atec systems associates, inc.

Submittal
and
Operation and Maintenance Manual

FOR

DOCKTON WATER ASSOCIATION

SANDY SHORES WELL

WATER SYSTEM TREATMENT EQUIPMENT

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ATEC SYSTEMS ASSOCIATES, INC.

IRON AND MANGANESE REMOVAL SYSTEM

OPERATIONS AND MAINTENANCE MANUAL







Version 12.11.01c

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Section I
DESCRIPTION OF SYSTEM OPERATION

This section describes the basic system operation for the ATEC high rate iron and manganese removal system.

SYSTEM DESCRIPTION

The ***ATEC Iron and Manganese Removal System*** [1] is an in-line, pressure filter system that uses *ATEC* AS-741M Filter Media[2], a granular manganese dioxide (MnO_2) with a pyrolusite base, as the filtration media. The typical system contains three to twenty filter vessels with common inlet and outlet manifolds.

The media-bed usually consists of a single 36"-to-48" layer of *ATEC Systems* 741M Filter Media. An anthracite cap is not used over the filter media. The use of a mono-media filter bed, combined with the physical properties of the media, simplifies the backwash operation.

ATEC IRON AND MANGANESE REMOVAL PROCESS

Iron and manganese are relatively abundant in the earth's crust and find their way into many ground and surface water supplies. These metals can result in discolored water, growth of autotrophic bacteria called *ctenophores*, increase chlorine demand, tubercle formation and taste and odors in potable water supplies.

Removal Mechanisms

Two of the most commonly used removal mechanisms for iron and manganese removal include:

- Oxidation, precipitation and filtration, and
- Adsorption.

Iron and manganese found in groundwater systems are predominantly found in their reduced forms: ferrous iron (Fe^{2+}) and manganous manganese (Mn^{2+}). Oxidation of these reduced forms results in formation of ferric iron (Fe^{3+}) and manganic manganese (Mn^{4+}) sometimes Mn^{3+} is formed as well.

Adsorption removal mechanisms sorb dissolved iron and manganese onto manganese dioxide and has also been reported to act as an oxidizing contact medium and filtration medium. Adsorption kinetics are much faster than oxidation kinetics. In laboratory tests performed by Knocke (1990) manganese concentrations of up to 1.0 mg/L found most uptake occurred in the top 6 inches of the media. This finding was also repeated in full-scale plants at Durham N.C.

Knocke's (1991) later findings included:

1. The sorption of Mn (II) by MnOx(s)-coated filter media is very rapid. Both sorption kinetics and sorption capacity increase with increasing pH or surface MnOx concentration.
2. In the absence of a filter-applied oxidant, Mn (II) removal is by adsorption alone.
3. When free chlorine is present, the oxide surface is continually regenerated, promoting efficient Mn (II) removal over extended periods of time.

Media used for adsorption includes pyrolusite; the material from which AS-741M Filter Media are derived. To maintain efficient uptake kinetics, a continuous application of chlorine adequate to yield a free chlorine residual in the range of 0.5 to 1.0 mg/L in the product water is provided as a continuous regenerant.

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1 Patent pending.

2 ATEC Systems 721M and 741M Filter Media is certified by NSF to ANSI/NSF Standard 61.

ATEC High-Rate Iron and Manganese Removal

Iron and manganese are removed by adsorbing partially the reduced forms of the compound onto AS-741M filter media.

This process differs from most iron and manganese removal processes in that iron and manganese are purposely ***not precipitated*** during the process. By avoiding precipitation, loading rates of 7 to 16gpm/ft^2 are commonly achieved.

In order to optimize and maintain removal, chlorine is used to maintain the media in a highly oxidized state. Chlorine is introduced into the water supply at the wellhead or other injection point immediately before the water enters the filters at a level adequate to maintain a free chlorine residual in the treated water. If iron or manganese bacteria are present, a free chlorine residual of at least 1.0 mg/L is recommended to control the bacteria. This oxidation of the manganese dioxide media maintains the adsorption capacity and is effectively a continuous regeneration process.

Application Rates

Typical service flow rates (also referred to as application or loading rates) range from 7 to 16gpm/ft^2. These rates vary depending on water quality. The normal interval between backwash cycles is from 12- to -24 hours under most operating conditions. Operating pressure loss through the filter system at flow rates of 15-gpm or less per square foot of filter surface area is less than 3 psig. The system normally overrides the time setting on the backwash controller when the pressure differential exceeds 5 psig.

Refer to the ATEC Systems, Treatment System Summary Table for the application rate information for your specific system. The application rate for your system may be exceeded during backwash, when all of the well's water output is being run through one less filter.

Backwashing to Maintain Removal Characteristics

After a specified period of adsorption, the vessels are backwashed to remove the adsorbed iron and manganese from the media. In the event that water quality adversely changes, the media will be backwashed when the pressure differential exceeds 5 psig. Backwash is normally performed with filtered system water but the system can be set up to backwash with water from an external source if necessary or desired. Unless required by the specific characteristics of a particular installation, the system remains on-line during backwash. The controller can interface with the customer's SCADA system if desired.

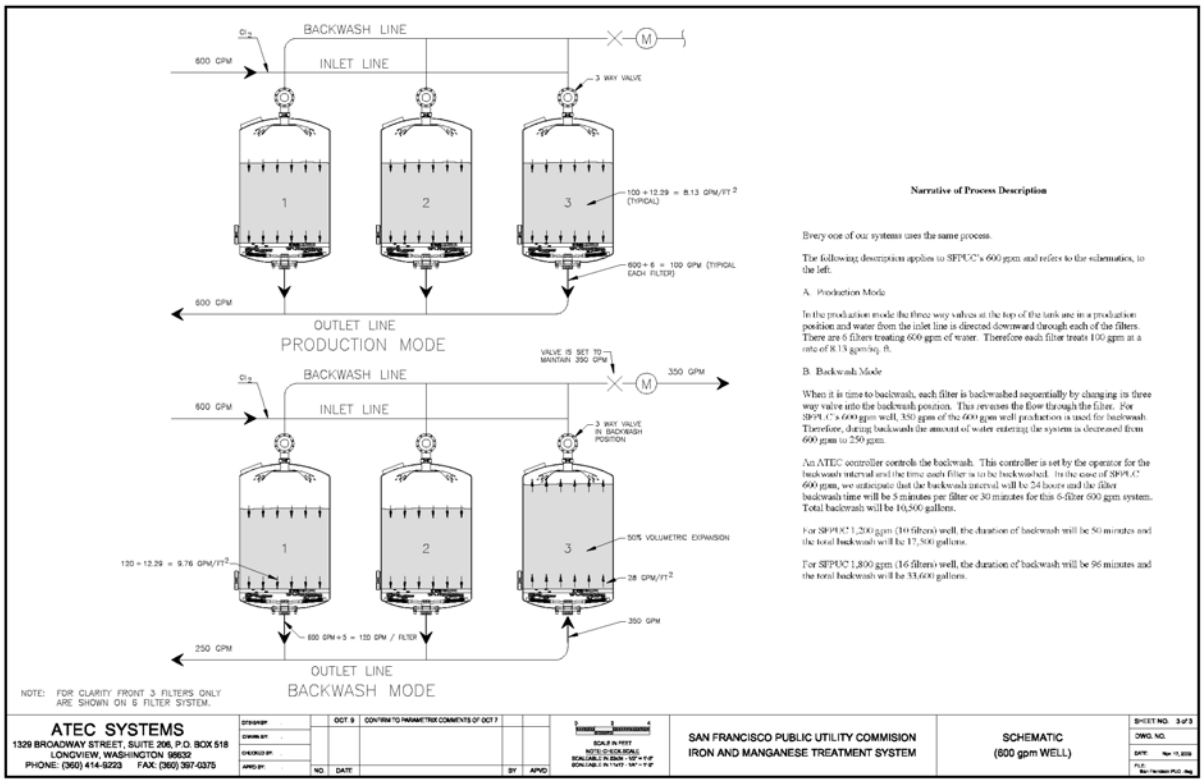
As mentioned above, much of the adsorption takes place in the top of the filter media bed. It follows that it is easier and more efficient to backwash the media before the iron and manganese that is being removed from the source water penetrates to the lowest sections of the media bed. For this reason, we recommend backwashing at least once every twenty-four hours of production and preferably every twelve hours, particularly at the outset. Refer to the ATEC Systems, Treatment System Summary Table for the backwash rate and duration for your specific system.

