H2K Technologies, Inc.

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OPERATION & MAINTENANCE

MANUAL

For
Panhandle Geotech

Project Name
DPE & GWT System
Time Saver- North Platte. NE

H2K Technologies Inc., Project Number # 4918

Supplied By
H2K Technologies Inc.
7550 Commerce St.
Corcoran, MN 55340
(763) 746-9900
August 18, 2017

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Warranty Terms & Conditions

WARRANTIES: We warrant performance against defects in workmanship for a period of twelve (12) months from date of shipment. We also agree to pass on to the Purchaser any extended warranties by the manufacturer for material supplied. Remedies are limited to the repair and/or replacement of the defective part at H2K Technologies Plant in Plymouth, MN, and do not included freight to and from the point of operation or onsite labor to install or remove the product for service. It is agreed that any action for breach of express or implied warranty shall be initiated within fifteen (15) months of the date of shipment and only those defects that are documented to have occurred within twelve (12) months of shipment will be covered by the warranty. In no event shall H2K Technologies be liable for unintended or consequential damages, including, but not limited to, loss of profits or use damages arising out of the manufacture sale or supplying of the product. The provisions of the warranty are in lieu of any other warranty, whether expressed or implied, written or oral, and H2K Technologies liability arising out of the manufacture, sale or supplying of the product and its use, whether based on warranty, contract, negligence, product liability or otherwise shall not exceed the original cost of the defective product.

Section 1. System / Equipment Description

This manual contains important information about the equipment H2K Technologies, Inc has supplied for this project. Specific operation and maintenance information for individual components or systems can be found in the numbered sections. If additional information is required, please call.

The appendices contain the original equipment manufacturers' operation and maintenance manuals, specification sheets, modeling, etc.

Equipment Description:

The below is a list of equipment supplied by H2K Technologies Inc. for this project, more specific information on most of these items can be found in numbered sections of the manual.

DPE Equipment

(1) DPE intake manifold, with 3" Main header and (8) 2" laterals, to include:
- Sch. 80 PVC construction
- (8) 2" PVC ball valves
- (8) Vacuum gauges
- (8) Sample ports

(1) Moisture separator, ***H2K*** model VLS 100
- Tangential inlet and demister for 99% + moisture removal
- Carbon steel construction, industrial enamel finish
- Full Vacuum design rating
- 4" NPT inlet and outlet
- 100 gallon total capacity
- PVC site glass with ss High/high-high & low level switches and union for easy removal
- Polypropylene demister element
- Vacuum gage on separator inlet and outlet
- Sample port on separator inlet and outlet
- 1" Drain valve
- 2" Air bleed valve with filter/silencer on separator
- Vacuum relief valve on separator
- 6" Cleanout port

(1) Inline air filter, Solberg CT-235P-300 with replaceable polyester element
- Differential pressure gauge across filter

(1) XP Vacuum transmitter on blower intake – Dwyer Series 3100

(1) Claw DPE Blower, Rietschle VLR400
- 250 acfm at 17" Hg vacuum at blower inlet
- Flexible couplings for vibration isolation on blower inlet and outlet
- 10 HP, 460 VAC, 3Ø, XP motor
- Vacuum gage on inlet
- Discharge silencer
- Temperature gage on blower discharge
- Sample port on blower intake and discharge stack
- Silencer on blower discharge
- Air flow meter on blower discharge – Dwyer DS-300 pitot tube w/ differential pressure gauge
- High pressure switch on discharge, Dwyer model 1950P-2

Water Treatment Equipment

(1) Discharge pump, AMT model 490D end suction centrifugal pump

50 gpm @80' TDH
Cast iron bronze fitted
2 HP, 460VAC, 3Ø, TEFC motor
Check valve, Throttle valve and pressure gage on pump discharge
Sample port on pump discharge
Pump re-circulation loop with ball valve

(1) H2K model LLS-32 oil/water separator
99%+ removal of 20 micron & larger droplets at 50 gpm w/ gasoline (0.85 SG)
304 Stainless steel construction
PVC slant rib coalescing media
Adjustable skimming weir
Solids collection sump with valve
Gravity flowing drains floating product discharges
Vapor tight gasketed cover
PVC Sight glass with 3 point level switch (LSHH, LSH, LSL)

(1) AMT model 489B end suction centrifugal pump
50 gpm @ 40' TDH
Cast iron bronze fitted
1.5 HP, 460VAC, 3Ø, TEFC motor
Check valve, Throttle valve and pressure pressure gage on pump discharge
Sample port on pump discharge

(1) H2K model HDTA4 diffused aeration stripper, to include:
(4) 304 SST diffusor chambers
(5) 304 SST Diffusers per chamber (total of 20)
(1) Pump out clearwell
Site glass with ss high/high-high-low pump out level switches
Pressure gage on sump vapor space
(1) Blower, NYB model 2306 centrifugal blower
600 cfm at 30” wc pressure,
7.5 HP, 460 VAC, 3Ø, EXP motor
6” Pitot tube with Magnehelic gage on blower outlet
Low blower pressure switch, Dwyer model 1950-5

(1) Discharge pump, AMT model 490D end suction centrifugal pump
50 gpm @ 80' TDH
Cast iron bronze fitted
2 HP, 460VAC, 3Ø, TEFC motor
Check valve, Throttle valve and pressure pressure gage on pump discharge
Sample port on pump discharge

(1) Water flow totalizer, 1 1/2” Zenner multi-jet on discharge

(1) High-high level switch, for installation in customer-provided product tank on site

Section 2. Installation, Start–up

Contains general installation instructions, start up and shut down procedures.

Before starting any system, thoroughly inspect the system for signs of damage. Use the provided P&ID to verify that the system has been connected correctly. Then, read the start up procedure before proceeding.

Start-Up Procedure:

- Verify the system is properly secure.
- Verify that all influent and effluent connection have been made, and open all valves to ensure that there are no restrictions on the blower.
- Turn on power to the control panel. If any lights come on press the reset button and the alarms should clear. If not, check the switches and controls to determine the problem.
- Verify the power leads are properly wired to the motor. **Incorrect voltage or improper wiring will ruin the motor**

Control Panel 3ϕ, 480V

WARNING! – Do not power the panel until this procedure is complete. Damage to the panel may result.

- Switch the disconnect to the "OFF" position and open the inner door. Verify that the inner door disconnect is in the off position.
- Switch on the main incoming power to the panel. CAUTION! - The disconnect now has power!
- Confirm that incoming power is 480 V on all three phases. .
- It is best to record the initial readings of the system for trouble shooting purposes later. Record the following operating conditions:

  L1 to L2 _____ V
  L1 to L3 _____ V
  L2 to L3 _____ V

- Be sure that all circuit protectors are reset.
- Close the inner door. Make sure that all of the green HOA's (Hand-Off-Auto) are in the "OFF" position. Turn the inner disconnect to the "ON" position. The panel should have power. All of the alarm lights may be lit depending on the panel. If so, press the "RESET" button. If the alarms will not reset, an alarm may be tripped. (See section "B" for details.)
- Rotation needs to be verified on all motors. To do so, bump any motor holding the HOA in the "HAND" position for no more than a second. Rotation arrows are located most pieces of equipment.
- If rotation is backwards, have an electrician exchange the incoming power leads L1 and L3. **Be sure to lock out and tag the main incoming power. Verify that there is no power with a multimeter.**

Centrifugal Pump

- Ensure that all valves up stream on the pump are open. Valves up stream should never be used to throttle the pump. All valves located up stream of a pump are strictly isolation valves for servicing the pump. Close all sample taps.
- Verify the power leads are properly wired to the blower motor. **Incorrect voltage or improper wiring will ruin the motor.**
- Bump the pump to verify rotation by holding the PUMP HOA in the "HAND" position for no more than a few seconds. Rotation arrows are located on the pump to signify proper rotation.
- If rotation is backwards, have an electrician exchange two of the power leads. **Be sure to lock out and tag the main incoming power. Verify that there is not power at the motor with a multimeter.**
- Prime the pump.
- If there is a suction head requirement on the pump inlet due to elevation, the pump may be primed by open the top plug and adding water until full.
- If there is a suction head requirement due to a mechanical vacuum, the pump may be primed by turning off the source of the vacuum. Water should gravity feed into the pump.
- If there is a positive suction head, the pump should self-prime.
- Test the prime. Run the pump for a few seconds to verify that water is flowing through the pump at a constant rate and pressure. If not, repeat the above steps.
- Put the Pump HOA in the "AUTO" position. Throttle the pump to the desired flow.
- It is best to record the initial readings of the system for trouble shooting purposes later. Record the following operating conditions:

  PUMP motor amp draw _____
  PUMP pressure _____
  PUMP flow rate _____
  Deadhead pressure (pressure w/pump effluent valve closed) _____

Notes: Depending on the interlock schedule, the pump may not run until all of the appropriate alarms have been cleared and the correct pieces of equipment enabled.

DPE - Claw Blower System

- Verify that there is oil in the blower: Although the blower is filled with oil when tested, it is important to verify that there is oil in the blower. Open the lower side plug to verify that there is oil in the blower.
- Open all inlet, outlet, and bleed valves to ensure that there are no restrictions on the sparge blower.
- Verify the power leads are properly wired to the blower motor. **Incorrect voltage or improper wiring will ruin the motor.**
- Bump the blower to verify rotation by holding the sparge blower HOA in the "HAND" position. Rotation arrows have been placed on the blower to signify proper rotation. It is pertinent to physically verify the proper flow. This can be achieved by testing to see if there is pressure on the sparge bleed line.
- If rotation is backwards, have an electrician exchange two of the power leads. **Be sure to lock out and tag the main incoming power. Verify that there is not power at the motor with a multimeter.**

- Once rotation has been confirmed to be correct, put the sparge blower HOA in the "AUTO" position to start the blower. Let the blower run with no load for a few minutes. If the system has an after cooler, verify that the fan is operational.
- Throttle the discharge bleed valve until operating conditions are reached. Depending on the actual well restriction, the operating pressure may not be reached. The desired flow conditions at the well header can now be adjusted.
- It is best to record the initial readings of the system for trouble shooting purposes later. Record the following operating conditions:

Sparge inlet vacuum	_____
Motor amp draw	_____
Pressure drop across the filter	_____
Exhaust temperature	_____
Exhaust pressure	_____
Air flow rate	_____
After cooler temperature	_____

Notes: Depending on the interlock schedule, the blower may not run until all of the appropriate alarms have been cleared and the correct pieces of equipment enabled.

LLS – Liquid/Liquid Separator (Oil/Water Separator)

- Verify that the unit is level in both directions. This is critical to the operation of the unit. Verify that the influent and effluent connection have been made. Close all sample taps and make that the all drain valves and plugs are closed.
- Turn the skimmer tube so the slot is in its highest position. Fill up the sump end until water is flowing over the weir. While the flow is at its anticipate design maximum, adjust the skimmer tube so that the slot is ¼" above the liquid level. It is important to do this while the water is flowing through the unit. If the skimmer is set while the water is still, water may flow into the product drum at a high rate, cause errant alarms.
- It is best to record the system operation for trouble shooting purposes later. Record the following operating controls (circle to verify OK):

Pump On	_____
Pump Off	_____
Sump LAH	_____
Product drum LAH	_____

Notes: Depending on the interlock schedule, the pump may not run until all of the appropriate alarms have been cleared and the correct pieces of equipment enabled.

DTA – Diffused Aeration Tank Stripper

Please review the below for recommend operating flow rates. The correct flow rate for your system will be determined by the contaminate levels you are treating.

HDTA-4
1-80 GPM 200-320 CFM

- Verify that all influent and effluent connection have been made, and open all inlet, outlet, and bleed valves to ensure that there are no restrictions on the blower. Close all sample taps.
- Verify the power leads are properly wired to the blower motor. **Incorrect voltage or improper wiring will ruin the motor.**
- Bump the blower to verify rotation by holding the DTA blower HOA in the "HAND" position. Rotation arrows are located on the blower to signify proper rotation.
- If rotation is backwards, have an electrician exchange two of the power leads. **Be sure to lock out and tag the main incoming power. Verify that there is not power at the motor with a multimeter**.
- Once rotation has been confirmed to be correct, put the DTA blower HOA in the "AUTO" position to start the blower. Let the blower run with no load for a few minutes. If the system has a bleed valve, close the bleed valve.
- Introduce water into the system.
- It is best to record the initial readings of the system for trouble shooting purposes later. Record the following operating conditions:

DTA tank blower pressure _____
DTA Blower motor amp draw _____
DTA back pressure, if there is off gas treatment _____
Air flow rate, if a meter is available _____
Water flow rate, if a meter is available _____

Notes: Depending on the interlock schedule, the blower may not run in "Auto" until all of the appropriate alarms have been cleared and the correct pieces of equipment enabled.

SECTION 3: SHUT DOWN PROCEDURES:

CAUTION! – When disabling any motor or piece of equipment be certain that all source of power and fluid have been locked out and tagged.

DTA Tank

Be sure all sources of water are disables.
Let system blower continue to run for 10 minutes.
Disable blower.
Remove all remaining water in the tank

DPE – Claw Vacuum System

If the blower is to be shut down for less than one month, use the following procedure.
Let the blower run for one minute without any load.
Shut down the blower.
Disconnect the air inlet line and spray WD-40 or equivalent into blower. . Turn the shaft by hand until all sides of the lobes are completely covered. Reattach the inlet line.
Drain any water that may have accumulated in the blower silencer or knock out tank.

If the blower is to shut down for more than one month, use the following procedure.
Disable the blower and all other sources of air or water into the system.
Remove the inlet piping and coat the lobes with Nox-Rust # VCI10 or equivalent rust inhibitor. Turn the shaft by hand until all sides of the lobes are completely covered. Coat the shaft and any other non-painted surfaces with the rust inhibitor.
Cap inlet and outlet of blower with tape or a plug.
Grease bearings.
Drain any water that may have accumulated in the blower.
Periodically rotate lobes and inspect blower for rust.

Centrifugal Pump

Disable pump.
Drain pump head and all inlet and effluent lines.

Section 4. Maintenance Schedule

These forms should be used as a guide for general maintenance items. The recommended maintenance intervals are based upon past experience with the equipment and equipment manufactures' literature. It is important to use discretion when implementing the maintenance schedule. Unforeseen operating condition may require additional maintenance.

Maintenance Schedule

Recommend frequency	Task	Comment

VLS – Vapor / Liquid Separator (Moisture Separator)

As Needed	Clean/replace inlet filter and demister	When differential pressure across the filter exceeds 15"H_20.
	Clean sump, site glass, pump down switch	As need, depending on water quality. Recommend initial inspection after six month.

LLS – Liquid / Liquid Separator (Oil/Water Separator)

Weekly As needed	Inspect operation	Any signs of leaks or other problems caught early enough can eliminate major problems.
	Clean separator	As needed, depending on water quality. Recommend initial inspection after first month. This might include draining the sludge, washing/replacing the packing, or removing any bacteria growth.
Monthly	Check any controls, switches or interlocks with the SVE system	Finding a faulty instrument can prevent problems if detected.

Centrifugal Pump

6 months/Yearly	Disassemble, inspect, and clean impeller housing, and rotor	May require service more often based on the site operating conditions
Yearly	Grease motor with NLGI #2, if applicable.	

DTA – Diffused Aeration Tank Stripper

As needed	Clean tank and air distributors	Depending on the amount of hardness in the water. An initial inspection of the tank is suggested after the two to three weeks.
	Clean site glass and level assembly	Depending on the amount of hardness in the water. If the site glass every becomes rust colored, the site glass should be cleaned.

Recommend frequency	Task	Comment
	Blower filter cleaning or replacement	Depending on air quality conditions
Yearly	Grease blower motor bearings with NLGI #2. Grease..	If applicable

DPE –Claw Vacuum Blower

Weekly	Check SVE oil by opening lower side plug to see if there is enough oil.	
Every 20,000 operating hours	SVE oil change. Use BP Enersyn HTX 220 oil or equivalent synthetic	
Every 2,000 operating hours	Check oil level	
	Clean (with pressurized air) or replace inlet filter	
	Check inlet screen, clean if necessary	
Every 6 months	Clean housing of dust and dirt	Lock-out pump switch Remove acoustic enclosure Clean fan cowlings, fan wheels vents and cooling fins

Section 5 Trouble Shooting Guide:

Any time the system will not run and there is not an alarm condition present, verify the following:

1. All alarm lights are functioning. To test the lights, press the alarm light to verify if the bulb is functional.
2. All circuit protectors are reset. Open the inner door and reset any circuit protectors that may have been tripped. A tripped circuit protect may indicate a problem with the system. Inspect the system for abnormal conditions.
3. All of the inter locks have been properly installed.
    - On the control panel terminal strip, verify that the 201-202 interlock is a closed circuit.
    - Verify that all motor temperature switches are wired. Some motors have internal temperature switches that do not require external connection. If a motor has internal temperature switches, the provided space in the panel for external temperature switches must be wired to close the circuit.
    - If the provided panel requires an upstream or a downstream enable, verify that the enable is present and wired correctly.

For all other troubleshooting refer to the following table:

System Problem	Possible cause	Solution
DPE –Claw Vacuum Blower		
Blower will run in "HAND" but not in "AUTO"	Alarm condition	Clear any alarm condition and reset the control panel, see "Section 3" for alarm interlocks.
Blower will not run in the "HAND" position	Tripped circuit protector	Open the inner door and reset the circuit protector. A tripped circuit protect can be an indication of a problem. Inspect the system thoroughly and check the operating conditions.
	Motor temperature switch is inoperative	Check to see that the motor temperature switch has been wired. If the motor does not have an external temperature switch, a jumper is required.
	Faulty blower motor	Refer to Appendix or contact H2K Tech for help in diagnosing faulty blower.
Positive pressure instead of negative pressure at SVE inlet	Incorrect blower rotation	Verify and change rotation
Blower runs at a reduced performance	Inlet filter fouled	Clean or replace inlet filter
	Excessive effluent pressure	Verify operating condition. Ensure that there is not excessive backpressure on the unit, (i.e. reduced pipe sizes, fouled Carbon bed, or fouled CATOX.)
	Moisture separator relief valve set to low	Refer to Appendix or contact H2K Tech for help in adjusting relief valve

System Problem	Possible cause	Solution
	Sheaves incorrectly installed	Verify that the sheaves are installed in their appropriate location. If they are incorrect, switch sheaves.
Excessive Amp Draw	Excessive influent vacuum	Reduce inlet vacuum
	Excessive effluent pressure	Verify operating condition. Ensure that there is not excessive backpressure on the unit, (i.e. reduced pipe sizes, fouled Carbon bed, water in the after cooler, or fouled CATOX.)
	Sheaves incorrectly installed	Verify that the sheaves are installed in their appropriate location. If they are incorrect, switch sheaves.
	Obstruction in blower	Inspect blower for signs of wear on the lodes, or obstructions. Be sure blower motor power is tagged and locked out before inspecting blower.
	Blower damaged	Refer to Appendix or contact H2K Tech for help in diagnosing faulty blower

Air Stripper Blower

Blower will run in "HAND" but not in "AUTO"	Alarm condition	Clear any alarm condition and reset the control panel. See "Section 3" for alarm interlocks.
Blower will not run in the "HAND" position	Tripped circuit protector	Open the inner door and reset the circuit protector. A tripped circuit protect can be an indication of a problem. Inspect the system thoroughly and check the operating conditions.
	Motor temperature switch is inoperative	Check to see that the motor temperature switch has been wired, or that there is a jumper, if a switch is not present.
	Faulty Blower	Refer to Appendix or contact H2K Tech for help in diagnosing faulty blower.
Blower runs at a reduced performance	Incorrect blower rotation	Verify and change rotation
	Inlet filter fouled	Clean or replace inlet filter
	Excessive effluent pressure	See High Pressure Drop section

Centrifugal Pump

Pump will run with the selector switch in "hand", but not "auto"	Alarm condition is active	Clear any alarm condition and reset the control panel.
	Pump down latch not active	Allow sump to fill until the high level switch activates the pump.

System Problem	Possible cause	Solution
Pump will not run when the operator turns the switch on “hand” or “auto”	Circuit protection is tripped	Reset overload protection. Try restarting the blower. Since the overload tripped, there might still be a problem in the system. Try to determine what caused the overload to trip.
	Motor temperature switch is Open	The motor might have an internal motor temperature switch. Check to see that it was wired. If not, it needs to be wired into the logic of the controls. If it was wired, the motor might have gotten too hot. Try restarting the blower and monitor it to see if it opens again. If it does, there is either a problem with the motor or the system causing the motor to overheat.
	Alarm condition occurs, or a system enable is not active.	Verify what alarm is active or what system enable is not active. Even if the panel doesn’t show there is an alarm, there might be a light bulb burnt out which would normally display the alarm condition. There needs to be a jumper from terminal 21 to terminal 25 if an upstream enable is not present.
Pump operating at reduced performance	Incorrect pump rotation	Verify and change rotation
	Pump restricted	Inspect and clean all influent lines, pump head and effluent lines.
	Rotor is worn	Replace the rotor
Pump leaking	Shaft seal worn, cracked housing	Replace shaft seal, inspect housing and fittings

LLS – Liquid / Liquid Separator (Oil/Water Separator)

Oil in discharge chamber	Skimmer set too high	Adjust skimmer to ¼” above water level during operating conditions
	Flow rate too high	Turn influent flow to the proper rating for the size of O/W separator used
Water in product tank	Skimmer set too low	Adjust skimmer to ¼” above water level during operating conditions

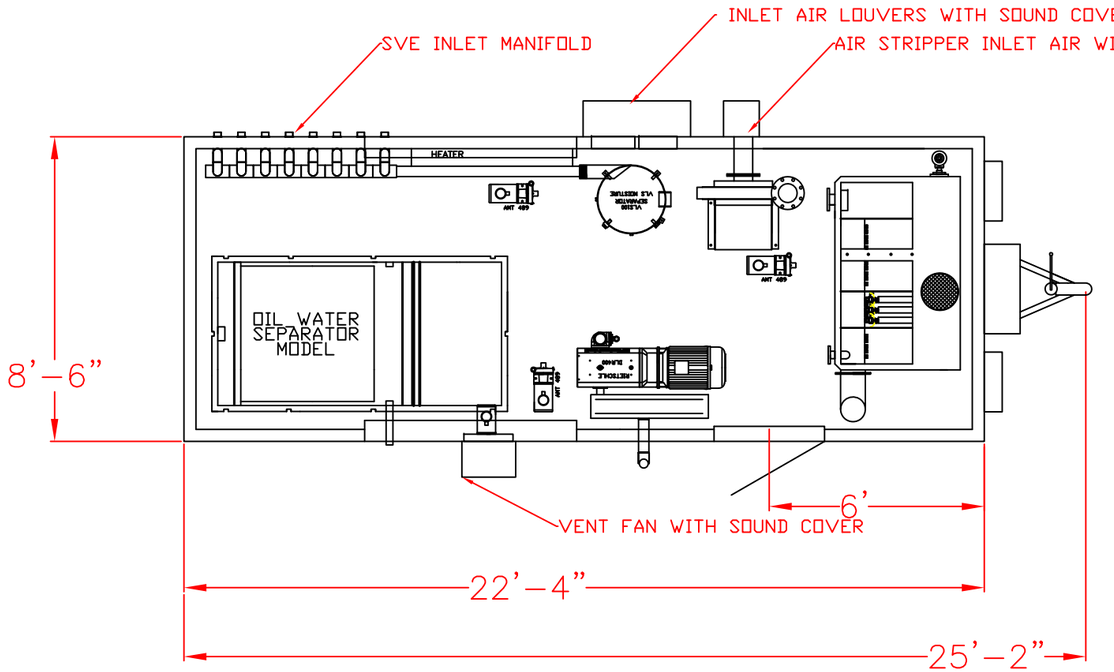
DTA Blower (Diffused Aeration Tank Blower)

Blower will run in “HAND” but not in “AUTO”	Alarm condition	Clear any alarm condition and reset the control panel. See “Section 3” for alarm interlocks.
Blower will not run in the “HAND” position	Tripped circuit protector	Open the inner door and reset the circuit protector. A tripped circuit protect can be an indication of a problem. Inspect the system thoroughly and check the operating conditions.

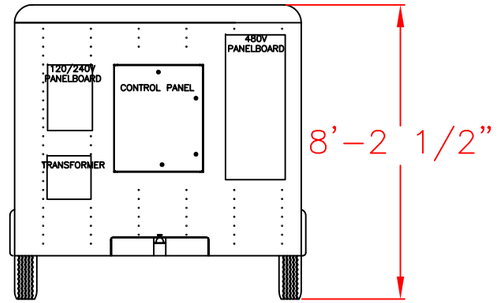
System Problem	Possible cause	Solution
	Motor temperature switch is inoperative	Check to see that the motor temperature switch has been wired, or that there is a jumper, if a switch is not present.
	Faulty Blower	Refer to Appendix or contact H2K Tech for help in diagnosing faulty blower.
Blower runs at a reduced performance	Incorrect blower rotation	Verify and change rotation
	Inlet filter fouled	Clean or replace inlet filter
	Excessive effluent pressure	Check for fouled air distributors

Section 6. Mechanical Drawings:

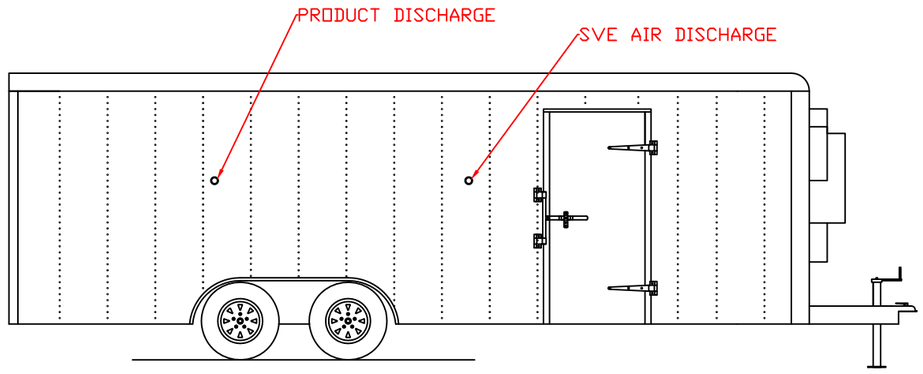
Contains any H2K Technologies Inc. generated drawings



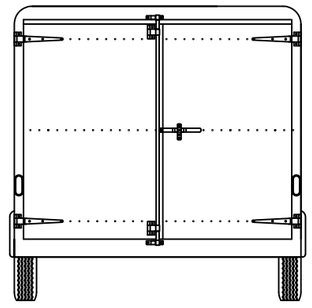
TOP VIEW



FRONT VIEW



SIDE VIEW



BACK VIEW

REVISIONS			
REV	DESCRIPTION	DATE	DWN

UNLESS SPECIFIED OTHERWISE
* DIMENSIONS ARE IN INCHES
* DO NOT SCALE DRAWING

DRAWN BY: TP
DESIGNED BY: TP
PROJECT MGR.: JU
DATE: 4/21/17
PROJECT NO.: 4918

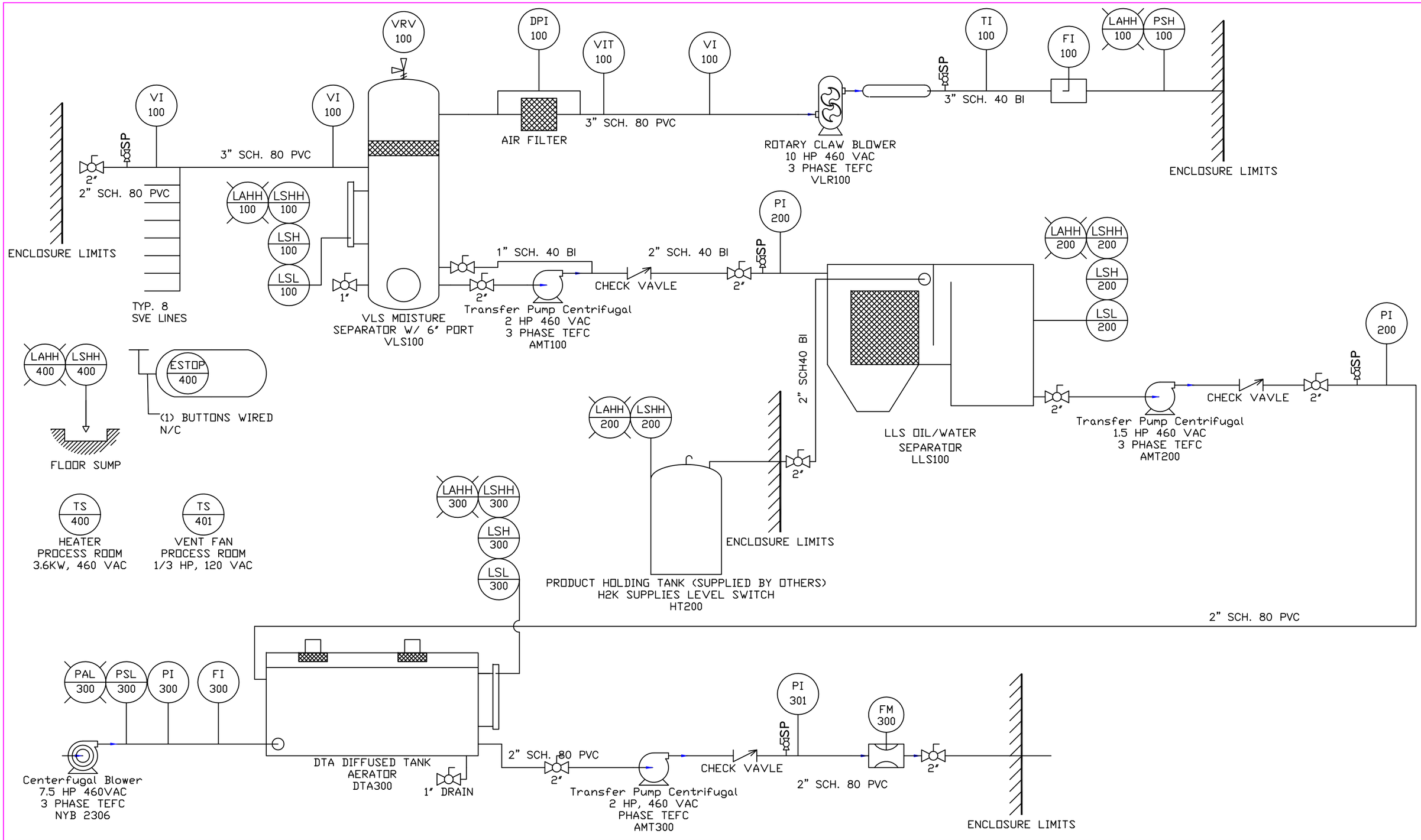
H2K Technologies, Inc.
7550 Commerce St. Corcoran, MN 55340, Tel: 763-746-9900

PROJECT TITLE:
DPE & GWT SYSTEM
TIME SAVER-
NORTH PLATTE, NE

DRAWING TITLE:
LAYOUT

SHEET 1 OF 1

DRAWING NO.:
4918-02



REVISIONS

REV	DESCRIPTION	DATE	DWN

UNLESS SPECIFIED OTHERWISE
* DIMENSIONS ARE IN INCHES
* DO NOT SCALE DRAWING

DRAWN BY: TP
DESIGNED BY: TP
PROJECT MGR.: MK
DATE: 4/20/17
PROJECT NO.: 4918

H2K Technologies,Inc.
7550 Commerce St. Corcoran, MN 55340, Tel: 763-746-9900

PROJECT TITLE:
DPE & GWT SYSTEM
TIME SAVER-
NORTH PLATTE, NE

DRAWING TITLE:
P&ID

SHEET 1 OF 1

DRAWING NO.:
4918-01

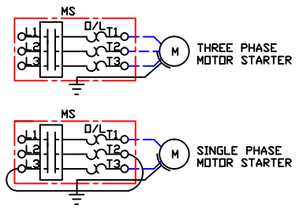
Section 7. Control Panel Schematic & Description:

Contains the Control Panel Schematic, Operation Description of the control system and Alarm Schedule.

