and Override

1 EARTH GROUND WIRE LENGTH SHOULD BE HELD TO A MINIMUM.

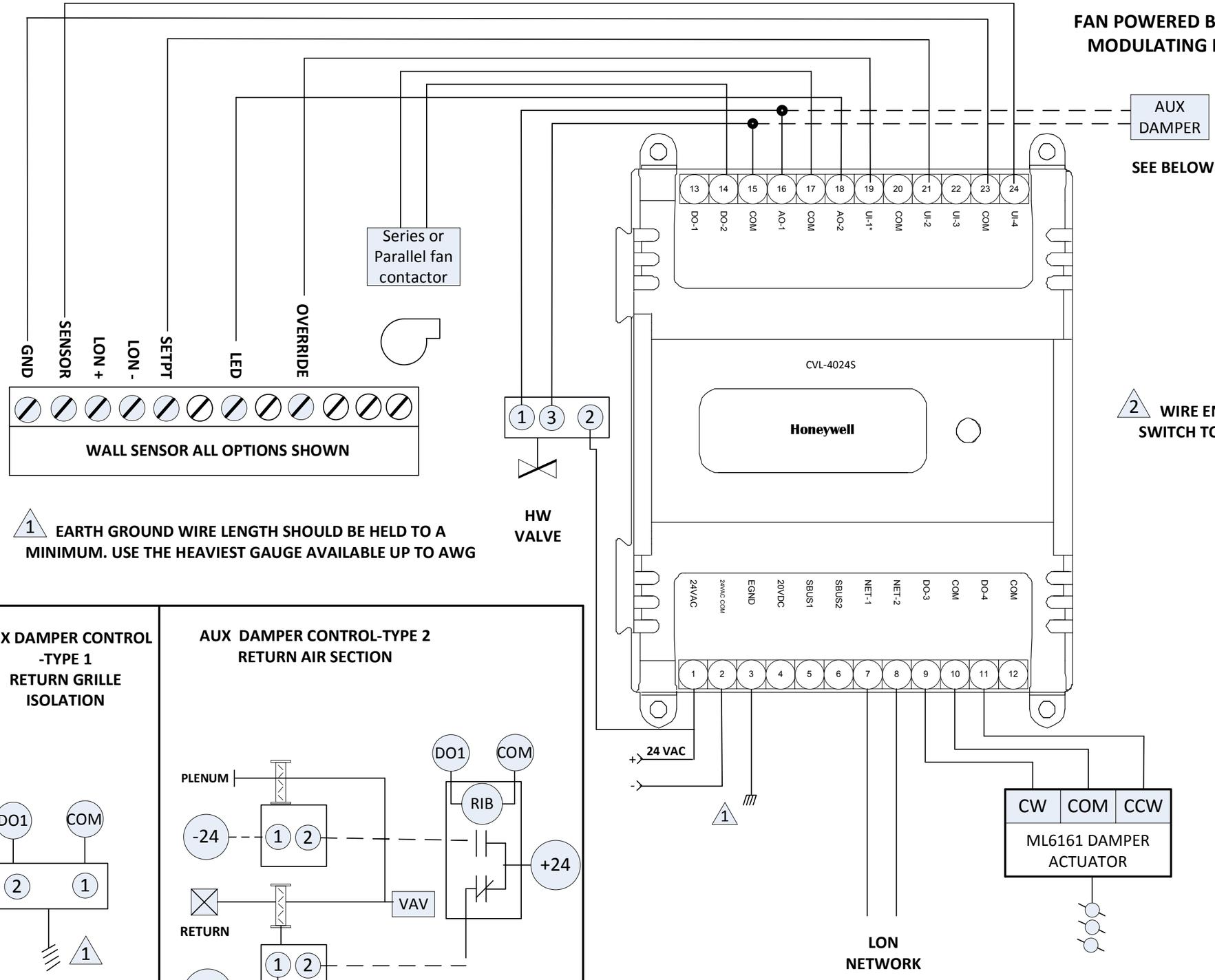
REV.	DATE	DESCRIPTION
1	08/22/2015	SUBMITTAL DRAWING
2	9/20/2016	As-Built

PROJECT NAME: **CONNCAT**

DESCRIPTION: **COOLING ONLY VAV BOX**

PROJ MGR:	PROJ ENG:	DRAWN BY:	DRAWING No:
CB	CB	ZJ	5 OF 10

FAN POWERED BOX WITH MODULATING REHEAT



1 EARTH GROUND WIRE LENGTH SHOULD BE HELD TO A MINIMUM. USE THE HEAVIEST GAUGE AVAILABLE UP TO AWG

2 WIRE END SWITCH TO UI-3

POINTS

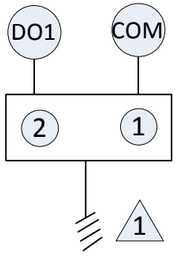
UI-1	FUTURE OVERRIDE BUTTON
UI-2	FUTURE SET POINT BUTTON
UI-3	DAMPER MOTOR END SWITCH
UI-4	SPACE TEMP
DO-1	FAN STOP/START
DO-2	AUX DAMPER CONTROL
DO-3	DAMPER-OPEN
DO-4	DAMPER-CLOSED
AO-1	HW VALVE
AO-2	FUTURE LED @ WALL SENSOR