Proper backwashing is a critical and controllable variable in the treatment process and merits significant operator attention. In excess of 98% of the calls *ATEC Systems* receive from customers having problems with removal, whether it be iron and manganese or particulate matter, are ultimately found to be related to improper backwash operations.

HOW ATEC FILTERS BACKWASH

The *ATEC Iron and Manganese Removal System* contains multiple vessels. The backwash controller operates only one backwash valve at a time. This design normally allows for the vessels to be backwashed with finished water, without the need for an extra source of backwash water from a storage tank and without the need for special backwash pumps. The illustration below shows how the filters operate under normal conditions and while backwashing.

Figure 1
FILTER BACKWASH OPERATION



Backwash Variables

Proper backwashing is one of the single most important variables in maintaining successful long-term system operation. There are three important components to backwashing including: (1) backwash frequency; (2) backwash flow or volume; and, (3) backwash duration.

Backwash Frequency

If the filter system is not backwashed often enough (frequency), the product water quality will be adversely affected by the presence of unwanted contaminants in the product water and, over time, the media bed will become progressively more contaminated. Ultimately contaminants will be driven deep into the media bed and become increasingly more difficult to remove.

Backwash Flow Rate

To successfully clean the media bed, it must be expanded until it is fluidized, allowing the contaminants to be removed with the backwash. If the backwash flow rate is too low, the media bed will not fluidize. If the backwash flow rate is excessively high, the filter bed will expand to the point that media will be expelled with the backwash effluent. Neither condition is acceptable.

Generally speaking, AS-741M Filter Media will fluidize at about 26 gpm/ft^2 and at a rate of 28-gpm/ft^2 will have expanded on the order of 50%. This rate is approximately twice that required to fluidize most media. There are two primary reasons for this high backwash flow rate requirement: (1) AS-741M is much heavier than most other media, having an apparent specific gravity of 1.96 and a real specific gravity of some 3.7; and, (2) AS-741M Filter Media is much larger than much media. The combination of weight and size results in the need for higher flow rates to fluidize the media. One benefit of these two factors is that the flow rate is high enough to effectively shear the bond between the media and the iron and manganese that have been removed from the source water, allowing it to be rapidly backwashed to waste without the need for air-scour or other backwash aids

Duration of Backwash

If each filter vessel backwash cycle does not continue for long enough (duration), insufficient time will have passed to allow the media bed to fully expand and the contaminants to be flushed out, cleaning the media bed. Properly setting and maintaining this backwash function will help assure successful filter operation over the life cycle of a filter system.

Time/Pressure Differential Backup

The backwash operation is activated by a controller that is located either on the filter vessel legs or pre-mounted on polyboard for remote installation. The controller initiates backwash by one of four methods:

- A Timer that is integrated into the controller
- Manually initiated by the operator
- A Pressure Differential switch that is integrated into the controller, or
- Externally through a SCADA system

The controller is designed to normally backwash by initiation of the timer located on the controller or via remote initiation by the SCADA system. The timer can be adjusted by the operator. The controller has four dials that control the backwash:

- The ***Periodic Flush*** dial sets the backwash interval in hours.
- The ***Backwash Time*** top dial sets the backwash time for an individual vessels in minutes
- The ***Backwash Time*** bottom dial sets the backwash time for an individual vessel in seconds
- The ***Dwell Time*** dial sets the time between backwashing individual vessels.

Refer to the ATEC Systems, Treatment System Summary Table for the initial settings information for your specific system. The typical initial settings for most systems are shown in the Table below:

Dial	Initial Setting
Periodic Flush	12 hours
Backwash Time (Upper)	4 minutes
Backwash Time (Lower)	30 seconds
Dwell	5 seconds

Figure 2
CONTROLLER

The backwash controller keeps track of time only when power is available to the controller. Normally, the controller is powered by a "switched" circuit that is energized only while the well pump is operating.

As a backup measure, the controller will also automatically backwash when the pressure differential switch is activated by exceeding a pre-determined level. The pressure differential switch can be adjusted. The pressure differential is normally set to 5 to 8 psig. A time delay, to avoid initiation of a pressure differential induced backwash, can be set from 0-to-180 seconds—it is recommended that the time delay be set for at least 180 seconds to avoid initiation of a PD backwash as the result of a transient PD condition. To adjust the pressure differential activation pressure, manually turn the knob on the switch until the silver indicator points towards the desired pressure.

In the event of a power failure, the backwash controller has the ability to resume a backwash cycle at the station that was backwashing at the time of the power failure. When the solenoids are without power, the backwash control valve on each vessel remains in the normal (or filter) operating position.

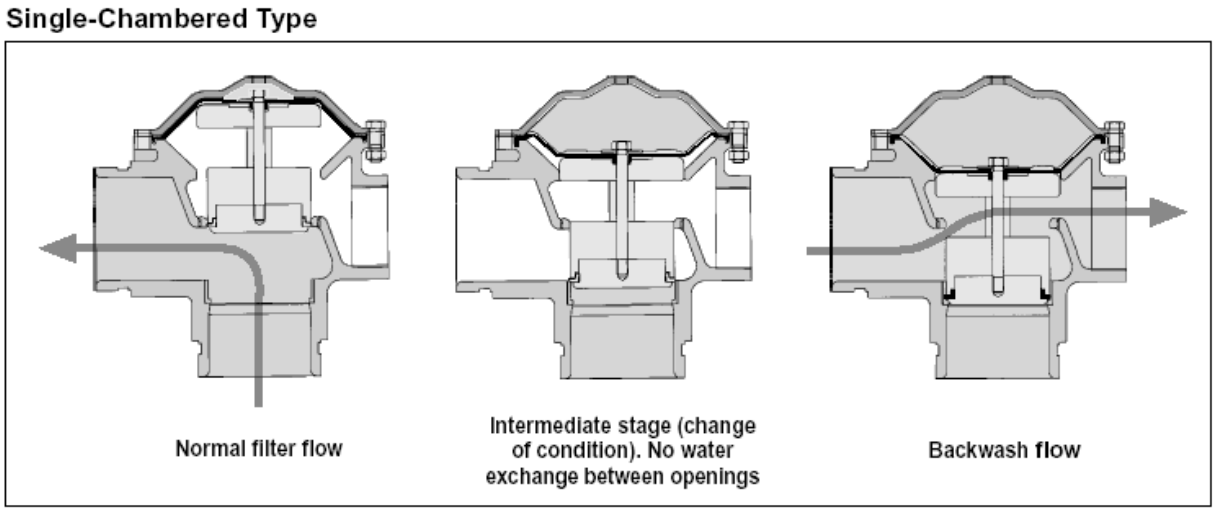
Backwash Sequence

When a backwash cycle is indicated, the controller energizes the solenoid valve operating the first backwash valve, initiating the backwash cycle. The first filter vessel is backwashed for the time specified after which the first solenoid valve is de-energized, returning vessel number 1 to normal operation. The process is repeated with vessel number 2 and so on, until all of the filters have been backwashed.

Backwash Valve

A drawing of a typical backwash valve in normal operating mode, in backwash mode, and in an intermediate stage is shown in figure 3. As you can see, the valve is a three-way valve. In normal mode the water supply is directed into the filter and the backwash port is closed. During backwash, the water supply is closed and the backwash port is opened. Because water follows the course of least resistance, flow is reversed in the filter being backwashed and the backwash effluent is discharged to atmosphere. To properly backwash, the filters require at least 30 psi to system. If this is not available, one may need to consider installing a (normally open, or) pressure sustaining valve to obtain the necessary pressure to insure proper backwash flow.

Figure 3
FILTER BACKWASH VALVE
Bermad Series 350, 4X4X3 Single Chamber Backwash Valve



Integration with SCADA system

The system can be externally monitored, or the backwash can be externally activated through a Supervisory Control and Data Acquisition (SCADA) system. An internal alarm from the controller can be monitored by attaching a relay to the alarm output on the controller.

To initiate backwashing from a SCADA system, a relay is used to initiate the backwash by bypassing the periodic flush timer on the controller. The SCADA system can then initiate backwash based on time or on flow. This is achieved by completing an electrical circuit wired to the back of the manual backwash initiation button. (This is a momentary closed dry contact circuit.)