DPE & GWT SYSTEM – TIME SAVER – NORTH PLATTE, NE/#4918

STANDARD CONTROL PANEL SYMBOLS AND NOTES

- ▲ TERMINAL IN PANEL
- (CK) MOTOR CONTACTOR
- (G) GREEN PILOT LIGHT
- (R) RED PILOT LIGHT
- (W) WHITE PILOT LIGHT
- (A) AMBER PILOT LIGHT
- (TDR) CONTROL TIMER
- (CR) CONTROL RELAY
- (RTM) ELAPSED RUN TIMER METER
- FLOAT SWITCH CLOSES ON RISING LEVEL
- FLOAT SWITCH OPENS ON RISING LEVEL
- PRESSURE SWITCH CLOSES ON RISING PRESSURE
- PRESSURE SWITCH OPENS ON RISING PRESSURE
- TEMPERATURE SWITCH OPENS ON RISING TEMPERATURE
- TEMPERATURE SWITCH CLOSES ON RISING TEMPERATURE
- TIMER CONTACT CLOSES AFTER TIME SET
- TIMER CONTACT OPENS AFTER TIME SET
- NORMALLY OPEN CONTACT
- NORMALLY CLOSED CONTACT
- FIELD WIRING
- MULTI-POSITION GROUNDING BLOCK



- NORMALLY OPEN MOMENTARY PUSHBUTTON
- NORMALLY CLOSED MOMENTARY PUSHBUTTON
- THREE POSITION H.O.A. SELECTOR SWITCH
- SELECTOR SWITCH ADDITIONAL CONTACTS MAY BE ADDED
- 1 POLE CIRCUIT BREAKER
- 2 POLE CIRCUIT BREAKER
- 3 POLE CIRCUIT BREAKER
- WIRE CONTINUATION
- DISTRIBUTION BLOCK
- FUSE WITH HOLDER (TYPE & SIZE INDICATED)
- DISCONNECT SWITCH

WIRING COLORING & NOTES:

1) 120VAC CONTROL - RED (16AWG OR 18AWG)
2) 120NEUTRAL - WHITE (16AWG OR 18AWG)
3) 24VDC POSITIVE - BLUE (16AWG)
4) 24VDC COMMON - WHITE W/ BLUE STRIPE (16AWG)
5) GROUND - GREEN (16AWG)
6) ALL OTHER WIRING AS INDICATED
6) ALL OTHER WIRING AS INDICATED

TORQUE SPECIFICATIONS

1) FIELD WIRING TERMINALS - 7LB-IN
2) 23 AMP CONTACTORS - 16LB-IN
3) OVERLOADS - 16LB-IN
4) PDB1 PRIMARY - 120LB-IN
5) FUL1-20 & FUL2-20 - 20LB-IN
6) CB23 - 20LB-IN

480VAC, 3ø SYSTEM LOAD ANALYSIS

480VAC, 3ø, 3 WIRE		L1	L2	L3	
SVE BLOWER	10HP	12A	12A	12A	
MOISTURE SEPARATOR TRANSFER PUMP	1.5HP	2.2	2.2	2.2	
D/W SEPARATOR TRANSFER PUMP	2HP	2.6A	2.6A	2.6A	
AIR STRIPPER BLOWER	7.5HP	9A	9A	9A	
AIR STRIPPER TRANSFER PUMP	2HP	2.6A	2.6A	2.6A	
XP TRAILER HEATER	3600W	4.3A	4.3A	4.3A	
TRANSFORMER	5KVA	10.4A		10.4A	
25% OF LARGEST MOTOR		3A	3A	3A	
TOTAL AMPS		46A	35.7A	46A	

120/240VAC, 1ø SYSTEM LOAD ANALYSIS

120/240VAC, 1ø, 3 WIRE		L1	L2		N
GFCI		6A			6A
CONTROL POWER	300W	2.5A			2.5A
XP TRAILER VENT FAN	1/3HP		6.6A		6.6A
XP LIGHTING	300W		2.5A		2.5A
		8.5A	9.1A		17.6A

REVISIONS

REV	DESCRIPTION	DATE	DWN
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B	RELEASE FOR PRODUCTION	05/03/17	RC
C	AS BUILT	08/04/17	RC

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PROJECT NO.: 4918

H2K Technologies, Inc.
7550 Commerce St, Corcoran, MN 55340, Tel: 763-746-9900

PROJECT TITLE:
DPE & GWT SYSTEM
TIME SAVER –
NORTH PLATTE, NE

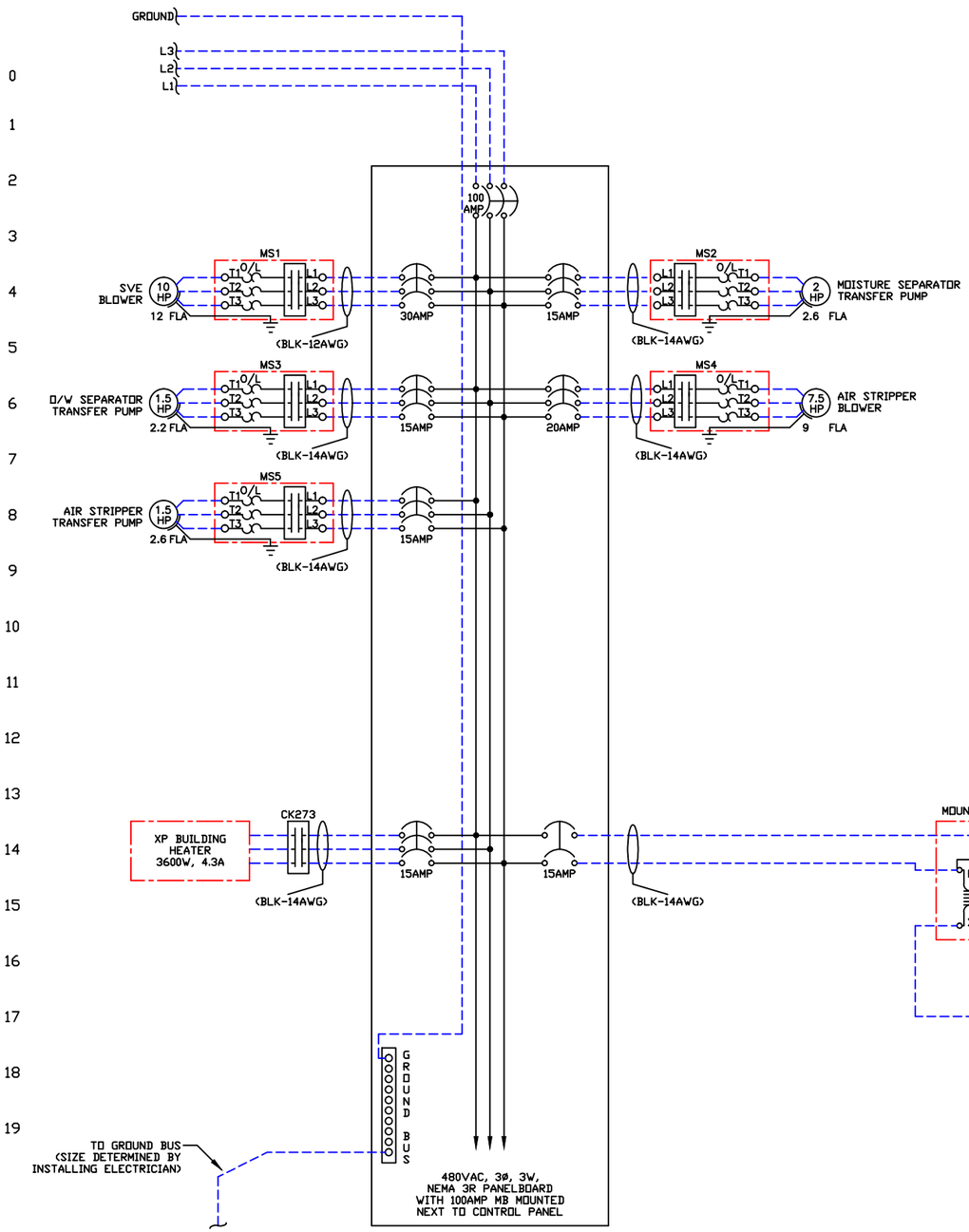
DRAWING TITLE:
SCHEMATIC CONTROL PANEL

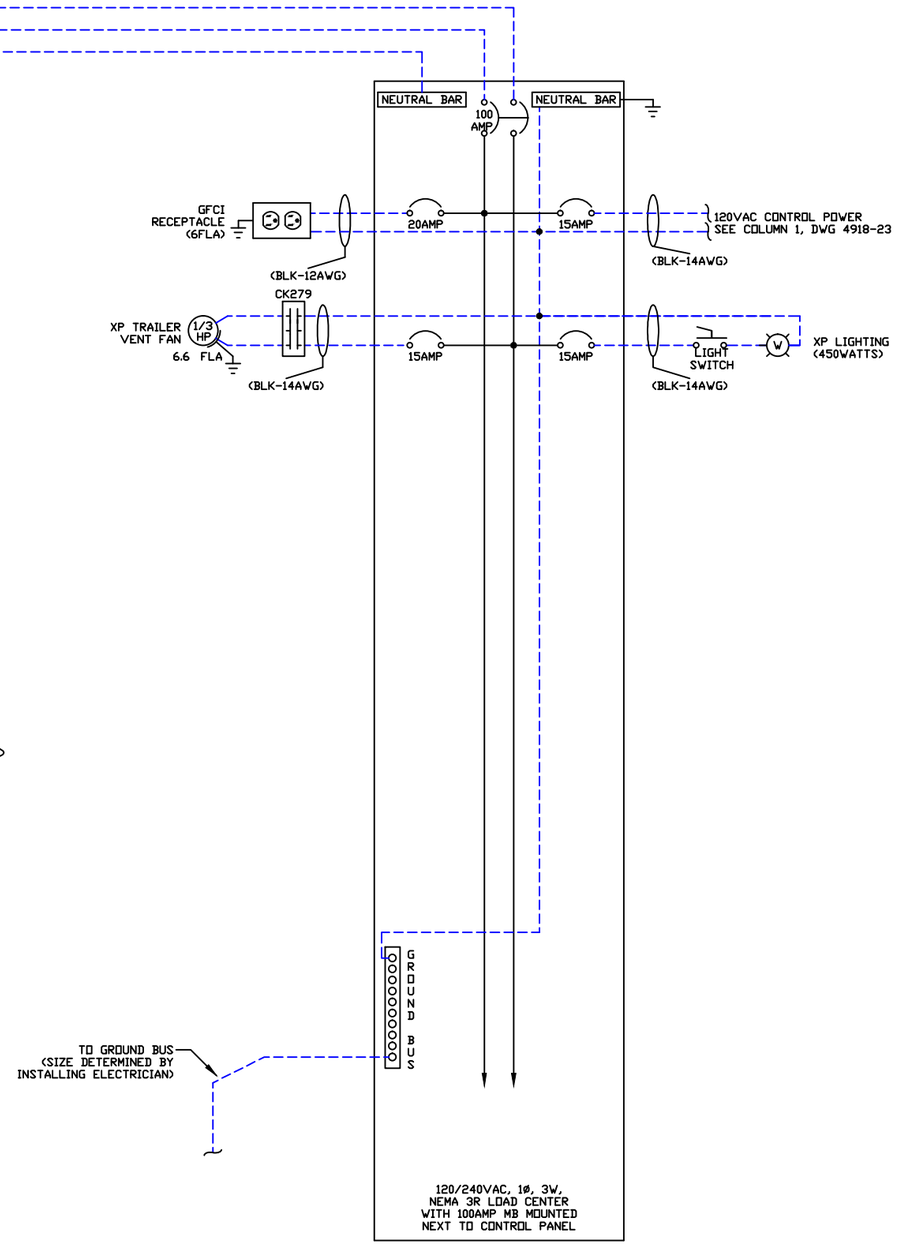
SHEET 1 OF 8

DRAWING NO.:
4918–21

INCOMING POWER SUPPLY

480VAC, 3PHASE, 4WIRE
SYSTEM FLA-46 AMPS





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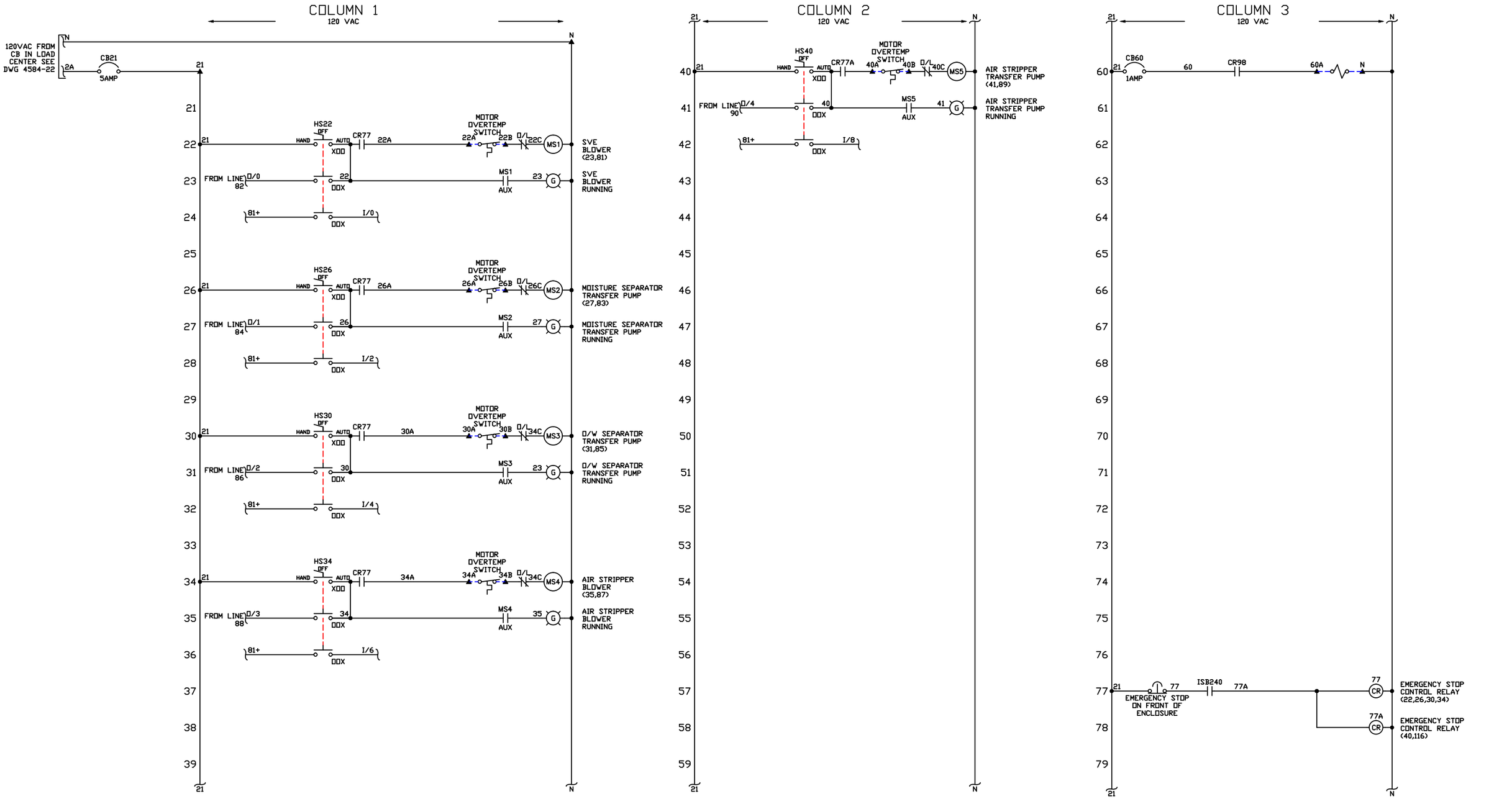
DPE & GWT SYSTEM
TIME SAVER -
NORTH PLATTE, NE

DRAWING TITLE:
SCHEMATIC CONTROL PANEL

SHEET 2 OF 8

DRAWING NO.:
4918-22



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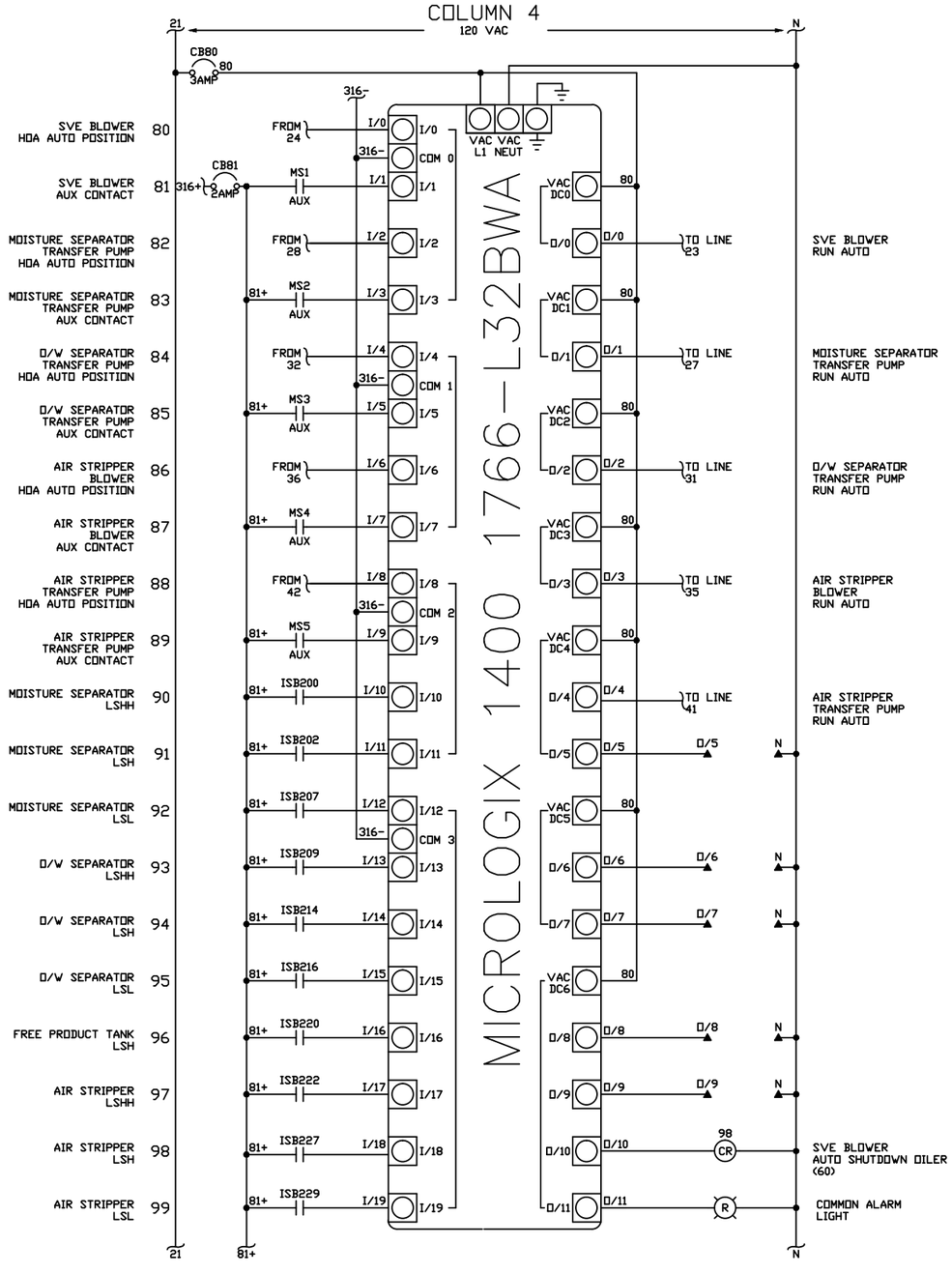
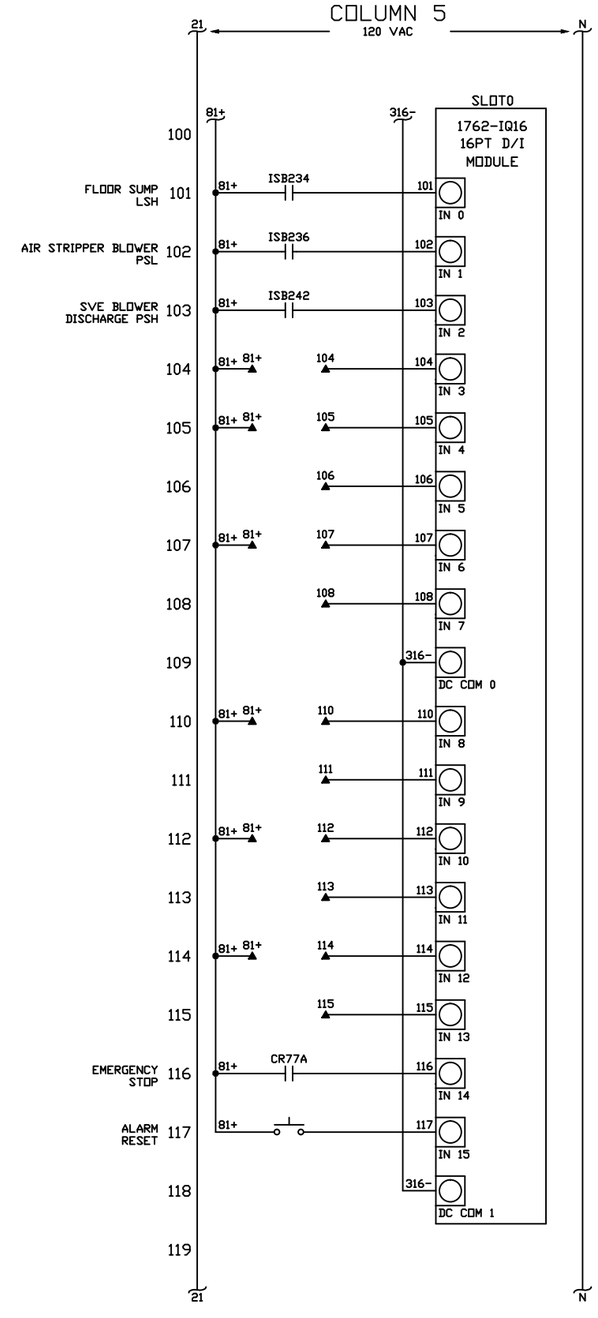
DPE & GWT SYSTEM
TIME SAVER -
NORTH PLATTE, NE

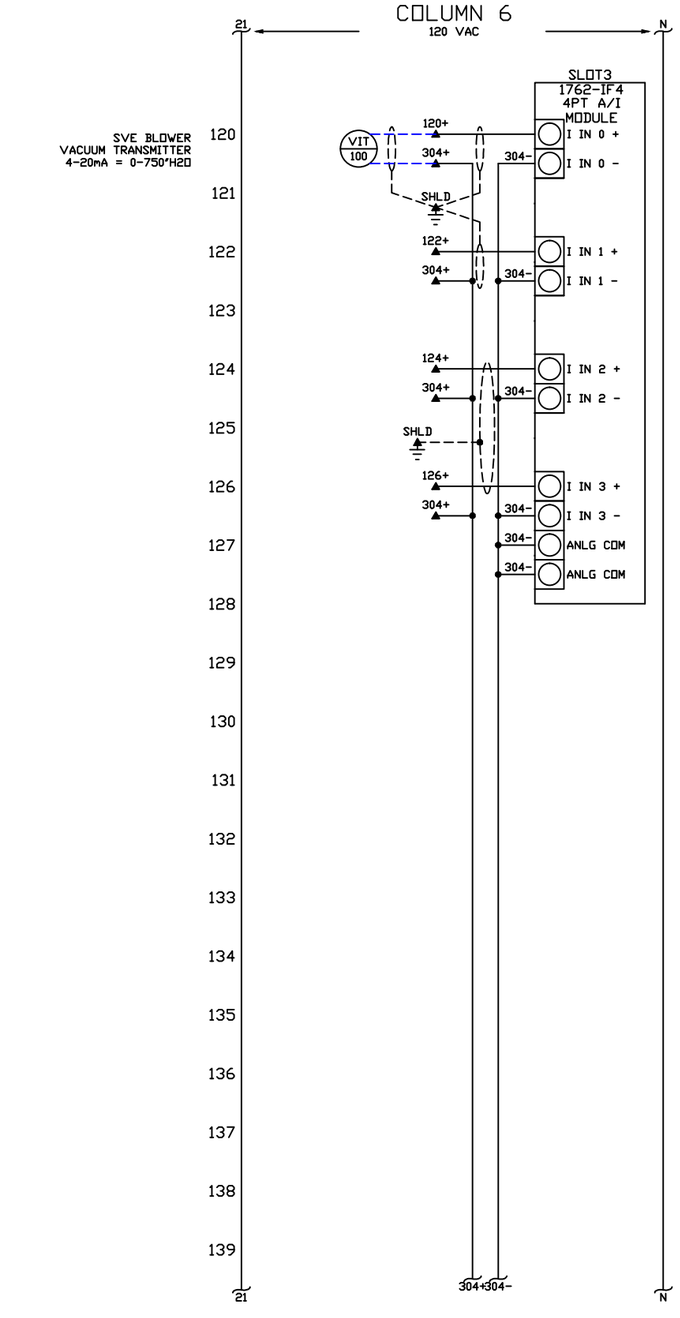
DRAWING TITLE:
SCHEMATIC CONTROL PANEL

SHEET 3 OF 8

DRAWING NO.:
4918-23







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PROJECT TITLE:
DPE & GWT SYSTEM
TIME SAVER -
NORTH PLATTE, NE

DRAWING TITLE:
SCHEMATIC CONTROL PANEL

SHEET 4 OF 8

DRAWING NO.:
4918-24

COLUMN 7
120 VAC

21 ← → N

140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159

21 N

COLUMN 8
120VAC

21 ← → N

160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179

21 N

COLUMN 9
120 VAC

21 ← → N

180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199

21 N

REVISIONS				UNLESS SPECIFIED OTHERWISE * DIMENSIONS ARE IN INCHES * DO NOT SCALE DRAWING
REV	DESCRIPTION	DATE	DWN	
A	RELEASE FOR SUBMITTAL	04/26/17	RC	DRAWN BY: RC
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C	AS BUILT	08/04/17	RC	PROJECT MANAGER: MK
				DATE: 04/24/17
				PROJECT NO.: 4918

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7550 Commerce St, Corcoran, MN 55340, Tel: 763-746-9900

PROJECT TITLE:
DPE & GWT SYSTEM
TIME SAVER –
NORTH PLATTE, NE

DRAWING TITLE:
SCHEMATIC CONTROL PANEL

SHEET 5 OF 8

DRAWING NO.:
4918–25

COLUMN 10

120VAC

21 — N

ISB200 — PHOENIX CONTACT MCR-EX-SL-2NAM-RO, 24VDC

200	81+	3.1	4.1	200
201	I/10	3.2	4.2	201
202	81+	2.1	5.1	202
203	I/11	2.2	5.2	203
204	316+	1.1	1.2	316−

MOISTURE SEPARATOR LSHH

MOISTURE SEPARATOR LSH

ISB207 — PHOENIX CONTACT MCR-EX-SL-2NAM-RO, 24VDC

207	81+	3.1	4.1	207
208	I/12	3.2	4.2	208
209	81+	2.1	5.1	209
210	I/13	2.2	5.2	210
211	316+	1.1	1.2	316−

MOISTURE SEPARATOR LSL

D/W SEPARATOR LSHH

ISB214 — PHOENIX CONTACT MCR-EX-SL-2NAM-RO, 24VDC

214	81+	3.1	4.1	214
215	I/14	3.2	4.2	215
216	81+	2.1	5.1	216
217	I/15	2.2	5.2	217
218	316+	1.1	1.2	316−

D/W SEPARATOR LSH

D/W SEPARATOR LSL

COLUMN 11

120VAC

21 — N

ISB220 — PHOENIX CONTACT MCR-EX-SL-2NAM-RO, 24VDC

220	81+	3.1	4.1	220
221	I/16	3.2	4.2	221
222	81+	2.1	5.1	222
223	I/17	2.2	5.2	223
224	316+	1.1	1.2	316−

FREE PRODUCT TANK LSH

AIR STRIPPER LSHH

ISB227 — PHOENIX CONTACT MCR-EX-SL-2NAM-RO, 24VDC

227	81+	3.1	4.1	227
228	I/18	3.2	4.2	228
229	81+	2.1	5.1	229
230	I/19	2.2	5.2	230
231	316+	1.1	1.2	316−

AIR STRIPPER LSH

AIR STRIPPER LSL

ISB234 — PHOENIX CONTACT MCR-EX-SL-2NAM-RO, 24VDC

234	81+	3.1	4.1	234
235	101	3.2	4.2	235
236	81+	2.1	5.1	236
237	102	2.2	5.2	237
238	316+	1.1	1.2	316−

FLOOR SUMP LSH

AIR STRIPPER BLOWER PSL

COLUMN 12

120VAC

21 — N

ISB240 — PHOENIX CONTACT MCR-EX-SL-2NAM-RO, 24VDC

240	77	3.1	4.1	240
241	77A	3.2	4.2	241
242	81+	2.1	5.1	242
243	103	2.2	5.2	243
244	316+	1.1	1.2	316−

XP AREA EMERGENCY STOP

SVE BLOWER DISCHARGE PSH

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TIME SAVER –
NORTH PLATTE, NE

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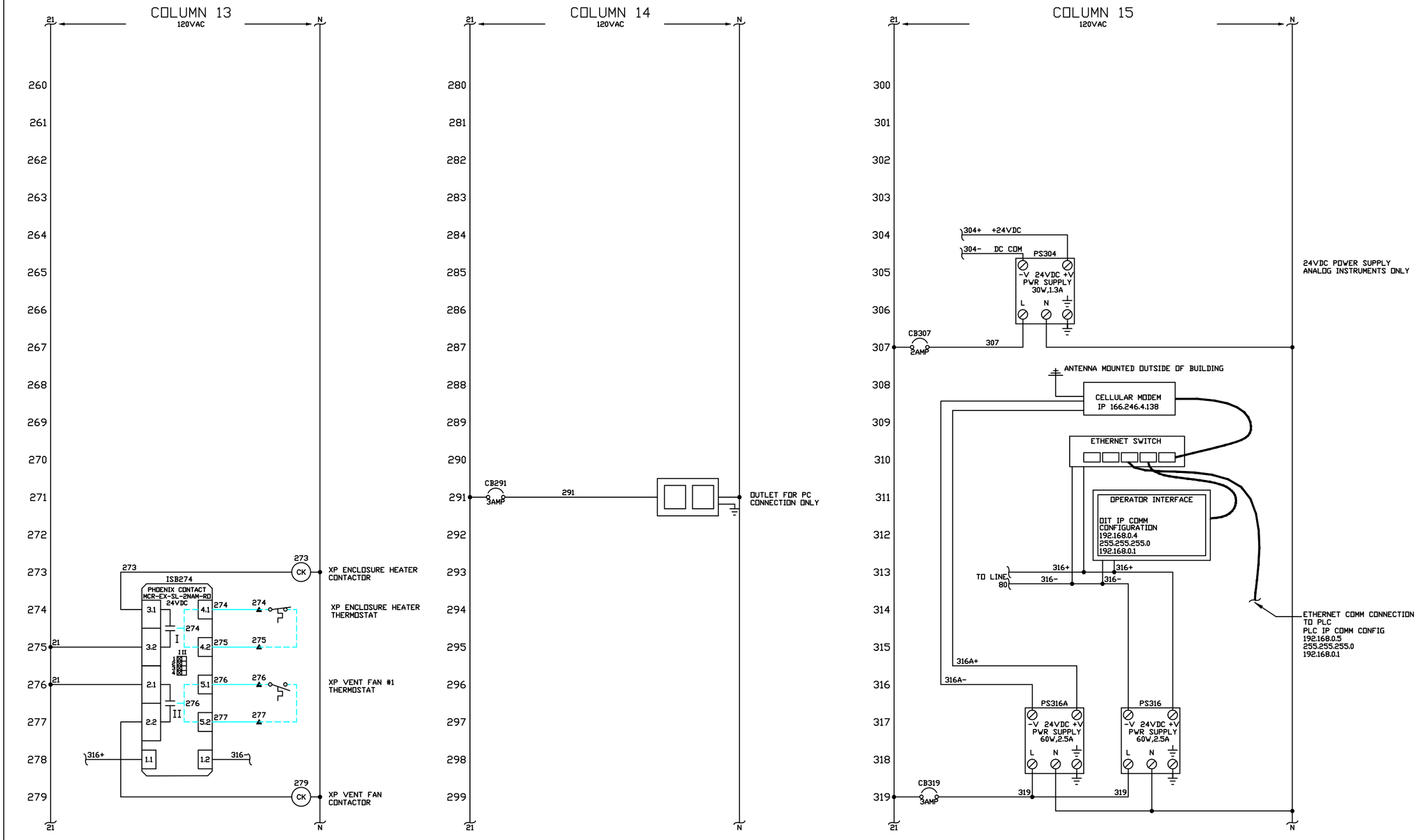
SCHEMATIC CONTROL PANEL

SHEET 6 OF 8

DRAWING NO.:
4918–26



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DPE & GWT SYSTEM
TIME SAVER –
NORTH PLATTE, NE

DRAWING TITLE:
SCHEMATIC CONTROL PANEL

SHEET 7 OF 8

DRAWING NO.:
4918–27

FIELD WIRING
TERMINAL BLOCKS
TB1

21	
21	
21	
N	
N	
N	
0/5	
0/6	
0/7	
0/8	
0/9	
0/10	
60A	SVE BLOWER AUTO SHUTDOWN OILER SOLENOID VALVE
N	
22A	SVE BLOWER MOTOR OVERTEMP SWITCH
22B	INSTALL JUMPER IF MOTOR OVERTEMP SWITCH DOES NOT EXIST IN MOTOR
26A	MOISTURE SEPARATOR TRANSFER PUMP MOTOR OVERTEMP SWITCH
26B	INSTALL JUMPER IF MOTOR OVERTEMP SWITCH DOES NOT EXIST IN MOTOR
30A	O/W SEPARATOR TRANSFER PUMP MOTOR OVERTEMP SWITCH
30B	INSTALL JUMPER IF MOTOR OVERTEMP SWITCH DOES NOT EXIST IN MOTOR
34A	AIR STRIPPER BLOWER MOTOR OVERTEMP SWITCH
34B	INSTALL JUMPER IF MOTOR OVERTEMP SWITCH DOES NOT EXIST IN MOTOR
40A	AIR STRIPPER TRANSFER PUMP MOTOR OVERTEMP SWITCH
40B	INSTALL JUMPER IF MOTOR OVERTEMP SWITCH DOES NOT EXIST IN MOTOR