Wall Sensor: TR-23 with Sensor, Setpoint wheel, and Override

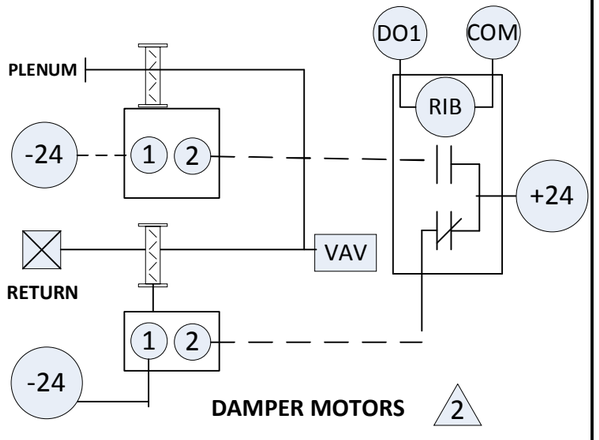
AUX RELAY FUNCTION

VAV	TYPES
A	RETURN SELECTION
C	ISOLATION
E	ISOLATION
F	ISOLATION
G	ISOLATION
H	ISOLATION
I	ISOLATION
J	RETURN SELECTION

AUX DAMPER CONTROL -TYPE 1 RETURN GRILLE ISOLATION



AUX DAMPER CONTROL-TYPE 2 RETURN AIR SECTION

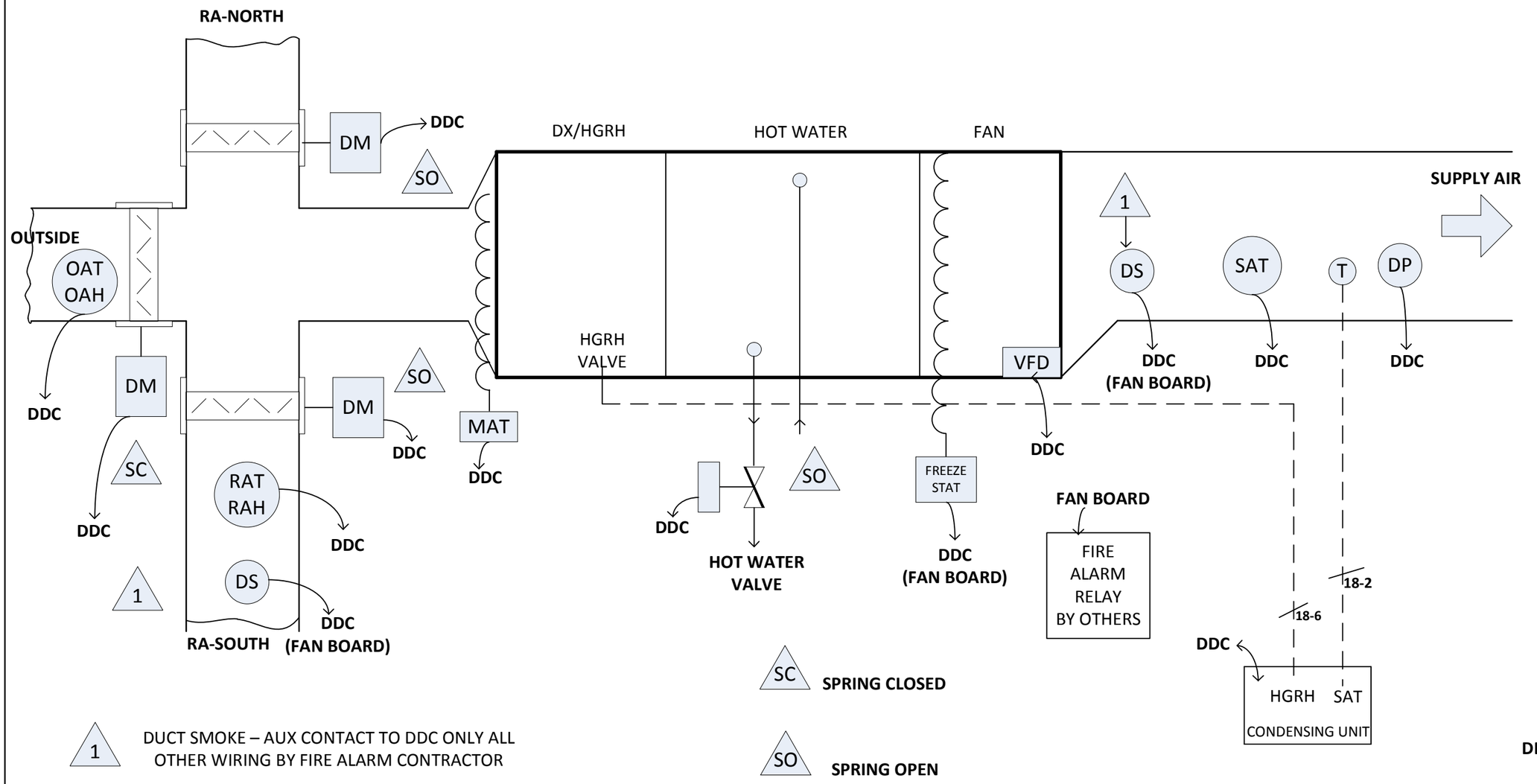


REV.	DATE	DESCRIPTION
1	08/22/2015	SUBMITTAL DRAWING
2	9/20/2016	As-Built

PROJECT NAME: **CONNCAT**

DESCRIPTION: **VAV BOX WITH HEAT**

PROJ MGR:	PROJ ENG:	DRAWN BY:	DRAWING No:
CB	CB	ZJ	6 OF 10



SC **SPRING CLOSED**

SO **SPRING OPEN**

1 DUCT SMOKE – AUX CONTACT TO DDC ONLY ALL OTHER WIRING BY FIRE ALARM CONTRACTOR

DDC – SEE PAGE 8, 9

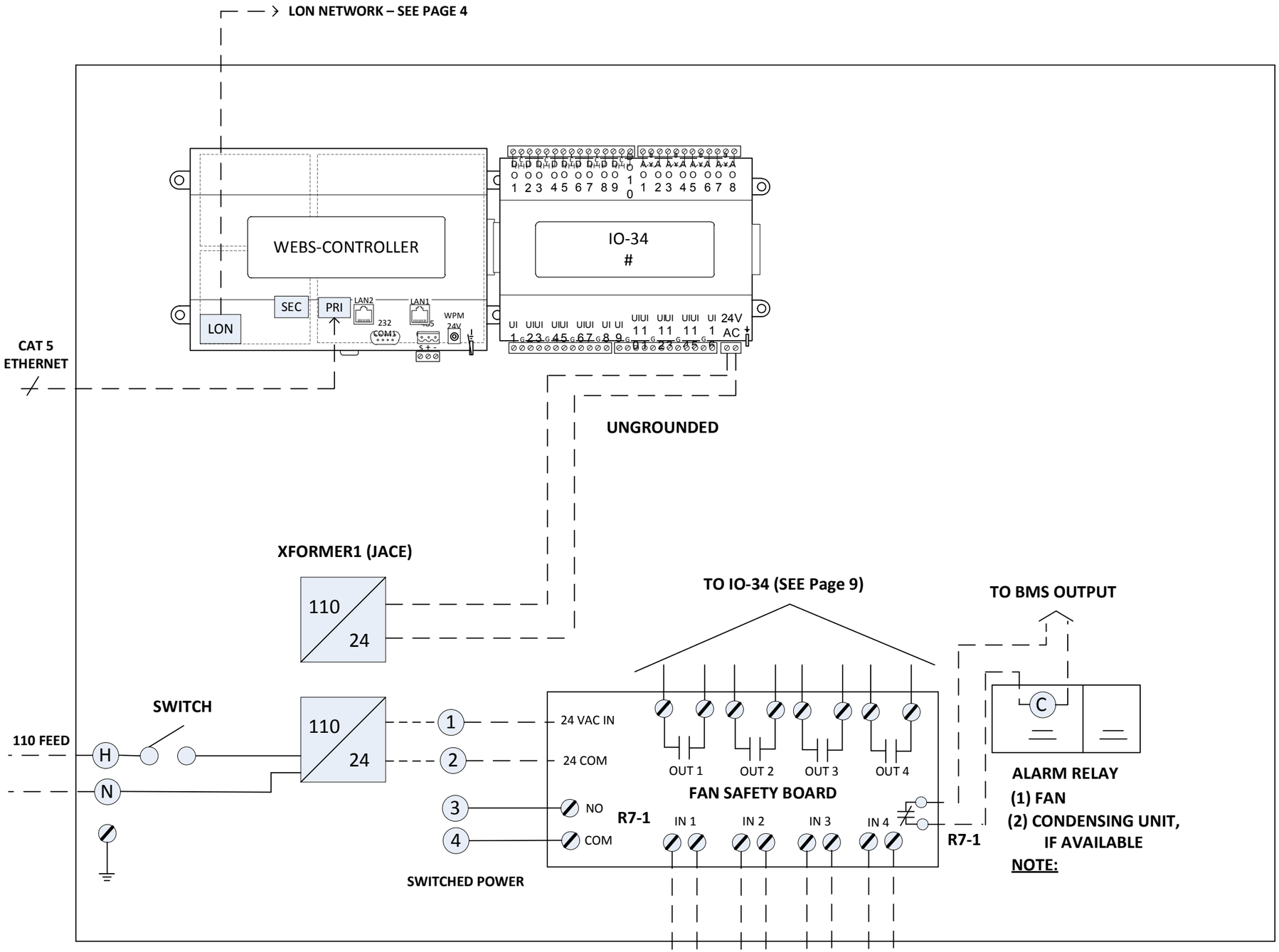
DS: DUCT SMOKE
DM: DAMPER MOTOR
DP: DUCT PRESSURE
DAT/DAH: OUTSIDE TEMP/HUMIDITY
RAT/RAH: RETURN AIR TEMP/HUMIDITY
RAT/RAH: RETURN AIR
SAT/RAH: SUPPLY AIR TEMP
MAT: MIXED AIR TEMP
HGRH : HOT GAS REHEAT