SPECIAL REQUIREMENTS

This section covers some special design considerations including supplementing backwash flow, using special valves and providing adequate backpressure.

Supplementing Backwash Water Supply

Supplementing backwash water flow can normally be avoided by proper design and selection of the correct ATEC System for your installation. However, in some cases supplemental backwash flow is needed for a particular installation. In these cases, a separate backwash pump can be installed or the system can be backwashed with treated water from the distribution system.

Use of Normally Open / Normally Closed Solenoid Operated Valves in Backwash

One method of ensuring adequate backwash in some special cases is to place a normally opened valve on the finished water discharge manifold of the system that closes during backwashing to ensure that all of the water treated by the *ATEC Iron and Manganese Removal System* is available for backwashing. The normally opened valve can be actuated by attaching a relay to the master control output on the backwash control panel.

In some cases a normally closed valve will be included in the design. The normally closed valve may be connected to the discharge side of a distribution booster pump or some other source of water supply. When backwashing occurs, the normally closed valve opens and additional water supply is available for backwashing. This is typically controlled by an electrically actuated solenoid valve.

Pressure Sustaining Valves (Backpressure Valves)

Pressure sustaining valves are often used under one or a combination of more than one of three different conditions: (1) where there is not adequate backpressure to smoothly operate the backwash valves; (2) where there is low pressure and marginal supply to sustain full backwash flow is made available to the vessels as discussed above; or, (3) when the filters are located above a clear well or other storage facility to prevent the filters from draining when the are not operating.

Air Actuated Backwash Valves

The backwash valves are set-up to change position using air (pneumatic) actuated valves by connecting a ¼" line from the air compressor. The air supply line should typically be set, via the air compressor's regulator, at between 2 and 5 psi above the backpressure maintained by the system or pressure sustaining valve, but no more than is absolutely necessary to fully actuate the backwash valves within approximately 8 – 12 seconds. Activating the backwash valves with excessive pressure can damage the valves, causing them to not seal properly.

Section II
OPERATING THE ATEC IRON AND MANGANESE REMOVAL SYSTEM

OPERATING THE ATEC IRON AND MANGANESE REMOVAL SYSTEM

The operation of the ATEC Iron and Manganese Removal System is relatively simple. There are, however, several variables that need to be monitored and settings that need to be closely followed. The most important of these are summarized below:

- **Application Rates**

  The application rate (hydraulic loading rate) for this project may be found in the ATEC Systems, Treatment System Summary Table. This rate should not be exceeded except during system backwash when it will normally increase because the system is filtering with one less vessel.

- **Setting Chlorine Level in Product Water**

  Sodium hypochlorite should be dosed to yield a minimum recommended free chlorine residual of 0.5 mg/L in the product water for most systems, and 0.6 mg/L with systems containing ammonia or hydrogen sulfide. This should be regularly monitored at least on a weekly, and, preferably, on a daily basis. The chlorine residual should be maintained within 0.1 mg/L of this recommended level.

- **Setting Backwash Parameters**

  The backwash frequency and duration will be initially set by *ATEC Systems* during start-up. The backwash frequency will normally range from 12 to 24 hours. The backwash duration will normally range from 4.0 to 5.0 minutes per vessel. The typical recommended starting backwash frequency is once every 12 hours with duration of 4.5 minutes per vessel.

- **Monitor Pressure Loss**

  A typical *ATEC Iron and Manganese Removal System* will operate with a head-loss, or pressure differential between the water supply and discharge of about 2-psig. It is good practice to regularly monitor head-loss because it can be both a predictor and an indicator of filter condition. If the pressure loss exceeds 5-psig on a regular basis, the filter bed is fouled and should be checked immediately.

Sample Ports and Water Quality Testing

Sample ports for raw and finished water are provided on most systems. Please refer to the system design drawings for the location of the sample ports. During the first few months of operation, it is good practice to regularly test system performance daily paying particularly close attention to chlorine residual and manganese and iron removal. After the system operators have developed a familiarity with the system, iron and manganese monitoring can be reduced to a weekly or twice weekly routine. Chlorine should be monitored daily.

---DO NOT FORGET---

- **PROPER CHLORINATION IS CRITICAL TO THE SUCCESSFUL LONG-TERM OPERATION OF YOUR ATEC IRON AND MANGANESE REMOVAL SYSTEM**
- **CORRECT BACKWASH OPERATION IS CRITICAL TO THE SUCCESSFUL LONG-TERM OPERATION OF YOUR ATEC IRON AND MANGANESE REMOVAL SYSTEM**

SHUT DOWN PROCEDURE

The filters can be shut down and kept off-line for prolonged periods. The media can be kept either wet or dry. The normal procedure is to simply take the well pump off line. Assuming that the source water is adequately chlorinated, there should be no other action required to shut down. No special actions are required if the filters are to be drained, for example when shutting down a treatment system located outside, to prevent freezing in the winter months.

START-UP AFTER PROLONGED PERIOD OUT-OF-SERVICE

To start-up the filters after draining or more than 1 month off-line, use the following procedures.

1. If the filter vessels were drained, fill the vessels with water slowly; follow the start-up procedure to eliminate air from the vessels.
2. Filter to waste for at least one hour, providing the required chlorine dose and residual.

or

1. Add one quart (32 fluid ounces) of 6% sodium hypochlorite to each tank, fill the vessels with water and hold for 6 hours.
2. Backwash the system two times in immediate succession.
3. Check chlorine residual.
4. Place on-line.

These procedures are derived from and intended to meet AWWA Standard C653-03, (latest revision), Disinfection of Water Treatment Plants.

MAINTENANCE

Certain maintenance procedures must be observed for proper filter operation. The procedures discussed below should be implemented with the initial operation of the filters and on a regular basis thereafter. The following maintenance should be used as a guide rather than as a comprehensive list of every maintenance item that might require attention.

Controller

- The controller needs to be kept dry. If it is properly installed at the outset, the controller circuit board will provide reliable service for a long time. If it is damaged by a power surge, struck by lightning, is submerged, or similarly damaged, the repair is to replace the circuit board and wiring. Other than replacing a pressure differential switch, fuse or making sure that all circuits are properly terminated, there is no on-going maintenance for this component.

Backwash Control Valves

- Backwash control valves normally require very little maintenance. The recommended practice for Iron and Manganese Removal System installations is to rebuild or exchange the valves on a five-year cycle. In case of emergency repairs or replacement, backwash control valves are always maintained in inventory and can be shipped for next day arrival.

Solenoid Valves

- Peter-Paul Model 73 3-Way Solenoid Valves are used to control the air that actuates the 3-Way Backwash Control Valves. Parts are available to rebuild the solenoid valves or the valves can be sent to *ATEC Systems* for rebuilding. The maintenance and cleaning procedures for the solenoid valves are shown in the manufacturer's materials provided.

Backwash Restrictor Valves

- Fully open and close the backwash restrictor valve on an annual basis. Remember to reset the backwash restrictor valve to allow the required backwash flow after exercising.

Lines and Valves

- Inspect all line and valve connections for tightness and leaks. If leaks are observed, tighten coupling. If this does not stop the leak, remove the coupling and inspect the gasket. If the gasket is worn or damaged, replace. When installing a gasket, it should be coated with a light lubricant.

Control Tubing

- Inspect all pneumatic or hydraulic tubing for leaks and restrictions or damage. If tubing is crimped or damaged, it should be replaced.

Sight Glass

- Many ATEC Iron and Manganese Removal Systems are shipped with a cast brass and acrylic sight glass to allow for easy observation of the backwash discharge. Overtime, this will discolor. The easiest way to clean the site tube is to remove it and soak it for fifteen minutes in a 5% solution of ascorbic acid and then wipe it clean with a soft cloth. Replacement sight glasses are available.

Media and Checking Media Levels

- It is recommended that the media level in all filters be checked and recorded approximately once each six months. If the media is below the recommended level for your system, enough of the appropriate media should be added to bring the level back to the recommended media bed depth. The recommended media depth should be maintained. The easiest way to maintain the appropriate depth is to open the access hatch (on the depressurized vessels) on the top head and measure and record the distance from a fixed point on the access port to the top of the media at initial system start-up and at regular intervals thereafter. The media should be maintained within $\pm$ 1 inch of the initial media depth.