FIELD WIRING
TERMINAL BLOCKS
TB2-24VDC DISCRETE ONLY

316+	
316+	
316-	
316-	
81+	
104	SPARE DISCRETE INPUT
105	SPARE DISCRETE INPUT
81+	
106	SPARE DISCRETE INPUT
81+	
107	SPARE DISCRETE INPUT
108	SPARE DISCRETE INPUT
81+	
110	SPARE DISCRETE INPUT
111	SPARE DISCRETE INPUT
81+	
112	SPARE DISCRETE INPUT
81+	
113	SPARE DISCRETE INPUT
114	SPARE DISCRETE INPUT
81+	
115	SPARE DISCRETE INPUT

FIELD WIRING
TERMINAL BLOCKS
TB3-24VDC ANALOG ONLY

304+	
120+	VIT 100 SVE BLOWER VACUUM TRANSMITTER 4-20mA = 0-750"H2O
SHLD	
122+	
304+	
304+	
124+	
SHLD	
126+	
304+	

INTRINSICALLY SAFE WIRING TERMINALS

INSTALL IN ACCORDANCE WITH ARTICLE 504 OF THE NEC
I/S EQUIPMENT INSTALLED IN CLASS 1, GROUPS C, D, E, F, OR G AREAS
MAXIMUM FIELD WIRE LENGTH IS 2400FT
FOR CONNECTING PURELY RESISTIVE NON-ENERGY STORING DEVICES

200	MOISTURE SEPARATOR LSHH
201	
202	MOISTURE SEPARATOR LSH
203	
207	MOISTURE SEPARATOR LSL
208	
209	O/W SEPARATOR LSHH
210	
214	O/W SEPARATOR LSL
215	
216	O/W SEPARATOR LSL
217	
220	FREE PRODUCT TANK LSH
221	
222	AIR STRIPPER LSHH
223	
227	AIR STRIPPER LSH
228	
229	AIR STRIPPER LSL
230	
234	FLOOR SUMP LSH
235	
236	AIR STRIPPER BLOWER PSL
237	
240	XP AREA EMERGENCY STOP
241	
242	SVE BLOWER DISCHARGE PSH
243	
274	XP HEATER THERMOSTAT
275	
276	XP VENT FAN THERMOSTAT
277	

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DPE & GWT SYSTEM
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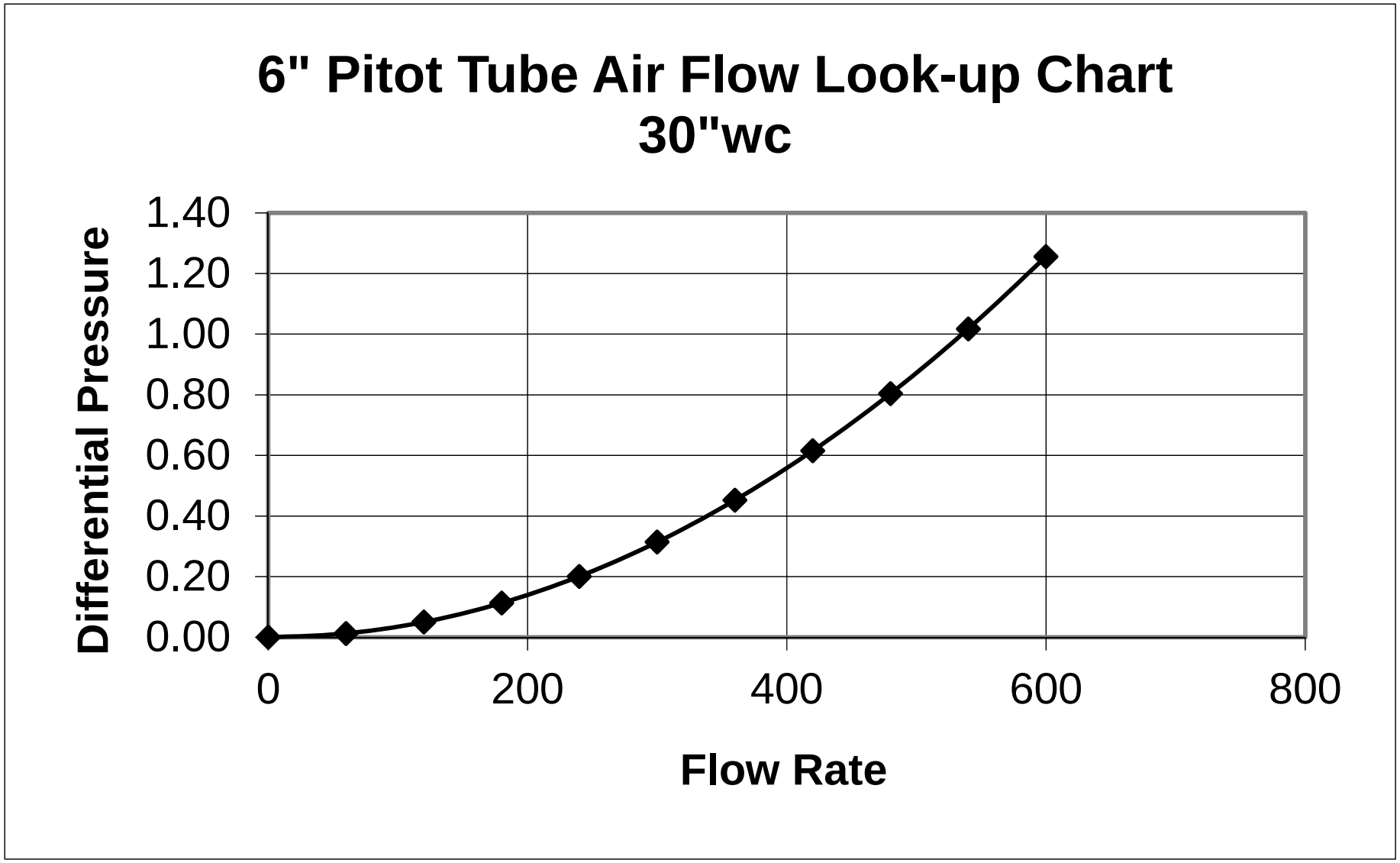
NORTH PLATTE, NE

DRAWING TITLE:
SCHEMATIC CONTROL PANEL

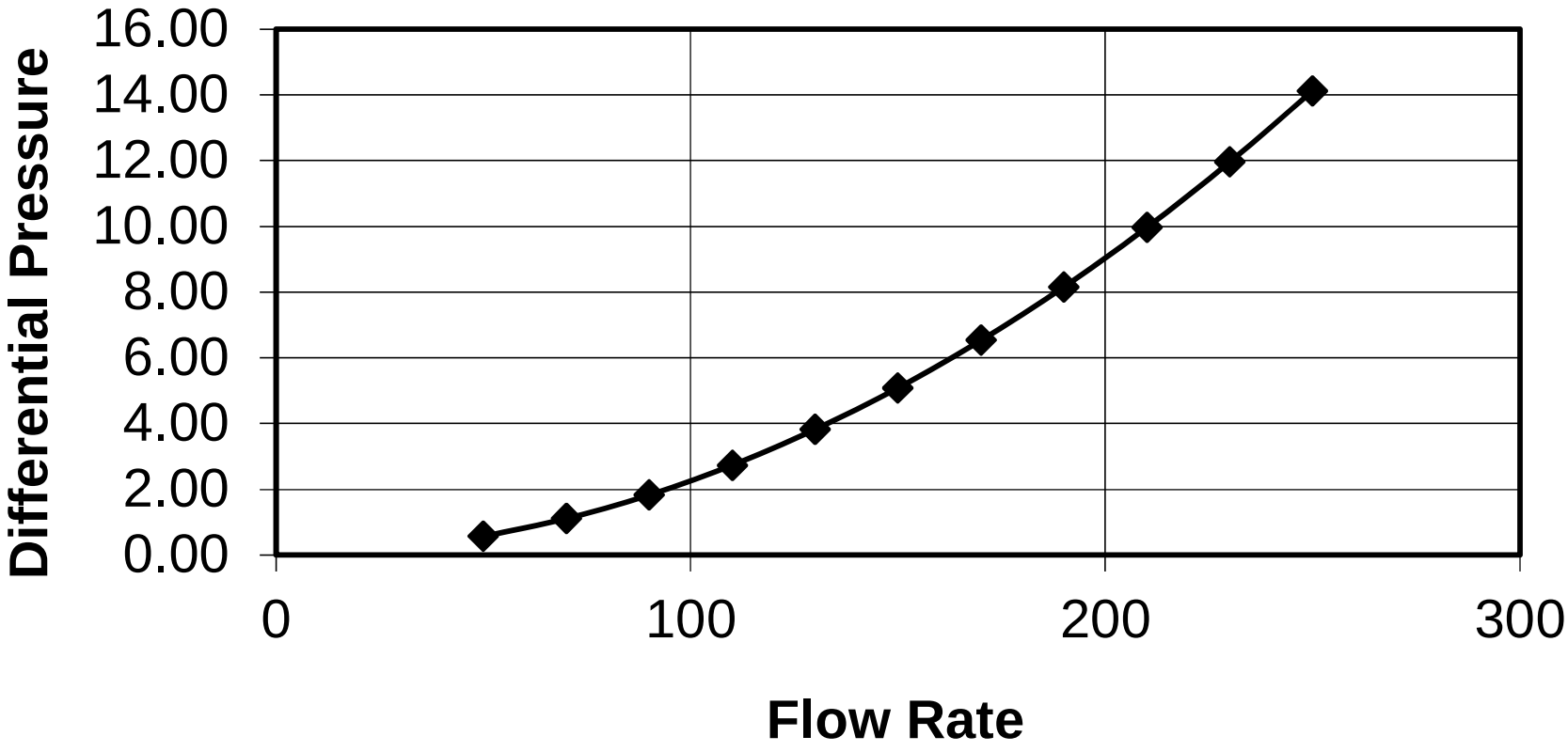
SHEET 8 OF 8

DRAWING NO.:
4918-28

Section 8 VENDOR O&M MANUALS:


6" Pitot Tube Air Flow Look-up Chart
30"wc
Differential Pressure
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
200
400
600
800
Flow Rate

2" Pitot Tube Air Flow Look-up Chart
17"Hg

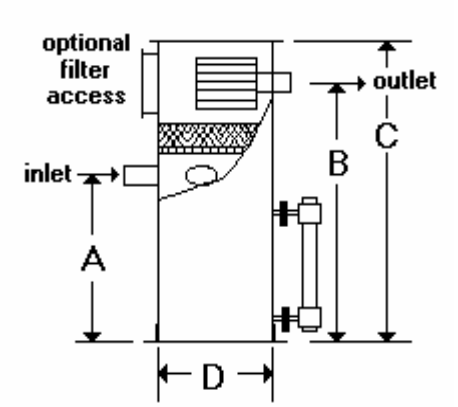


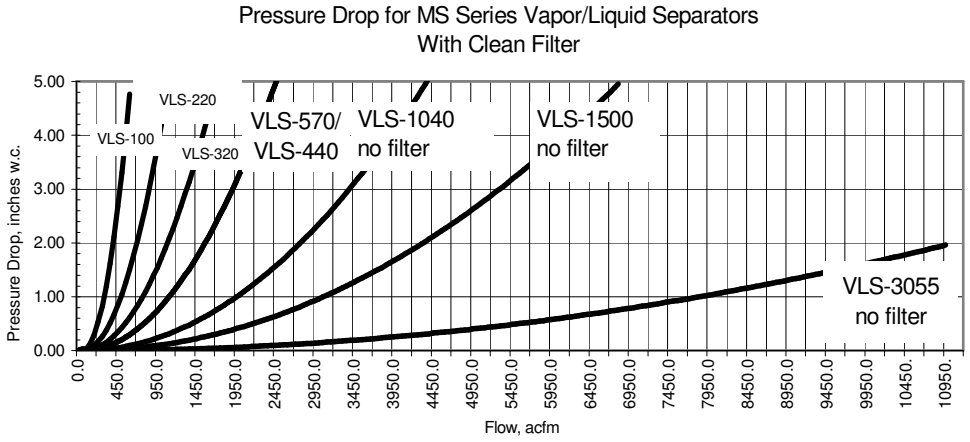
VLS Series Vapor/Liquid Separator Operation & Maintenance Manual

Receiving

- Always use a properly sized piece of lifting equipment to offload the vessel from the delivery truck. Take care not to damage the system during the offloading and setting into place.
- Carefully inspect system for damage that might have occurred during shipping. Note any damage on the bill of lading before the delivery truck leaves the site.

Features & Specifications





Model Number	Inlet/Outlet Connection	Dim A In.	Dim B In.	Dim C In.	Dim D In.	Rated Flow SCFM	Separator Total Volume Gallons	Liquid Holding Volume Gallons	Shipping Weight Lbs.	Operating Weight Lbs.	Vacuum/ Pressure Rating, "Hg/PSI
VLS-100	4"/6" FPT	32	52	50	22	650	100	40	140	480	17"Hg/9psi
VLS-220	8"/10" 150 lb flange	37	62	72	30	1440	220	75	350	1,020	17"Hg/9psi
VLS-320	10"/12" 150lb flange	37	62	72	36	2600	320	110	450	1,356	17"Hg/9psi
VLS-440	12" 150lb flange	37	62	74	42	2600	440	150	625	1,860	17"Hg/9psi
VLS-570	12" 150 lb flange	37	62	74	48	2600	570	195	860	2,465	17"Hg/9psi
VLS-1040	16" Duct flange	37	72	84	60	4500	1,040	200	1,250	2,978	10"Hg/5psi
VLS-1500	20" Duct flange	32	72	85	72	7000	1,500	440	1,525	5,325	10"Hg/5psi
VLS-3055	32" Duct flange	32	74	96	96	11,000	3,055	780	1,820	8,532	10"Hg/5psi

Installation

- Set the system in place using the properly sized lifting equipment. Anchor the system in place per the site specifications.
- Connect the influent and effluent piping to the system.
    - It is recommended to use a flex connector on both the influent and effluent piping connections. The piping connected to the system should be self-supporting.
    - A pump can be connected to the vessel if a pump out operation is required, or the vessel and be gravity drained.
    - Wire and switches that were provided with the vessel.
    - If the vessel has an internal filter, a gauge should be installed (if one is not provided by H2K) to monitor the differential pressure across the filter.
    - Allow enough access around the perimeter and the top of the vessel for maintenance.

Start-Up Procedure

- Verify the system is properly secured to the floor.
- Verify that all influent and effluent connection have been made.
- It is best to record the initial readings of the system for trouble shooting purposes later.

Vacuum Reading _____ Differential Pressure Across the Filter _____

Shutdown Procedure

Drain any liquid that has collected in the moisture separator.

Maintenance Procedure

****The list below is a recommend system maintenance list. The individual manufacturers' O&M manuals must be followed in addition to the list below.**

Weekly	Monitor filter differential pressure	The differential pressure should not exceed 15" wc. Depending on the system operating conditions, this might have to be changed earlier or allowed to go for a longer period of time. The filter life will be site dependent.
	Record system operating conditions	A good record of operating conditions helps monitor the performance of the system and helps to trouble shoot when a problem occurs.
Monthly	Clean moisture separator	As needed, depending on water quality. Recommend initial inspection after first month.
	Check any controls, switches or interlocks with the system	Finding a faulty instrument can prevent problems if detected.

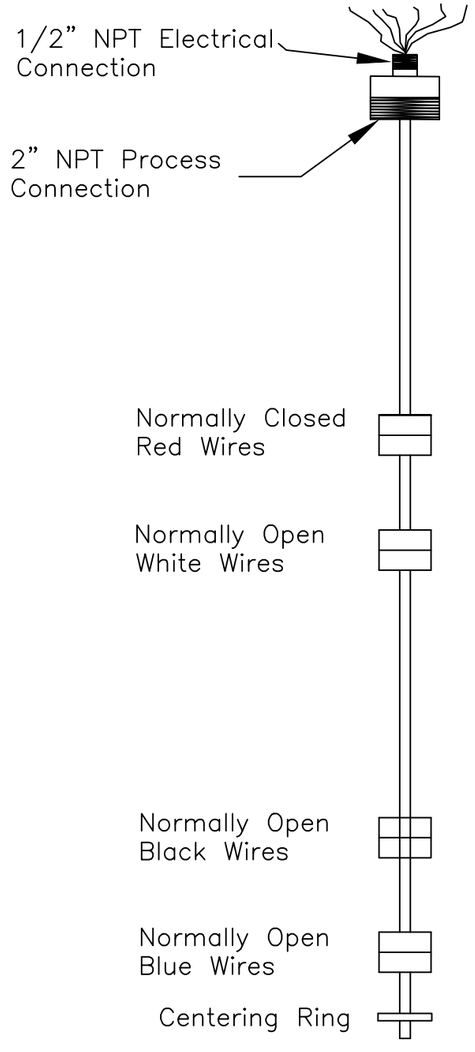
Trouble Shooting Procedure

Problem	Cause	Task
Moisture in discharge	Demister Pad is plugged	Clean or replace demister pad.
	Too high of air flow	If the air flow exceeds the recommended air flow limit of the separator, the velocity through the demister can be too high and water will pass through. Reduce the air flow to the recommended limits.
High differential pressure across separator	Filter or demister pad dirty.	Inspect and clean or replace filter and/or demister pad.

Options

- Stainless steel or Fiberglass re-enforced plastic construction (low pressure)
- Stainless steel coalescer media
- ASME designed & stamped for vacuum or pressure
- Full vacuum design
- Immersion heaters, NEMA 4 or NEMA 7 for freeze protection
- Heat trace for classified or non-classified electrical areas for freeze protection
- Clean out Ports
- Internal aeration diffuser for low level stripping or iron oxidation
- DP gage across filter, demister or both
- R-5 insulation with jacket, (steel or aluminum jacket)
- ¾" Vacuum break port for centrifugal pumping under high vacuum
- Air filter material and sizes
- Enamel internal finish, epoxy coatings or hot dipped galvanized finish
- Flanged or NPT inlet and outlet connections
- Flow, pressure, level & temperature gages or transmitters

H2K Technologies, Inc., 9851 13th Ave., Plymouth, MN 55441, Tel: 763-746-9900, Fax: 763-746-9903, www.H2Ktech.com



Note:
1. All components to be 316 stainless steel.
2. Multiple or single float assemblies.
3. Switch to be 50 watt reed switch with 22 gage PVC insulated leads
4. Length can be specified, but is not field adjustable

REVISIONS			
REV	DESCRIPTION	DATE	DWN

UNLESS SPECIFIED OTHERWISE
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DRAWN BY: MK
DESIGNED BY: MK
PROJECT MGR.: MK
DATE: 6/3/03
PROJECT NO.: Level Switch

H2K Technologies, Inc.
7550 Commerce St Corcoran MN 55340 Tel: 763-746-9900 ©2017

PROJECT TITLE:
Standard Product

DRAWING TITLE:
Custom Level Switch

SHEET 1 OF 1

DRAWING NO.:
O&M

SOLBERG

Inlet Vacuum Filters
Maintenance Manual

www.solbergmfg.com

Note: Please read the maintenance instructions given by the OEM for the machinery first. The OEM's manual should be adhered to in order to protect the equipment. Solberg Manufacturing, Inc has made every effort to make sure that these instructions are accurate but is not responsible for any typos, slight variations or for human errors that may occur.

Solberg Manufacturing, Inc., 1151 Ardmore Itasca, IL 60143 USA
Ph: 630.773.1363 Fax: 630.773.0727 Email: sales@solbergmfg.com Web: www.solbergmfg.com
Rev: MMVF-407

Maintenance Manual

SOLBERG Inlet Vacuum Filters

CONTENTS

**For Further Information Please Call: 630-773-1363*

Solberg Manufacturing, Inc., 1151 Ardmore Itasca, IL 60143 USA
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Rev: MMVF-407

Section A

INTRODUCTION

The purpose of this manual is instruction on the proper assembly and care of Solberg inlet vacuum filters.

WARNING

This manual must be read and thoroughly understood before using and caring for this air filter. Failure to comply could result in explosion, product/system contamination or personal injury.

This manual should be used as a supplement to the user's understanding of the proper care needed to maintain a safe and dependable air filter. It is the responsibility of the user to interpret and explain all instructions to persons who do not read or understand English BEFORE they are allowed to maintain and use this filter.

This manual should be readily available to all operators responsible for operation and maintenance of the vacuum inlet filters.

We thank you for selecting products from Solberg Manufacturing, Inc. We are confident that our superior filter designs will exceed your application requirements.

Section B

GENERAL INFORMATION

1. Identification of Solberg Vacuum Inlet Filters.

All Solberg inlet vacuum air filters should have an identification label/nameplate that gives the following information:

Assembly Model #
Replacement Element #

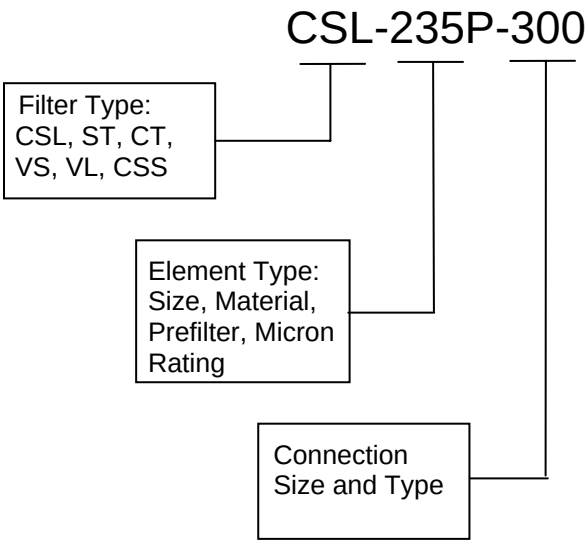
(The exception is OEM supplied units. In this case please enter the OEM part numbers below.)

Fill in the actual nameplate data from your new Solberg inlet filter(s):

No.	Filter Model Number	Replacement Element
1		
2		
3		
4		
5		

Table 1

The model number designates the filter type, the original element configuration and housing connection size. For example, the following part number identifies the filter as being a 'CSL' design filter with a 235 element with prefilter and 3" MPT connection size:



2. Filtration Rules of Thumb

General: For peak output performance from a compressor, blower, vacuum pump, engine, or any other machine that consumes air, one must have clean, unrestricted air. Proper filtration can help stabilize the working environment within rotating equipment even when the external conditions may be quite severe. A critical component in creating the right working conditions is filter sizing. With the properly sized filter, equipment will run smoothly over its entire expected operating life.

A major factor in filtration and filter sizing is air velocity through the filter media. Generally, the slower the velocity of air through a media the higher the filter

efficiency and, conversely, the lower the pressure drop. Therefore, the primary goal in filter sizing is to optimize the velocity of air through the media (sometimes called face velocity).

Rule of Thumb #1: Always begin with the filter cartridge requirements when sizing a filter. Once the appropriate element has been selected then move on to the housing requirements.

Rule of Thumb #2: Always ask or specify a filter based on a micron rating **with** filtration efficiencies. As an example, stating a requirement for a 1-micron filter is misleading because no efficiency rating has been specified. A 1-micron filter at 95-% efficiency may be less efficient than a 5-micron filter at 99% efficiency. For proper air system performance in light and industrial duty environments, a filter with a minimum of 99% filtration efficiency at 5 microns is required.

Rule of Thumb #3: Size your filter correctly by understanding the impact air velocity through a media has on efficiency and pressure drop. Maintain the suggested Air-to-Media ratios listed below based on the external environment listings and Filtration efficiency needs.

Filtration Efficiency Requirements (99+% efficiency)	**Environmental Conditions**	**Air to Media Ratio**	
Industrial Grade 2-micron **Paper**	Industrial Duty (clean, office/warehouse-like)	30 CFM/ft^2	(51m^3/h)/cm^2
	Severe Duty (workshop, factory-like)	15 CFM/ft^2	(25.5m^3/h)/cm^2
	Extreme Duty (Foundry, Construction-like)	10 CFM/ft^2	(17m^3/h)/cm^2
Industrial Grade 5-micron **Polyester**	Industrial Duty (clean, office/warehouse-like)	50 CFM/ft^2	(85m^3/h)/cm^2
	Severe Duty (workshop, factory-like)	40 CFM/ft^2	(68m^3/h)/cm^2
	Extreme Duty (Foundry, Construction-like)	25 CFM/ft^2	(42.5m^3/h)/cm^2
Industrial Grade 1-micron **Polyester**	Severe Duty (Foundry, Construction-like)	10 CFM/ft^2	(17m^3/h)/cm^2
Industrial Grade 0.3-micron **HEPA** Glass @ 99.97% efficiency	Industrial Duty (clean office/warehouse-like)	10 CFM/ft^2	(17m^3/h)/cm^2
	Severe Duty (workshop, factory-like)	7 CFM/ft^2	(12m^3/h)/cm^2
	Extreme Duty (Foundry, Construction-like)	5 CFM/ft^2	(8.5m^3/h)/cm^2

Table 2

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Rule of Thumb #4: Pressure drop is also caused by the dirt holding capacity of the element. As the element fills up with dirt, the pressure drop increases. It is important to document the pressure drop across a given filter when it is new and then clean or replace it when the pressure drop increases by 10" to 15" / 250-380mm H_2O from the original reading.

Rule of Thumb #5: The inlet connection greatly influences the overall pressure drop of the filter system. To minimize the restriction contributed by an inlet filter, a velocity of 6,000 ft/min (10200m^3/h) or less is suggested through the outlet pipe. The table below lists the suggested flows based on pipe size:

Pipe Size (inches)	Max Airflow		Pipe Size (inches)	Max Airflow		Pipe Size (inches)	Airflow	
1/4"	6 CFM	10m^3/h	1 ¼"	60 CFM	102m^3/h	6"	1,100 CFM	1870m^3/h
3/8"	8 CFM	14m^3/h	1 ½"	80 CFM	136m^3/h	8"	1,800 CFM	3060m^3/h
1/2"	10 CFM	17m^3/h	2"	135 CFM	230m^3/h	10"	3,300 CFM	5610m^3/h
3/4"	20 CFM	34m^3/h	2 ½"	195 CFM	332m^3/h	12"	4,700 CFM	7990m^3/h
1"	35 CFM	60m^3/h	3"	300 CFM	510m^3/h	14"	6,000 CFM	10200m^3/h
			4"	520 CFM	884m^3/h			
			5"	800 CFM	1360m^3/h			

Table 3 **Note: This information is for general use only. A qualified engineer must properly design each system.*

3. Element Specifications

Temperature Range: -15° to 220°F / -26° to 105°C
Filter Change-Out Differential: 10" to 15" / 250-380mm H_2O Over Initial Delta P

Media	Micron Rating
Standard Paper	99+% @ 2 micron
Standard Polyester	99+% @ 5 micron
"S" Series Wire Mesh	Epoxy Coated Wire Mesh
"Z" Series Polyester	99+% @ 1 micron
"HE" Series HEPA	99.97% @ 0.3 microns
"U" Series Polyester	99+% @ 25 micron
"W" Series Polyester	99+% @ 100 micron
"S2" Series	Stainless Steel Wire Mesh
"AC" & "ACP" Series	N/A
"Y" Series Polypropylene	99+% @ 5 micron

Table 4

Temperature Range: -15° to 385°F / -26° to 196°C
Filter Change-Out Differential: 10” to 15” / 250-380mm H_2O Over Initial Delta P

Media	Micron Rating
“MX” & “MXD” Series – Nomex Cloth	99+% @ 5 micron

Table 5

4. **Element Cleaning**

Some types of Solberg inlet filter elements can be cleaned and reused. However, damage can occur to an element during cleaning so it is imperative that care is taken during disassembly, cleaning and re-assembly. Damaged elements can allow particulate bypass, which will damage rotating equipment.

A. ***Polyester Element***: The polyester element may be washed in warm soapy water, vacuumed, gently blown out or replaced. The element should be dry before reinstallation.
B. ***Paper Element***: The paper element may be lightly blown with low pressure air. It is disposable and in most cases should be replaced with a new element.
C. ***Polyurethane Prefilter***: The prefilter may be washed as a sponge or replaced to give the element a longer service life.
D. ***Epoxy Coated Wire Mesh and Stainless Steel Wire Mesh Elements***: Cleaning instructions similar to polyester, except mild solvents may be used.
E. ***Activated Carbon Element***: Not cleanable
F. ***Polypropylene Element***: Cleaning instructions similar to polyester
G. ***Nomex Cloth Element***: Cleaning instructions similar to polyester

If you are not confident that the integrity of the element was maintained during cleaning, it is recommended that a new element be installed. Also, spare parts such as gaskets, wingnuts and washers can be supplied upon request.

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Section C

PROCEDURES

1. Installation.

A. Maximum inlet gas stream temperature for most Solberg inlet vacuum filter products is 220°F / 105°C. Temperatures in excess of this could cause damage to elements, media and elastomers.

B. Direction of flow is typically from the outside of the element to the inside of the element. Most products have arrows indicating direction of flow on inlet and outlet ports.

C. Ensure that pipe/flange connections are adequately sealed so the potential for leaks is reduced to a minimum.

2. Disconnecting canister top from canister base.

A. ST/CT/Small CSL: Release wire-form clips or loosen wing nut on “claw” bolts.

B. Large CSL: Loosen wing nut or hex head on T-bolts.

C. CSS: Twist upper housing to release.

D. VS/VL: Remove V-clamp by loosening Hex Nut or T-bolt and releasing.

E. Lift off canister top.

3. Removing element for service/maintenance.

A. Remove retaining hex head/wing-nut and washer carefully, and then remove element. Some elements will have a top plate that should also be removed.

B. Clean sealing surfaces of housing, top & base plates, and element endcaps so that they are free of dirt or any other particulate.

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WARNING

Failure to comply with these instructions may result in system or pump contamination.

4. Securing Element.

A. Place new or cleaned element evenly on base plate. Be sure element seats properly on base and there is no dirt or particulate present on sealing surfaces.

B. Place top plate (if necessary) on element by centering on tap bolt.

C. Secure washer and wing nut to end cap (or top plate) and tap bolt. Element must be tightly secured. Note: DO NOT over tighten!

WARNING

Defective installation may cause system or pump contamination. Use only genuine Solberg replacement parts.

5. Securing canister top to canister base.

A. Make sure all surfaces are free from dust and other particulate.

B. Hemisphere o-ring must rest evenly along canister/casting base o-ring groove.

C. ST/CT/Small CSL: Hold canister housing against o-ring or sealing ring on main filter head. Re-fasten wire-form clips or “claw” bolts.

D. Large CSL: Replace housing top plate. Feed T-bolts into corresponding slots and tighten evenly around perimeter. Note: Do NOT over tighten!

E. VS/VL: Secure V-clamp by disconnecting hex nut or T-bolt portion and placing V-clamp along the diameter of canister o-ring groove. Fasten T-bolt and secure tightly. V-CLAMP LEGS MUST REST UNIFORMLY ALONG ENTIRE O-RING GROOVE.

F. CSS: Reassemble top housing to bottom housing by aligning tabs and turning into place.

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Section D

MAINTENANCE RECOMMENDATIONS

1. Pressure drop readings are recommended to have an effective air filter. Always document initial pressure drop during start-up when element is clean. Replacement cartridge is needed when system experiences 10” to 15” / 250-380mm H_2O higher pressure drop above the initial reading. Refer to page 4 for instructions.

2. Always check replacement cartridge gaskets to insure they are adhered uniformly along the end caps during handling. If not, contact Solberg Manufacturing, Inc. immediately. Do not modify or change from Solberg specified parts!

3. Always check inlets/outlets, element base and its components when replacing element to insure cleanliness. Wipe clean if necessary.

4. Operate only when a proper seal exists.

5. VS/VL: Never operate without absolute assurance that V-clamp is secured correctly along entire diameter of canisters. Check along V-clamp for wear. Replace if any distortion occurs due to handling and usage.

SPARE PARTS LIST:

CSL/CT/VS/VL Series

		Housing						Element		
Parent Model Model-Element-Connection	Prefilter Model	Top Model No.	O-Ring Model No.	Gasket(s)/ Adapter Model No.	Wingnut(s) Model No.	Washer(s) Model No.	Clips/ Bolts Model No.	Top Plate Model No.	Wingnuts/ Bolt Model No.	Washer(s) Model No.
CSL-825/824-xxx	N/A	T824	OR337	BG224	N/A	N/A	CPWF	N/A	N/A	N/A
CSL-843/842-xxx	PF842	T842	OR550	BG268	N/A	N/A	CPWF	N/A	N/A	N/A
CSL-849/848-xxx	PF848	T848	OR675	BG281	N/A	N/A	CPWF	N/A	N/A	N/A
CSL-851/850-xxx	PF850	T850	OR750	BG412	N/A	N/A	CPWF	N/A	N/A	N/A
CSL-239/238-xxx	PF238	TD238	OR1250	N/A	N/A	N/A	CPWF	N/A	WN38X16	WR38X16
CSL-235/234-xxx	PF234	TC1400	OR1200	N/A	WN38X16	WR38X16	BT38163	T8000437	WN38X16	WR38X16
CSL-335/334-xxx	PF334	TC1400	OR1200	ADEX300	WN38X16	WR38X16	BT38163	T8000437	WN38X16	WR38X16
CSL-245/244-xxx	PF244	TC1850	OR1600	N/A	WN38X16	WR38X16	BT38163	T1000437	WN38X16	WR38X16
CSL-345/344-xxx	PF344	TC1850	OR1600	ADEX300	WN38X16	WR38X16	BT38163	T1000437	WN38X16	WR38X16
CSL-275/274-xxx	PF274	TC1850	OR1600	N/A	WN38X16	WR38X16	BT38163	T12000437	WN38X16	WR38X16
CSL-375/374-xxx	PF374	TC1850	OR1600	ADEX300	WN38X16	WR38X16	BT38163	T12000437	WN38X16	WR38X16
CSL-377/376-xxx	PF376	TC2250	OR2000	N/A	WN38X16	WR38X16	BT38163	T14750625	HN50X13	WR50X13
CSL-384(2)-xxx	PF384(2)	N/A	OR2400	N/A	WN38X16	WR38X16	BT38163	T19750625	HN50X13	WR50X13
CSL-685-xxx	PF684	N/A	OR2400	N/A	WN38X16	WR38X16	BT38163	T19750625	HN50X13	WR50X13
CSL-485(2)/484(2)-xxx	PF484(2)	N/A	OR2400	N/A	WN38X16	WR38X16	BT38163	T19750625	HN50X13	WR50X13
CT-851/850-xxx	PF850	N/A	OR725	BG412	N/A	N/A	CPWF	N/A	N/A	N/A
CT-235/234-xxx	PF234	N/A	GCT1100	ADCT234	N/A	N/A	CPWF	T8000437	BH38X16	WR38X88
CT-275/274-xxx	PF274	N/A	OR386	ADCT234	N/A	N/A	KITCT274	T12000437	BH38450	WR38X16
VS-275/274-xxx	PF274	N/A	OR386	N/A	N/A	N/A	N/A	T12000437	WN38X16	WR38X16
VL-275/274-xxx	PF274	N/A	OR386	N/A	N/A	N/A	N/A	T12000437	WN38X16	WR38X16

*Note: Spare parts are for standard products. See page 4 for replacement element.