REV.	DATE	DESCRIPTION
1	08/22/2015	SUBMITTAL DRAWING
2	9/20/2016	As-Built

PROJECT NAME: **CONNCAT**

DESCRIPTION: **AHU-1**

PROJ MGR:	PROJ ENG:	DRAWN BY:	DRAWING No:
CB	CB	ZJ	7 OF 10



DS: DUCT SMOKE

FAR: FIRE ALARM RELAY (BY OTHERS)

CONSTANT POWER (1 & 2)
DUCT PRESS SENSOR
HUMIDITY SENSORS
LEAK DETECTOR

SWITCHED POWER 3 & 4
OA – DAMPER: SPRING CLOSED
RA – DAMPER (2): SPRING OPEN
HHW VALUE: SPRING OPEN

REV.	DATE	DESCRIPTION
1	08/22/2015	SUBMITTAL DRAWING
2	9/20/2016	As-Built

PROJECT NAME: **CONNCAT**

DESCRIPTION: **DDC PANEL**

PROJ MGR:	PROJ ENG:	DRAWN BY:	DRAWING No:
CB	CB	ZJ	8 OF 10

CONTROLLER: WEBS-600; IO MODULE: IO-34		Terminal	Product/Notes
UI-1	Outside Air Temperature		10 K thermistor
UI-2	Outside Air Humidity		H7635C2015 OA Humidity
UI-3	Fan Speed Feedback from VFD		0-60 HZ (0-10 VDC)from VFD
UI-4	Freezestat Alarm		via Fan Shutdown relay
UI-5	Duct Smoke Alarm		via Fan Shutdown Relay
UI-6	Building Fire Alarm Contact Alarm		via Fan Shutdown relay
UI-7	Supply Air Temperature Sensor		C7041B Duct Sensor
UI-8	Return Air Temperature Sensor		C7041B Duct Sensor
UI-9	Return Air Humidity		H7635 Duct Humidity
UI-10	Hot Water Valve Feedback		0-10 VDC
UI-11	Spare		Beckett Float
UI-12	Duct Static Pressure		P7640A1026 (0-10")
UI-13	Mixed Air Sensor		C7041J Averaging Sensor
UI-14	Refrigerant Pressure Sensor		Inside/Provided by Aon
UI-15	Compressor Alarm		From Condensing Unit
UI-16	Spare		
DO-1	Supply Fan Stop/Start (VFD)		Relay
DO-2	DX-1 (Y1 Command)		Relay at Panel
DO-3	DX-2 (Y1 Command)		Relay at Panel
DO-4	DX-3 (Y1 Command)		Relay at Panel
DO-5	DX-4 (Y1 Command)		Relay at Panel
DO-6	VAV Box FPB-A Return Damper Command		
DO-7	VAV Box FPB-C Ceiling Damper Command		
DO-8	EF-5 (Toilet Fan) Start/Stop		Relay at Starter
DO-9	VAV Box FPB-F Ceiling Damper Command		
DO-10	VAV Box FPB-G Ceiling Damper Command		
AO-1	Fan Speed command to VFD		0-10 VDC
AO-2	Hot Water Valve Command		0-10 VDC
AO-3	Outside Air/Return Air Damper Command		0-10 VDC
AO-4			
AO-5			
AO-6			
AO-7	Compressor Capacity Control		To Condensing Unit
AO-8			

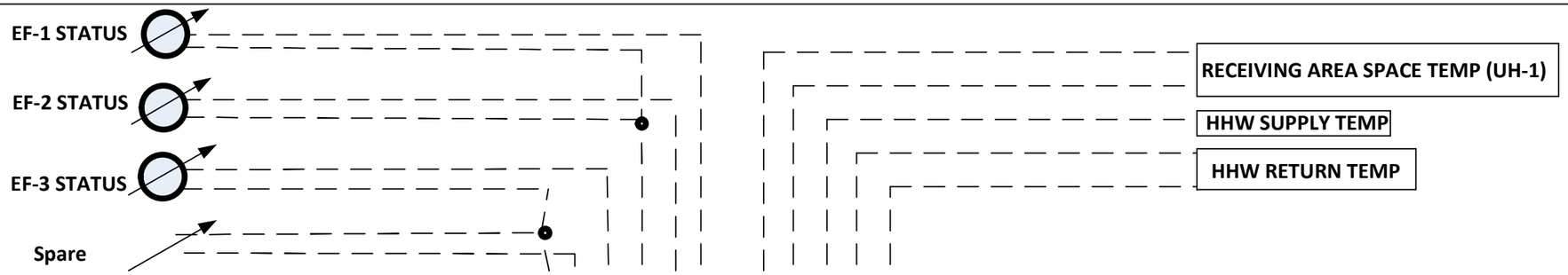
CONTROLLER: WEBS-600; IO MODULE: IO-16 A		Terminal	Product/Notes
UI-1	Receiving/Loading Dock Space Temp		TR-21
UI-2	Heating Hot Water Supply Temp		Strap-on Sensor
UI-3	Heating Hot Water Return Temp		Strap-on Sensor
UI-4	EF-1 Status		Current Sensor Switch
UI-5	EF-2 Status		Current Sensor Switch
UI-6	EF-3 Status		Current Sensor Switch
UI-7	Spare		
UI-8	AHU Outside Air Damper Feedback		2-10 VDC From OA Damper
DO-1	UH-1 Fan S/S		Relay at UH/Aquastat
DO-2	VAV Box FPB-J Ceiling Damper Command		
DO-3	VAV Box FPB-H Ceiling Damper Command		
DO-4	VAV Box FPB-I Ceiling Damper Command		
AO-1	Spare		
AO-2	Spare		
AO-3	Spare		
AO-4	Spare		