Paint

- Water Treatment Plants are typically corrosive environments. It is, therefore, important that any rust be removed and paint be regularly touched up to protect the filter vessels and manifolds as well as other metal components in the facility. Touch-up paint kits are available from *ATEC Systems* or, if you prefer, paint can be ordered directly from Cardinal Industrial Finishes. The color and number is included in to the ATEC Systems, Treatment System Summary Table.

TROUBLE SHOOTING

The ***ATEC Iron and Manganese Removal System*** is designed to provide years of trouble free service if you follow the installation and maintenance procedures outlined above. Nonetheless, from time to time, problems may occur as the result of power surges, lightning, unexpected changes in water conditions, failure to follow operating, particularly chlorination and backwash, and maintenance procedures outlined above or for a variety of other reasons. The *Trouble Shooting Guide* (on the following page) is designed to help you identify, trace and resolve the more common problems that have been reported to us over the years. Please review your problem and the *Trouble Shooting Guide* carefully before seeking outside help. Usually your filter system will be back in operation much more quickly if you follow the steps outlined in the *Trouble Shooting Guide* and the rest of this manual before you call for assistance. That said; do not hesitate to call for help at any time. The earlier problems are identified and resolved, the less potential there is for service interruption.

Troubleshooting Guide

Probable Cause	Solution
Poor Iron and Manganese Removal? 1. Improper chlorine dose 2. Insufficient backwash flow or frequency 3. Inadequate media volume	1. Check chlorine residual; consider increasing it to 1.0 mg/L. 2. Check restrictor valves. Backwash more often. 3. Add media to reach proper level or volume. This problem may be caused by excessive backwash flow rate. (See Backwash Flow Control)
Consistently High Pressure Differential? 1. Excessive contaminant load restricts flow through filters and prevents sufficient flow to properly backwash filters. 2. Insufficient backwash flow. 3. Sand in media bed.	1. Drain tanks, remove hand-hole access covers and remove any excessive or caked contaminants on the media bed surface. Add media to proper level. 2. Adjust backwash control valve to allow for increased backwash flow. 3. Sample raw water for sand content.
Backwash Valves Leak? 1. Obstruction in valve seat. 2. Rubber poppet is worn or damaged 3. Diaphragm is damaged (leaking from bleed port of diaphragm chamber at rear of valve.	1. Remove obstruction. 2. Replace rubber poppet. 3. Replace diaphragm. Install pressure regulator is necessary to control problem.
Water Hammer? 1. Long backwash line causing vacuum. 2. Air in tanks.	1. Install vacuum breaker on backwash line. 2. Bleed off trapped air. Check for leaks in pump suction. Air bleed off valve may help.
Increasing Frequency of Backwash Cycle? 1. Duration of backwash or flow is inadequate to flush filter bed of contaminants. 2. Insufficient media volume. 3. Increased levels of contaminants in water supply. (Possibly seasonal problem.)	1. Readjust backwash flow. 2. Add media to achieve proper level. Check backwash flow. 3. Install Additional filter tank(s) to system.
Automatic Backwash Fails to Cycle? 1. Controller power off or circuit breaker tripped. 2. Improper setting of pressure differential switch. 3. Insufficient system pressure to actuate valves. 4. Solenoid(s) malfunctioning.	1. Turn power on. Assure that wiring is properly connected. Re-set circuit breaker. 2. Adjust as required. 3. Check system for pressure leaks (break in irrigation line, cracked pressure control tubing, etc). 4. Check connections. Clean parts. Check filter screen on high pressure control line for damaged screen and replace if necessary.
Decreasing iron or manganese removal? 1. Improper backwashing 2. Improper chlorine residual 3. Change in raw water quality	1. Check backwashing rate, frequency and duration. Make sure all valves are operating. 2. Check chlorine residual on a daily basis. 3. Check raw water iron and manganese concentrations
Steadily increasing head-loss? 1. Sand in raw water 2. Improper backwashing	1. Check raw water for sand content. 2. Check backwashing rate, frequency and duration.

EQUIPMENT FOR ON-SITE ANALYSIS OF WATER QUALITY AND RELATED PARAMETERS

If it is not already a part of the system's operating procedures, we recommend that every water system that includes an iron and manganese removal system have the capability to analyze key water quality parameters. These include tests for iron and manganese, hydrogen sulfide (if present) and free and total chlorine. A variety of colorimeter and spectrophotometer based analytical tools are available for analyzing these variables as well as many others.

If pH adjustment is a part of your system's treatment, a good quality pH meter should be included as part of your treatment equipment.

If you purchase or generate sodium hypochlorite, it is recommended that you have the tools on hand to analyze the strength of the sodium hypochlorite solution. This ability will help the system operator accurately monitor chlorine dosing levels as well as the strength of the sodium hypochlorite solution you are purchasing. The strength of sodium hypochlorite solutions can be determined by titration or by the use of a hydrometer. Either tool will work; the best tool for your site will depend on your specific circumstances and needs. *ATEC Systems* normally suggests the use of a digital titrator which can also be used for a number of other purposes.

If you have any questions about analytical equipment, your consulting engineer is often a good source of information and suggestions as to what type of equipment you might wish to consider.

REPAIR PARTS

Generally, we are able to ship repair parts the same day ***if*** they are ordered by noon (PST). Because of this level of service, most of our customers do not maintain extensive repair parts inventory. If, however, your circumstances warrant the maintenance of a repair parts inventory, the following is a list that some of our customers have found helpful:

A. Controller Board (1 each)
B. Control Valve (1 each)
C. Control Valve Rebuild Kits (1 each)
D. Solenoid Valve (2 each)
E. ¼" OD Tubing, High Pressure (50')
F. Fittings for Tubing (*Prestolok*)
   (6 each, tees and 90° elbows)
G. Pressure Gauges (1 each)

These parts can be ordered from:

ATEC Systems Associates, Inc.
P. O. Box 10329
Seattle, Washington 98110-0329
Telephone: 360-414-9223
Facsimile: 360-397-0375

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atec systems associates, inc.

APPENDIX A

SPECIFICATIONS AND DRAWINGS

ATEC BACKWASH FILTERS

FOR

ATEC SYSTEMS TREATMENT EQUIPMENT FOR PUBLIC DRINKING WATER

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ATEC IRON AND MANGANESE REMOVAL SYSTEM

TECHNICAL SPECIFICATIONS
DOCKTON WATER ASSOCIATIOIN, SANDY SHORES WELL

NOTES

The proposed system is designed to treat approximately 100 gpm produced by the capacity of Sandy Shore Well owned by the Dockton Water Association. The application rate will not exceed 8.30 gpm/sf during normal operation and 11.07 gpm/sf during backwash.

The normal operating pressure of the proposed system will not exceed 150-psig. The treatment system shall consist of 4 each 24-inch diameter filters with 60-inch sidewalls. The filter vessels legs are to be welded to base plates that have an oversized ¾-inch diameter hole for an anchor bolt. All materials used in the manufacture of this system will conform to the specifications contained herein. Each filter shall contain 42" of AS-741M Filter Media.

1. FILTER TANKS

Tanks shall be of electric welded pressure vessel quality low carbon steel construction rated for 150 psig working pressure and hydrostatically tested at 100% in excess of the working pressure. Heads shall be built of Grade SA455 steel. Sidewalls shall be built of Grade SA-572 steel and tank heads and hand-holes shall comply with ASME Code requirements. Sidewalls shall be at least ¼" gauge and heads shall be at least ¼" gauge.

Tanks shall have stainless steel grooved coupling connections on the service inlet and outlet. Manifolds shall have a flanged connection on the system inlet and outlet.

Access opening for tanks shall include one 8” by 6” manhole in the top head one 8" circular access ports in lower sidewall of tank as close to lower head as possible to allow for under drain servicing or media removal.

Support for tanks shall be structural steel angle iron legs welded to lower section of the sidewall.

2. COATINGS

Immersed steel surfaces on tanks of all diameters shall be sand blasted to a near white metal surface finish per (SSPC-SP10) finish. Non-immersed steel surfaces shall be Commercial Blast Cleaned as per SSPC-SP6.