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Series 3100 Explosion-Proof Differential Pressure Transmitter

Specifications - Installation and Operating Instructions

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Table of Contents

Chapter 1 Introduction

The 3100 Smart Pressure Transmitter is calibrated at the factory before shipping. To ensure correct and efficient use of the instrument, please read the manual thoroughly and fully understand how to operate the instrument before operation.

1. The contents of this manual are subject to change without prior notice.
2. All rights are reserved. No part of this manual may be reproduced in any form without Dwyer Instruments, Inc. written permission.
3. If any question arises, errors are found or if any information is missing from this manual, please inform Dwyer Instruments, Inc.
4. The specifications covered by this manual are limited to standard transmitters and do not cover custom-made instrument.
5. Please note that changes in the specifications, construction, or component parts of the instrument may not immediately be reflected in this manual at the time of change, provided that postponement of revisions will not cause difficulty to the user from a functional or performance standpoint.

1.1 Using This Manual

The operating manual provides information on installing, operating, and maintaining the Mercoid® Model 3100 Smart Pressure Transmitter. The Chapters are organized as follows.

Chapter 2 Handling Cautions
Chapter 2 provides instructions on commissioning and operating the Model 3100 Smart Pressure Transmitters. Informations on software functions, configuration parameters, and on-line variables are also included.

Chapter 3 Transmitter Functions
Chapter 3 contains suggestions on handling the Model 3100 Smart Pressure Transmitter.

Chapter 4 Installation
Chapter 4 contains mechanical, environment consideration and electrical installation instructions for the Model 3100 Smart Pressure Transmitter.

Chapter 5 On-line Operation
Chapter 5 describes how to configure the parameters of the Model 3100 Smart Pressure Transmitter. See the following list for the details.

1. Regulations for circuit's Input/Output characteristics; Sensor or Output Trim
2. Changing the output characteristic; Range Configuration, Output Type, Dampening, Unit
3. Changing the general data; Tag No., Date, Message etc.

Chapter 6 Maintenance
Chapter 6 contains hardware diagnostics, troubleshooting and maintenance task.

1.2 Overview of Transmitter

The Mercoid® Smart Pressure Transmitter is a microprocessor based pressure transmitter with a capacitance sensor optimized for draft measurement. The Model 3100 has a true draft analog range from 0 to 20 mA. This transmitter is explosion-proof, high precision accuracy, reliability and has digital communication for remote communication system.

The Model 3100 is enabled with HART® communication with Host, HHT (HART® Communicator) or PC Configurator. The transmitter's various variables in host are able to be changed, configured and calibrated by users. The HART® Communication between DC power supply and transmitter requires a 250~ 550 Ohm resistance.

1.3 Software Compatibility

The Mercoid® Smart Pressure Transmitter's software is implemented at the factory. The following functions can be configured using a HHT (Hart® Communicator).

Function	Function Supports		
	ZERO/SPAN Button	PC/PDA	HART HHT
	Rev.58		
ZERO/SPAN	•	•	•
ZERO TRIM	•	•	•
ZERO Adj	•	•	•
Units set	•	•	•
Range set	•	•	•
Dampening set	•	•	•
LCD decimal set	•	•	Δ

• : Supported
Δ : Supported but update required

Chapter 2 Handling Cautions

This chapter consists of cautions for transmitter handling, storage, installation, insulation and explosion structure, etc.

Step	Job	Job Details	Instrument
1	Unpacking	- Unpack transmitter packing	
2	Model and Specifications	- Make sure the transmitter nameplate matches the model number on the P.O.	
3	Storage	- In a dry, non-vibration and non-impact area - Ambient temperature around 77°F (25°C) and 65% relative humidity	
4	Calibration	- Configuration of the Range, Zero/Span, Unit, Tag, Dampening Time, Transfer Function, DA Trim and other parameters	- HHT - Pressure Source - Galvanometer
5	Installation Locations	- Where ambient temperature are constant - Exposure to chemical corrosion, etc. - Where shock and vibration are minimal - Where the area classification does not exceed the explosion-proof rating - Where maintenance is easy	(Engineering)
6	Mechanical Considerations	- Where the transmitter can be handled easily - Be cautious of process connections leaking	(Engineering)
7	Electrical Considerations	- 24 VDC (Power Supply is 11.9 Vdc – 45 Vdc) - For HART® communication, resistance on transmitter terminal loop should be between 250 – 550 Ohms	(Engineering)
8	Mounting and Installation	- When mounting the transmitter, an appropriate bracket should be used - The transmitter should be mounted securely to prevent swing	(Mounting and Installation)
9	Calibration on Spot	- Sensor Zero Trim should be done ten seconds after differential pressure stabilizes - Make sure that PV value is zero and current is 4 mA	HHT or Zero/Span button
10	Pressure	- Do not apply a regulated differential pressure and line pressure - Close the equalizing valve on the 3 valve manifold and then open the valve on high and low side slowly and simultaneously	(Applying pressure)
11	Operation	- Make sure the transmitter operates properly	Eye or HHT

2.1 Unpacking Transmitters

When moving the transmitter to the installation site, keep it in the original packaging. Unpack the transmitter at the installation site to avoid damage on the way.

2.2 Model and Specifications Check

The model number and specifications are indicated on the nameplate. Please check the specification and model number.

2.3 Storage

The following precautions must be observed when storing the instrument, especially for a long period of time.

1. Select a storage area that meets the following conditions:
   - is not exposed to rain or water.
   - minimal vibration and shock.
   - stored at normal temperature and humidity (approx. 77°F (25°C), 65% RH).

   The ambient temperature and relative humidity ratings are:

Ambient Temperature:	-40 to 185°F (-40 to 85°C) (without LCD module)
	-22 to 176°F (-30 to 80°C) (with LCD module)
General Use:	-4 to 140°F (-20 to 60°C)
Relative Humidity:	5% ~ 98% RH at 104°F (40°C)

2. When storing the transmitter, repack it the way it was delivered from the factory.

3. If storing a used transmitter, thoroughly clean the diaphragm surfaces, so that no media remains. Make sure the transmitter assemblies are securely mounted before storing.

2.4 Selecting Installation Locations

The transmitter is designed to withstand severe environmental conditions. However, to ensure stable and accurate operation, the following precautions must be observed when selecting an installation location.

1. Ambient Temperature
   Avoid locations subject to wide temperature variations or a significant temperature gradient. If the location is exposed to radiant heat from plant equipment, provide adequate insulation or ventilation.

2. Ambient Atmosphere
   Avoid installing the transmitter in a corrosive atmosphere. If the transmitter must be installed in a corrosive atmosphere, there must be adequate ventilation. Precautions must be put into place to prevent intrusion or stagnation of rainwater in conduits.

3. Shock and Vibration
   Select an installation site with minimum shock and vibration (although the transmitter is designed to be relatively resistant to shock and vibration).

4. Installation of Explosion-Proof Transmitters
   Explosion-Proof transmitters can be installed in hazardous areas according to the gas types for which they are certified.

5. Select a place where the transmitter can be maintenanced easily.

2.5 Calibration after Installation

1. Sensor Zero Trim should be done after transmitter is installed, because the zero point is not configured for mounting status.
2. When calibrating the Sensor Zero Trim apply a pressure for zero in advance, Sensor Zero Trim the sensor when the pressure is sufficiently stabilized (after approximately 10 seconds).
3. There are two ways to pressure zero. One way is to apply zero differential pressure (making pressure the same on both the high and low side). The other is to close High and Low side of a 3 valve manifold and open the equalizing valve.
4. Sensor Zero Trimming can also be done with the Zero/Span button or a HHT (HART® Communicator), PC or PDA configurator.
5. Refer to On-line Operation for configuring other parameters.

2.6 Pressure Connections

⚠ CAUTION Instrument installed in the process under pressure.
Never loosen or tighten as it may cause dangerous spouting of process fluid. If the process fluid is toxic or otherwise harmful, take appropriate care to avoid contact or inhalation of vapors even after disconnecting the instrument from process line for maintenance.

The following precautions must be observed in order to safely operate the transmitter under pressure.

1. Never apply a pressure higher than the specified maximum working pressure.
2. Confirm the option pressure of transmitter. It is necessary to use standardized and quality-approved parts.
3. There should be isolation valves in case of leakage.

2.7 Waterproofing Cable Conduit Connections

Apply a non-hardening sealant (silicone or tape, etc.) to the threads to waterproof the transmitter cable conduit connections.

2.8 Restrictions on Use of Radio Transceivers

⚠ WARNING Although the transmitter has been designed to resist high frequency electrical noise, if a radio transceiver is used near the transmitters external wiring, the transmitter may be affected by high frequency noise pickup. To test for such effects, bring the transceiver in slowly from a distance of several feet from the transmitter, and observe the measurement loop for noise affects. Always use the transceiver outside the area affected by noise.

2.9 Installation Resistance Test and Dielectric Strength Test

Since the transmitter has undergone insulation resistance and dielectric strength tests at the factory, normally these tests are not required. However, if required, observe the following precautions in the test procedures.

1. Do not perform such tests more frequently than necessary. Even test voltages, that do not cause visible damage to the insulation, may degrade the insulation and reduce safety margins.
2. Never apply a voltage exceeding 500VDC for the insulation resistance test, or a voltage exceeding 500VAC for the dielectric strength test.
3. Before conducting these tests, disconnect all signal lines from the transmitter terminals. Perform the tests in the following procedures.

   Insulation Resistance test

   1. Short-circuit the + and - SUPPLY terminals in the terminal box.
   2. Turn OFF the insulation tester. Then connect the insulation tester plus (+) lead-wire to the shorted SUPPLY terminals and the minus (-) lead wire to the grounding terminal.
3. Turn ON the insulation tester power and measure the insulation resistance. The voltage should be applied briefly to verify that insulation resistance is at least 20MΩ.

4. After completing the test and being very careful not to touch exposed conductors. Disconnect the insulation tester and connect a 100kW resistor between the grounding terminal and the short-circuiting SUPPLY terminals. Leave this resistor connected at least three seconds to discharge any static potential. Do not touch the terminal while it is discharging.

Dielectric Strength Test

1. Short-circuit the + and - SUPPLY terminals in the terminal box.
2. Turn off the dielectric strength tester. Then connect the tester between the shorted SUPPLY terminal and the grounding terminal. Be sure to connect the grounding lead of the dielectric strength tester to the ground terminal.
3. Set the current limit on the dielectric strength tester to 10 mA, then turn on the power and gradually increase the tester voltage from '0' to the specified voltage.
4. When the specified voltage is reached, hold it for one minute.
5. After completing this test, slowly decrease the voltage to avoid any voltage surges.

2.10 Explosion-Proof Rating

2-10-1. FM Certification

HAZARDOUS LOCATION ELECTRICAL EQUIPMENT
Equipment Rating: Explosion-Proof for use in Class I, Division 1, Groups A, B, C and D;
Dust- Ignition-Proof for Class II/III, Division 1, Groups E, F and G;
Nonincensive for use in Class I, Division 2, Groups A, B, C and D;
Suitable for use in Class II, Division 2, Groups E, F and G;
and Suitable for Class III, Division 1;
Hazardous (classified) location, indoor and outdoor
(NEMA Type 4X/IP67).

2.10.2 DEKRA/ATEX Certification

ATEX Certification number : DEKRA 11ATEX0192X
CE 0344 Ⓔx II 2 G

NOTICE **Model 3100 for potentially explosive atmosphere**

1. Ex d IIC T6...T4
2. Operating Temperature : -20°C ≤ T_{amb} ≤ +60°C
3. T6 for process ≤ 85°C;
4. T5 for process ≤ 100°C;
5. T4 for process ≤ 130°C;

NOTICE **Electrical Data**

1. Supply Voltage : 42 Vdc Max
2. Output Signal : 4 to 20 mA + HART

NOTICE **Electrical Connection : 2 x 1/2-14 NPT Female**

NOTICE **3100 ATEX Certification is according to the below standards**

EN 60079-0 : 2006
EN 60079-1 : 2007

NOTICE **Installation**

1. All wiring shall comply with local installation requirement.
2. The cable glands and blanking elements shall be of a certified flameproof type, suitable for the condition of use and correctly installed. Also those devices should be endured at the 130°C.
3. Housing Ground must be followed to “local electrical codes”. The most efficient ground procedure is to connect directly to the earth as least impedance.

1. How to Housing Ground:
   A. Internal Ground Connection:
      Internal ground connection screw is located in terminal in housing; the screw can be identified as ground sign.
   B. External Ground Assembly:
      This is located in the right side of housing and identified as ground sign. (Grounding with a cable lug)
2. When use tubing, stopping boxes must be connected with the wall of housing directly.
3. Tubing is installed a minimum of 5 threads.
4. Sensor is to be threaded a minimum of 7 threads and prevented from turing by tightening the housing rotation set screw.
5. Do not disassemble flameproof Joints but in an unavoidable case to disassemble it or need the specification of flameproof Joints, contact the manufacturer before doing.

NOTICE **Operation**

WARNING DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE MAY BE PRESENT.

1. Take care not to generate mechanical spark when access to the instrument and peripheral devices in hazardous location.

NOTICE **Maintenance and Repair**

The instrument modification or parts replacement by other than authorized representative of Dwyer/Mercoid is prohobited and will void KEMA/ATEX explosion-proof/flame-proof.

2.11 EMC Conformity Standards
EMI (Emission): EN55011
EMS (Immunity): EN50082-2

Dwyer Instruments, Inc. recommends customer use metal conduit wiring or twisted pair shield cable for signal wiring to conform with EMC regulation, when installing the Mercoid® 3100 transmitters.

Chapter 3 Transmitter Functions

3.1 Overview

This Chapter contains information on operating the Model 3100. Tasks that should be performed on the bench prior to installation are explained in this chapter.

3.2 Safety Messages

Procedures and instructions in this chapter may require special precautions to ensure the safety of the personnel performing the operations. Potential safety issues are indicated by a warning symbol (▲). Refer to the following safety messages before performing an operation preceded by this symbol.

3.3 Warning

DANGER **Explosion can result in death or serious injury:**

Do not remove the transmitter covers in explosion environments when the circuit is powered. Transmitter covers must be fully engaged to meet explosion-proof requirements.

WARNING **Electrical shock can result in serious injury:**

Only qualified personnel can install the transmitter.

3.4 Fail Mode Alarm

Mercoid® Smart Pressure Transmitter automatically and continuously performs self-diagnostic test. If the self-diagnostic test detects a failure, the transmitter drives the output outside of the normal operation values. The transmitter will drive its output low (down) or high (up) based on the position of the failure mode alarm jumper. See Table 3.1 for output values.

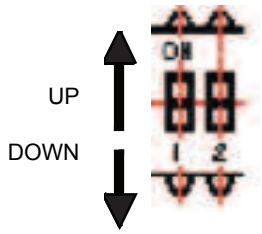
Level	4~20 mA Saturation	4~20 mA Alarm
Low/Down	3.9 mA	≤ 3.75 mA
High/Up	20.8 mA	≥ 21.75 mA

[Table 3.1 Standard Alarm and Saturation Values]

⚠ WARNING **Electrical shock can result in serious injury:**
Avoid contact with the leads and terminals. High voltage, that may be present, on leads can cause electrical shock.

Fail Safe mode can be set via Jumper switches provided on the LCD module or the main CPU module. The jumper switch for an indicating transmitter, located on the LCD module, can be set to the right (fail down i.e. ≤ 3.75 mA) or left (fail up i.e. ≥ 21.75 mA). For non-indicating transmitters the jumper switch is located on the main CPU module, it can be set up (fail up to ≥ 21.75 mA) or down (fail down to ≤ 3.75 mA). Refer to Figure 3-1 for detailed summary of jumper settings for both CPU and LCD modules.

Select Fail Mode	**Both LCD Module and CPU Module**		**Only CPU Module**
	CPU Module	LCD Module	CPU Module
Fail Down	Down	D	D
Fail Up	Down	U	U
	Up	U or D	



Fail Safe Mode Selection (LCD & CPU Module)
1. WR_EN (EEPROM Write Enable)
   DOWN : ENABLE
   UP : DISABLE
2. Fail Mode(Alarm)
   DOWN : LOW
   UP : HIGH

Fail Mode for LCD Module Selection Jumper Switch												
U	O	O	O		O	O	O	D		O	O	O	D
(If Down)					FAIL MODE					(If Up)			

Figure 3-1. Fail Mode and EEPROM-Write Selection Jumper Switch

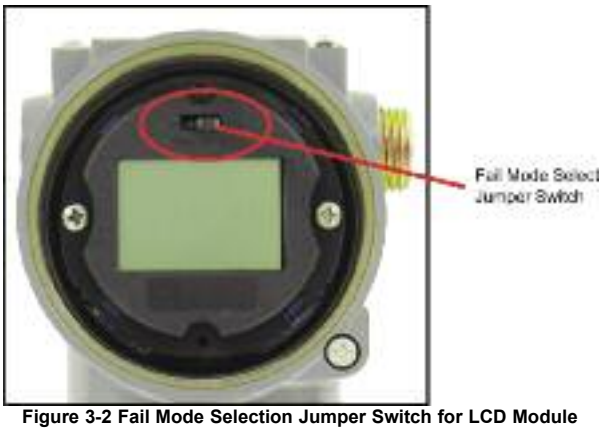


Figure 3-2 Fail Mode Selection Jumper Switch for LCD Module

3-5 EEProm-Write Enable / Disable Mode Switch

EEPROM (Electrically Erasable Programmable ROM), included on the CPU module, is used by the transmitter to save/restore configuration variables. To protect the transmitter from any unauthorized changes, a hardware lockout feature can be implemented by using the Write-Protect mode jumper switch provided on the main CPU Module. If the jumper switch is connected to DIS, this disables writing/changing of any data saved in the EEPROM. On the other hand, if the jumper switch is set to “EN”, changes can be made to the configuration data stored in the EEPROM. The factory default setting is “EN” (Enable) for all transmitters. The location of the Wire Protect Jumper Switch can be seen in Figure 3-3.

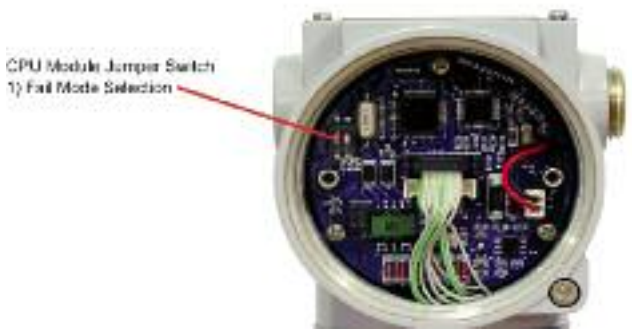


Figure 3-3. CPU Module Fail Mode, EEPROM-Write Selection Jumper Switch

The 3100 has two security settings.
1. Security Jumper: the transmitter configuration parameters are protected.

2. Physically removing Zero and Span Magnetic Buttons: you are unable to regulate zero and span locally.

3.5.1 Security Jumper (EEPROM Write Protect)

Prevents the transmitter’s configured parameters from being changed.

3.5.2 Zero and Span Buttons

By removing the Magnetic Buttons, you can’t configure the transmitter using the Zero and Span locally.

3.6 Configuration of Alarm and Security Jumper Procedures

Changing jumper position.
1. If the transmitter is installed, cutoff power.

2. Open the front cover. If the transmitter is powered, don’t open the cover.

3. Move the jumper to the preferred position.

4. Close the front housing covers. You must fully engage the cover to meet explosion-proof requirements.

3.7 Configuration of Zero and Span Procedures

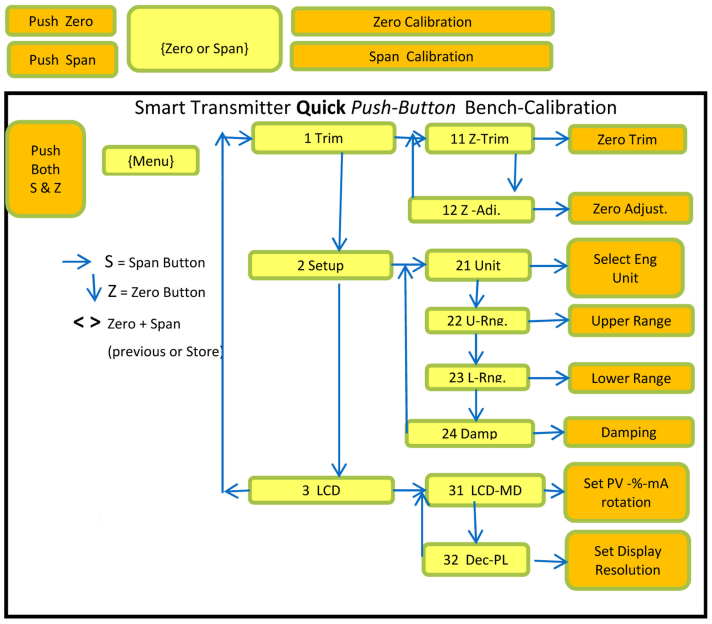
The ZERO and SPAN Buttons are under the transmitter's nameplate. The ZERO, SPAN, ZERO TRIM, ZERO ADJ, Units, Range, Dampening, LCD and decimal set functions are configurable using the ZERO / SPAN buttons.

Zero/Span Configuration Process

Remove both name plate screws on the upper part of transmitter. Remove top name plate to access the Zero and Span Buttons. (following Figure 3-4)

1. Zero Configurations
   Set the current process value for Lower Range Value (4 mA). Apply zero pressure for 10 seconds and push the Zero Button for 5 seconds. The LCD should display "Zero". Push the Zero button for 3 seconds, after 1 second the LCD should display "-ZE-". This message means the zero configuration is finished. If the zero configuration failed, the LCD will display "SPEr" or "SEtE", try repeating the zero configuration steps.
2. Span Configurations
   Apply the desired pressure for 10 seconds and push the Span Button for 5 seconds. The LCD should display "Span". Push the Span button for 3 seconds, after 1 second the LCD should display "-SP-". This message means that the span configuration is finished. If the span configuration failed the LCD will display "SPEr" or "SEtE", try repeating the span configuration steps.

- Please refer to Appendix 1 for the button error and LCD display message.
  The other functions supported by the ZERO / SPAN Buttons are below.



[Menu Tree for Zero+Span Button Function]

1. Moving between menus: Zero
2. Enter or moving to sub menu: Span
3. Moving to top menu: Zero+Span
   - Press the button for 3 seconds to execute each function. After 3 seconds press the Zero+Span buttons, the LCD display will change from Menu to Trim. To see the next menu, press the Zero button for 3 seconds. Use the Zero button to move down the directory.
   - Use the Span button to select the displayed menu. The same procedure will be used for the sub menus.

⚠ CAUTION 30 seconds without any action, the button function will return to normal operation.

4. How to select a numerical value
   A. Functions use numerical values: 12 Zero Adjustment, 22 Change Upper Range Value, 23 Change Lower Range Value, 24 Dampening Second
   B. How to select numerical value: First, select an increasing rate (10^n), then change each decimal value to increase or decrease as wanted. For example, select 3810 : Select increasing rate 1000 -> Increase 3 times -> Select increasing rate 100 -> Increase 8 times -> Select increasing rate as 10 -> Increase 1 time
   C. To select the increase / decrease steps: SelInc message will be displayed on the bottom of the LCD. Select parameter and press the Zero button : The decimal value will be changed when the Zero button is pressed. After set, press the span button to execute the parameter.
   D. To set the required values using Zero/Span buttons: VALUE message will be displayed on the bottom of the LCD.
      1. Press the Zero button, the menu will increase 1 item.
      2. Press the Span button, the menu will decrease 1 item.
      3. After setting, save the parameter by pressing the Zero+Span buttons.
   E. To set the final value, repeat C and D.
   F. After setting the final parameter, exit the menu by pressing the Zero+Span buttons.

5. Exercises for each function
   - ZERO TRIM
     1. Access the menu by pressing the Zero+Span buttons.
     2. Move to the sub directory using the Span button until the 1 TRIM message appears on the display.
     3. Change the Zero Trim Function by using the Span button until the 11 Z-TRIM message appears on the display.
   - ZERO ADJUSTMENT : Change the PV value to 14
     1. Exit the menu by pressing the Zero+Span button.
     2. Moving thru the sub directory using the Span button until 1 TRIM message appears.
     3. Moving thru the sub directory using the Zero button until 11 Z-TRIM message appears.
     4. Access the Zero Adjustment function by pressing the Span button until the 12 Z-ADJ messages appears.
     5. When the SelInc message appears, press the Zero button repetitively until the 10.0 message appears on the LCD. Set the value by pressing the Span button.
     6. When VALUE message appears, change the LCD value to 10.0 and press the Zero button, then press the Zero+Span buttons.
     7. When SelInc message appears, change the LCD value to 1.0 and press the Zero button, then set the value and press the Span button. Press the Zero+Span buttons after the LCD value changes to 14.0.
     8. To save the settings, press the Zero+Span buttons until the SelInc message appears.
   - CHANGE UNITS
     1. Access the menu by pressing the Zero+Span buttons.
     2. Moving to next menu by pressing the Zero button until the 1 TRIM message appears.
     3. Moving thru the sub directory press the Span button until the 2 SETUP message appears.
     4. Press the Span button to access 21 UNIT, press Span again to access Change Unit.
     5. Save the values by pressing the Span button when the desired value is displayed on the LCD.

- CHANGE UPPER RANGE VALUE
  1. Access the menu by pressing the Zero+Span buttons.
  2. Move to the next menu by pressing the Zero button until the 1 TRIM message appears.
  3. Press the Span button until the 2 SETUP message appears.
  4. Press the Span button until the 21 Unit message appears.
  5. Press the Zero button until the 22 U-RNG message appears.
  6. Press the Span button until the Zero Adjustment message appears.
- CHANGE LOWER RANGE VALUE
  1. Access the menu by pressing the Zero+Span buttons.
  2. Move the to next menu by pressing the Zero button until the 1 TRIM message appears.
  3. Press the Span button until the 2 SETUP message appears.
  4. Press the Span button until the 21 Unit message appears.
  5. Press the Zero button until the 22 U-RNG message appears.
  6. Press the Zero button until the 23 L-RNG message appears.
  7. Press the Span button until the Change Lower Range Value message appears.
- CHANGE LCD MODE (Cyclic or Fixed Display)
  1. Enter programming menu by pushing both (ZERO+SPAN) button together for 5 seconds. Release buttons when LCD displays Menu and display will automatically change to “1 TRIM” confirming access into programming menu.
  2. Push (ZERO) button when “1 TRIM” message appears on LCD. Release button when display changes to “2 SETUP”.
  3. Push (Zero) button and release when display changes to “3 LCD”.
  4. To move into sub directory push (Span) button after “3 LCD” message appears on display. Release button when 31 LCD-MD message is displayed.
  5. To enter this sub-menu, push (Span) button and release when display changes to 311. Bottom line of display will show current Mode setting e.g. NOR-RO, NOR-PVetc.
  6. Push (Zero) button to cycle through available mode options and select desired LCD rotation mode. Options are: NOR-RO (rotate all PV, %, mA), NOR-PV (fixed PV), NOR-% (fixed %), NOR-mA fixed, ENG-RO, ENG-PV, ENG-% or ENG-mA
  7. Push (Span) to save changes and EXIT programming mode.
- DECIMAL PLACE
  1. Access the menu by pressing the Zero+Span buttons.
  2. Move to the next menu by pressing the Zero button until the 1 TRIM message appears.
  3. Press the Span button until the 2 SETUP message appears.
  4. Press the Span button until the 3 LCD message appears.
  5. Press the Span button until the 31 DEC-PL message appears.
  6. Press the Span button until the Decimal Place message appears, the decimal place will appear on the second line of the LCD as follows.

Display	Explanation	Max. Value
AUTO	Target value will be displayed automatically	99999
5-0	No decimal place	99999
4-1	Display one decimal place	9999.9
3-2	Display two decimal places	999.99
2-3	Display three decimal places	99.999
1-4	Display four decimal places	9.9999

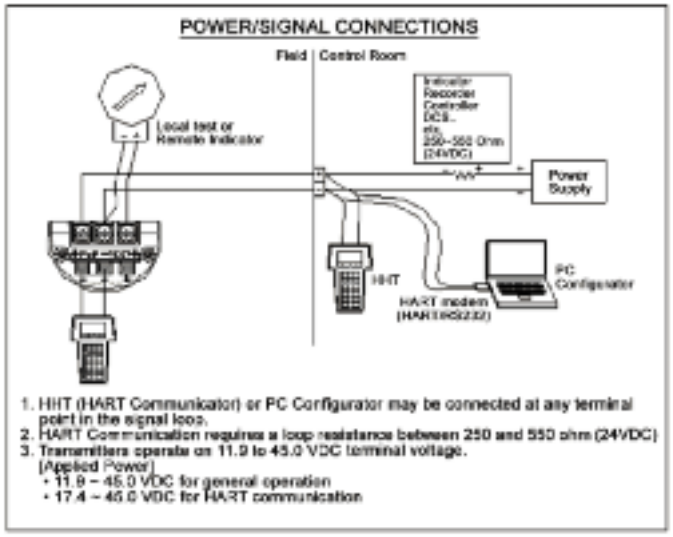
  7. The first line on the LCD will display 0.0.
  8. The Decimal Place can be changed by pressing the Zero button. Save the setting by pressing the Span button after the decimal place has been selected.
  9. The set value will display the PV value and Engineering value.
  10. The LCD will display LCD_OV and the saved Unit when the pressure is over or under a set value.

Figure 3-4 Transmitter Zero/Span Configuration Buttons

3.8 Commissioning on the Bench with HHT

The 3100 Pressure Transmitter can be commissioned using an HHT before or after installation.

▲ Connect an HHT (HART® HANDHELD Communicator) across the COMM pins for HART® communication. The TEST pin connections can be used for connecting a multimeter to measure the output current directly from the transmitter. Since the 3100 is a two wire loop powered transmitter, it requires an external loop power supply (11.9V to 45VDC) to enable HART® communication. Any HART® communication via HHT (or PC based configurator) requires a minimum 250 ~ 550 (max) ohm loop resistance.



[Figure 3-5 Connecting the Transmitter to HHT]

Chapter 4 Installation

4.1 Overview

The information in Chapter 4 explains installation.

4.2 Safety Messages

Procedures and instructions in this chapter may require special safety measures to ensure the safety of the personnel performing the operation. Potential installation safety issues are indicated by a safety alert symbol (▲). Refer to the following safety messages before installing the 3100 pressure transmitter.

4.3 Warning

DANGER Explosion can result in death or serious injury: Do not remove the transmitter covers in an explosion-proof environment when the circuit is powered. Both transmitter covers must be fully engaged to meet the explosion-proof requirements.

WARNING Electrical shock can result in serious injury: Only qualified personnel can wire the pressure transmitter.

WARNING Process leaks can cause death or serious injury: Install and tighten before applying pressure. If you don't, it can cause process leaks.

DANGER Electrical shock can result in death or serious injury: Avoid contact with the leads and terminals.

4.4 Commissioning on the Bench with Hand-Held Terminal

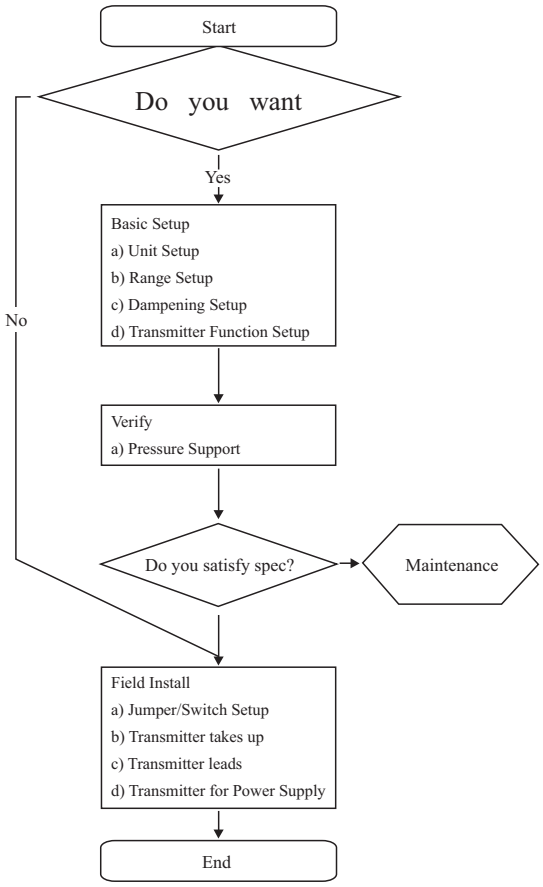
The 3100 Pressure Transmitter can be commissioned before and after installation. Commissioning is easier if the transmitter is configured on a bench with an HHT before installation.