REV.	DATE	DESCRIPTION
1	08/22/2015	SUBMITTAL DRAWING
2	9/20/2016	As-Built

PROJECT NAME: **CONNCAT**

DESCRIPTION: **DDC POINT LIST**

PROJ MGR:	PROJ ENG:	DRAWN BY:	DRAWING No:
CB	CB	ZJ	9 OF 10



IO Module on WEBSERVER CONTROLLER in Closet

UH-1 Fan Via
Strap-on Aquastet

REV.	DATE	DESCRIPTION
1	08/22/2015	SUBMITTAL DRAWING
2	9/20/2016	As-Built

PROJECT NAME:
CONNCAT

DESCRIPTION:
1ST FLOOR DOC CONTROLLER

PROJ MGR:	PROJ ENG:	DRAWN BY:	DRAWING No:
CB	CB	ZJ	10 OF 10

Northern

Test and Balance Corporation

40 Old Hattertown Road
P.O. Box 407
Redding Ridge, CT 06876
(203) 938-2400
NTBC # 1692
www.northerntb.com

Mechanical Contractor
Eastern Mechanical Services, Inc.
3 Starr Street
Danbury, CT 06810

TESTING AND BALANCING SUBMITTAL
FOR

Conn CAT

4 SCIENCE

FAIRFIELD, CT

January 10, 2016

TESTING, ADJUSTING AND BALANCING BUREAU

THE PROFESSIONAL'S CHOICE℠

This certifies that

Northern Test & Balance Corporation

has completed the requirements of certification as an

Independent Testing, Adjusting and Balancing Contractor

on

December 17, 2012

Joseph J Nigro
Labor Co-Chairman

Robert C. Lovelace
ICB Co-Chairman

BB038003C
Certification No.

Energy Management Institute Committee National Established 1983 NEMIC District of Columbia

Management Co-Chairman

ICB Co-Chairman

December 31, 2014
Expiration Date

Northern Test and Balance Corporation
P.O.Box 407, Redding Ridge, CT 06876

Ph - (203) 938-2400
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ConnCAT Culinary Arts

4 Science Park

New Haven, CT 06511

NTBC#1692

T.A.B. AIR REPORT ABBREVIATION TABLE

ABBR.	MEANING
ADD	ADDRESS
ACT	ACTUAL
AC	AIR CONDITIONER
AHU	AIR HANDLING UNIT
AMPS	AMPERAGE
AVG	AVERAGE
BHP	BRAKE HORSEPOWER
BTU	BRITISH THERMAL UNIT
MBH	BRITISH THERMAL UNITS PER HR 1000
C	CENTER
CAV	CONSTANT AIR VOLUME BOX
CLG	COOLING
CFM	CUBIC FEET PER MINUTE
°F	DEGREE, FAHRENHEIT
DIAM	DIAMETER
DP	DIFFERENTIAL PRESSURE
DT	DIFFERENTIAL TEMPERATURE
DIFF	DIFFUSER
DB	DRY BULB
ENT.	ENTERING
E/A	EXHAUST AIR
EF	EXHAUST FAN
ESP	EXTERNAL STATIC PRESSURE
EVAV	EXHAUST VARIABLE AIR VOLUME
FCU	FAN COIL UNIT
FP	FAN POWER
FT, ′	FEET
FPM	FEET PER MINUTE
FEV	LAB FUME EXHAUST VALVE
F.C.	FLOW COEFFICIENT
HP	HEAT PUMP
HTG	HEATING
HP	HORSEPOWER
IN, ″	INCH
LEV.	LEAVING
MUA	MAKE UP AIR
MAU	MAKE UP AIR UNIT
MFG	MANUFACTURER
MAX	MAXIMUM
MER	MECHANICAL EQUIPMENT ROOM
MIN	MINIMUM
M/A	MIXED AIR
MD	MOTORIZED DAMPER

ABBR.	MEANING
N. A.	NOT AVAILABLE OR NOT APPLICABLE
OED	OPEN END DUCT
O/A	OUTSIDE AIR
O.D.	OUTSIDE DIAMETER
POS	POSITION
P.P.	PULLEY POSITION
REG	REGISTER
RHC	REHEAT COIL
RH	RELATIVE HUMIDITY
R/A	RETURN AIR
RPM	REVOLUTIONS PER MINUTE
RTU	ROOF TOP UNIT
SAV	SUPPLY AIR VALVE
SF	SERVICE FACTOR
SCH.	SCHEDULE
SL	SLOT
SQ FT	SQUARE FEET
SP	STATIC PRESSURE
S/A	SUPPLY AIR
TEMP	TEMPERATURE
T.P.	THERMALLY PROTECTED
TSP	TOTAL STATIC PRESSURE
UV	UNIT VENTILATOR
VAV	VARIABLE AIR VOLUME
VSD	VARIABLE SPEED DRIVE
VVD	VARIABLE VOLUME DAMPER
V.D.	VOLUME DAMPER
VEL	VELOCITY IN FEET PER MINUTE
VP	VELOCITY PRESSURE
W.C.	WATER COLUMN
W.G.	WATER GAGE
WB	WET BULB
V.D.	VOLUME DAMPER
VEL	VELOCITY IN FEET PER MINUTE
VP	VELOCITY PRESSURE
W.C.	WATER COLUMN
W.G.	WATER GAGE
WB	WET BULB

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4 Science Park

New Haven, CT 06511

NTBC#1692

T.A.B. WATER REPORT ABBREVIATION TABLE

ABBR.	MEANING
ACT:	ACTUAL
AMPS	AMPERAGE
AVG	AVERAGE
BHP	BRAKE HORSEPOWER
BTU	BRITISH THERMAL UNIT
BTUH	BRITISH THERMAL UNITS PER HOUR
CUH	CABINET UNIT HEATER
MBH	1000 BRITISH THERMAL UNITS PER HR
CHWC	CHILLED WATER COIL
COV	CONVECTOR
DEG, °	DEGREE
°F	DEGREE, FAHRENHEIT
P	DENSITY
DIAM	DIAMETER
DP	DIFFERENTIAL PRESSURE
DT	DIFFERENTIAL TEMPERATURE
DRC	DUCT REHEAT COIL
EWT	ENTERING WATER TEMPERATURE
FCU	FAN COIL UNIT
FTR	FIN TUBE RADIATION
FT	FOOT
GAL	GALLON
GPM	GALLONS PER MINUTE
H	HEAD
HD FT	HEAD IN FEET OF WATER
HX	HEAT EXCHANGER
HP	HORSEPOWER
HWC	HOT WATER COIL
HZ	HERTS
IN	INCH
LWT	LEAVING WATER TEMPERATURE
MFG	MANUFACTURER
N. A.	NOT AVAILABLE OR NOT APPLICABLE
PSI	POUNDS PER SQUARE INCH
PSID	POUNDS PER SQUARE INCH DIFF.
PSIG	POUNDS PER SQUARE INCH GAGE
RP	RADIANT PANEL
RHC	REHEAT COIL
RH	RELATIVE HUMIDITY
RPM	REVOLUTIONS PER MINUTE
SP GR	SPECIFIC GRAVITY
DB	TEMPERATURE DRY BULB
WB	TEMPERATURE WET BULB

ABBR.	MEANING
UH	UNIT HEATER
UV	UNIT VENTILATOR

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NTBC#1692

FAN

SYSTEM	AHU-1
FAN LOCATION	2ND FLOOR CEILING HUNG
FAN SERVES	1ST FLOOR KITCHEN AREAS
FAN MANUFACTURER	AAON
MODEL #	M2-H-026 RBBOCX
SERIAL #	201509-CGDG02567