All filter vessel and manifold immersion and non-immersion service surfaces shall be coated with 3M Corporation ScotchKote 134, an epoxy fusion coating which conforms to the requirements of ANSI/NSF Standard 61 for contact with potable water and the requirements of AWWA Standards C550 and C213, applied in accordance with the manufacturer’s recommendations. Total dry film thickness

(DFT) of immersion service coatings shall be at least twelve mils, applied in one or more coats. The epoxy fusion coating shall be applied by electrostatic spray.

The exterior finish shall be applied in at least two coats and may be achieved in more than two coats. Exterior surfaces will be coated with the same fusion epoxy coating as the immersed surfaces and shall be covered with a 1.5-2.5 mil DFT color coat Cardinal Paint Series 6400 Polyurethane or equal.

3. INTERNAL DISTRIBUTION

The filter system shall be a "down-flow" type with untreated water entering the top of the filter and flow through the filter tank and out the bottom of the tank.

The upper distribution system shall be of the baffle type to evenly distribute the water over the entire tank area.

The lower distribution system shall be of a proven design to provide a uniform backwash flow across all of the filter media. The under drain will be constructed with individual stainless steel wedge wire radial outlets with openings of not more than 0.010". The radial arms are secured to a stainless steel hub-base by nipples threaded into stainless steel pipe couplings welded to the hub. Each radial arm shall have adequate outlet orifices for the stated flow located beneath the wedge wire (the specific design requirement is that each arm be capable of handling 37.5 gpm of water with a pressure loss not to exceed 2 psig). The distribution system shall be embedded in a single layer sub-fill of 3/8" x 3/4" washed gravel to support the filter bed.

4. MAIN OPERATING VALVE

The main operating valve on each tank shall be an industrial automatic multi-port diaphragm type, slow opening and closing, free of water hammer. The diaphragm assembly shall be fully guided on its perimeter when pressure activated from one position to another to assure a smooth reliable shut-off without sticking. There shall be no contact of dissimilar metals within the valve and no special tools shall be required to service the valve. The valve shall be operated pneumatically.

5. PIPE AND FITTINGS

Raw and treated water manifold and piping shall be 4-inch Schedule 40 steel with a wall thickness of 0.25" or greater. Backwash piping shall be 3-inch Schedule 40 steel unless otherwise specified. Immersed portions of manifolds shall be coated with a fusion epoxy coating, certified to ANSI/NSF Standard 61 in the same manner specified for filter vessels in Section 2, above except that manifolds with diameters smaller than 3" shall be made of Type 316L stainless steel and left uncoated.

6. FLOW CONTROL

An adjustable backwash flow restrictor, to assure proper backwashing, is provided with each system. Backwash flow will be provided internally to the system (i.e. no additional flow from the well or distribution system shall be used during backwash). Proper filter bed fluidization during backwashing shall be required. Backwash flow rates shall be made at system start-up. An approved backwash flow meter will monitor backwash flow.

7. CONTROLS

Contractor shall provide the filtration system controls. A factory-mounted and wired cycle controller shall incorporate an adjustable time switch with multi-ported pilot valves to control all steps of automatic backwash. Provision for push button initiated-backwash shall be included, as will provisions to accommodate remote initiation of backwash. The controller to be used is an Alex-Tronic FM-8 which requires a 120 VAC connection which provides a local panel indication of backwash status and alarm.

The multi-ported pilot control valve shall be pre-connected to automatically pressure activate the operating control valve through the steps of backwash and return to service. The control panel shall indicate the cycle of operation at all times. In case of power failure, a complete backwash cycle can be performed by manual operation of the pilot control valve.

Electrical lockouts to prevent more than one unit from backwashing at the same time, except when the system is manually overridden shall be included.

The electrical time switch control shall be fully adjustable to initiate backwash at regular frequencies and/or for a set pressure differential. The capability for backwash, initiated from a remote location, by an electrical signaling device shall be included.

8. AS 741M FILTER MEDIA

The filter media shall be a granular material having both oxidizing and catalytic properties for iron and manganese removal. The size of the media shall be 20-to-40 U. S. Mesh. The media is NSF Certified to ANSI/NSF Standard 61.

The media shall operate on in a pH range of 6.0 to 10.0.

Iron and manganese shall be removed to a level below one half of the established maximum contaminant level (MCL). Particle retention shall be ten (10) micron and larger for particles other than iron and manganese.

9. PRESSURE RELIEF VALVE

None Provided

10. REGENERATION SYSTEM

Media regeneration is not required. Chlorine is the oxidant that will be used on this system and a free chlorine residual equal to or greater than 0.5 mg/L shall be maintained in the product water leaving the treatment unit. No oxidant other than chlorine is authorized for use in this system.

11. ACCESSORIES

Liquid filled pressure gauges of ½% full scale accuracy in corrosion resistant frames shall be provided (0-160 psig) for inlet and outlet manifold of the system. Gauges shall be 4½" in diameter and will be mounted above the control panel.

Sampling ports will be provided for the product water from each filter vessel as well as composite sampling ports for raw and finished water as well as for backwash effluent.

12. INSTRUCTIONS

Three complete sets of *ATEC Systems*' *Installation, Operating and Maintenance Manual* are included with the treatment system. The O & M manual includes schematics of electrical controls.

13. FIELD SERVICE

The services of a factory authorized service representative with at least five years experience commissioning similar installations shall be made available to supervise, inspect and provide operator training initial start-up and as required for system operation up to 2 days.

14. GUARANTEES

ATEC Systems guarantees all equipment, coatings, valves, and controls for three (3) years against defects in workmanship or materials. Any part proving defective will be replaced or repaired, at our option, within this period in accordance with our standard guarantee.

The manufacturer guarantees that, under actual operating conditions: (1) the media shall not be washed out of the system during the service run or backwashing period; and, (2) the under drain system, gravel and media shall not become fouled, either with turbidity or by other particles, while operating as specified by the manufacturer.

The manufacturer further guarantees that: (1) iron, and manganese will be removed at all times except during and immediately following the backwash cycle for a period not to exceed five (5) minutes to a content level of 0.15 mg/L of iron, and 0.025 mg/L of manganese (2) that filtered water turbidity shall be less than 1.0 NTU; and, (3) that filtered water color shall be less than 5

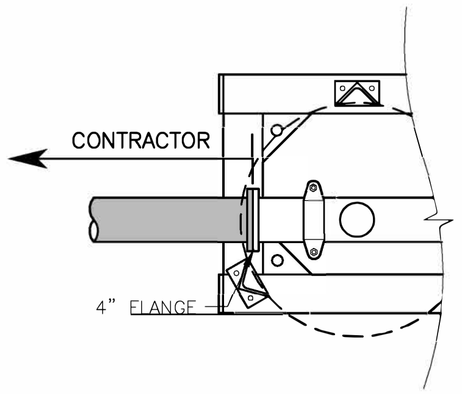
standard color units. These levels will maintain with no more than three backwash cycles per 24-hour period under normal operating conditions.

Failure to properly chlorinate the source water prior to its introduction to the filter vessels shall void this performance guaranty and may require the replacement of all filter media to obtain adequate removal of iron and manganese.