4.5 General Considerations

The transmitter can be mounted near the process to minimize piping. Keep in mind that easy access is required for personnel, field calibration, and installation. Install the transmitter in an area with minimal vibration, shock, and temperature fluctuations.

4.6 Electrical Considerations (Power Supply)

The transmitter housing is composed of two parts. One side is electronics, and the other side is terminal block. The terminal block side is the transmitter's front side and is labeled "Field Terminal" on the housing. The terminal block can be accessed by removing the front cover. When wiring the power supply to the transmitter make sure the positive and negative wires are connected correctly.
A HHT configurator can be connected directly across the (COMM) pin terminal located just below the power supply (PWR) terminal block connections.



[Figure 4-1 Installation Flow Chart]

4.6.1 Power Supply

The 3100 Pressure Transmitter requires an 11.9 – 45 VDC power supply. A 250 ~ 550Ω (24 VDC) loop resistance is recommended for HART® communication. Loop resistance is the sum of the resistance in the loop.

Max. Loop Resistance [Ω] = (E-11.9) [vdc] / 0.022 [mA]

4.7 Wiring

4.7.1 Wiring Caution

1. Install the signal cables away from potential sources of electrical noise such as transformers, electrical motors, etc.
2. Before wiring, remove electrical conduit cap.
3. All screwed connections on the housing must be sealed with waterproof sealant. We recommend use of silicone based sealants to minimize post-hardening.
4. Avoid running DC signal and AC power cables in the same ducts/cable conduits to avoid signal noise issues.
5. All explosion-proof transmitters must meet the wiring & installation requirements specified within the applicable electrical codes.

4.7.2 Selecting the Wiring Materials

1. Use 600V shielded PVC wire or standard wire of the same class. (To ensure proper communication use 24 AWG or larger wire, and do not exceed 5000 feet)
2. Use shielded wire in areas with electrical noise.
3. In areas with high or low ambient temperatures, use wire or cable that is rated for the extreme temperatures.
4. If the wire or cable is going to be used in oil, solvent, toxic gas or liquid, make sure it is rated accordingly.
5. Process wire or cable must not be soldered to the terminal lug. Spade connectors are recommended to connect the process wires to the transmitter.

4.7.3 Connecting External Wires to Transmitter Terminal Box

1. Open the cover indicated "FIELD TERMINAL". Do not open the cover if the transmitter is located in an explosion-proof area and powered. Connect the power supply to the terminal indicated "+PWR"(left terminal) and "-" in the central terminal. Do not connect "+" power supply to "+" terminal "TEST". It will damage the test diode.
2. Seal and close the conduit connection to prevent humidity and explosion-proof atmosphere from entering the housing.
3. Transmitter power is supplied by signal wire. Do not install near high voltage wires or high voltage equipment.
4. Close the transmitter cover. To meet the explosion-proof ratings make sure the covers are fully engaged.
   NOTE: Do not power the transmitter with high voltage (AC). It can damage the transmitter.
5. You must connect a 250~550 Ohm Resistor in Current Loop (between Power Supply and Transmitter) for HART® Communication. See Figure 4-2.

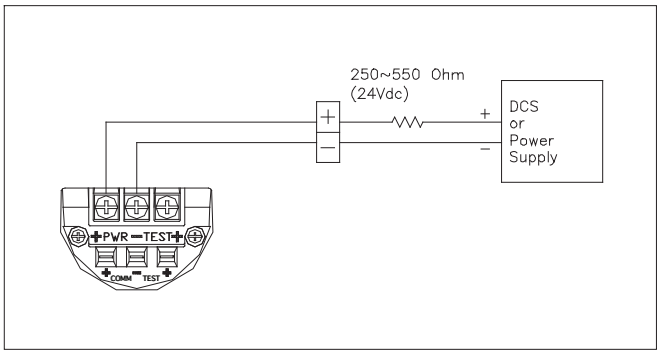


Figure 4-2 Wiring the 3100 Pressure Transmitter

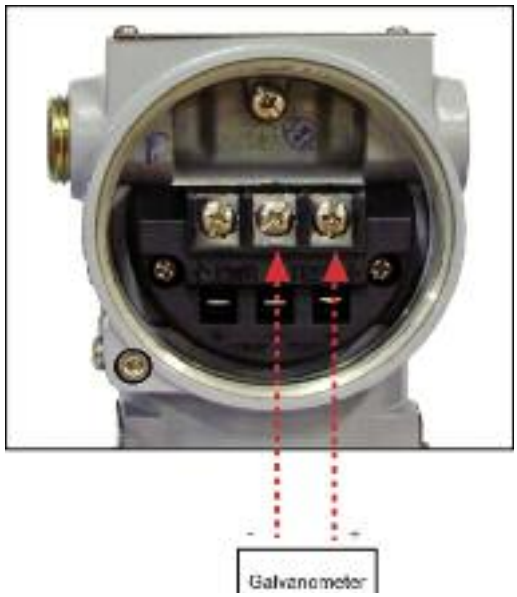


Figure 4-3 Picture of Transmitter Wiring Terminal

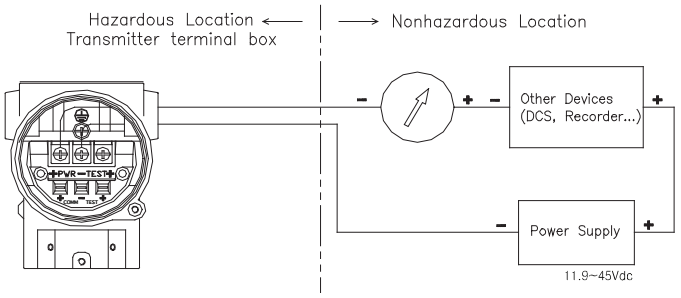
4.7.4 Wiring (Loop Configuration)

DANGER Explosion can result in death or serious injury: Do not remove the transmitter covers in an explosion-proof environment when the circuit is powered. Both transmitter covers must be fully engaged to meet explosion-proof requirements.

A. Loop Configuration

Mercoid® 3100 Pressure Transmitters use a two-wire system for power, 4~20mA analog signal transmission and HART® digital transmission.

A DC Power Supply is required for the transmitter loop. The transmitter and power supply should be connected as shown below.



B. Wiring Installation

General-use (Figure 4-4a)

1. Use metallic conduit or waterproof cable glands for wiring.
   a. Apply non-hardening sealant to the terminal box and the threads on the flexible metal conduit for waterproofing.

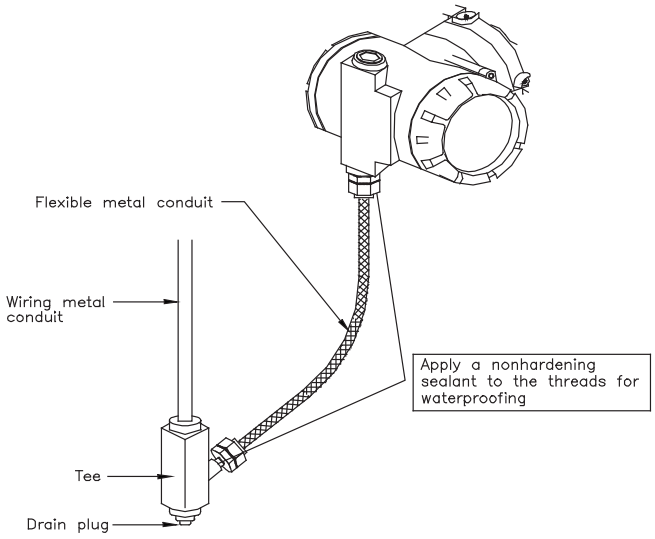


Figure 4-4a Typical Mounting using Flexible Metal Conduit

Explosion-proof

1. Explosion-proof metal conduit wiring (Figure 4-4b)
   a. A seal fitting must be installed near the terminal box port.
   b. Apply a non-hardening sealant to the threads of the terminal connection box.

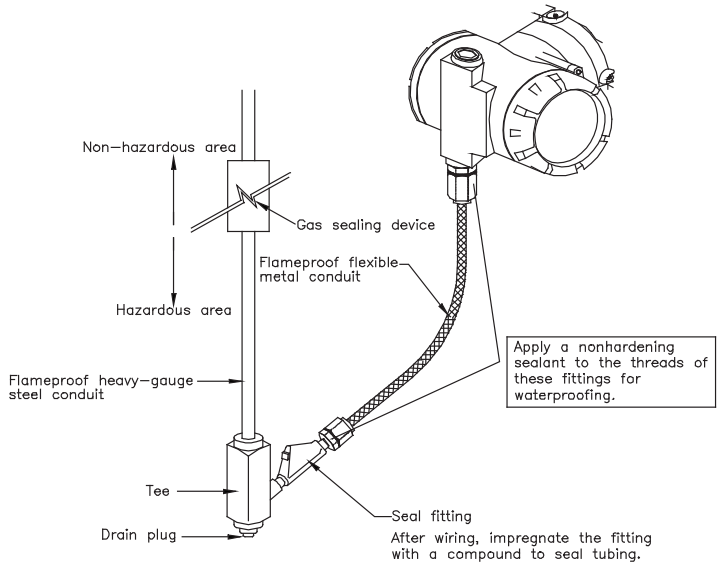
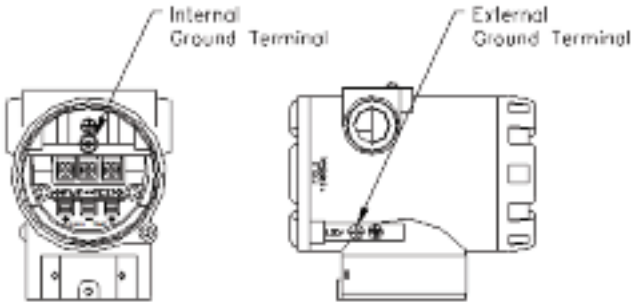


Figure 4-4b Typical Wiring using Explosion-Proof Conduit

4.7.5 Grounding

a. Grounding should satisfy KS requirements (grounding resistance should be 10 ohm or less). Grounding is required for explosion-proof applications and the ground resistance must be below 10 ohms.
   [Note] In case of Built-in Lightening Protector, Grounding should satisfy Special KS requirements (grounding resistance, 10 ohm or less).
b. There are ground terminals on the inside and outside of the transmitter. Either of these terminals may be used.
c. Use 600V insulated PVC wire for grounding.



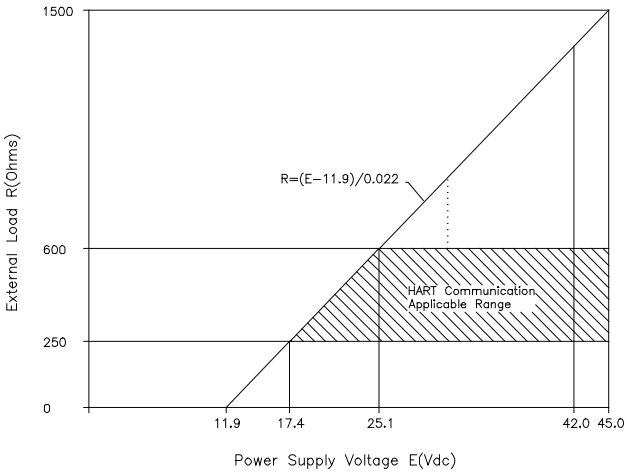
3100 Smart Pressure Transmitter
Internal and External Ground Terminal

4.7.6 Power Supply Voltage and Load Resistance

When configuring the loop, make sure that the external load resistance is within the range (see figure below). The transmitter supply voltage should be:

- Standard : 11.9 to 45 Vdc
- HART Communication : 17.4 to 45 Vdc

And maximum loop current is 24mA, Load resistance R:
R = (E-11.9) / 0.022 (E = Power Supply Voltage)



4.8 Mechanical Considerations

Figure 4-6 is a dimensional drawing for the 3100. Figure 4-7 shows how the A-630 angle bracket is mounted to a pipe.

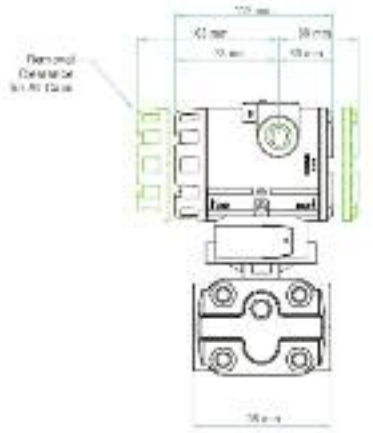


Figure 4-6. Model 3100 Outline Dimension Drawing

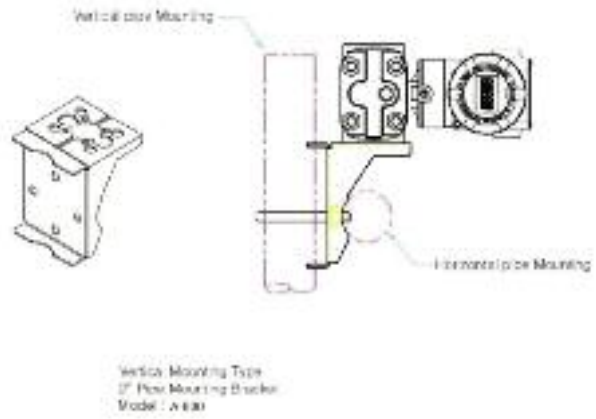


Figure 4-7. A-630 Mounting Bracket

4.8.1 Mounting

Avoid installing transmitters in environments with excessive vibration. If it cannot be avoided it is highly recommended to provide adequate support when mounting.

4.8.2 Transmitter Access

When selecting the installation location, accessibility must be taken into consideration.

- Housing rotation: The housing can be rotated 90°.
- Wiring terminals: The cover and wiring terminals are easily accessible.
- LCD/Circuits: Install the transmitter in a location where it can be seen. For transmitters without an LCD, the cover and jumpers are easily accessible.

4.9 Environmental Considerations

4.9.1 Ambient Temperature

The transmitter ambient temperature range is 4 to 180°F (-20 to 60°C). If the ambient temperature is going to exceed the temperature range, precautions must be taken to keep the temperature within the temperature limits.

4.9.2 Toxic and Moist Environments

The 3100 housing will protect the transmitter against moisture or toxic material. The electronic circuit is separated from the terminals. The housing covers have o-rings that seal the housing, but moisture can penetrate the housing thru the conduit. The transmitter should be mounted in a position to prevent moisture from entering the housing thru the conduit.

4.9.3 Installation in Hazardous Location

The transmitter is designed with an explosion-proof housing. Installation environment must not exceed the explosion-proof rating.

Chapter 5 On-Line Operation

5.1 Overview

This chapter describes how to configure the 3100 Smart Pressure Transmitter. The transmitter can be configured in On-Line or Off-Line mode. In On-Line Mode a compatible HHT or PC configuration device must be used.

5.2 Safety Messages

For added operator safety please pay specific attention to procedures outlined in this manual listed under the warning symbol (▲).

5.2.1 Warning

⚠ DANGER Explosion can result in death or serious injury: Do not remove the transmitter covers in explosion-proof environments when the circuit is powered. Both transmitter covers must be fully engaged to meet explosion-proof requirements.

⚠ DANGER Electrical shock can result in serious injury: When installing transmitters in close proximity of high voltage sources (near power lines) the transmitter leads can be subject to high voltages. Avoid contact with the leads and terminals.

5.2.2 Current to Passive Mode Configuration

For multi-drop mode the current output must be configured as passive mode. Please disregard any other messages shown on HHT.

5.3 Configuration Data Review

Before operating the transmitter make sure the configuration data on the nameplate matches the application.

5.4 Configuration Verification

Before the transmitter is ready for service, the configuration must be checked to confirm the settings are configured for the application.

5.4.1 Process Variable

There are two process variables in the 3100 Smart Pressure Transmitter. The primary variable and temperature compensated SV (Second Variable), the PV value outputs the 4~20mA analog value.

5.5 Basic Setup

The correlation variable must be configured before operating the transmitter.

5.5.1 Select Sensor Range

The pressure range must be selected when ordering the pressure transmitter.

5.5.2 Set Output Units

Select from the following engineering units:

Volumetric Flow Unit:

CubicFeet/min, Gallons/min, Liters/min, ImperialGallons/min, CubicMeter/hr, Ft/s, meters/s, Gallons/s, mGallons/day, Liters/s, mLiters/day, CubicFeet/s, CubicMeter/s, CubicMeter/day, ImperialGallons/hr, ImperialGallons/day, NormalCubicMeter/hr, NormalLiter/hr, StandardCubicFeet/min, CubicFeet/hr, CubicFeet/day, CubicMeters/min, Barrels/s, Barrels/min, Barrels/hr, Barrels/day, Gallons/hr, ImperialGallons/s, Liters/hr, Gallons/day

Mass Flow

Grams/s, Grams/min, Grams/hr, Kilograms/s, Kilograms/min, Kilograms/hr, Kilograms/day, MetricTons/min, MetricTons/hr, MetricTons/day, Pounds/s, Pounds/min, Pounds/hr, Pounds/day, ShortTons/min, ShortTons/hr, ShortTons/day, LongTons/hr, LongTons/day

Pressure

kPa, mmH2O, InH2O, InHg, FtH2O, mmHg, psi, bar, mbar, g/cm^2, Kg/cm^2, Pascals, MPa, torr, ATM

Miscellaneous

%

Time

Min, sec, hr, days

Mass

Grams, kilograms, metric tons, pounds, short tons, long tons, ounce

Volume

Gallons, liters, imperial gallons, cubic meters, barrels, bushels, cubic yards, cubic feet, cubic inches, bbl liq, normal cubic meter, normal liter, standard cubic feet, hectoliters

5.5.3 4-20mA Configuration

Set the Zero and Span for the 4~20mA analog output.

5.6 Detailed Setup

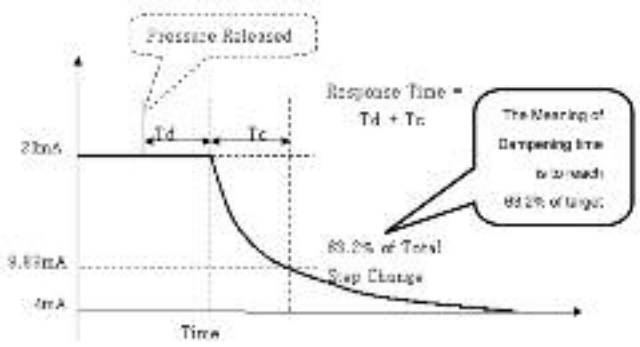
5.6.1 Set Fail Mode

When the sensor or microprocessor is not operating properly, the transmitter will output 3.75mA or 21.75mA based on the Fail Mode setting.

5.6.2 Set Dampening Time

The Dampening Seconds value changes the response time of the transmitter to smooth out variations caused by rapid process changes. Determine the appropriate dampening setting based on the required response time, signal stability, and other requirements of your system.

The Dampening Seconds can be set from 0-60 seconds; the default dampening value is 1.0 second.



5.7 Configuration of Information Variable

5.7.1 Set Tag

Tags are an easy way to classify transmitters in multi transmitter application. Tags can use 8 words/numbers.

5.7.2 Set Messages

When using several transmitters, the user can define each transmitter by using 32 words/numbers. This message is saved in EEPROM.

5.8 Diagnostics and Service

5.8.1 Loop Test

The Loop Test verifies the output of the transmitter, the integrity of the loop, and the operations of any recorders or similar devices installed in the loop. The following procedures are required for a loop test.

- Connect a reference meter to the transmitter.
- Select the Loop Test on the HHT and operate the Loop Test.
- Select current output (4mA/20mA/etc.)
- If the readings match, then the transmitter and the loop are configured and functioning properly. If the readings do not match, then you may have the current meter attached to the wrong loop, there may be a fault in the wiring, the transmitter may require an output trim, or the current meter may be malfunctioning.

5.9 Calibration

The scale is implemented by calibrating the transmitter. Trim function has several calibration functions. Smart transmitters operate differently than analog transmitter. A smart transmitter uses a microprocessor that contains information about the sensor's specific characteristics in response to pressure and temperature for calculating the process variable. 4-20mA configuration sets the transmitter's analog output to a selected upper and lower range and can be done with or without an applied pressure. 4-20mA configuration does not change the factory characterization curve stored in the microprocessor. Sensor trimming requires an accurate pressure input and adds additional compensation that adjusts the factory characterization curve to optimize transmitter performance over a specific pressure range. 4-20mA configuration provides the ability to readjust the 4~20mA sensor inputs without an applied pressure. Reranging does not change the factory or characterization curve stored in the microprocessor. Sensor trimming requires an accurate pressure input and adds additional compensation to the factory characterization curve to optimize transmitter performance over a specific pressure range. Rerange provides ability to readjust the 4~20 mA points sensor inputs.

5.9.1 Sensor Trim

The Sensor trim function adjusts the A/D signal conversion within the transmitter sensor electronics and determines how it digitally interprets any pressure changes applied to the sensor inputs. It is highly recommended to perform a sensor trim when first commissioning the transmitter on site. There are three ways to trim the sensor: Sensor zero trim, full trim and zero adjustment. Sensor zero trim is a one-point adjustment typically used to compensate for the mounting position. Two point trim is a full sensor trim, in which two accurate pressures are applied (equal to or greater than the range values), and the output is linear. You should always adjust the low trim value first to establish the correct offset.

5.9.2 D/A (Digital to Analog) Trim

The D/A trim function makes minor adjustments to the analog (4-20mA) output scaling from the transmitter. It is recommended to do a D/A trim on both hi (20mA) & low (4mA) values for best results. This function corrects any minuscule offsets within the D/A conversion of the transmitter

Chapter 6 Maintenance

6.1 Overview

This chapter describes diagnostic and maintenance.

6.2 Safety Messages

When the transmitter is in operation, operators should follow all safety messages. Potential safety issues are indicated by a safety alert symbol (▲). Refer to the following safety messages before performing any operation proceeded by a (▲) symbol.

6.2.1 Warning

DANGER Explosion can result in death or serious injury: Do not remove the transmitter covers in explosion-proof environments when the circuit is powered. Both transmitter covers must be fully engaged to meet explosion-proof requirements.

DANGER Electrical shock can result in serious injury: When installing transmitters in close proximity of high voltage sources (near power lines) the transmitter leads can be subject to high voltages. Avoid contact with the leads and terminals.

WARNING Electrical shock can result in death or serious injury:
Only qualified personnel can configure and wire the 3100 Smart Pressure Transmitter.

6.3 Hardware Diagnostics

If there is a failure despite a diagnostic message on the HHT, Table 6.1 can help troubleshoot the problem.

Symptom	Potential Source	Corrective Action
Transmitter does not Communicate with HART® Communicator	Loop Wiring	• Check for a 250-550 ohms resistance between the power supply and HHT. • Check for adequate voltage to the transmitter (the transmitter requires 11.9 ~ 45 Vdc). • Check for intermittent shorts, open circuits, and multiple grounds.
High Output	Sensor Input Failure	• Connect HHT and enter the transmitter test mode to isolate a sensor failure.
	Loop Wiring	• Check for dirty or defective terminals, interconnecting pins, or receptacles.
	Power Supply	• Check the output voltage of the power supply at the transmitter terminals. It should be 11.9 to 45 Vdc.
	Electronics Module	• Connect HHT and enter the transmitter test mode to isolate module failure. Check the sensor limits to ensure the calibration adjustments are within the sensor range.
Erratic Output	Loop Wiring	• Check the output voltage of the power supply at the transmitter terminals. It should be 11.9 to 45 Vdc. • Check for intermittent shorts, open circuits, and multiple grounds. • Check for proper polarity at the signal terminals.
	Electronics Module	• Connect HHT and enter the transmitter test mode to isolate an electronics mode failure.
Low Output or No Output	Sensor Element	• Connect HHT and enter the transmitter test mode to isolate a sensor failure. • Is the PV out of range.
	Loop Wiring	• Check for adequate voltage to the transmitter (the transmitter requires 11.9 ~ 45 Vdc). • Check for intermittent shorts, open circuits, and multiple grounds. • Check polarity of signal terminal. • Check the loop impedance.
	Electronics Module	• Connect HHT and check the sensor limits to ensure calibration adjustments are within the sensor range.

Table 6.1 Troubleshooting

6.4 Hardware Maintenance

The Mercoid® 3100 Smart Transmitter has no moving parts and requires little maintenance. If a transmitter fails, it must be returned to Dwyer Instruments, Inc. for inspection, repair, or replacement.

6.4.1 Test Terminals

The test terminals are marked TEST on the terminal block. The test and negative terminals are connected to the power terminals; so long as the voltage across the receptacles are below the diode threshold voltage, no current will pass through the diode. To ensure that current isn't leaking through the diode, test the reading with an indicating meter. The test connection should not exceed 10 ohms. A resistance value of 30 ohms will cause an approximate 10 percent of reading error.

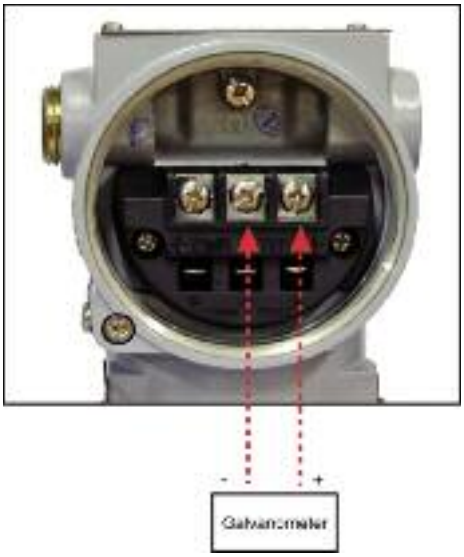


Figure 6-1 Test Terminals

6.4.2 Disassembling the Housing

The transmitter is designed with dual-compartment housing; one contains the electronics module, and the other contains all wiring terminals and communication terminal.

Figure 6-2 Structure of Housing

6.4.3 Fail Mode Jumper Switch and EEPROM-Write

Fail-mode jumper switch and EEPROM-Write is located behind the front cover.

Figure 6-3 Structure of Electronics Module

Appendix I
3100 SMART PRESSURE TRANSMITTER - LCD DISPLAY CODE

Message	Description
ADJ-U	Zero adjustment value – used to configure transmitter when it is out of range (on higher side)
ADJ-L	Zero adjustment value – used to configure transmitter when it is out of range (on low side)
ZERO	Initial message when using Zero button
SPAN	Initial message when using Span button
BT-ERR	Button Sequence error
P-LOCK	Button input error - Protect Locked
ZT-ERR	Zero Trim value is over limit (10%)
-TR-	Zero Trim done
ZR-ERR	Setting Limit error when executing Zero button function
SP-ERR	Setting Limit error when executing Span button function
-ZR-	Zero button function done
-SP-	Span button function done
-ZA-	Zero Adjustment done
-DONE-	Configuration completed using buttons
RNGOVR	Limit error when executing other setting function
LCD_OV	Over Values for LCD
SCD-ER	Sensor Code Error
F-RST	Flash Setting Data Reset
F-LOCK	Flash Setting Data Reset, Protect Locked
F-FAIL	Flash Setting Data Reset Failure
-FR-	Flash Reset done
A-RST	Analog EEPROM Initializing Start
A-STOR	Analog EEPROM Stored
A-FAIL	Failure in writing configuration values on to the EEPROM of transmitter CPU
-AC-	Analog EEPROM Configuration done
S-FL	Sensor Fail
S-OP	Sensor Overpressure
AEP-RF	Check error with EEPROM on CPU board
TS-FL	Temperature Sensor Error
AEP-WF	Analog EEPROM write fail
EOSC	Crystal Element Defect Alarm
FAVE	Flash Access Violation

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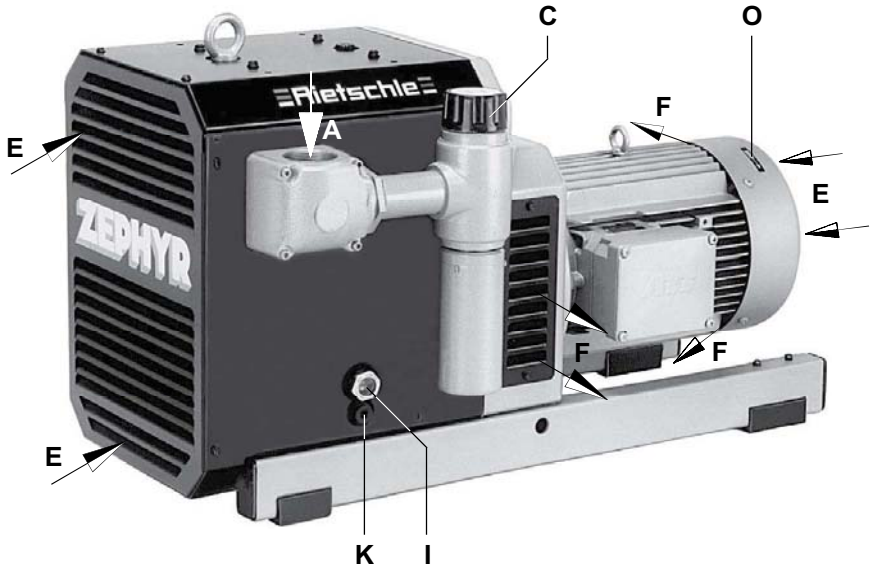
Claw vacuum pumps

VLR

ZEPHYR

VLR 100
VLR 250
VLR 300
VLR 400
VLR 500



1

Pump ranges

These operating instructions concern the following contact-less operating claw vacuum pumps: Models VLR
The vacuum capacities at atmosphere are 100, 235, 300, 385 and 500 m^3/hr operating on 50 cycles. The pumping curves which show capacity compared to pressure can be found in data sheet D 880.

Description

The ZEPHYR VLR are two shaft, rotary lobe vacuum pumps, where two claws are rotating contact-less and dry in opposite directions in a housing and are synchronised by a pair of gears. The pumping chamber is oil free. The synchronised drive gears and the A-side bearings for the rotors are oil lubricated. The drive gears and the A-side bearings are fitted into a gear chamber which also contain the oil tank. The oil tank is designed so that at all rotational speeds, bearings and gears are supplied with the correct amount of oil. ZEPHYR 400 and 500 have on the B-Side also greased bearings.
The pumping chamber is separated from the gear chamber using labyrinth seals. The sealing system can be enhanced with sealing gas (special version).
The ZEPHYR is enclosed in a sound box. The cooling takes place over the coupling fan. The fresh cool air (E) is sucked in and the warm air is exhausted through the vents (F).
All the pumps are driven by a direct flanged three phase, standard TEFV motor via a pin and bush coupling.
Vacuum can be adjusted to the required levels, however, they are limited to a maximum point (see regulating valve (C)).
Optional extras: As required, non-return valve (ZRK), vacuum tight suction filter (ZVF), motor starter (ZMS), exhaust silencer (ZSZ) (see picture 2), soft starter (ZAD) and silencing hood.

2

Contents:

BE 880

1.8.2000

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Fax 07622 / 392300
E-Mail: info@rietschle.com
http://www.rietschle.com

Rietschle (UK) Ltd.
Bellingham Way
NEW HYTHE
KENT ME20 6XS
UNITED KINGDOM
☏ 01622 / 716816
Fax 01622 / 715115
E-Mail: info@rietschle.co.uk
http://www.rietschle.co.uk

Application

The units ZEPHYR are suitable for use in the industrial field i.e. the protection equipments corresponds to EN DIN 294 table 4.

The ZEPHYR VLR can be used for the evacuation of a closed system or for a permanent vacuum from: 150 mbar (abs.) → VLR 100, 200 mbar (abs.) → VLR 250/300 and 250 mbar (abs.) → VLR 400/500.

Warning – Suction of explosive gases

Any non compliance may lead to severe injury to persons and damage to the ZEPHYR may occur!
Dangerous mixtures (i.e. inflammable or explosive gases or vapours), extremely humid air, water vapour, aggressive gases or traces of oil and grease must not be handled.

The standard versions may not be used in hazardous areas. Special versions with Ex-proof motors can be supplied.

Caution – Do not exceed the temperature

At non compliance severe damage may occur on the ZEPHYR.
The ambient and suction temperatures must be between 5 and 40° C.

Caution – Noise Emission

Potential risks for operating personnel.
When working permanently in the vicinity of an operating ZEPHYR, we recommend wearing ear protection to avoid any damage to hearing.

Setting up (picture ❶ and ❸)

Warning – hot surfaces

Pumps that have reached operating temperature may have a surface temperature at position (Q) of more than 70°C.
Do not touch these hot surfaces (see also warning signs)!

The oil filler ports (H), oil sight glasses (I), oil drain plugs (K) must all be easily accessible. The cooling air entries (E) and the cooling air exits (F) must have a minimum distance of 20 cm from any obstruction. The discharged cooling air must not be re-circulated.