	SPECIFIED	**ACTUAL**
TOTAL CFM - OUTLETS	12080	11830
TOTAL CFM - FAN	12580	13697
R/A CFM	1531	1907
O/A CFM	11049	11790
FAN TSP	4.21"	N.A.
FAN ESP	2.0"	2.8"
FAN RPM	1340	1294

	SPECIFIED	**ACTUAL**
MOTOR MFG.	BALDOR	
MOTOR SHEAVE POSITION	DIRECT DRIVE	
MOTER SPEED AND/OR HZ	73% / 44 HZ	
MOTOR FRAME	256 T	
SERVICE FACTOR	1.15	
MOTOR HP	20	20
MOTOR BHP	12.34	N.A.
VOLTS/PHASE	208/3	208/3
AMPERAGE	47	42.5
MOTOR RPM	1765	1294

Remarks:

1. SYSTEM STATIC PRESSURE SET POINT +1.5"WC.

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4 Science Park

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NTBC#1692

EXHAUST FAN

FAN	EF-1	EF-2	EF-3	EF-5	
SERVES	KITCHEN HOOD 51A & 51B	KITCHEN HOOD 49A & 49B	HOOD DEM. RM.	TOILETS	
MFG.	GREENHECK	GREENHECK	GREENHECK	GREENHECK	
MODEL	USF-318-10-BI-30-G	USF-318-10-BI-30-G	CUBE-161XP-10-6	G-090-VG-6-X	
SHEAVE	FIXED	FIXED	1/2	D.D.	
DESIGN CFM	4711	4136	1200	525	
TEST CFM	4339	3741	1217	575	
DESIGN RPM	1666	1549	2136	1375	
TEST RPM	1687	1591	2170	1487	
MOTOR MFG	BALDOR	BALDOR	WEG	VARI GREEN	
MOTOR SIZE	3	3	1	0.17	
SERVICE FACTOR	1.15	1.15	1.15	T.P.	
VOLTS/Ø	208/3	208/3	208/3	120/1	
AMP RATING	8.4	8.4	3.15	2.45	
AMP DRAW	8.2	8	2.9	1.8	
ACTUAL BHP	2.92 EST.	2.85 EST.	0.92 EST.	.12 EST.	

REMARKS:

Northern Test and Balance Corporation
P.O.Box 407, Redding Ridge, CT 06876

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4 Science Park

New Haven, CT 06511

NTBC#1692

DUCT TRAVERSE

SYSTEM	DUCT SIZE	SQ. FT.	DESIGN DATA		TEST DATA		
			FPM	CFM	FPM	CFM	SP
AHU-1				13000		13697	
RETURN AIR-1	28"Ø	4.27	228	975.5	211	900	-.05"
RETURN AIR-2	28"Ø	4.27	228	975.5	236	1007	-.04"
OUTSIDE AIR							
MODE #1	46 X 21	6.7	298	2000	295	1976	-.28"
MODE #2	46 X 21	6.7	477	3200	486	3256	-.36"
MODE #3	46 X 21	6.7	1618	10847	1621	10860	-.65"
MODE #4	46 X 21	6.7	1649	11049	1759	11790	-.7"

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VAV / DIFFUSER / REGISTER

FAN	VAV / LOCATION	RM #	DIFF/ REG	SIZE	C.F.M		REMARKS
					DESIGN	TEST	
AHU-1					12080	11830	
	FP-VAV-A			8	650	690	
	DRY GOODS	112	1	2408	250	260	
	CORRIDOR 4	109C	2	9 X 9	200	210	
	CORRIDOR 4	109C	3	9 X 9	200	220	
	VAV-B			7	550	425	
	LOCKERS 1	119	1	2408	150	105	
	CORRIDOR 1	109A	2	2408	150	125	
	LAUNDRY	115	3	2408	150	115	
	RECEIVING	113	4	6 x 6	100	80	
	FP-VAV-C			10	1200	1205	
	DEMONSTRATION RM	111	1	2410	400	420	
	DEMONSTRATION RM	111	2	2410	400	395	
	DEMONSTRATION RM	111	3	2410	400	390	
	VAV-D			4	200	200	
	CHEF FACULTY	108	1	2408	200	200	
	FP-VAV-E			10	1000	1010	
	DISHWASH	107	1	2412	500	510	
	DISHWASH	107	2	2412	500	500	

Remarks:

1. VAV BOX MINIMUM AIR FLOW QUANTITIES SET AT 20% OF THE INDICATED MAXIMUM AIR FLOW RATES.

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NTBC#

VAV / DIFFUSER / REGISTER

FAN	VAV / LOCATION	RM #	DIFF/ REG	SIZE	C.F.M		REMARKS
					DESIGN	TEST	
AHU-1							
	FP-VAV-F			14	2000	1910	
	PRODUCTION KITCHEN	106	1	2412	350	315	
	PRODUCTION KITCHEN	106	2	2412	325	305	
	PRODUCTION KITCHEN	106	3	2412	325	320	
	PRODUCTION KITCHEN	106	4	20 X 6	250	240	
	PRODUCTION KITCHEN	106	5	20 X 6	250	235	
	PRODUCTION KITCHEN	106	6	20 X 6	250	245	
	PRODUCTION KITCHEN	106	7	20 X 6	250	250	
	FP-VAV-G			14	2000	1870	
	PRODUCTION KITCHEN	106	1	2412	500	460	
	PRODUCTION KITCHEN	106	2	2412	500	465	
	PRODUCTION KITCHEN	106	3	2412	500	450	
	PRODUCTION KITCHEN	106	4	20 X 6	250	245	
	PRODUCTION KITCHEN	106	5	20 X 6	250	250	
	FP-VAV-H			14	2300	2320	
	CAFÉ	101	1	24 X 8	500	515	
	CAFÉ	101	2	24 X 8	500	490	
	CAFÉ	101	3	20 X 8	400	410	
	CAFÉ	101	4	20 X 8	400	400	
	CAFÉ	101	5	24 X 8	500	505	

Remarks:

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NTBC#

VAV / DIFFUSER / REGISTER

FAN	VAV / LOCATION	RM #	DIFF/ REG	SIZE	C.F.M		REMARKS
					DESIGN	TEST	
AHU-1							
	FP-VAV-I			14	2000	2015	
	CAFÉ	101	1	16 X 6	200	200	
	CAFÉ	101	2	16 X 6	200	205	
	CAFÉ	101	3	16 X 6	200	210	
	CAFÉ	101	4	16 X 6	200	210	
	CAFÉ	101	5	20 X 6	300	290	
	CAFÉ	101	6	20 X 6	300	285	
	CAFÉ	101	7	20 X 6	300	295	
	CAFÉ	101	8	20 X 6	300	320	
EF-1					4711	4339	
	KITCHEN -HOOD 51A	106	1	10 X 89	2243	2316	
	KITCHEN -HOOD 51B	106	2	10 X 117	2468	2023	
EF-2					4136	3741	
	KITCHEN -HOOD 49A	106	1	10 X 108	2030	1835	
	KITCHEN -HOOD 49B	106	2	10 X 108	2106	1906	
EF-3	DEMONSTRATION RM	111	1	98 X 10	2136	2170	
EF-5					525	575	
	JAN CLOSET	117	1	8 X 8	N.A.	130	
	TOILET-1	120	2	8 X 8	N.A.	95	
	TOILET-2	120	3	8 X 8	N.A.	90	
	MEN	105	4	8 X 8	N.A.	125	
	WOMEN	104	5	8 X 8	N.A.	135	