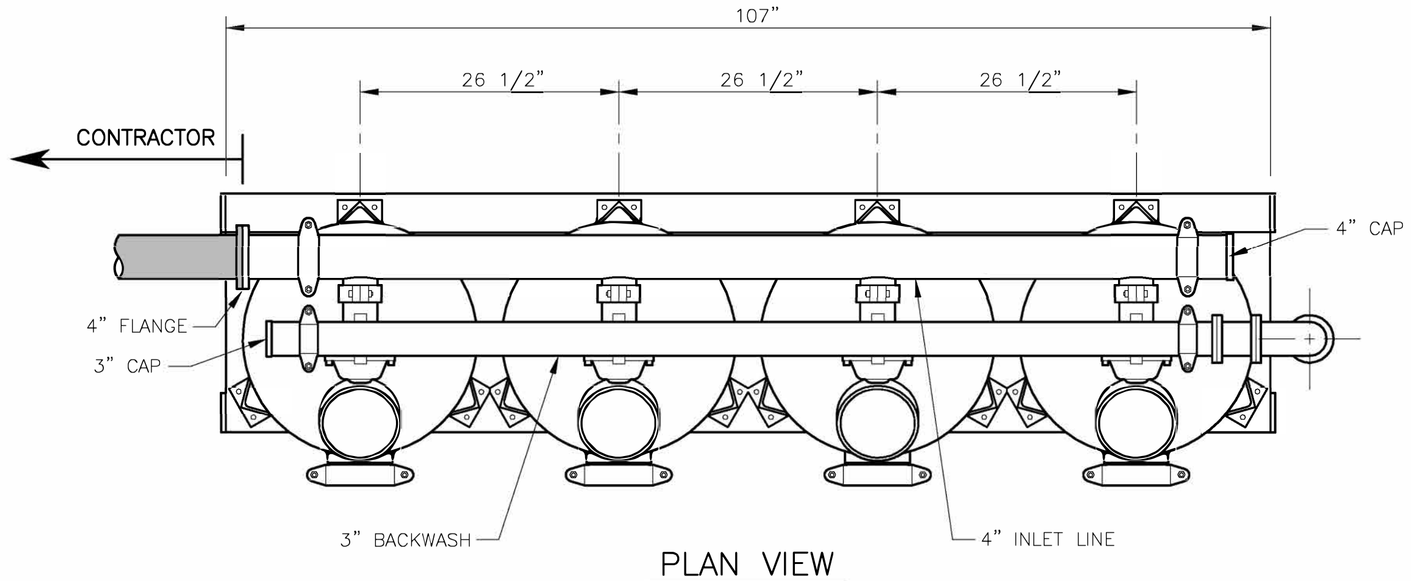
Failure to properly backwash the filter vessels shall void this performance guaranty and may require the replacement of all filter media to obtain adequate removal of iron and manganese.

15. OTHER DOCUMENTS

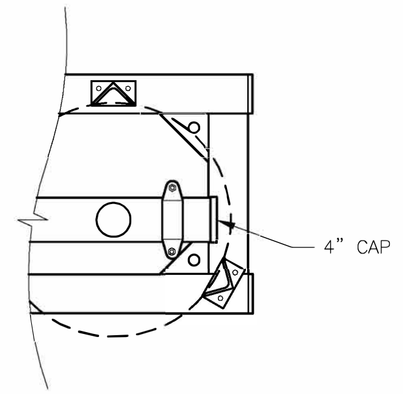
Drawings of the proposed system are enclosed and are incorporated into this specification by reference.