▶ Note

The ZEPHYR can only be operated reliably if they are installed horizontally.
For installations that are higher than 1000 m above sea level there will be a loss in capacity.

Installation (picture ❶ and ❸)

For operating and installation follow any relevant national standards that are in operation.

1. Vacuum connection at (A).
   The air handled can be exhausted into the atmosphere through the exhaust silencer (ZSZ) or by utilising a pipe connection and pipeline.

   ▶ Note

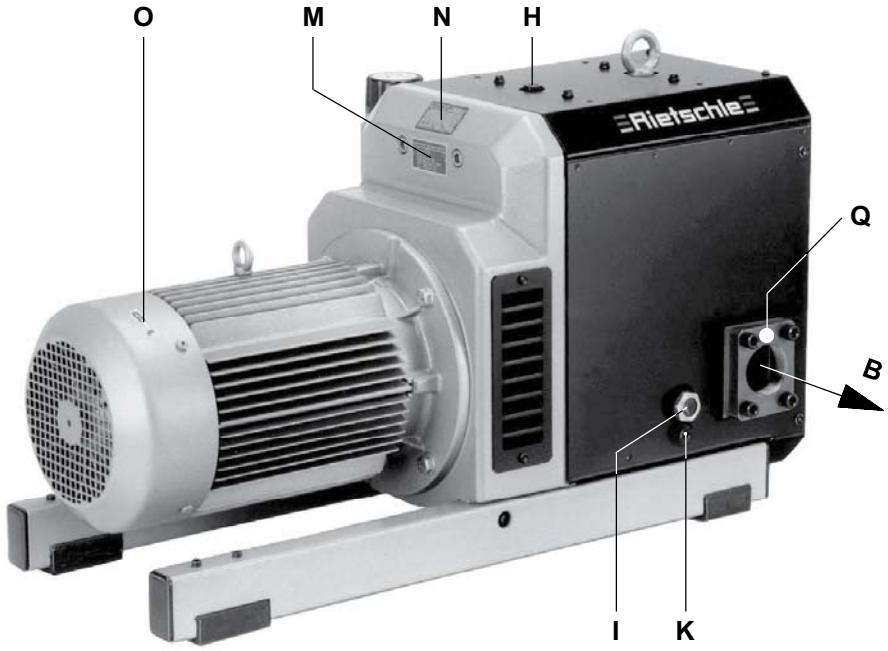
   Long and/or small bore pipework should be avoided, as this tends to reduce the capacity of the pump.
2. The lubricating oil (recommended brands see under servicing) for the gears and bearings should be put into the oil filler port (H), until the oil level shows at the middle of the oil sight glasses (I). After filling make sure the oil filler port is closed.
3. The electrical data can be found on the data plate (N) or the motor data plate. The motors correspond to DIN/VDE 0530 and have IP 54 protection and insulation class B or F. The connection diagram can be found in the terminal box on the motor (unless a special plug connection is fitted). Check the electrical data of the motor for compatibility with your available supply (voltage, frequency, permissible current etc.).
4. Connect the motor via a relevant direct on-line motor starter. It is advisable to use thermal overload motor starters to protect the motor and wiring. All cabling used on starters should be secured with good quality cable clamps.
   We recommend that motor starters should be used that are fitted with a time delayed trip resulting from running beyond the amperage setting. When the unit is started cold, overamperage may occur for a short time.

Warning – electrical installation

Danger to life through unprofessional electrical installation!
The electrical installation should only be made by a qualified electrician under the observance of EN 60204. The main switch must be provided by the operator.

Initial Operation (picture ❶ and ❸)

1. Initially switch the compressor on and off for a few seconds to check the direction of rotation against the direction arrow (O).
2. Connect the suction pipe at (A).
3. Vacuum regulating valve:
   The vacuum can be adjusted by turning the regulating valve (C) according to the symbols on the top of the regulating valve.



3

Maintenance and Servicing

When maintaining these units and having such situations where personnel could be hurt by moving parts or by live electrical parts the ZEPHYR must be isolated by totally disconnecting the electrical supply. It is imperative that the unit cannot be re-started during the maintenance operation.

Do not maintain a ZEPHYR that is at its normal operating temperature as there is a danger from hot parts.

1. Lubrication (pictures ❶, ❸ and ❹)

The oil level in the sight glasses (I) should be checked weekly.
The oil level can only be topped up when the ZEPHYR is switched off and vented to atmospheric pressure.
The oil should be changed after 5000 operating hours under normal ambient conditions (see oil drain screws (K)).
The viscosity must correspond to ISO-VG 150 according to DIN 51519. Designation according to DIN 51502: CLP HC 150
We recommend the following oil brands: GEAR-LUBE 150 or equivalent oils from other manufacturers (see oil type plate (M)).

▶ Note

If the oil brand is changed, the old oil must be drained completely from the oil chamber.
Old and used oil must be disposed of corresponding with the relevant health, safety and environmental laws.

VLR 400 / 500:
The bearings of the VLR 400 / 500 need to be greased every 5,000 operating hours or at the latest after 2 years with 30 g grease (see 2 greasing points (L)). We recommend Klüber PETAMO GY 193 or other equivalent greases (see label for recommended grease (M)).

▶ Note

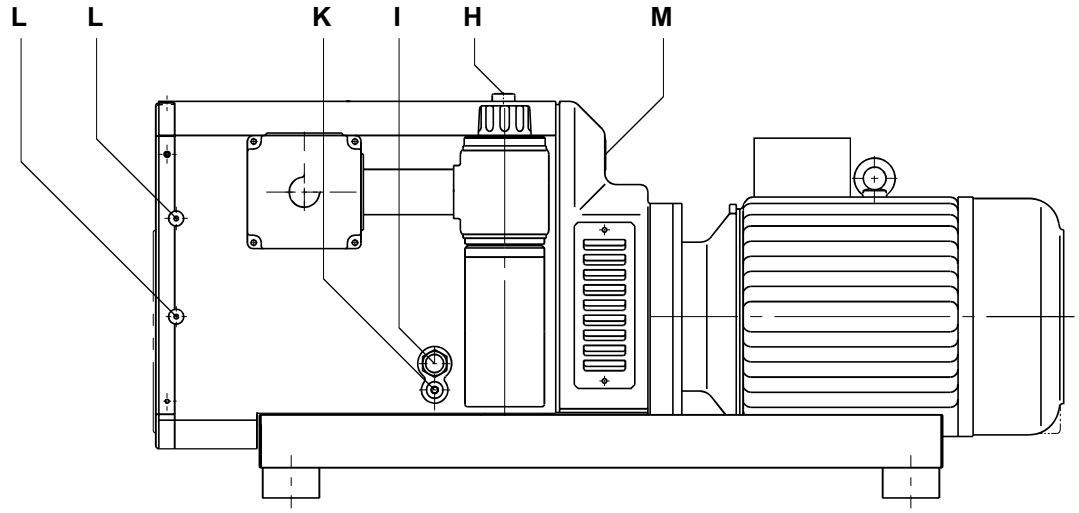
These greasing instruction is valid for operation at 20°C ambient temperature. At 40°C this should be reduced by 50 %.

2. Protection mesh

! Caution – Pollution in the suction air

The capacity of the ZEPHYR could be reduced if the air inlet filters are not maintained correctly.
The protective mesh on the suction side must be cleaned regularly depending upon the amount of contamination. Cleaning can be carried out by blowing out with compressed air.

VLR 400 / 500



4

Trouble Shooting:

1. Motor starter cuts out:

1.1 The incoming voltage and frequency does not corresponds with the motor data plate.
Solution: Adjustment of the mains voltage.

1.2 The connections on the motor terminal block is incorrect.
Solution: Check connections on the motor terminal block or the plug.

1.3 Incorrect setting on the motor starter.
Solution: Check the setting of the motor starter.

1.4 Motor starter trips too fast.
Solution: Use a motor starter with a time delay trip (version as per IEC 947-4).

2. Insufficient suction capacity:

2.1 Protection mesh is blocked.
Solution: Clean the protection mesh.

2.2 Suction pipework is too long or too small.
Solution: Use bigger pipe diameter, avoid restriction.

3. ZEPHYR VLR does not reach ultimate vacuum:

3.1 Leak on the suction side of the pump or on the system.
Solution: Check the suction side and the pipework for pressure losses.

4. ZEPHYR operates at an abnormally high temperature:

4.1 Ambient or suction temperature too high.
Solution: The ambient and suction temperatures must be between 5 and 40° C.

4.2 Cooling air flow is restricted.
Solution: The cooling air entries (E) and the cooling air exits (F) must have a minimum distance of 10 cm from any obstruction.

5. ZEPHYR emits abnormal noise:

5.1 Contamination of the rotary lobes.
Solution: Clean pumping chamber and rotary lobes.

Appendix:

Repair on Site: For all repairs on site an electrician must disconnect the motor so that an accidental start of the unit cannot happen.
All engineers are recommended to consult the original manufacturer or one of the subsidiaries, agents or service agents. The address of the nearest repair workshop can be obtained from the manufacturer on application.
After a repair or before re-installation follow the instructions as shown under the headings ”Installation and Initial Operation”.

Lifting and Transport: To lift and transport the ZEPHYR the eye bolt must be used.
The weight of the VLR are shown in the accompanying table.

Storage: ZEPHYR units must be stored in dry ambient conditions with normal humidity. We recommend for a relative humidity of over 80% that the pump should be stored in a closed container with the appropriate ”drying” chemicals.

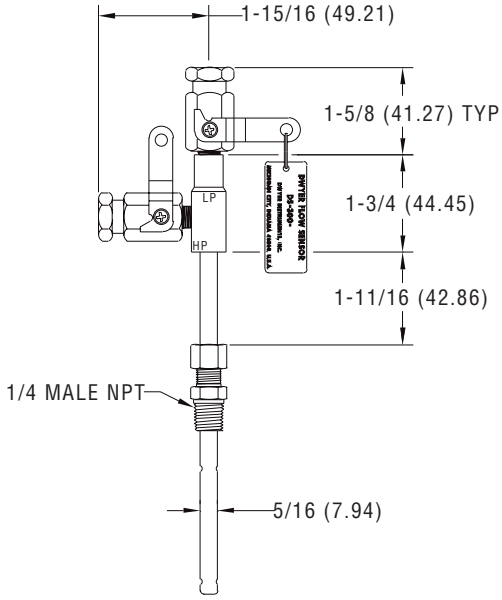
Disposal: The wearing parts (as listed in the spare parts lists) should be disposed of with due regard to health and safety regulations.

Spare parts lists: E 880 → VLR

VLR			100	250	300	400	500
Noise level (max.)	dB(A)	50 Hz		83	83		
		60 Hz		88	88		
Sound power	dB(A)	50 Hz		95	95		
		60 Hz		100	100		
Weight (max.)		kg	100	175	225	250	275
Length (max.)		mm	661	806	891	1059	1201
Width		mm	444	564	564	600	600
Height		mm	360	525	525	525	525
Oil capacity		l	0,5	0,9	0,9	0,9	0,9

Series DS-300 Flow Sensors

Installation and Operating Instructions Flow Calculations



Series DS-300 Flow Sensors are averaging pitot tubes that provide accurate, convenient flow rate sensing. When purchased with a Dwyer Capsuhelic® for liquid flow or Magnehelic® for air flow, differential pressure gage of appropriate range, the result is a flow-indicating system delivered off the shelf at an economical price. Series DS-300 Flow Sensors are designed to be inserted in the pipeline through a compression fitting and are furnished with instrument shut-off valves on both pressure connections. Valves are fitted with 1/8″ female NPT connections. Accessories include adapters with 1/4″ SAE 45° flared ends compatible with hoses supplied with the Model A-471 Portable Capsuhelic® kit. Standard valves are rated at 200°F (93.3°C). Where valves are not required, they can be omitted at reduced cost. Series DS-300 Flow Sensors are available for pipe sizes from 1″ to 10″.

INSPECTION

Inspect sensor upon receipt of shipment to be certain it is as ordered and not damaged. If damaged, contact carrier.

INSTALLATION

General - The sensing ports of the flow sensor must be correctly positioned for measurement accuracy. The instrument connections on the sensor indicate correct positioning. The side connection is for total or high pressure and should be pointed upstream. The top connection is for static or low pressure.

Location - The sensor should be installed in the flowing line with as much straight run of pipe upstream as possible. A rule of thumb is to allow 10 - 15 pipe diameters upstream and 5 downstream. The table below lists recommended up and down piping.

PRESSURE AND TEMPERATURE

Maximum: 200 psig (13.78 bar) at 200°F (93.3°C).

Upstream and Downstream Dimensions in Terms of Internal Diameter of Pipe*

Upstream Condition	Minimum Diameter of Straight Pipe		
	Upstream		Downstream
	In-Plane	Out of Plane	
One Elbow or Tee	7	9	5
Two 90° Bends in Same Plane	8	12	5
Two 90° Bends in Different Plane	18	24	5
Reducers or Expanders	8	8	5
All Valves**	24	24	5

* Values shown are recommended spacing, in terms of internal diameter for normal industrial metering requirements. For laboratory or high accuracy work, add 25% to values.

** Includes gate, globe, plug and other throttling valves that are only partially opened. If valve is to be fully open, use values for pipe size change. **CONTROL VALVES SHOULD BE LOCATED AFTER THE FLOW SENSOR.**

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Fax: 219/872-9057 **e-mail: info@dwyer-inst.com**

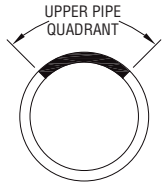
POSITION

Be certain there is sufficient clearance between the mounting position and other pipes, walls, structures, etc, so that the sensor can be inserted through the mounting unit once the mounting unit has been installed onto the pipe.

Flow sensors should be positioned to keep air out of the instrument connecting lines on liquid flows and condensate out of the lines on gas flows. The easiest way to assure this is to install the sensor into the pipe so that air will bleed into, or condensate will drain back to, the pipe.

For Air or Gas Flow

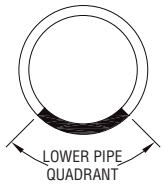
Install in upper quadrant of pipe



Condensate drains back to pipe

For Liquid or Steam Flow

Install in lower quadrant of pipe



Air bleeds back to pipe

INSTALLATION

1. When using an A-160 thred-o-let, weld it to the pipe wall. If replacing a DS-200 unit, an A-161 bushing (1/4˝ x 3/8˝) will be needed.

2. Drill through center of the thred-o-let into the pipe with a drill that is slightly larger than the flow sensor diameter.

3. Install the packing gland using proper pipe sealant. If the packing gland is disassembled, note that the tapered end of the ferrule goes into the fitting body.

4. Insert sensor until it bottoms against opposite wall of the pipe, then withdraw 1/16˝ to allow for thermal expansion.

5. Tighten packing gland nut finger tight. Then tighten nut with a wrench an additional 1-1/4 turns. Be sure to hold the sensor body with a second wrench to prevent the sensor from turning.

INSTRUMENT CONNECTION

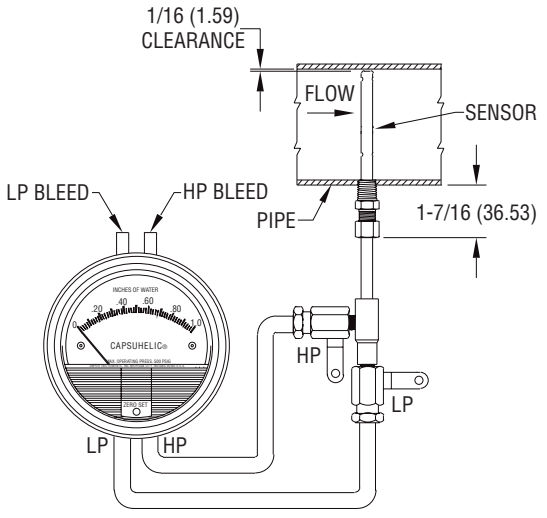
Connect the slide pressure tap to the high pressure port of the Magnehelic® (air only) or Capsuhelic® gage or transmitting instrument and the top connection to the low pressure port.

See the connection schematics below.

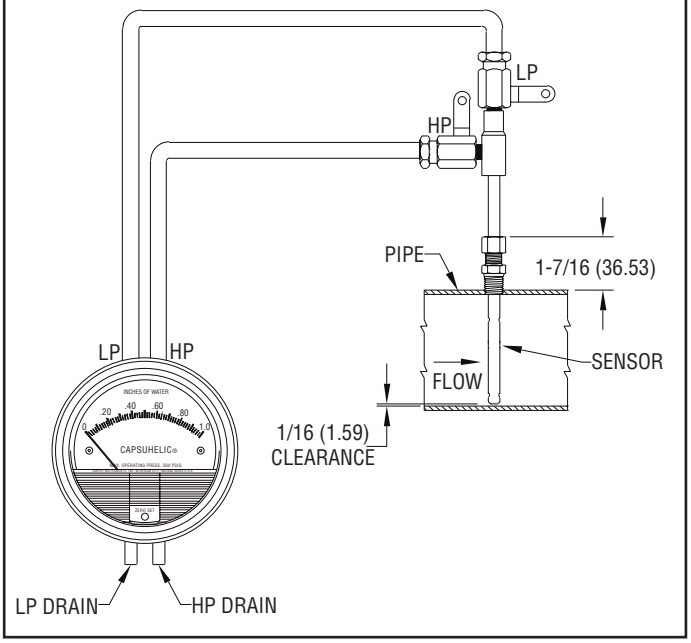
Bleed air from instrument piping on liquid flows. Drain any condensate from the instrument piping on air and gas flows.

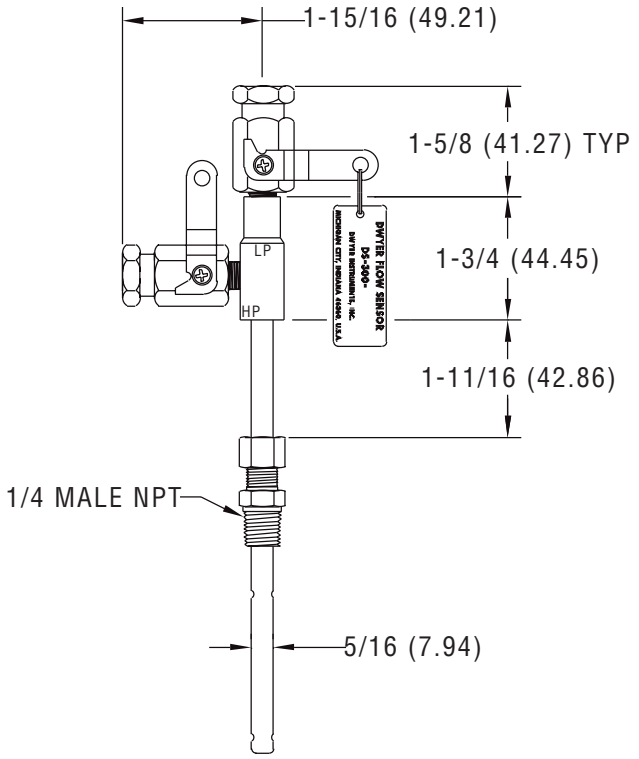
Open valves to instrument to place flow meter into service. For permanent installations, a 3-valve manifold is recommended to allow the gage to be zero checked without interrupting the flow. The Dwyer A-471 Portable Test Kit includes such a device.

Water Flow



Air or Gas Flow





Flow Calculations and Charts

The following information contains tables and equations for determining the differential pressure developed by the DS-300 Flow Sensor for various flow rates of water, steam, air or other gases in different pipe sizes.

This information can be used to prepare conversion charts to translate the differential pressure readings being sensed into the equivalent flow rate. When direct readout of flow is required, use this information to calculate the full flow differential pressure in order to specify the exact range of Dwyer Magnehelic® or Capsuhelic® gage required. Special ranges and calculations are available for these gages at minimal extra cost. See bulletins A-30 and F-41 for additional information on Magnehelic® and Capsuhelic® gages and DS-300 flow sensors.

For additional useful information on making flow calculations, the following service is recommended: Crane Valve Co. Technical Paper No. 410 "Flow of Fluids Through Valves, Fittings and Pipe." It is available from Crane Valve Company, www.cranevalve.com.

Using the appropriate differential pressure equation from Page 4 of this bulletin,calculate the differential pressure generated by the sensor under normal operating conditions of the system. Check the chart below to determine if this value is within the recommended operating range for the sensor. Note that the data in this chart is limited to standard conditions of air at 60°F (15.6°C) and 14.7 psia static line pressure or water at 70°F (21.1°C). To determine recommended operating ranges of other gases, liquids an/or operating conditions, consult factory.

Note: the column on the right side of the chart which defines velocity ranges to avoid. Continuous operation within these ranges can result in damage to the flow sensor caused by excess vibration.

Pipe Size (Schedule 40)	Flow Coefficient "K"	Operating Ranges Air @ 60°F & 14.7 psia (D/P in. W.C.)	Operating Ranges Water @ 70°F (D/P in. W.C.)	Velocity Ranges Not Recommended (Feet per Second)
1	0.52	1.10 to 186	4.00 to 675	146 to 220
1-1/4	0.58	1.15 to 157	4.18 to 568	113 to 170
1-1/2	0.58	0.38 to 115	1.36 to 417	96 to 144
2	0.64	0.75 to 75	2.72 to 271	71 to 108
2-1/2	0.62	1.72 to 53	6.22 to 193	56 to 85
3	0.67	0.39 to 35	1.43 to 127	42 to 64
4	0.67	0.28 to 34	1.02 to 123	28 to 43
6	0.71	0.64 to 11	2.31 to 40	15 to 23
8	0.67	0.10 to 10	0.37 to 37	9.5 to 15
10	0.70	0.17 to 22	0.60 to 79	6.4 to 10

FLOW EQUATIONS

1. Any Liquid

$$Q\ (GPM) = 5.668 \times K \times D^2 \times \sqrt{\Delta P / S_f}$$

2. Steam or Any Gas

$$Q\ (lb/Hr) = 359.1 \times K \times D^2 \times \sqrt{p \times \Delta P}$$

3. Any Gas

$$Q\ (SCFM) = 128.8 \times K \times D^2 \times \sqrt{\frac{P \times \Delta P}{(T + 460) \times S_s}}$$

DIFFERENTIAL PRESSURE EQUATIONS

1. Any Liquid

$$\Delta P\ (in.\ WC) = \frac{Q^2 \times S_f}{K^2 \times D^4 \times 32.14}$$

2. Steam or Any Gas

$$\Delta P\ (in.\ WC) = \frac{Q^2}{K^2 \times D^4 \times p \times 128{,}900}$$

3. Any Gas

$$\Delta P\ (in.\ WC) = \frac{Q^2 \times S_s \times (T + 460)}{K^2 \times D^4 \times P \times 16{,}590}$$

Technical Notations

The following notations apply:

ΔP = Differential pressure expressed in inches of water column
Q = Flow expressed in GPM, SCFM, or PPH as shown in equation
K = Flow coefficient— See values tabulated on Pg. 3.
D = Inside diameter of line size expressed in inches.

For square or rectangular ducts, use: $D = \sqrt{\frac{4 \times \text{Height} \times \text{Width}}{\pi}}$

P = Static Line pressure (psia)
T = Temperature in degrees Fahrenheit (plus 460 = °Rankine)
p = Density of medium in pounds per square foot
S_f = Sp Gr at flowing conditions
S_s = Sp Gr at 60°F (15.6°C)

SCFM TO ACFM EQUATION

$$SCFM = ACFM \times \left(\frac{14.7 + PSIG}{14.7}\right) \left(\frac{520^*}{460 + °F}\right)$$

$$ACFM = SCFM \times \left(\frac{14.7}{14.7 + PSIG}\right) \left(\frac{460 + °F}{520}\right)$$

$$\text{POUNDS PER CUBIC FOOT STD.} = \text{POUNDS PER CUBIC FOOT ACT.} \times \left(\frac{14.7}{14.7 + PSIG}\right) \left(\frac{460 + °F}{520^*}\right)$$

$$\text{POUNDS PER CUBIC FOOT ACT.} = \text{POUNDS PER CUBIC FOOT STD.} \times \left(\frac{14.7 + PSIG}{14.7}\right) \left(\frac{520^*}{460 + °F}\right)$$

1 Cubic foot of air = 0.076 pounds per cubic foot at 60° F (15.6°C) and 14.7 psia.
* (520°= 460 + 60°) Std. Temp. Rankine

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Please read and save this Repair Parts Manual. Read this manual and the General Operating Instructions carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. The Safety Instructions are contained in the General Operating Instructions. Failure to comply with the safety instructions accompanying this product could result in personal injury and/or property damage! Retain instructions for future reference. AMT reserves the right to discontinue any model or change specifications at any time without incurring any obligation.

⚠WARNING Periodic maintenance and inspection is required on all pumps to insure proper operation. Unit must be clear of debris and sediment. Inspect for leaks and loose bolts. Failure to do so voids warranty.

High Head Centrifugal Pumps

Cast Iron, Bronze, and Stainless Steel Models

Refer to pump manual 1808-634-00 for General Operating and Safety Instructions.

Description
These pumps are non self-priming units designed for use where higher heads are needed to handle liquid transfer, heating and cooling application, where no suction lift is required. All models feature high-efficiency closed impellers and continuous duty, 3450 RPM, 56J frame motors. The discharge port on all models can be rotated in 90º increments to accommodate specific applications. Casing working pressure to 150 psi (1034 kPa). These are manual units, no controls are supplied. Single phase units are capacitor start and have automatic thermal protection. Check motor wiring before putting unit into operation (see motor nameplate for specific wiring diagrams). All units are for use with non-flammable, non-abrasive liquids compatible with pump component materials.

CAST IRON UNITS
Pump construction is cast iron casing and adapter. Stainless steel impeller. Buna N type 21 mechanical shaft seal with carbon and ceramic wear faces. O-ring casing seal. Handles liquids from 40º to 180º F (4º to 82º C).

BRONZE UNITS
Pump construction is cast bronze casing and adapter. Stainless steel impeller. Viton type 21 mechanical shaft seal with carbon and ceramic wear faces. O-ring casing seal. Handles liquids from 40º to 200º F (4º to 93º C).

STAINLESS STEEL UNITS
Pump construction is cast 300 series stainless steel casing, adapter, and impeller. Viton type 21 mechanical shaft seal with carbon and ceramic wear faces. O-ring casing seal. Handles liquids from 40º to 200º F (4º to 93º C).

MAINTENANCE

⚠WARNING ***Make certain that the unit is disconnected from the power source before attempting to service or remove any components!***

SHAFT SEAL REPLACEMENT
Refer to Figures 2 and 3.

REMOVAL OF OLD SEAL
IMPORTANT: Always replace both seal seat (Ref. No. 5) and seal head (Ref. No. 6) to insure proper mating of components! Also, impeller seal (Ref. No. 9) should be replaced anytime impeller fastener (Ref. No. 10) has been removed.

1. Remove fasteners (Ref. No. 3) connecting casing (Ref. No. 12) to adapter (Ref. No. 4).
2. Remove casing.

⚠ CAUTION ***Care should be taken not to pinch or "shave" casing seal (Ref. No. 11) between adapter and casing.***

3. Use a box and/or socket wrench to remove impeller fastener. Remove impeller seal and impeller (Ref. No. 8).

NOTE: Motor shaft must be held in place to remove impeller. Back of the motor either has slot in shaft (use large screwdriver to hold) or has 2 flats on motor shaft (use 7/16 open end wrench to hold). Impeller and impeller fastener unscrew CCW when looking at the front of pump.

IMPORTANT: Care should be taken to insure that the same number of thickness of shim washers (Ref. No. 7) are replaced behind the impeller as was removed. Shim washers are located directly behind impeller and become loose as impeller is removed.

4. The seal head can now be pulled from shaft.
5. Pry seal seat from adapter.

INSTALLATION OF NEW SEAL

⚠ CAUTION ***The precision lapped faces on mechanical seal are easily damaged. Handle your repair seal carefully. Do not touch polished seal faces.***

IMPORTANT: Be sure that shaft shoulder does not damage polished face (see figure 2).

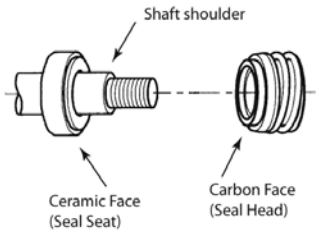


Figure 2

1. Thoroughly clean all surfaces of seal seat cavity in adapter.
2. Using a clean cloth, wipe shaft and shaft sleeve and make certain that they are perfectly clean.
3. Wet the rubber portion of new seal seat with a light coating of soapy water. While wearing clean gloves or using a clean light rag, press seal seat squarely into adapter recess. Use cardboard washer (usually supplied with new seal), place over polished surface and use a piece of pipe or dowel rod to press in firmly but gently. Avoid scratching polished face.
4. Dispose of cardboard washer. Check again to see that polished face is free of dirt and all other foreign particles and that it has not been scratched or damaged.
5. Wet the inside rubber portion of new seal head with a light coating of soapy water. Slide head onto motor shaft with sealing surface facing seal seat (see figure 2).

Note: A short "run in" period may be necessary to provide completely leak-free operation.

6. Screw impeller onto shaft. Use screwdriver slot at rear of motor shaft (opposite the threaded end) to tighten impeller.

NOTE: It may be necessary to remove plug in motor end cap to expose slot. If removed, be sure to reinstall plug AFTER pump is completely assembled.

7. Check if shaft turns freely by spinning impeller. If rubbing or binding is found,

remove impeller and add a shim to shaft, then recheck. Repeat procedure until all rubbing is eliminated.

8. Slide impeller seal onto exposed shaft. Screw acorn nut onto shaft and tighten.
9. Place casing seal on adapter mounting flange. Attach casing using bolts being careful not to pinch or "shave" casing seal. As casing is being tightened, periodically spin impeller to check for interference with casing.

⚠ CAUTION ***Seal will produce minor drag when spinning motor shaft, but rubbing anywhere else must be eliminated! Otherwise, damage to pump and/or motor may occur.***

For Repair Parts, contact dealer where pump was purchased.
Please provide following information:
- Model number
- Serial number (if any)
- Part description and number as shown in parts list

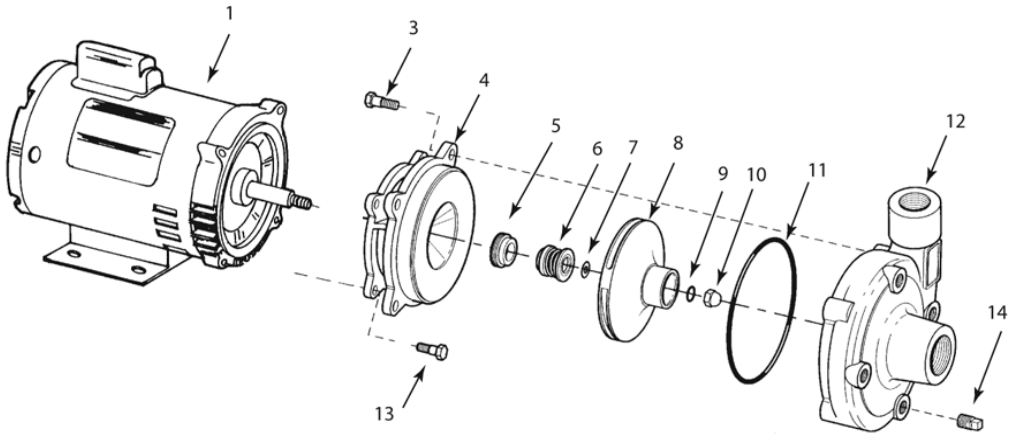


Figure 3 - Repair Parts Illustration

Repair Parts List

Ref. No.	Description	*4893 (½ HP) 4894 (½ HP) 489C (¾ HP) 489D (¾ HP)*	*4895 (¾ HP) 4896 (¾ HP) 489E (1 HP) 489F (1 HP)*	*4890 (1 HP) 4891 (1 HP) 489A (1½ HP) 489B (1½ HP)*	*4902 (1½ HP) 4903 (1½ HP) 490C (2 HP) 490D (2 HP)*	*4904 (2 HP) 4905 (2 HP) 490A (3 HP) 490B (3 HP)*	*4900 (3 HP) 4901 (3 HP) — —*	*Qty.*
1	Motor -1 Ph ODP	1626-009-00	1626-010-00	1626-011-00	1626-012-00	1626-024-00	1626-026-00	1
	Motor -3 Ph ODP	1626-013-00	1626-014-00	1626-015-00	1626-016-00	1626-025-00	1626-027-00	
	Motor -1 Ph TEFC	1626-302-00	1626-303-00	1626-304-00	1626-305-00	1626-306-00	—	
	Motor -3 Ph TEFC	1626-308-00	1626-309-00	1626-310-00	1626-311-00	1626-312-00	—	
3	Fastener	*	*	*	*	*	*	4
4	Adapter -Cast Iron	4890-030-09	4890-030-09	4890-030-09	4900-030-09	4900-030-09	4900-030-09	1
	Adapter -Bronze	4890-030-97	4890-030-97	4890-030-97	4900-030-97	4900-030-97	4900-030-97	
	Adapter -Stainless Steel	4890-031-98	4890-031-98	4890-031-98	4900-030-98	4900-030-98	4900-030-98	
5&6‡	Shaft seal assy -Buna N	1640-161-96	1640-161-96	1640-161-96	1640-161-96	1640-161-96	1640-161-96	1
	Shaft seal assy -Viton	1640-161-97	1640-161-97	1640-161-97	1640-161-97	1640-161-97	1640-161-97	
7	Impeller shim set (0.005", 0.020", 0.030" (1 each)	1806-044-90	1806-044-90	1806-044-90	1806-044-90	1806-044-90	1806-044-90	1
8	Impeller	4894-011-09	4896-011-09	4890-011-01	4903-011-09	4905-011-09	4900-011-01	1
9	Impeller seal -Buna N	2105-036-00	2105-036-00	2105-036-00	2105-036-00	2105-036-00	2105-036-00	1
	Impeller seal -Viton	2105-037-00	2105-037-00	2105-037-00	2105-037-00	2105-037-00	2105-037-00	
10	Impeller fastener	1784-001-00	1784-001-00	1784-001-00	1784-001-00	1784-001-00	1784-001-00	1
11	Casing seal -Buna N	2221-009-00	2221-009-00	2221-009-00	2119-007-00	2119-007-00	2119-007-00	1
	Casing seal -Viton	2221-010-00	2221-010-00	2221-010-00	2119-013-00	2119-013-00	2119-013-00	
12	Casing -Cast Iron	4890-001-09	4890-001-09	4890-001-09	4900-001-09	4900-001-09	4900-001-09	1
	Casing -Bronze	4890-003-09	4890-003-09	4890-003-09	4900-003-09	4900-003-09	4900-003-09	
	Casing -Stainless Steel	4890-002-09	4890-002-09	4890-002-09	4900-002-09	4900-002-09	4900-002-09	
13	Fastener	*	*	*	*	*	*	4
14	3/8" NPT pipe plug	*	*	*	*	*	*	4

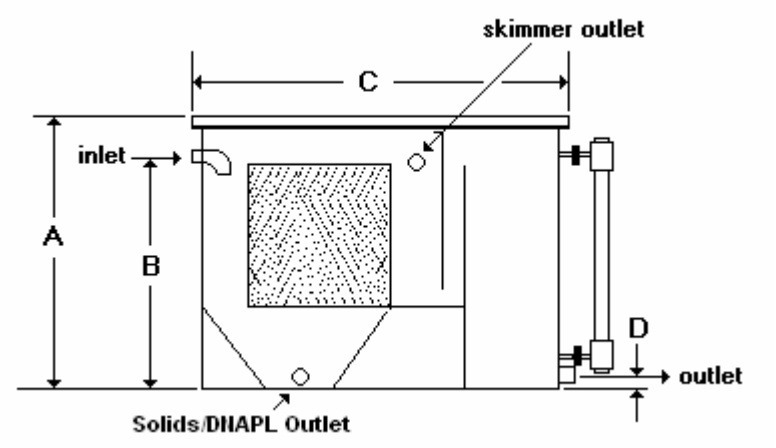
(*) Standard hardware item, available locally
(‡) Seal head and seat available as set only.