Remarks:

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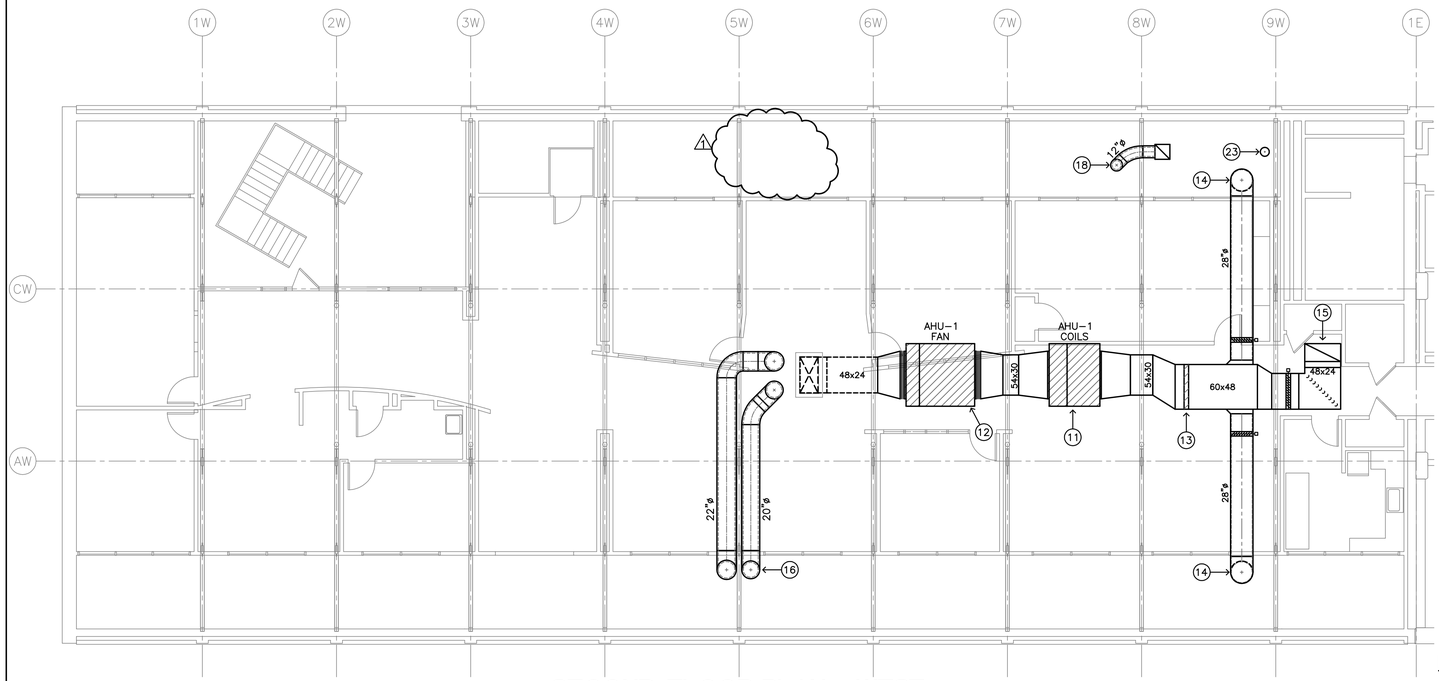
NTBC#1692

CIRCUIT SETTER

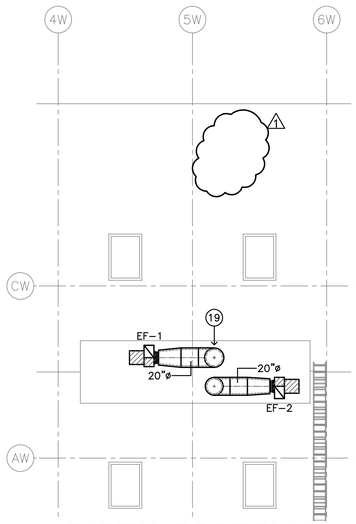
EQUIPMENT TYPE / LOCATION		No.	MODEL.	SIZE	DESIGN GPM	VALVE SETTING	FINAL	
							PD	GPM
HOT WATER								
EXISTING PUMPS								
FP-VAV-A		1	B & G	3/4"S	1.2	50°	17'	1.35
FP-VAV-C		2	B & G	3/4"S	2.4	30°	8'	2.5
FP-VAV-E		3	B & G	3/4"S	1.4	42°	14'	1.8
FP-VAV-F		4	B & G	3/4"S	1.9	45°	13.5'	2.1
FP-VAV-G		5	B & G	3/4"S	1.9	45°	17.5'	1.9
FP-VAV-H		6	B & G	3/4"S	1.7	25°	6'	2
FP-VAV-I		7	B & G	3/4"S	1.9	42°	14.9'	1.9
FP-VAV-J		8	B & G	3/4"S	0.8	50°	8.5'	1
UH-1		9	B & G	3/4"S	0.75	50°	15'	1.2
AHU-1								
COIL		10	B & G	2 1/2"	60	0°	1.7'	57
BY-PASS		11	B & G	2 1/2"	60	0°	1.7'	57

Remarks:



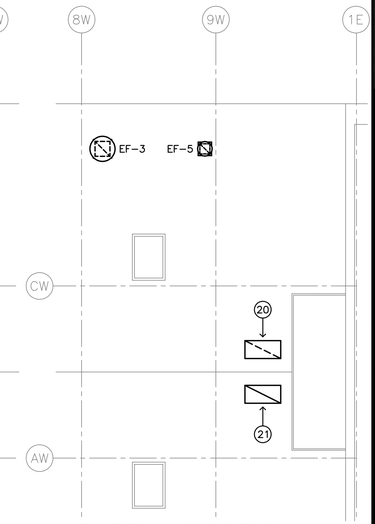
SECOND FLOOR PLAN - WEST - HVAC - DUCTWORK

SCALE: 1/8" = 1'-0"



PARTIAL ROOF PLAN - WEST - HVAC - DUCTWORK

SCALE: 1/8" = 1'-0"