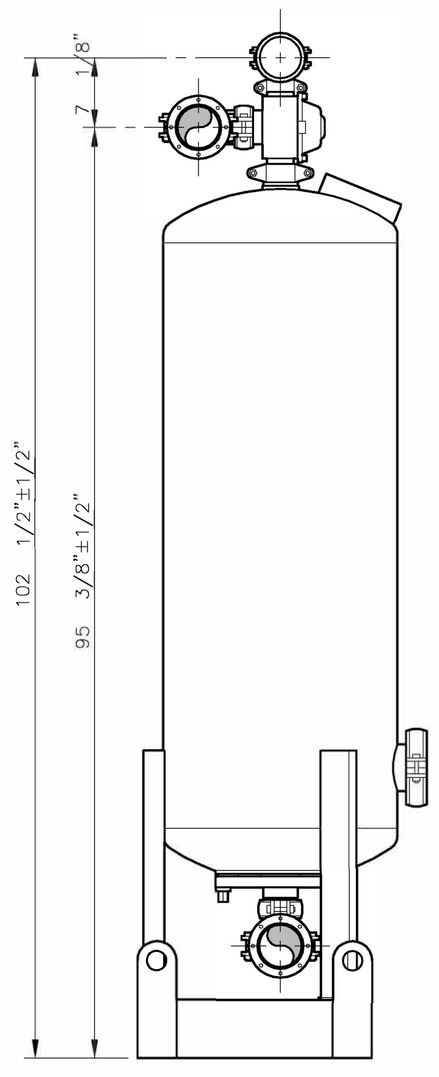
LEFT SIDE
FILTERS REMOVED



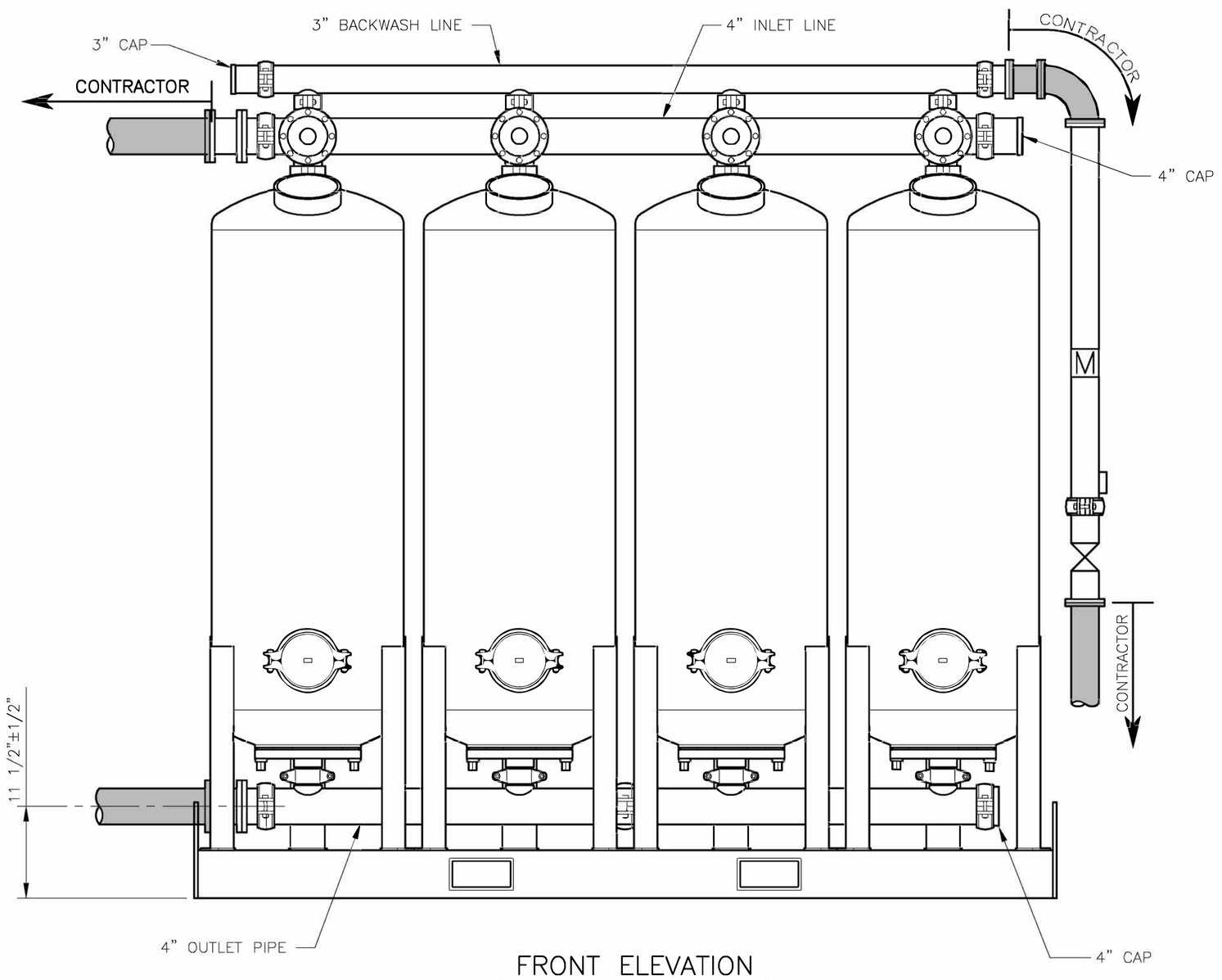
PLAN VIEW



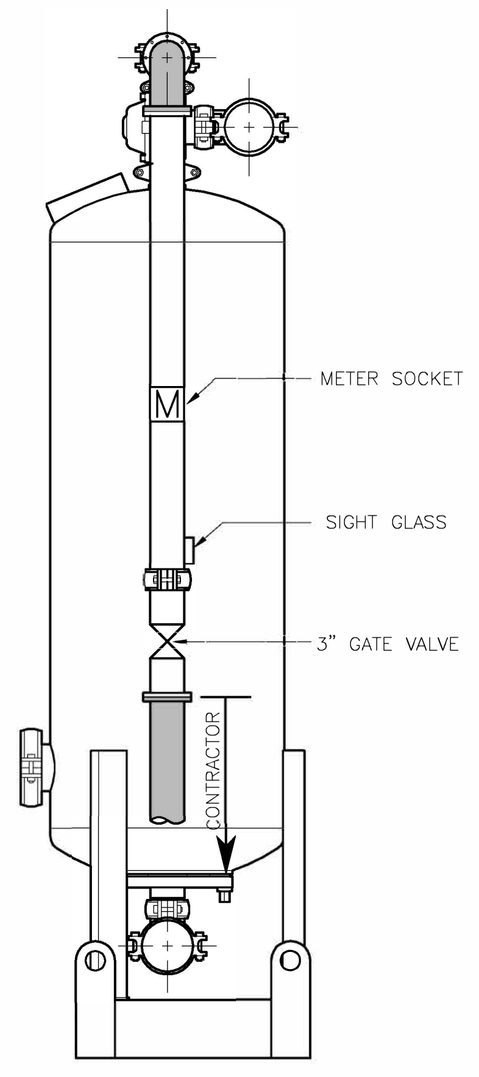
RIGHT SIDE
FILTERS REMOVED



LEFT END VIEW



FRONT ELEVATION



RIGHT END VIEW

NOTE:
60" LONG, 3" BACKWASH ASS'Y SHIPPED LOOSE, FLANGED BOTH ENDS. CONSISTING OF GATE VALVE, METER AND SIGHT GLASS

ATEC
P.O. BOX 10329
BAINBRIDGE ISLAND, WASHINGTON 98110-0329
PHONE: (360) 414-9223

DESIGN BY:	.
DRAWN BY:	.
CHECKED BY:	.
APR'D BY:	.

NO.	DATE		BY	APVD

0 1 2
SCALE IN FEET

NOTE: CHECK SCALE
SCALE AT 22x34 – 1" = 1'-0"
SCALE AT 11x17 – 1/2" = 1'-0"

DOCKTON WATER ASSOCIATION
SANDY SHORES WELL
IRON AND MANGANESE TREATMENT

PLAN AND
ELEVATION
DETAIL

SHEET NO. 1 of 2
DWG. NO.
DATE: 3-17-14
FILE:
Docton Water Association

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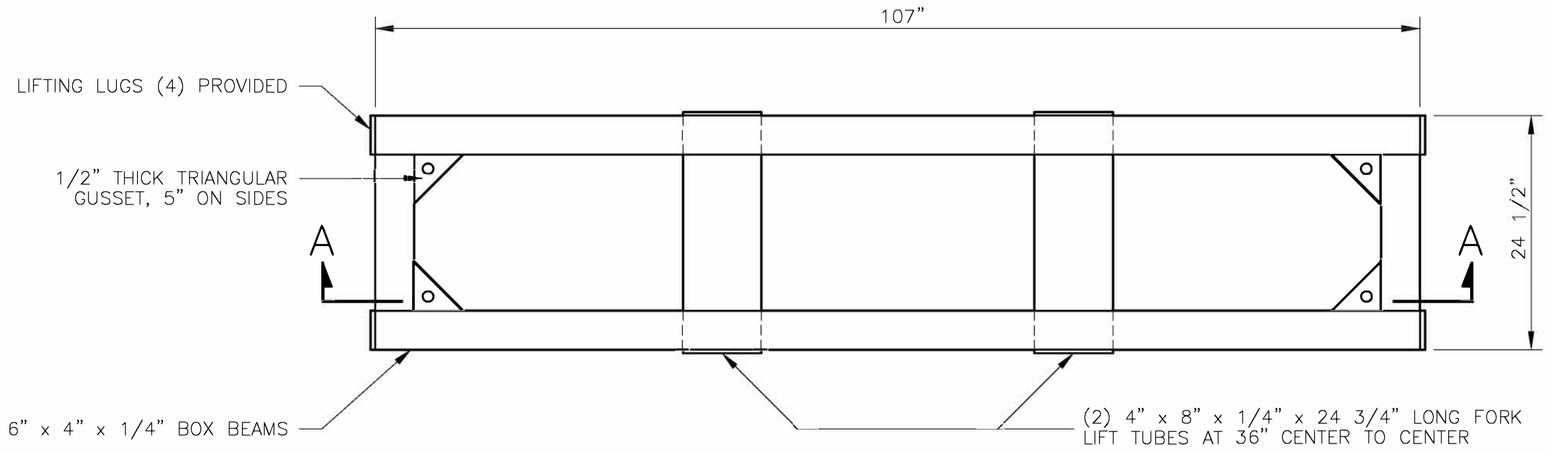
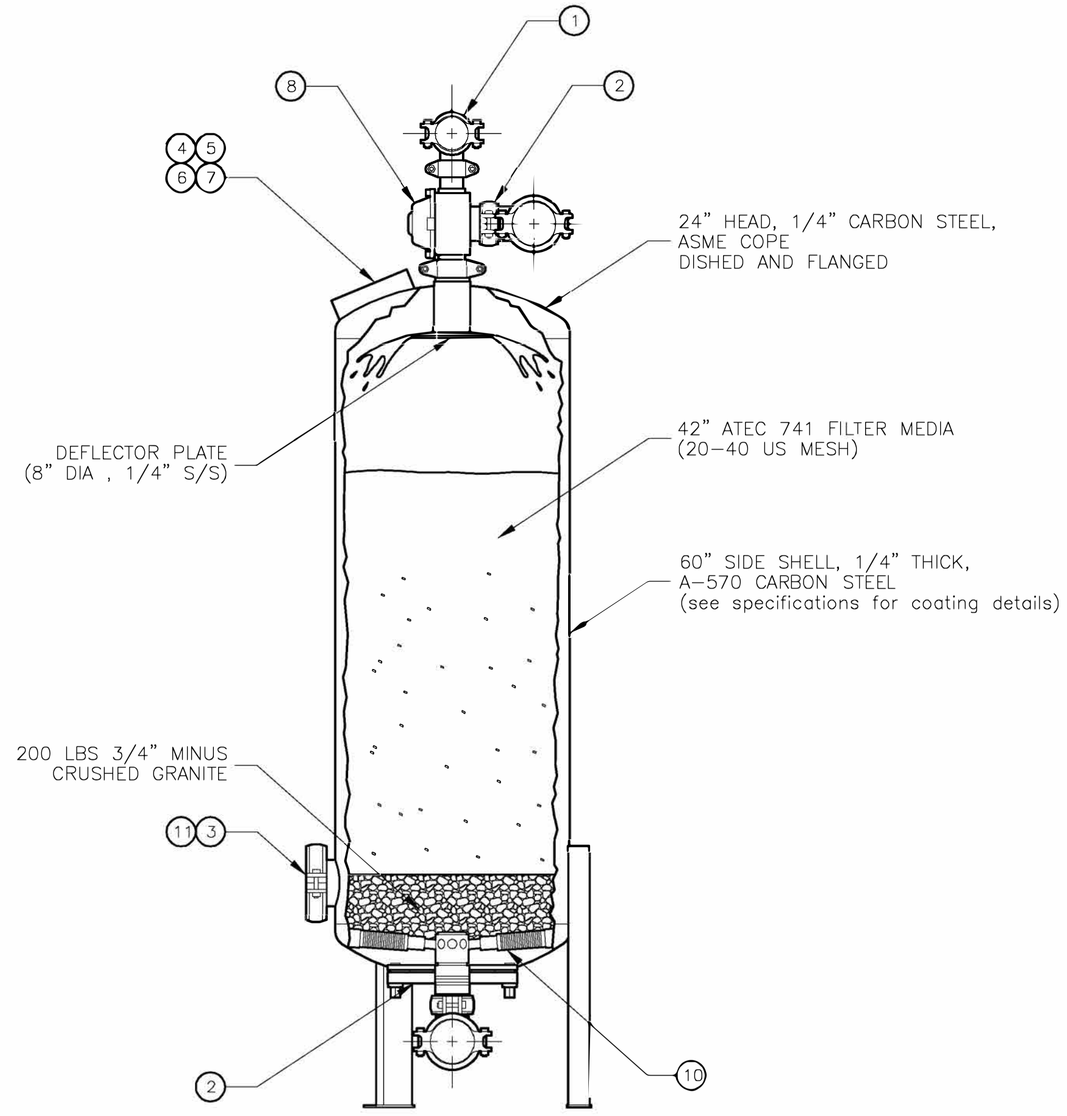
BILL OF MATERIALS			
ITEM	QTY	PART NO.	
1	1	PFS-CPL03	3" GROOVED COUPLING, CAST IRON W/ BOLTS & GASKET
2	3	PFS-CPL03	3" GROOVED COUPLING, CAST IRON W/ BOLTS & GASKET
3	1	PFS-CAP06	6" GROOVED END CAP
4	1	PFS-HHP6	6"x8" HAND HOLE PLATE
5	1	PFS-HHG6	6"x8" HAND HOLE GASKET
6	1	PFS-HHBS6	6"x8" HAND HOLE BOLT SET
7	1	PFS-HHCR6	6"x8" HAND HOLE HOLD DOWN CRAB
8	1	V-BBF3	3"x3"x2" BACKFLUSH VALVE, BERMAD
9	1	UASS24	UNDER-DRAIN ASSEMBLY 316L S.S. W/ SCH 80 CAP COMPLETE
10	1	73PP9YZCM24VAC	SOLENOID VALVE, PETER PAUL (NOT SHOWN)
11	1	PFS-CPL06	6" GROOVED COUPLING, CAST IRON, W/BOLTS & GASKET