LLS Series Liquid/Liquid Separator Operation & Maintenance Manual

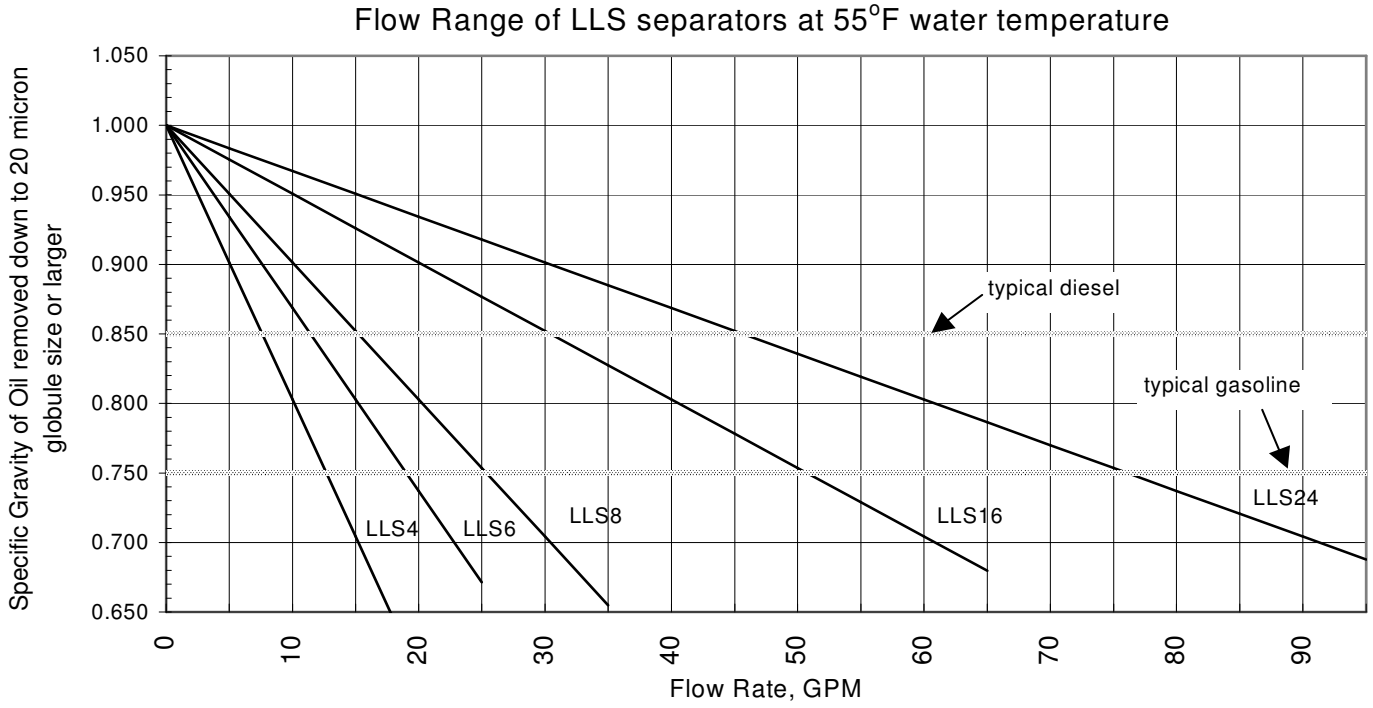
Receiving

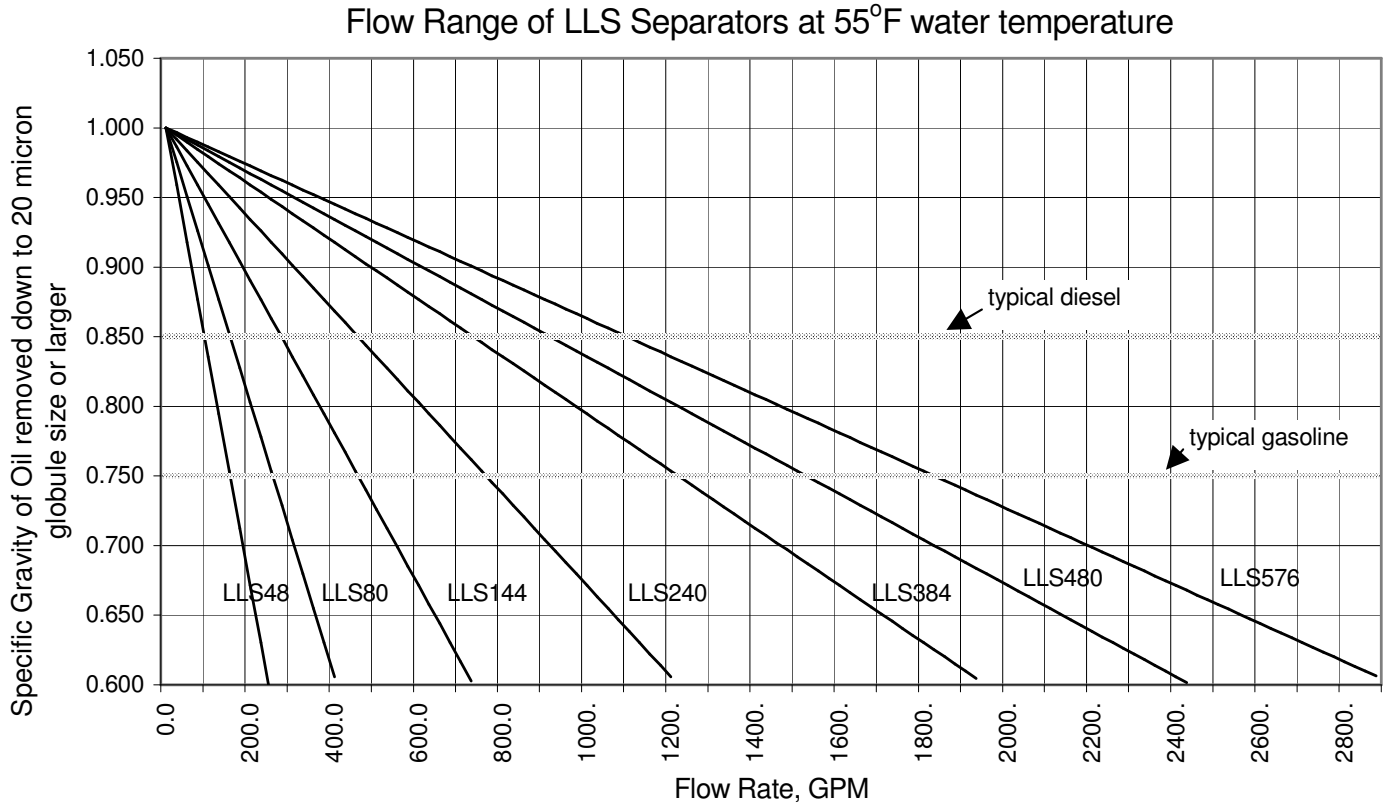
- Always use a properly sized piece of lifting equipment to offload the vessel from the delivery truck. Take care not to damage the system during the offloading and setting into place.
- Carefully inspect system for damage that might have occurred during shipping. Note any damage on the bill of lading before the delivery truck leaves the site.

Features & Specifications



Model Number	Inlet/Outlet Connection	Dim A In.	Dim B In.	Dim C In.	Dim D In.	Dim Width In.	Skimmer Outlet Dia. In.	Media Horizontal Surface Area Ft^2	GPM at 0.75 S.G. oil, 55°F (typical gasoline)	Shipping Weight Lbs.	Operating Weight Lbs.	Clearwell Volume Gallons	Standard Material
LLS4	2" FPT	34	28	60	3	28	2"	192	13	95	976	45	FRP
LLS6	2" FPT	34	28	60	3	40	2"	288	18	135	1,275	45	FRP
LLS8	3" FPT	47	41	60	4	28	2"	384	25	170	1,635	65	Steel
LLS16	3" FPT	47	41	64	4	52	2"	768	50	325	3,432	162	FRP
LLS24	4" FPT	47	41	80	4	52	2"	1152	75	400	4,292	195	FRP
LLS48	6" 150 lb flng	72	66	100	5	52	2"	2304	150	2,100	9,193	271	Steel
LLS80	6" 150 lb flng	72	66	124	5	52	2"	3840	250	2,650	12,134	271	Steel
LLS144	8" 150 lb flng	100	92	133	6	100	4"	6912	450	7,582	42,966	1,716	Steel
LLS240	10" 150 lb flng	100	92	166	6	100	4"	11520	760	9,100	52,125	1,716	Steel
LLS384	10" 150 lb flng	100	92	202	6	100	4"	18432	1200	9,627	57,172	1,716	Steel
LLS480	10" 150 lb flng	100	92	256	6	100	4"	23040	1500	13,057	82,356	2,145	Steel
LLS576	12" 150 lb flng	100	92	292	7	100	6"	27648	1800	14,260	90,000	2,544	Steel


Flow Range of LLS separators at 55°F water temperature
Specific Gravity of Oil removed down to 20 micron globule size or larger
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
typical diesel
typical gasoline
LLS4
LLS6
LLS8
LLS16
LLS24
0
10
20
30
40
50
60
70
80
90
Flow Rate, GPM


Flow Range of LLS Separators at 55°F water temperature
Specific Gravity of Oil removed down to 20 micron globule size or larger
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
0.600
typical diesel
typical gasoline
LLS48
LLS80
LLS144
LLS240
LLS384
LLS480
LLS576
0.0
200.0
400.0
600.0
800.0
1000.
1200.
1400.
1600.
1800.
2000.
2200.
2400.
2600.
2800.
Flow Rate, GPM

Installation

- Set the system in place using the properly sized lifting equipment. Anchor the system in place per the site specifications.
- Level the separator both length wise and width wise.
- Connect the influent and effluent piping to the system.
    - It is recommended to use a flex connector on both the influent and effluent piping connections. The piping connected to the system should be self-supporting.
- Connect the free – product discharge piping to the free product holding tank. The separator tank has two oil disharge ports (one each side of the vessel). One side can be used as the vent port and the other as the product discharge port, or one side can be plugged and a combined vent/product discharge fitting can be used. The product will gravity drain out of the vessel. For proper gravity drain of the product, match the piping size to the oil discharge fitting size until the piping is below the oil discharge piping. Immediately bushing the piping down to a smaller size will leave an area in the skimmer tube that will not drain.
    - For example, if the product fitting is 2", and a combined vent/product discharge fitting is used, first attach a 2" tee to the product discharge fitting. The vent side of the tee should be up and the product discharge side of the tee should point down.
    - If the product fitting is 2" and separate product discharge and vent is chosen, put a 2" 90 degree elbow on both of the product discharge fittings on the vessel.
- Plug or attach a valve to the sludge discharge fitting.

Start-Up Procedure

- Check that all fittings are tight and all necessary valves are open to allow flow through the separator.
- Turn the product skimmer weir so the slot in the pipe is as high up as it will go.
- Begin water flow into the separator.
- Adjust water flow to normal flow conditions. Note: Flow must not exceed the maximum flow rate of the separator.
- Once normal flow is established, turn the skimmer weir so the slot is about ¼" above the water surface. Tighten the compression fittings on the skimmer tube to prevent water from entering the product discharge piping. Note: Changing the normal operating flow rate will require the skimmer to be readjusted.
- Check that the discharge water is properly flowing out of the separator.
- Check for any leaks.

Shut Down Procedure

- Turn off the water supply to the separator.
- If the shut down is for an extended period, it is best to drain the separator and remove any product that might have accumulated in the separator.

Maintenance Procedure

****The list below is a recommend system maintenance list. The individual manufacturers' O&M manuals must be followed in addition to the list below.**

Weekly	Inspect operation	Any signs of leaks or other problems caught early enough can eliminate major problems.
As needed	Clean separator	As needed, depending on water quality. Recommend initial inspection after first month. This might include draining the sludge, washing/replacing the packing, or removing any bacteria growth.
Monthly	Check any controls, switches or interlocks with the SVE system	Finding a faulty instrument can prevent problems if detected.

Trouble Shooting Procedure

Problem	Cause	Task
Water in product discharge line.	Skimmer broken	Replace skimmer
	Compression fittings on skimmer are loose	Tighten compression fittings
	Skimmer rotated too low	Rotate the skimmer so the skimming height is out of the water and only skimming product.
Product in water discharge	Skimmer rotated too high	Rotate the skimmer so the skimming height is ¼" above the water level. Allow ¼" of product to accumulated above the water surface.
	Too much sludge in the sludge chamber.	Too much sludge can cause short circuiting of the packing. Clean out the sludge from the sludge holding area. Clean out packing if needed.
	Packing plugged	Clean packing or replace with new packing.

Options

- Stainless steel construction
- Integral product storage sump with level switch(es)
- Elevation stand for gravity drain
- Sludge pumps
- Flow, pressure, level & temperature gages or transmitters
- Immersion heaters, NEMA 4 or NEMA 7 for freeze protection
- ¼" spaced PVC media for higher removal efficiencies
- Media racks to ease removal of media for cleaning
- R-5 insulation with jacket, (steel or aluminum jacket)
- Product storage drums and tanks, single or double wall, typical UL 142
- Oil reservoir trough for pumping product directly from skimmer with level switch(es)

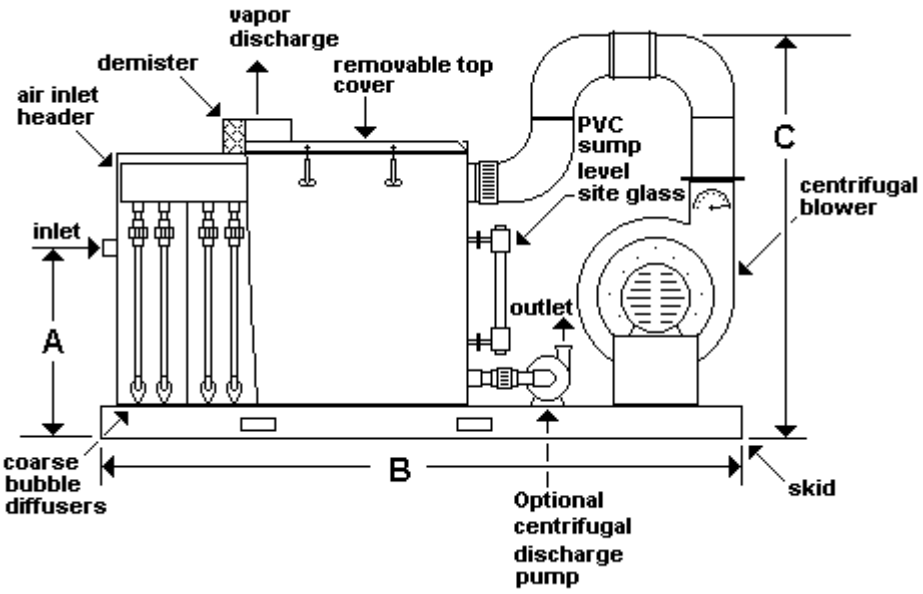
H2K Technologies, Inc., 9851 13th Ave., Plymouth, MN 55441, Tel: 763-746-9900, Fax: 763-746-9903, www.H2Ktech.com

DTA Series Diffused Aeration Tank Stripper
Operation & Maintenance Manual

Receiving

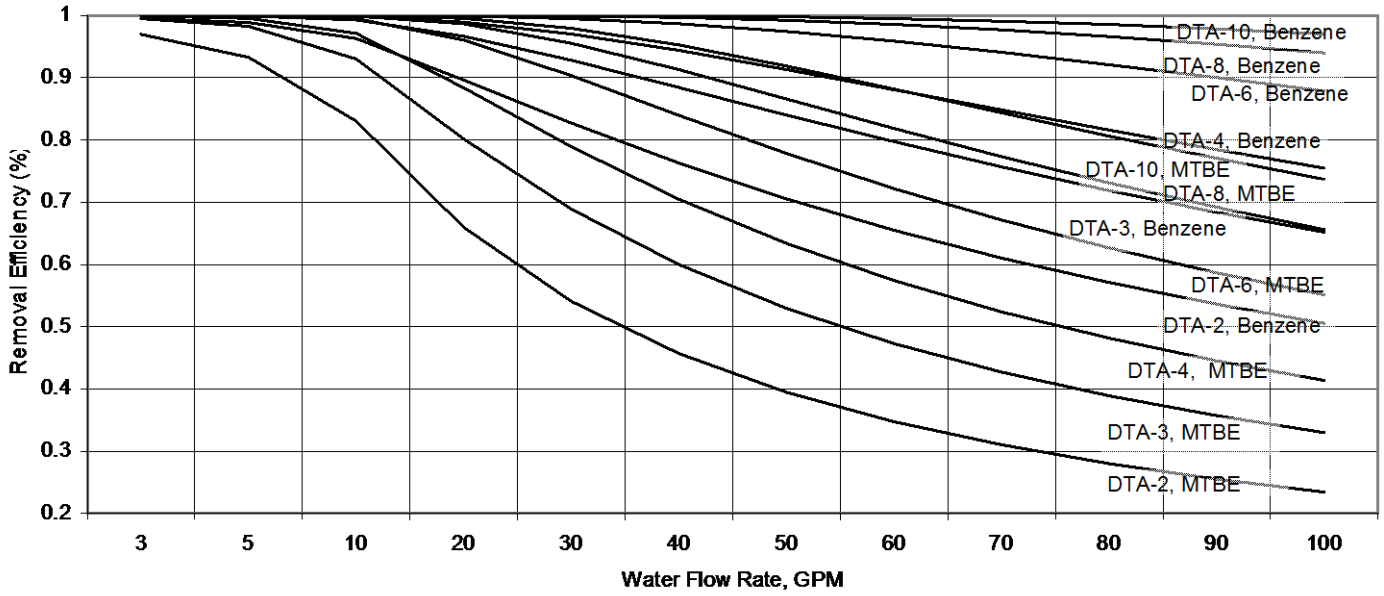
- Always use a properly sized piece of lifting equipment to offload the system from the delivery truck. Take care not to damage the system during the offloading and setting into place.
- Carefully inspect system for damage that might have occurred during shipping. Note any damage on the bill of lading before the delivery truck leaves the site.

Features & Specifications

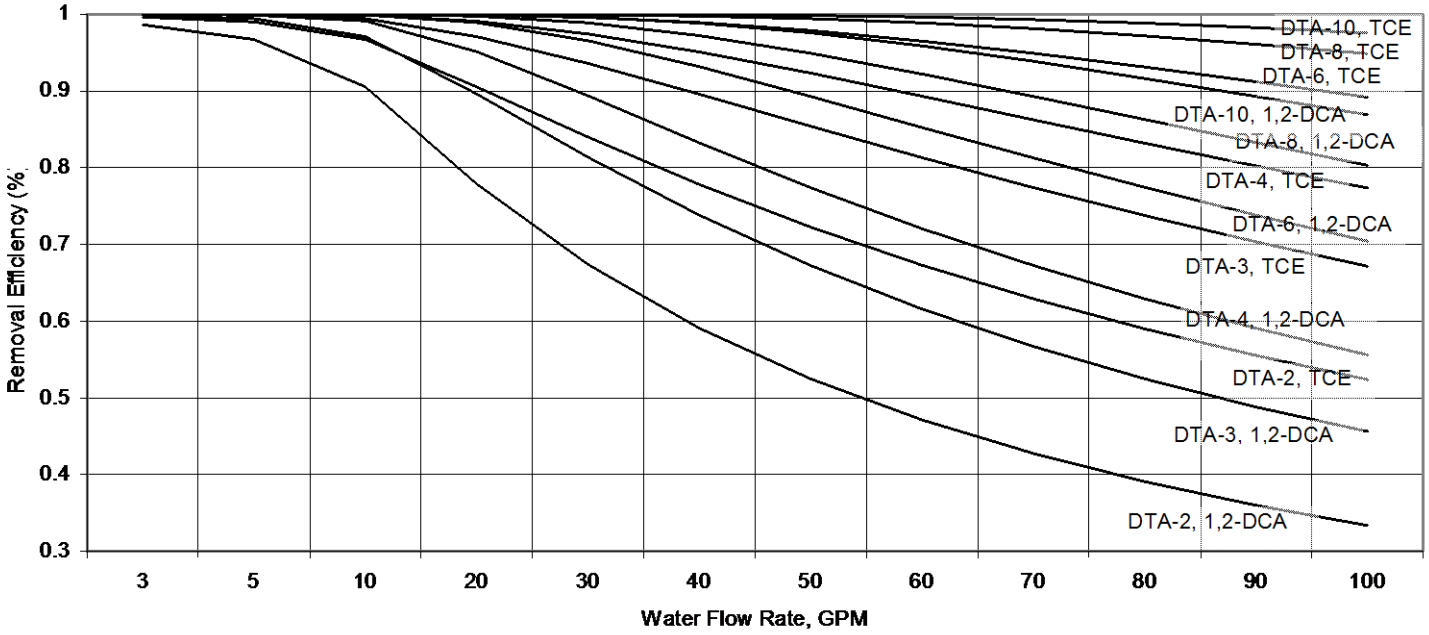


Model Number	Number of aeration chambers	Liquid Flow Range, GPM	Air flow range, SCFM	Dim A Feet	Dim B Feet	Dim C Feet	Dim Width Feet	Inlet/Outlet connection, Standard	Vapor discharge connection, inches	Standard sump holding capacity Gallons	Shipping Weight Lbs.	Operating Weight Lbs.
DTA-2	2	1-80	100-160	2.5	8.5	5.5	3.5	2" FPT	10"	35	1,790	3,200
DTA-3	3	1-80	150-240	2.5	9.5	5.5	3.5	2" FPT	12"	35	2,065	3,940
DTA-4	4	1-80	200-320	2.5	10.5	5.5	3.5	2" FPT	14"	35	2,480	4,820
DTA-6	6	1-80	300-480	2.5	12	6	3.5	2" FPT	16"	35	2,970	6,250
DTA-8	8	1-80	400-640	2.5	14	6.5	3.5	2" FPT	18"	35	3,590	7,800
DTA-10	10	1-80	500-800	2.5	16	7	3.5	2" FPT	22	35	4,090	9,230

Diffused Tank Aerator Removal Efficiency of Benzene & MTBE
at 55oF water temperature, limited to 25% of solubility limit



Diffused Tank Aerator Removal efficiency of TCE & 1,2-DCA
at 55°F water temperature, limited to 25% of solubility limit



Installation

- Set the system in place using the properly sized lifting equipment. Anchor the system in place per the site specifications.
- Connect the influent and effluent piping to the system.
    - It is recommended to use a flex connector on both the influent and effluent piping connections. The piping connected to the system should be self-supporting.

- If the unit is installed inside of a building, it is best to duct the blower inlet piping to the outside of the building especially in areas where there is a risk of freezing the equipment inside the building. The unit requires a large volume of air that a heater might not be able to keep up with inside a building.
- Make all electrical connections to the motors and instrumentation. If H2K Technologies supplied a control panel, a wiring diagram was provided showing where to land the wires in the control panel. The individual manufacturers' O&M manuals will show how to wire the individual pieces of equipment. Check operation of all the instruments prior to the introduction of contaminated water to make sure they function properly.

Start-Up Procedure

- Verify the system is properly secured to the floor.
- Verify that all influent and effluent connection have been made, and open all valves to ensure that there are no restrictions on the blower.
- Verify the power leads are properly wired to the blower motor. **Incorrect voltage or improper wiring will ruin the motor.**
- Bump the blower to verify rotation. Verify proper rotation. There should be suction on the inlet and pressure on the discharge line. If rotation is backwards, have an electrician correct the rotation. **Be sure to lock out and tag the main incoming power. Verify that there is not power at the motor with a multimeter.**
- If a pump was supplied double check the wiring, voltage and check rotation like the steps for the blower.
- Open the lid and inspect the air diffusers. Make sure they are all rotated correctly and sitting in the grooves of the support opposite the quick connect fittings.
- Make sure all of the camlocks are firmly closed.
- If possible, prime the tank with clean water up to the spill over weir. This will help distribute the air at startup when the blower is turned on.
- The DTA system can now be run in normal operation. Start the blower in the auto mode and adjust valving according to the desired operating conditions. The blower damper valve is marked with the normal operating setting and the maximum air flow setting.
- Begin introducing the water supply into the vessel.
- It is best to begin the water flow slowly and ramp up the flow for the initial startup.
- It is best to record the initial readings of the system for trouble shooting purposes later.

Vacuum at blower inlet_____ Pressure at blower discharge _____

Blower motor amp draw _____ Voltage _____

Pump motor amp draw _____ Water Inlet Temp _____

System air flow rate _____ Location of air flow meter _____

System water flow rate _____ Location of water flow meter _____

Shut Down Procedure

- Turn off the water supply
- Allow the blower to run for 5 minutes to treat the water in the tank.
- Turn off the blower
- Allow the discharge pump to pump down based on its level floats if it is ok to discharge the water.
- If the system is to be shut down for a short period of time, the water can stay in the unit. If an extended downtime is required, it is best to drain the unit and clean it out. If the unit is shut down for a long period, bio growth could develop if the water is left in the unit. There are weep holes in the bottom of the overflow weirs. If the tank does not drain down between chambers, the weep holes might have to be unplugged.

Maintenance Procedure

****The list below is a recommended system maintenance list. The individual manufacturers' O&M manuals must be followed in addition to the list below.**

Weekly	Inspect Diffusers	Turn off the air and water supply. Visually inspect the diffusers to make sure they are properly orientated in the bottom of the tank.
	Record system operating conditions	A good record of operating conditions helps monitor the performance of the system and helps to trouble shoot when a problem occurs.
	Check fouling level of the unit	Note the level of fouling of the unit. If air flow or water flow is starting to get obstructed, a cleaning will be required.
	Listen for any unusual noises	
Monthly	Clean DTA Tank	As needed, depending on water quality.
	Check any controls, switches or interlocks with the DTA system	Finding a faulty instrument can prevent problems if detected.
Yearly	Grease motors with NLGI #2	

Trouble Shooting Procedure

Problem	Cause	Task
Motors will not run when the operator turns the switch on "hand" or "auto"	Circuit protection is tripped	Reset overload protection. Try restarting the motor. Since the overload tripped, there might still be a problem in the system. Try to determine what caused the overload to trip. Check the circuit breaker to make sure it isn't tripped.
	Motor temperature switch is open	The motor might have an internal motor temperature switch. Check to see that it was wired to the control panel. If not, it needs to be wired into the logic of the controls. If it was wired, the motor might have gotten too hot. Try restarting the blower and monitor it to see if it opens again. If it does, there is either a problem with the motor or the system causing the motor to overheat.
Motor will run in with the selector switch in "hand", but not "auto"	Alarm condition occurs, or a system enable is not active.	Verify what alarm is active or what system enable is not active. Even if the panel doesn't show there is an alarm, there might be a light bulb burnt out which would normally display the alarm condition.
	Pump down latch not active	If the transfer pump will not run in "auto", verify the pump down latch has been made. Both the low and high level switches need to be raised up to start the pump. The pump should then turn off when both switches are lowered.
Blower does not run at the desired air flow capacity	Demisters are plugging	Clean or replace the demister pads
	Too much vacuum on the inlet	Verify the vacuum level is acceptable with the blower curve. A higher vacuum will decrease the blower air flow.
	Too much back pressure on the discharge	Decrease the backpressure. Verify nothing is obstructing the flow on the discharge. A higher back pressure on the blower will decrease the blower air flow. The blower has a throttle valve on the discharge of the housing. Verify the setting of the damper valve.
Blower seems to have vacuum on the pressure side.	Incorrect blower rotation	Verify and change rotation
Transfer pump will not pump down the clearwell	Influent flow too high	The influent flow has to be less than the discharge flow. Lower the influent flow or increase the discharge flow.

Problem	Cause	Task
	Pump suction piping getting blocked.	Disassemble and inspect the suction piping of the pump.
	Block in discharge piping	Inspect discharge piping and remove blockage.
Gaskets leaking	Latches not tight enough	Tighten latches if they are loose. Do not over tighten to the point where you are deforming the lid. If minor leaks still occur, apply a small amount of silicone grease to the top of the gasket. The grease will help it seal, but will not dry and stick the gasket to the cover.
	Air flow too high	Lower the air flow rate to the acceptable range of the unit
	Water flow too high	Lower the water flow rate
Foaming	Surfactant in water	The surfactants can be present in the ground water or there might have been a trace in the tank or pipes. This might be a temporary issue, or it could be long term depending on the source. A chemical defoaming agent might need to be added to the system and injected whenever they system is operating.

Cleaning Procedure

Supplies required:

- Clean water source
- Power washer – no soap should be used
- Scraper
- Standard tool box of tools
- Shop vac or vacuum system

1. Turn off blower and influent source of water.
2. Allow the discharge pump to pump out of the clearwell.
3. Drain the entire vessel. There are two drain valves. One valve will drain the clearwell, the other will drain the treatment side of the unit.
4. Vacuum the remaining water out of the unit.
5. Release the diffuser camlocks and remove the diffusers.
6. Pressure wash the inside of the unit. Scraping may be required depending on the fouling inside the unit.
7. Vacuum out any sludge/fouling that has been loosened from the unit.
8. Rinse the unit with clean water and vacuum out any remaining sludge.
9. Power wash the diffusers/scrape as necessary.
10. Scrape the diffusers if necessary.
11. Inspect the camlocks to make sure they are in good operating condition. Replace any that show any signs of problems.
12. Reinstall the diffusers into the tank.
13. Prime the tank with clean water again if possible to equalize the pressure when the blower starts.
14. Close the lid and restart the system per the startup procedures.

Note: In some cases, the system might need to be cleaned with acid. If this is required, contact H2K Technologies for further assistance.

Options

- Epoxy painted steel, fiberglass reinforced plastic construction or welded polypropylene construction
- Larger clearwell for more pump down volume
- High flow units up to 300 gpm
- Sound enclosure with urethane sound insulation to reduce sound level 10-15 dBA at 3
- Centrifugal discharge pump & level controls
- Heat trace or immersion heaters for classified or non-classified electrical areas for freeze protection
- Induced draft blower configuration for humidity
- R-5 insulation with jacket, (FRP or aluminum jacket)
- Custom control panel to control blower, pump and other equipment if required
- Process duct heater to lower humidity in off gas vapor before vapor GAC treatment
- Off gas ducting, FRP, PVC, coated or hot dipped galvanized steel construction
- Enclosures or trailer for freeze protection or mobility
- Flow, pressure, level & temperature gages or transmitters

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INSTALLATION
MAINTENANCE
OPERATING
INSTRUCTIONS

IM-140

PRESSURE BLOWERS
TYPE HP PRESSURE BLOWERS

WORD ABOUT SAFETY

Beginning in June 2012, the above **WARNING** signage has been placed on all **nyb** fans, as specified by ISO and recommended by the European Union. Air moving equipment involves electrical wiring, moving parts, sound, and air velocity or pressure which can create safety hazards if the equipment is not properly installed, operated and maintained. To minimize this danger, follow these instructions as well as the additional instructions and warnings on the equipment itself.