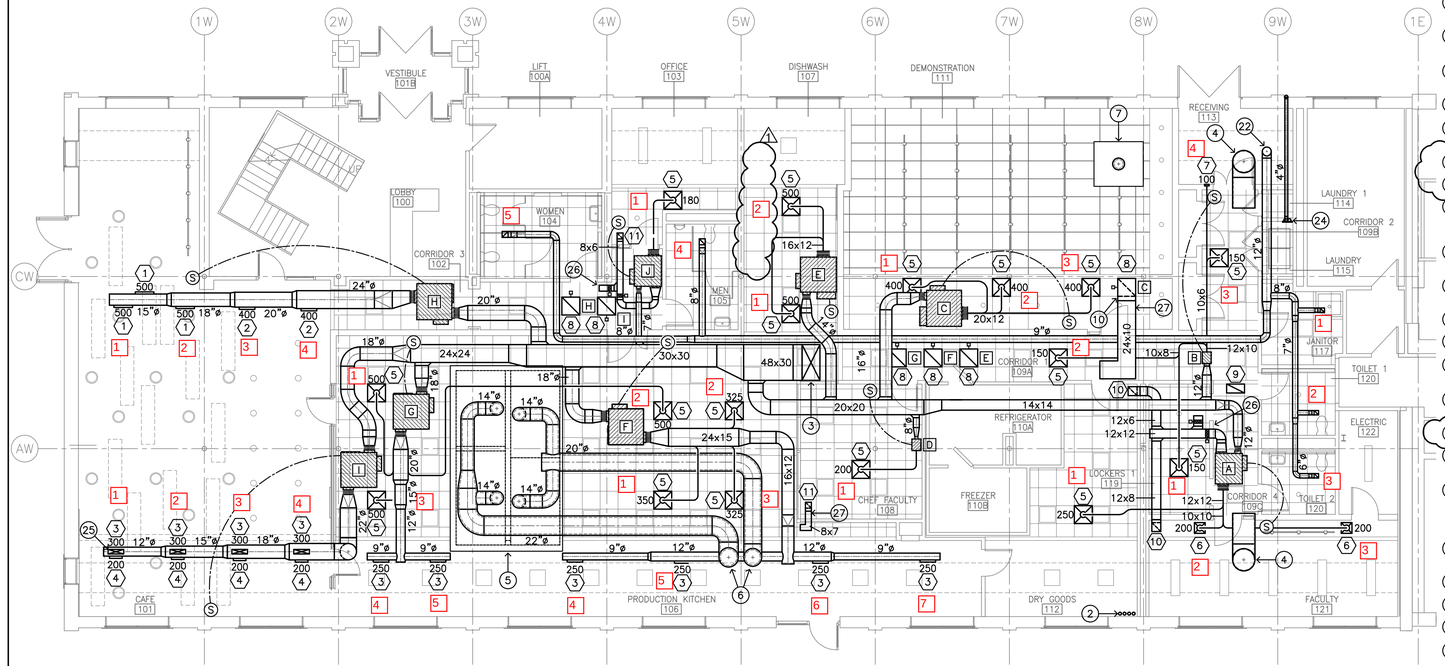
PARTIAL ROOF PLAN - WEST - HVAC - DUCTWORK

SCALE: 1/8" = 1'-0"

HVAC LEGEND

1. NEW OUTDOOR CONDENSING UNIT, MOUNT DEAD LEVEL ON CONCRETE CURB, CURB NOT IN HVAC DIVISION. COORDINATE EXACT LOCATION AND ORIENTATION WITH FINAL CONCRETE CURB LOCATION, TO BE DETERMINED IN FIELD BY OTHERS. RUN NEW REFRIGERANT PIPING LINE SETS FROM (NOT SHOWN) INTO BUILDING TO NEW REFRIGERANT PIPING RISERS LOCATION.
2. NEW REFRIGERANT PIPING LINE SETS FROM OUTDOOR CONDENSING UNIT RISERS LOCATION, RUN UP TO SECOND FLOOR AND TO NEW DX COIL SECTION AS REQUIRED (SECOND FLOOR PIPING NOT SHOWN). DETERMINE EXACT ROUTE OF PIPING IN FIELD.
3. EXISTING SUPPLY DUCT FROM ABOVE, SEE SECOND FLOOR PLAN THIS SHEET FOR CONTINUATION, CONNECT NEW DUCTWORK TO EXISTING AND RUN HORIZONTALLY AS HIGH AS POSSIBLE AS SHOWN.
4. NEW RETURN DUCTWORK, OPEN-END TO RETURN AIR PLENUM ABOVE CEILINGS, RUN UP TO AS SHOWN, SEE SECOND FLOOR PLAN FOR CONTINUATION.
5. CONNECT NEW KITCHEN HOOD EXHAUST DUCTS (GREASE DUCT) TO KITCHEN EXHAUST HOODS AS REQUIRED AND RUN ABOVE CEILINGS AND EXPOSED AS SHOWN, KITCHEN EXHAUST HOODS NOT IN HVAC DIVISION.
6. NEW EXPOSED KITCHEN HOOD EXHAUST DUCTS UP, SEE SECOND FLOOR PLAN FOR CONTINUATION.
7. CONNECT NEW KITCHEN HOOD EXHAUST DUCT (GREASE DUCT) TO KITCHEN EXHAUST HOOD AS REQUIRED AND RUN UP ABOVE CEILING THRU SECOND FLOOR, KITCHEN EXHAUST HOOD NOT IN HVAC DIVISION.
8. NOT USED.
9. NOT USED.
10. NEW EXHAUST GRILLE WITH TWO-POSITION LOW-LEAKAGE MOTORIZED DAMPER IN NECK, OPEN-END TO PLENUM ABOVE CEILINGS. VAV BOX SYMBOL DESIGNATION IS CORRESPONDING VAV BOX OPERATION TO OPEN OR CLOSE DAMPER, SEE SEQUENCES OF OPERATION IN MECHANICAL SPECIFICATIONS ON DRAWING M-1. TYPICAL.
11. NEW AIR HANDLING UNIT COILS SECTIONS, MOUNT ON EXISTING STEEL SUPPORT FRAME, PROVIDE AND INSTALL AUXILIARY STEEL AS REQUIRED TO PROPERLY SUPPORT SECTIONS.
12. NEW AIR HANDLING UNIT FAN MODULAR SECTION, MOUNT ON EXISTING STEEL SUPPORT FRAME, PROVIDE AND INSTALL AUXILIARY STEEL AS REQUIRED TO PROPERLY SUPPORT SECTION.
13. NEW SIDE ACCESS FILTER HOUSING, FARR 3P GLIDE PACK WITH MERV 8 FILTERS, 60"x48" TOTAL FACE AREA OF FILTERS.
14. RETURN DUCT FROM BELOW, CONNECT TO FIELD FABRICATED MIXING PLENUM AS SHOWN.
15. OUTSIDE AIR DUCT UP, CONNECT TO FIELD FABRICATED MIXING PLENUM AS SHOWN. SEE PARTIAL ROOF PLAN FOR CONTINUATION.
16. NEW KITCHEN HOOD EXHAUST DUCTS (GREASE DUCT) FROM BELOW, RUN HORIZONTALLY AS HIGH AS POSSIBLE AND UP THRU ROOF TO EXISTING PLATFORM ON ROOF.
17. NOT USED.
18. NEW EXPOSED KITCHEN HOOD EXHAUST DUCT FROM BELOW, OFFSET AS SHOWN AND RUN UP THRU ROOF TO ROOFTOP EXHAUST FAN EF-3, SEE PARTIAL ROOF PLAN.
19. NEW KITCHEN HOOD EXHAUST DUCT (GREASE DUCT) FROM BELOW, RUN HORIZONTALLY TO NEW EXHAUST FAN. MOUNT NEW EXHAUST FAN ON ISOLATION VIBRATION MOUNTS ON EXISTING PLATFORM ON ROOF AS REQUIRED, PROVIDE AND INSTALL A STACK AT OUTLET OF UPBLAST ARRANGEMENT FANS AND TERMINATE 36" ABOVE FANS OUTLET, SECURE STACK WITH (3) EVENLY SPACED GUY WIRES AS REQUIRED. TYPICAL FOR 2.
20. NEW 48"x24" OUTSIDE AIR GOOSENECK INLET WITH BIRDSCREEN, INLET SHALL BE A MINIMUM 36" ABOVE ROOF DECK, FABRICATE PER SMACNA STANDARDS, MOUNT ON EXISTING ROOF CURB, FLASH WEATHERTIGHT.
21. CAP EXISTING ROOF CURB WITH FIELD FABRICATED SHEET METAL WITH RIGID FIBERGLASS INSULATION CAP, SEAL WATERTIGHT.
22. NEW EXPOSED EXHAUST DUCT UP, SEE SECOND FLOOR PLAN FOR CONTINUATION.
23. NEW EXPOSED EXHAUST DUCT FROM BELOW AND UP THRU ROOF TO ROOFTOP EXHAUST FAN EF-5, SEE PARTIAL ROOF PLAN.
24. DRYERBOX MODEL 350 RECESSED DRYER VENT BOX IN WALL, CONNECT 4" FLEX METAL DUCT TO DRYER VENT OUTLET, RUN UP IN WALL, ABOVE CEILING AND THEN EXPOSED TO EXTERIOR WALL, TERMINATE WITH DRYER VENT CAP, SEIHO MODEL SFZC-4. CLOTHES DRYER NOT IN HVAC DIVISION.
25. SUPPLY REGISTER IN BORROM OF DUCT, DIRECT AIR TOWARDS INTERIOR OF SPACE. BOTTOM OF ENTIRE EXPOSED SPIRAL DUCT SHALL BE AT THE SAME ELEVATION AS THE BOTTOM OF ADJACENT SOFFIT.
26. RETURN AIR DUCTWORK ABOVE CEILINGS WITH (2) MOTORIZED 2-POSITION DAMPERS, SEE SEQUENCES OF OPERATION IN MECHANICAL SPECIFICATIONS ON DRAWING M-1.
27. LINED TRANSFER DUCT, CONNECT TO GRILLE IN CEILING, RUN AS SHOWN AND OPEN END TO PLENUM ABOVE CEILING.

SEE GENERAL NOTES ON DRAWING HVAC-3



FIRST FLOOR PLAN - WEST - HVAC - DUCTWORK

SCALE: 1/8" = 1'-0"

OUTDOOR CONDENSING UNIT SCHEDULE

SYMBOL	MAKE	MODEL	NOMINAL CAPACITY BTUH	SUCTION TEMPERATURE	AMBIENT TEMPERATURE °F DB/WB	EER BTUH/WATTS APPLICATION	VOLTAGE	MCA	MOCP
CU-1	AAON	CCC063	896,900	50°F	84/75	15	208-3PH	279	300

FURNISH WITH MODULATING FAN PRESSURE CONTROL, MODULATING HOT GAS REHEAT, SUCTION PRESSURE TRANSDUCER, COMPRESSOR SOUND BLANKET, 2,500 HOUR SALT-SPRAY TESTED EXTERIOR PAINT AND 5 YEAR EXTENDED COMPRESSOR WARRANTY. EACH SHALL HAVE A VARIABLE CAPACITY DIGITAL SCROLL COMPRESSOR WITH TWO CIRCUITS. START-UP BY FACTORY AUTHORIZED REPRESENTATIVE.

SVIGALS + PARTNERS
84 Orange Street + New Haven, CT 06510
203 786-5110 + www.svigals.com

CONSULTANT:

GENERAL DRAFTING & DESIGN, INC.
CONSULTING ENGINEERS
140 Washington Avenue, 3rd Floor
North Haven, CT 06473
(203) 239-6818 Tel.
(203) 239-7275 Fax

REVISION LOG:

No.	Description	Date
1	VALUE ENGINEERING	07/20/15

PROJECT NAME:

CONNCAT CULINARY ARTS

RECEIVED
Jul 24, 2015
Petra CONSTRUCTION CORP.

PHASE:

CONSTRUCTION DOCUMENTS

DRAWING TITLE:

FIRST FLOOR, SECOND FLOOR AND PARTIAL ROOF PLANS - WEST - DUCTWORK - HVAC

SCALE: 1/8"=1'-0"

DATE: 05/01/15

JOB NO: 1422.00

SHEET NO:

HVAC-2

KEY PLAN

Eastern Mechanical Services, Inc
3 Starr Street
Danbury, CT 06810
Phone: 203.792.7668 Fax: 203.748.0385 Web: www.emsinc.us

Subcontractor Letter of Warranty – Corporation.

This Letter of Warranty is issued by **Eastern Mechanical Services, Inc.**, (hereinafter "Subcontractor) to Petra Construction Corporation (hereinafter "Petra") and **Connecticut Center for Arts & Technology, Inc.** for the **ConnCat Culinary Arts Renovation, 4 Science Park, New Haven, CT 06511.** Subcontractor hereby agrees and warrants that all material, equipment and workmanship related to **Division 15 – HVAC and Plumbing,** furnished under contract for the completion of the above stated project has been performed in accordance with the Contract Documents. Subcontractor agrees to repair or replace all Work defective in workmanship, materials or equipment, and any work of others damaged due to its defective work, within a period of twelve (12) months from the date of Substantial Completion, **January 15, 2016,** or if required, Final Completion or for such longer term as may be required by the Contract Documents. Any defects and/or damage caused by ordinary wear, neglect or abuse are excluded under this Warranty.

If Subcontractor fails to perform or commence to perform repairs or replacement of defective materials, equipment and workmanship within the time period set forth in a written notice of required warranty work from the Owner, Architect or Petra, Subcontractor hereby authorizes the Owner or Petra to perform the work to repair said defects in their sole discretion and at the expense of Subcontractor, including any overtime, special premiums and maximum allowable interest. If Subcontractor fails to fulfill the preceding obligations and if the Owner or Petra brings legal action to enforce this Warranty, and judgment is entered in favor of the Owner or Petra, Subcontractor shall pay to the Owner and Petra in addition to the judgment, reasonable court costs, attorney's fees and contractor administration fees incurred in connection therewith.

EASTERN MECHANICAL SERVICES, INC
(Insert Subcontractor's Name)

By: _____
(Signature of officer)

Its: PRESIDENT
(Insert Title)

ACKNOWLEDGMENT

State of Connecticut

County of Fairfield

The foregoing instrument was acknowledged before me this 29th day of January, 2016, by Ted Huizinga (name of officer signing) the President (title) of Eastern Mech. Svs., Inc (name of corporation), a CT (State) corporation, on behalf of the corporation.

Christine L Hadgraft
Notary Public

8/31/19
My Commission Expires

CHRISTINE L HADGRAFT
Notary Public
Connecticut
My Commission Expires Aug 31, 2019