All installers, operators and maintenance personnel should study AMCA Publication 410, "Recommended Safety Practices for Air Moving Devices", which is included as part of every shipment. Additional copies can be obtained by writing to New York Blower Company, 7660 Quincy St., Willowbrook, IL 60527.

ELECTRICAL DISCONNECTS

Every motor driven fan should have an independent disconnect switch to isolate the unit from the electrical supply. It should be near the fan and must be capable of being locked by maintenance personnel while servicing the unit, in accordance with OSHA procedures.

MOVING PARTS

All moving parts must have guards to protect personnel. Safety requirements vary, so the number and type of guards needed to meet company, local and OSHA standards must be determined and specified by the user. Never start a fan without having all safety guards installed. Check regularly for damaged or missing guards and do not operate any fan with guards removed. Fans can also become dangerous because of potential “windmilling”, even though all electrical power is disconnected. Always block the rotating assembly before working on any moving parts.

SOUND

Some fans can generate sound that could be hazardous to exposed personnel. It is the responsibility of the system designer and user to determine sound levels of the system, the degree of personnel exposure, and to comply with applicable safety requirements to protect personnel from excessive noise. Consult **nyb** for fan sound power level ratings.

AIR PRESSURE AND SUCTION

In addition to the normal dangers of rotating machinery, fans present another hazard from the suction created at the fan inlet. This suction can draw materials into the fan where they become high velocity projectiles at the outlet. It can also be extremely dangerous to persons in close proximity to the inlet, as the forces involved can overcome the strength of most individuals. Inlets and outlets that are not ducted should be screened to prevent entry and discharge of solid objects.

Danger: Do Not Enter/Confined Space

ACCESS DOORS

The above DANGER decal is placed on all **nyb** cleanout doors. These doors, as well as access doors to the duct system, should never be opened while the fan is in operation. Serious injury could result from the effects of air pressure or suction.

Quick-opening doors must have the door handle bolts securely tightened to prevent accidental or unauthorized opening. Bolted doors must be tightened for the same reason.

RECEIVING AND INSPECTION

The fan and accessories should be inspected on receipt for any shipping damage. Turn the wheel by hand to see that it rotates freely and does not bind. If dampers or shutters are provided, check these accessories for free operation of all moving parts.

F.O.B. factory shipping terms require that the receiver be responsible for inspecting the equipment upon arrival. Note damage or shortages on the Bill of Lading and file any claims for damage or loss in transit. **nyb** will assist the customer as much as possible; however, claims must be originated at the point of delivery.

HANDLING AND STORAGE

Fans should be lifted by the base, mounting supports, or lifting eyes only. Never lift a fan by the wheel, shaft, motor, motor bracket, housing inlet, outlet, or any fan part not designed for lifting. A spreader should always be used to avoid damage.

On a direct drive Arrangement 8 fan, lifting holes are provided in the motor base to assist in handling the fan assembly. These lifting holes should be used in conjunction with the lifting eyes when lifting and positioning the fan onto its foundation. A heavy round steel bar or appropriate fixture can be passed through the lifting holes to simplify attachment of the lifting device. Be sure to follow all local safety codes when moving heavy equipment.

Whenever possible, fans and accessories should be stored in a clean, dry location to prevent rust and corrosion of steel components. If outdoor storage is necessary, protection should be provided. Cover the inlet and outlet to prevent the accumulation of dirt and moisture in the housing. Cover motors with water-proof material. Refer to the bearing section for further storage instructions.

Check shutters for free operation and lubricate moving parts prior to storage. Inspect the stored unit periodically. **Rotate the wheel by hand every two weeks to redistribute grease on internal bearing parts.**

FAN INSTALLATION

nyb wheels are dynamically balanced when fabricated. Complete assembled fans are test run at operating speeds to check the entire assembly for conformance to **nyb** vibration limits. Nevertheless, all units must be adequately supported for smooth operation. **Ductwork or stacks should be independently supported as excess weight may distort the fan housing and cause contact between moving parts.** Where vibration isolators are used, consult the **nyb** certified drawing for proper location and adjustment.

Slab-Mounted Units

A correctly designed and level concrete foundation provides the best means of installing floor-mounted fans. The mass of the base must maintain the fan/driver alignment, absorb normal vibration, and resist lateral loads. The overall dimensions of the concrete base should extend at least six inches beyond the base of the fan. The weight of the slab should be two to three times the weight of the rotating assembly, including the motor. The foundation requires firmly anchored fasteners such as the anchor bolts shown in Figure 1.

Move the fan to the mounting location and lower it over the anchor bolts, leveling the fan with shims around the bolts. Fasten the fan securely. When grout is used, shim the fan at least 3/4-inch from the concrete base. (See Figure 1.) When isolation is used, check the **nyb** certified drawing for installation instructions.

Elevated Units

When an elevated or suspended structural steel platform is used, it must have sufficient bracing to support the unit load and prevent side sway. The platform should be of welded construction to maintain permanent alignment of all members.

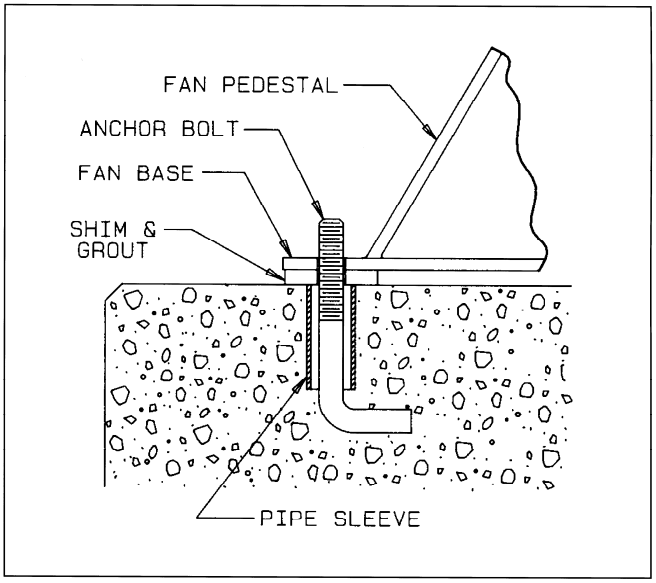


Figure 1

V-BELT DRIVE

Installation

1. Remove all foreign material from the fan and motor shafts. Coat shafts with machine oil for easier mounting. Mount the belt guard backplate at this time if partial installation is required prior to sheave mounting.
2. Mount sheaves on shafts after checking sheave bores and bushings for nicks or burrs. Avoid using force. If resistance is encountered, lightly polish the shaft with emery cloth until the sheave slides on freely. Tighten tapered bushing bolts sequentially so that equal torque is applied to each.
3. Adjust the motor on its base to a position closest to the fan shaft. Install belts by working each one over the sheave grooves until all are in position. Never pry the belts into place. On **nyb** packaged fans, sufficient motor adjustment is provided for easy installation of the proper size belts.
4. Adjust sheaves and the motor shaft angle so that the sheave faces are in the same plane. Check this by placing a straightedge across the faces of the sheaves. Any gap between the edge and sheave faces indicates misalignment. Important: This method is only valid when the width of the surface between the belt edge and the sheave face is the same for both sheaves. When they are not equal, or when using adjustable-pitch sheaves, adjust so that all belts have approximately equal tension. Both shafts should be at right angles to the center belt.

Belt Tensioning

1. Check belt tension with a tensioning gage and adjust using the motor slide base. Excess tension shortens bearing life while insufficient tension shortens belt life, can reduce fan performance and may cause vibration. The lowest allow-able tension is that which prevents slippage under full load. Belts may slip during start-up, but slipping should stop as soon as the fan reaches full speed. For more precise tensioning methods, consult the drive manufacturer's literature.
2. Recheck setscrews, rotate the drive by hand and check for rubbing, then complete the installation of the belt guard.

3. Belts tend to stretch somewhat after installation. Recheck tension after several days of operation. Check sheave alignment as well as setscrew and/or bushing bolt tightness.

COUPLING

Coupling alignment should be checked after installation and prior to start up. Alignment is set at the factory, but shipping, handling, and installation can cause misalignment. Also check for proper coupling lubrication. For details on lubrication and for alignment tolerances on the particular coupling supplied, see the manufacturer's installation and maintenance supplement in the shipping envelope.

Installation

Most **nyb** fans are shipped with the coupling installed. In cases where the drive is assembled after shipping, install the coupling as follows:

1. Remove all foreign material from fan and motor shafts and coat with machine oil for easy mounting of coupling halves.
2. Mount the coupling halves on each shaft, setting the gap between the faces specified by the manufacturer. Avoid using force. If mounting difficulty is encountered, lightly polish the shaft with emery cloth until the halves slide on freely.

Alignment

1. Align the coupling to within the manufacturer's limits for parallel and angular misalignment (see Figure 2). A dial indicator or laser can also be used for alignment where greater precision is desired. Adjustments should be made by moving the motor to change shaft angle, and by the use of foot shims to change motor shaft height. Do not move the fan shaft or bearing.
2. When correctly aligned, install the flexible element and tighten all fasteners in the coupling and motor base. Lubricate the coupling if necessary.
3. Recheck alignment and gap after a short period of operation, and recheck the tightness of all fasteners in the coupling assembly.

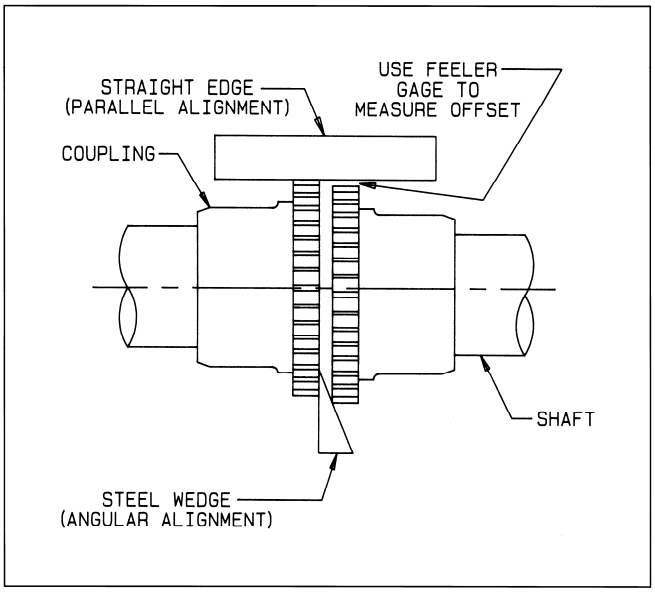


Figure 2

START-UP

Safe operation and maintenance includes the selection and use of appropriate safety accessories for the specific installation. This is the responsibility of the system designer and requires consideration of equipment location and accessibility as well as adjacent components. All safety accessories must be installed properly prior to start-up.

Safe operating speed is a function of system temperature and wheel design. Do not under any circumstances exceed the maximum safe fan speed published in the **nyb** engineering supplement, which is available from your **nyb** field sales representative.

Procedure

1. If the drive components are not supplied by **nyb,** verify with the manufacturer that the starting torque is adequate for the speed and inertia of the fan.
2. Inspect the installation prior to starting the fan. Check for any loose items or debris that could be drawn into the fan or dislodged by the fan discharge. Check the interior of the fan as well. Turn the wheel by hand to check for binding.
3. Check drive installation and belt tension.
4. Check the tightness of all setscrews, nuts and bolts. When furnished, tighten hub setscrews with the wheel oriented so that the setscrew is positioned underneath the shaft.
5. Install all remaining safety devices and guards. Verify that the supply voltage is correct and wire the motor. “Bump” the starter to check for proper wheel rotation.
6. Use extreme caution when testing the fan with ducting disconnected. Apply power and check for unusual sounds or excessive vibration. If either exists, see the section on Common Fan Problems. To avoid motor overload, do not run the fan for more than a few seconds if ductwork is not fully installed. On larger fans, normal operating speed may not be obtained without motor overload unless ductwork is attached. Check for correct fan speed and complete installation. Ductwork and guards must be fully installed for safety.
7. Setscrews should be rechecked after a few minutes, eight hours and two weeks of operation (see Tables 1 & 2 for correct tightening torques).

NOTE: Shut the fan down immediately if there is any sudden increase in fan vibration.

Table 1 - WHEEL SETSCREW TORQUES

Setscrew Size Diameter (in.)	Carbon Steel Setscrew Torque*	
	lb.-in.	lb.-ft.
1/2	600	50
5/8	--	97
3/4	--	168

*** Stainless Steel setscrews are not hardened and should not be tightened to more than 1/2 the values shown.**

Table 2 - BEARING SETSCREW TORQUE, lb.-in.

Setscrew Diameter	Manufacturer				
	Link-Belt	Sealmaster	SKF	McGill	Dodge
1/4	90	65	50	85	--
5/16	185	125	165	165	160

Note: Split pillow block bearings are fixed to the shaft with tapered sleeves and generally do not have setscrews.

FAN MAINTENANCE

nyb fans are manufactured to high standards with quality materials and components. Proper maintenance will ensure a long and trouble-free service life.

Do not attempt any maintenance on a fan unless the electrical supply has been completely disconnected and locked. In many cases, a fan can windmill despite removal of all electrical power. The rotating assembly should be blocked securely before attempting maintenance of any kind.

The key to good fan maintenance is regular and systematic inspection of all fan parts. Inspection frequency is determined by the severity of the application and local conditions. Strict adherence to an inspection schedule is essential.

Regular fan maintenance should include the following:

1. Check the fan wheel for any wear or corrosion, as either can cause catastrophic failures. Check also for the build-up of material which can cause unbalance resulting in vibration, bearing wear and serious safety hazards. Clean or replace the wheel as required.
2. Check the V-belt drive for proper alignment and tension (see section on V-belt drives). If belts are worn, replace them as a set, matched to within manufacturer's tolerances. Lubricate the coupling of direct-drive units and check for alignment (see section on couplings).
3. Lubricate the bearings, but do not over lubricate (see the bearing section for detailed specifications).
4. Ceramic-felt shaft seals require no maintenance, although worn seals should be replaced. When lip-type shaft seals are provided, lubricate them with "NEVER-SEEZ" or other anti-seize compound.
5. During any routine maintenance, all setscrews and bolts should be checked for tightness. See the table for correct torques.
6. When installing a new wheel, the proper wheel-to-inlet clearance must be maintained (see Figure 3).

WARNING: Do not remove or loosen the fan hub from the fan wheel. Removing or loosening the fan hub from the fan wheel will cause imbalance and void the warranty.

WHEEL BALANCE

Airstreams containing particulate or chemicals can cause abrasion or corrosion of the fan parts. This wear is often uneven and can lead to significant wheel unbalance over time. When such wear is discovered, a decision must be made as to whether to rebalance or replace the wheel.

The soundness of all parts should be determined if the original thickness of components is reduced. Be sure there is no hidden structural damage. The airstream components should also be cleaned to remove any build-up of foreign material. Specialized equipment can be used to rebalance a cleaned wheel that is considered structurally sound.

Balance weights should be rigidly attached at a point that will not interfere with the housing nor disrupt airflow. Remember that centrifugal forces can be extremely high at the outer radius of a fan wheel. Welding is the preferred method of balance weight attachment. Be sure to ground the welder directly to the fan wheel. Otherwise, the welding current could pass through the fan bearings and damage them.

WHEEL-INLET CLEARANCE

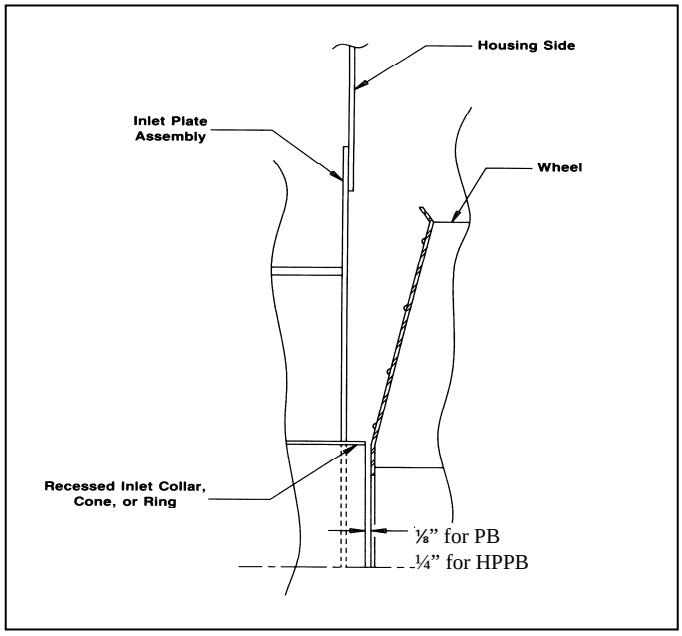


Figure 3

BEARINGS

Storage

Any stored bearing can be damaged by condensation caused by temperature variations. Therefore, **nyb** fan bearings are filled with grease at the factory to exclude air and moisture. Such protection is adequate for shipment and subsequent immediate installation.

For long term or outdoor storage, mounted bearings should be regreased and wrapped with plastic for protection. **Rotate the fan wheel by hand at least every two weeks to redistribute grease on internal bearing parts.** Each month the bearings should be purged with new grease to remove condensation, since even a filled bearing can accumulate moisture. Use caution when purging, as excessive pressure can damage the seals. Rotate the shaft while slowly adding grease.

Operation

Check the setscrew torque before start-up (see table for correct values). Since bearings are completely filled with grease at the factory, they may run at an elevated temperature during initial operation. Surface temperatures may reach 180°F. and grease may bleed from the bearing seals. This is normal and no attempt should be made to replace lost grease. Bearing surface temperatures will decrease when the internal grease quantity reaches a normal operating level. Relubrication should follow the recommended schedule.

Disposal of material should be made in accordance to local government regulations.

Lubrication

Use the table for relubrication scheduling according to operating speed and shaft diameter. Bearings should be lubricated with a premium quality lithium-based grease conforming to NLGI Grade 2. Examples are:

Mobil	-	Mobilgrease XHP	Chevron	-	Amolith #2
Texaco	-	Premium RB	Shell	-	Alvania #2

These greases are for bearing surface temperatures of 40°F. to 180°F. For surface temperatures of 181°F. to 230°F. use Mobilith SHC220.

Do not use “high temperature” greases, as many are not formulated to be compatible with fan bearings.

Add grease to the bearing while running the fan or rotating the shaft by hand. Be sure all guards are in place if lubrication is performed while the fan is operating. Add just enough grease to cause a slight purging at the seals. Except on split pillowblocks. Completely filled bearings will run hotter until a sufficient amount of grease is purged out of the seals.

Split pillowblock bearings (Link-Belt P-LB6800 & P-LB6900, SKF SAF 22500, Dodge SAF-XT) should be cleaned and repacked at approximately every eighth lubrication interval. This requires removal of the bearing cap. Clean out old grease and repack the bearing with fresh grease. Pack the bearing fully and fill the housing reservoir to the bottom of the shaft on both sides of the bearing. Replace the bearing cap, being careful not to mix caps as they are not interchangeable from one bearing to another. **Do not over lubricate.**

BEARING LUBRICATION INTERVAL [months]

RPM / Shaft	1 - 500	501-1000	1001-1500	1501-2000	2001-2500	2501-3000	3001-3500	3501-4000
1 7/16	6 / 6	6 / 4	5-6 / 4	4-6 / 2	4-6 / 2	3-5 / 1	2-4 / 1	2-4 / 1
1 11/16	6 / 6	6 / 4	4-6 / 2	4-6 / 1	2-4 / 1	2-4 / 1	2 / 1/2	1/2 / 1/2
1 15/16			6	4-6	4	2-4	2	--
2 7/16	6	4-6	6	4-6	4	2-4	2	1-2
2 15/16	5-6	4-6	4-6	4-6	2-4	2	1/2	1
3 7/16	4-6	3-5	3-4	2-4	2-4	1-2	1	1

Ball Bearings → ← **Non- Split Pillowblock Spherical Roller Bearings**

NOTE:

1. **These are general recommendations only; specific manufacturer’s recommendations may vary slightly.**
2. **Assumes clean environment, -20°F. to 120°F.**
   a. **Consult The New York Blower Company for operation below -20°F. ambient.**
   b. **Ambient temperatures greater than 120°F. will shorten bearing life.**
   c. **Under extremely dirty conditions, lubricate more frequently.**
3. **Assumes horizontal mounting configuration. For vertically mounted applications, lubricate twice as frequently.**

COMMON FAN PROBLEMS

Excessive Vibration

A common complaint regarding industrial fans is “excessive vibration”. **nyb** is careful to ensure that each unit is precisely balanced prior to shipment; however, there are many other causes of vibration including:

1. Loose mounting bolts, setscrews, bearings or couplings.
2. Misalignment or excessive wear of couplings or bearings.
3. Misaligned or unbalanced motor.
4. Bent shaft due to mishandling or material impact.
5. Accumulation of foreign material on the wheel.
6. Excessive wear or erosion of the wheel.
7. Excessive system pressure or restriction of airflow due to closed dampers.
8. Inadequate structural support, mounting procedures or materials.
9. Externally transmitted vibration.

Inadequate Performance

1. Incorrect testing procedures or calculations.
2. Fan running too slowly.
3. Fan wheel rotating in wrong direction or installed back-wards on shaft.
4. Wheel not properly centered relative to inlet cone.
5. Damaged or incorrectly installed cut off sheet or diverter.
6. Poor system design, closed dampers, air leaks, clogged filters, or coils.
7. Obstructions or sharp elbows near inlets.
8. Sharp deflection of airstream at fan outlet.

Excessive Noise

1. Fan operating near “stall” due to incorrect system design or installation.
2. Vibration originating elsewhere in the system.
3. System resonance or pulsation.
4. Improper location orientation of fan intake and discharge
5. Inadequate or faulty design of supporting structures.
6. Nearby sound reflecting surfaces.
7. Loose accessories or components.
8. Loose drive belts.
9. Worn bearings.

Premature Component Failure

1. Prolonged or major vibration.
2. Inadequate or improper maintenance.
3. Abrasive or corrosive elements in the airstream or surrounding environment.
4. Misalignment or physical damage to rotating components or bearings.
5. Bearing failure from incorrect or contaminated lubricant or grounding through the bearings while arc welding.
6. Excessive fan speed.
7. Extreme ambient or airstream temperatures.
8. Improper belt tension.
9. Improper tightening of wheel setscrews.

REPLACEMENT PARTS

It is recommended that only factory-supplied replacement parts be used. **nyb** fan parts are built to be fully compatible with the original fan, using specific alloys and tolerances. These parts carry a standard **nyb** warranty.

When ordering replacement parts, specify the part name, **nyb** shop and control number, fan size, type, rotation (viewed from drive end), arrangement and bearing size or bore. Most of this information is on the metal nameplate attached to the fan base.

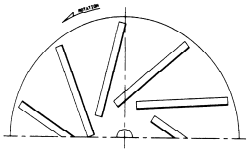
For assistance in selecting replacement parts, contact your local **nyb** representative or visit: http://www.nyb.com.

Example: Part required: Wheel/shaft assembly
Shop/control number: B-10106-100
Fan description: Size 2206A10 Pressure Blower Rotation: Clockwise
Arrangement: 4
Suggested replacement parts include:

Wheel	Component parts: Damper
Shaft [1]	Motor
Bearings*	Coupling*
Shaft Seal*	Sheaves*
	V-Belts*

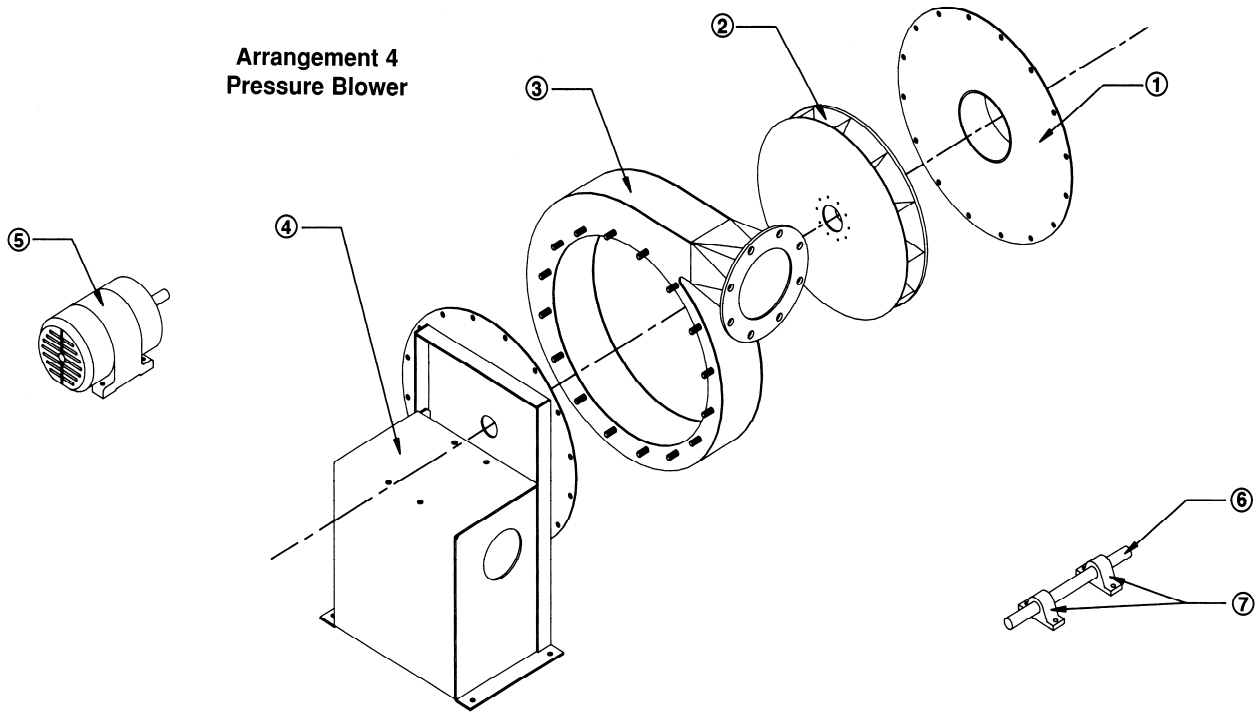
[1] For Arrangement 1/8 fan only.

SPECIFY ROTATION AS VIEWED FROM DRIVE SIDE

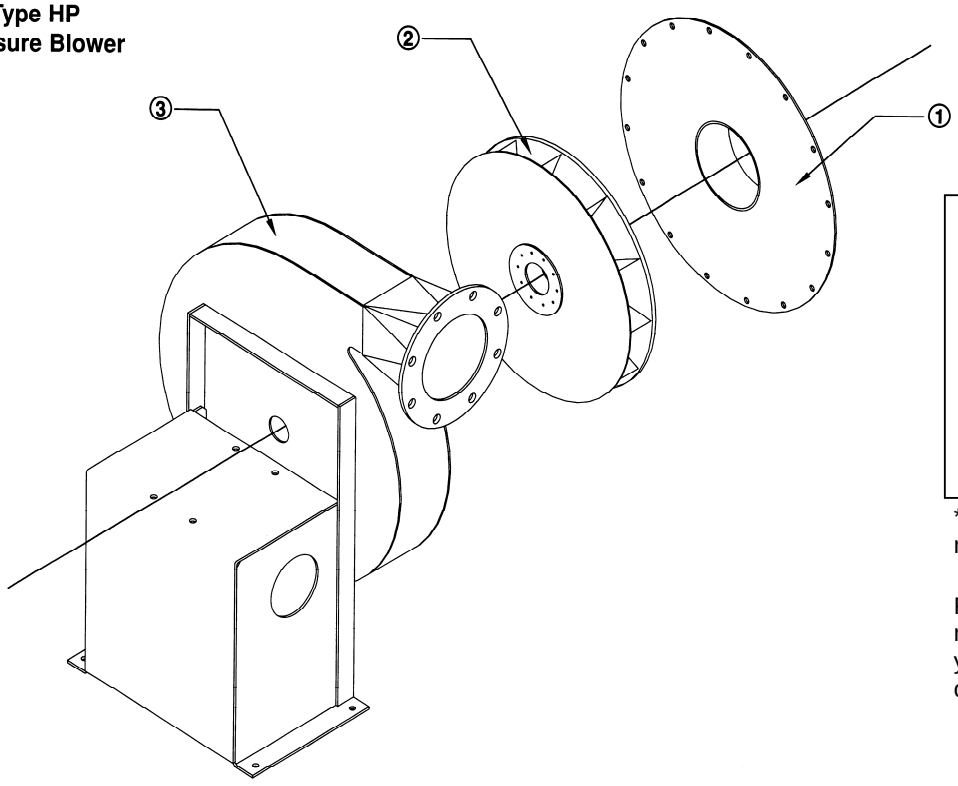


ARROW INDICATES COUNTER CLOCKWISE ROTATION

Arrangement 4
Pressure Blower



Arrangement 4
Type HP
Pressure Blower



Parts List

1. Inlet Plate Assembly
2. Wheel*
3. Housing*
4. Pedestal
5. Assembly Motor
6. Shaft
7. Bearings

* Order for parts must specify rotation.

For assistance in selecting replacement parts, contact your local **nyb** representative or visit: http://www.nyb.com.

ZENNER PERFORMANCE
Multi-Jet Type Magnetic Drive Cold Water Meters

5/8" (DN 15mm)
3/4" (DN 20mm)
1" (DN 25mm)
1 1/2" (DN 40mm)
2" (DN 50mm)

INTRODUCTION: ZENNER PERFORMANCE Multi-jet Water Meters utilize a magnetically driven multi-jet design. They are designed to measure cold potable water where flow is in one direction only in residential, commercial, and industrial settings.

OPERATION: Water flows through the meter's strainer and into the measuring chamber where it drives the impeller. A drive magnet transmits the motion of the impeller to a driven magnet located within the hermetically sealed register. Powerful rare earth magnets eliminate slipping and uncoupling to increase overall accuracy. The magnet is connected to a gear train which translates the impeller's rotation into volume totalization displayed on the register dial face.

CONSTRUCTION: ZENNER PERFORMANCE Multi-jet Water Meters consist of three basic components: main case, measuring chamber and sealed register. The main cases are constructed using either C89833 or C89850 Brass Alloys. Measuring Chambers are constructed of a durable synthetic polymer. Registers are available as either direct read or electronic output.

MAINTENANCE: ZENNER PERFORMANCE Multi-jet Water Meters are engineered and manufactured to provide long-term service and operate virtually maintenance free. The precise simple design allows for interchangeable parts, reducing parts inventory.

REGISTRATION: ZENNER PERFORMANCE Multi-jet Water Meters utilize a magnetically driven, hermetically sealed design. The sealed design eliminates dirt, moisture infiltration, and prevents fogging. The register includes a large odometer-type totalization display, center sweep hand (360°) test circle, low flow leak detector. All ZENNER PERFORMANCE Meters have electronic output capabilities for easy conversion to Automated Meter Reading. 5/8" through 1" capacities are: 10,000,000 Gallons, 1,000,000 Cubic Feet, 100,000 Cubic Meters, 6 odometer wheels. 1 1/2" and 2" registration capacities are: 100,000,000 Gallons, 10,000,000 Cubic Feet, 1,000,000 Cubic Meters, 6 odometer wheels.

CONFORMANCE: ZENNER PERFORMANCE Multi-jet Water Meters are tested and comply with AWWA C708, ISO 4064, and G13IT19001-ISO9000 performance standards.

TAMPERPROOF FEATURES: Customer removal of the register to obtain free water is prevented through the use of a locking device that requires a special tool, only available to water utilities.

CONNECIONS: These meters have been designed with ease of installation in mind through the use of wrench pads. Tailpiece/Unions for installations of meters are available as an option for various pipe types, sizes, and misaligned pipes.

ZENNER PERFORMANCE
15280 Addison Rd #340, Addison, TX 75001, (972) 386-6611, Fax (972) 386-1814
www.zennerusa.com

MODEL		PMN01	PMN02	PMN03	PMN04	PMN05	PMN07	PMN08	PMN09	PMN11	PMN12
SIZE		5/8 x 1/2	5/8 x 3/4	3/4" Short	3/4" x 3/4"	3/4" x 1"	1"	1-1/2" Female Threads	1-1/2" Flanged	2" Female Threads	2" Flanged
High Flow Rate	USGPM	20	20	30	30	30	50	100	100	160	160
Continuous Flow	USGPM	10	10	15	15	15	25	50	50	80	80
Starting Flow	USGPM	3/64	3/64	5/64	5/64	5/64	5/64	1/2	1/2	3/4	3/4
Normal Flow	USGPM	1 - 20	1 - 20	2 - 30	2 - 30	2 - 30	3 - 50	5-100	5-100	8-160	8-160
Low Flow	USGPM	1/4	1/4	1/2	1/2	1/2	3/4	1 1/2	1 1/2	2	2
Extreme High Flow (Intermittent)	USGPM	25	28	32	32	32	60	120	120	180	180
Maximum Working Pressure	P.S.I.	150	150	150	150	150	150	150	150	150	150
Maximum Temperature	Deg. F	122	122	122	122	122	122	122	122	122	122
Length	Inches	7 1/2	7 1/2	7 1/2	9	9	10 3/4	12 5/8	13	15 1/4	17
Length with Couplings	Inches	12 1/2	12 1/2	12 1/2	14 1/2	14 1/2	16 1/2	-	-	-	-
Height	Inches	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	5	7	7	7	7
Weight	Pounds	4.5	4.5	4.5	6	6.3	7	15	20	21	25

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