NOTE: QUANTITIES SHOWN ARE FOR (1) ONE TANK

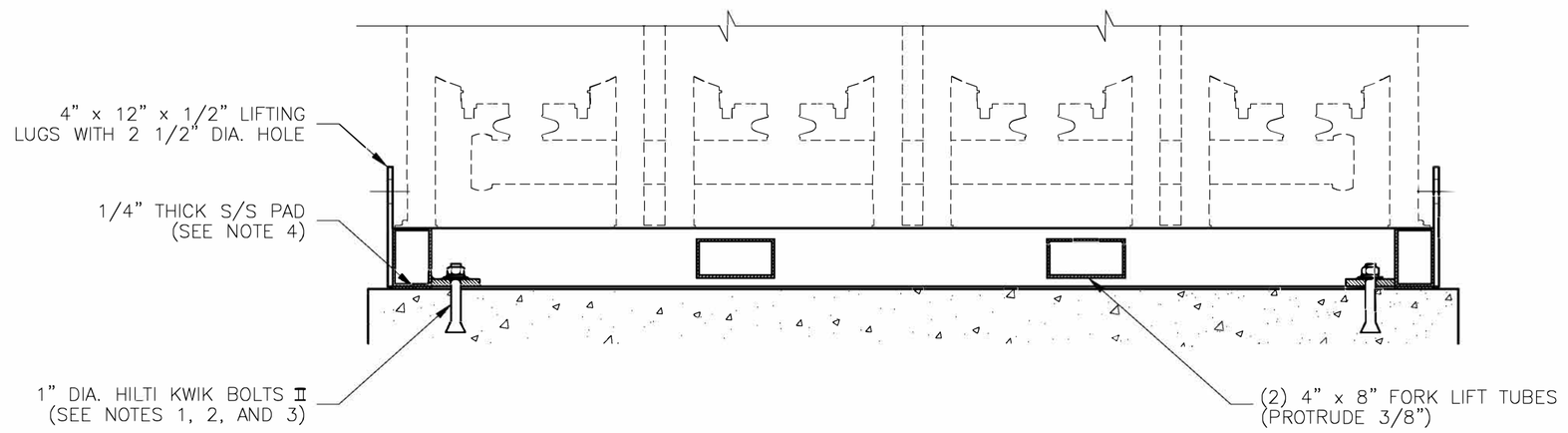


5-FILTER SKID PLAN

FILTER/SYSTEM INFORMATION	
ITEM	
PRESSURE	120 PSI
CAPACITY	135 GPM
LOADING RATE	8.6 GPM/Sq.Ft.
BACKWASH	88 GPM
COLOR	.



SECTION THROUGH TANK



SECTION A-A

INSTALLATION NOTES:

1. DESIGNER SHALL DETERMINE NO. AND DEPTH OF ANCHOR BOLTS TO SUIT LOCAL CODE REQUIREMENTS. FOUR BOLTS ARE REQUIRED AS A MINIMUM AT EXTERIOR GUSSETS.
2. ANCHOR BOLT HOLES SHALL BE DRILLED INTO CONCRETE FOUNDATION THROUGH OVERSIZED DRILL HOLES IN GUSSETS IN SKID ASSEMBLY BY INSTALLATION CONTRACTOR.
3. 1/4" THICK S/S PADS ARE PROVIDED UNDER SKIDS FOR CLEARANCE BETWEEN SKIDS AND CONCRETE FOUNDATION. SIX PADS ARE PROVIDED FOR 2 & 3 FILTER SKIDS, EIGHT PADS FOR 4-FILTER SKIDS.

ATEC
P.O. BOX 10329
BAINBRIDGE ISLAND, WASHINGTON 98110-0329
PHONE: (360) 414-9223
FAX: (360) 397-

DESIGN BY: .
DRAWN BY: .
CHECKED BY: .
APP'D BY: .

NO.	DATE		BY	APVD

0 1 2
SCALE IN FEET

NOTE: CHECK SCALE
SCALE AT 22x34 - 1" = 1'-0"
SCALE AT 11x17 - 1/2" = 1'-0"

DOCKTON WATER ASSOCIATION
SANDY SHORES WELL
IRON AND MANGANESE TREATMENT

SHEET NO. 2 of 2
DWG. NO.
DATE: 3-17-14
FILE: Docton Water Association

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atec systems associates, inc.

APPENDIX B

FILTER MEDIA DOCUMENTATION

ATEC BACKWASH FILTERS

FOR

ATEC SYSTEMS TREATMENT EQUIPMENT FOR PUBLIC DRINKING WATER

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atec systems associates, inc.

FILTER MEDIA DOCUMENTATION

ATEC SYSTEMS IRON, MANGANESE, HYDROGEN SULFIDE, ARSENIC, AND RADIUM TREATMENT EQUIPMENT

LIST OF DOCUMENTS

1. Pyrolox Media, Product Information

2. Pyrolox Filter Media ANSI/NSF Certification Standard 61 – Health Effect

3. Pyrolox Filter Media, Material Safety Data Sheet

4. Silica Resources, Inc., 3/4" Black and White Filter Rock ANSI/NSF Certification Standard 61 – Health Effect

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PRINCEMINERALS®

DATA SHEET

Pyrolox 6524

Granular Manganese Dioxide 20x40

Item Number: 05-6524

Typical Chemical Analysis

Mn	51%
MnO_2	77%
Fe_2O_3	5.4%
Al_2O_3	3.1%
SiO_2	3.2%
Moisture	1.0%

Physical Description

Color	black
Typical ASTM Sieve Profile	
+14 Mesh	0.1%
14 X 20 Mesh	2%
20 X 40 Mesh	95%
-40 Mesh	3%
Package	60 lb/27.2 kg paper bag
	2000 lb, 2205 lb/1000 kg sack

4/8/10 QSF200CB
Supercedes: 12/8/08

223 Hampshire Street • Quincy, IL 62301 Phone: 646-747-4200 Fax: 217-228-0466
www.princeminerals.com

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The Public Health and Safety Organization

NSF Product and Service Listings

These NSF Official Listings are current as of **Friday, December 27, 2019** at 12:15 a.m. Eastern Time. Please contact NSF to confirm the status of any Listing, report errors, or make suggestions.

Alert: NSF is concerned about fraudulent downloading and manipulation of website text. Always confirm this information by clicking on the below link for the most accurate information:
http://info.nsf.org/Certified/PwsComponents/Listings.asp?Company=C0028579&Standard=061&

NSF/ANSI/CAN 61
Drinking Water System Components - Health Effects

NOTE: Unless otherwise indicated for Materials, Certification is only for the Water Contact Material shown in the Listing. Click here for a list of Abbreviations used in these Listings. Click here for the definitions of Water Contact Temperatures denoted in these Listings.

Prince Minerals, Inc.
14 East 44tth Street 5th Floor
New York, NY 10017
United States
646-747-4200
Visit this company's website
(http://www.princeminerals.com)

Facility : Leesburg, AL

Process Media

Trade Designation	Size	Water Contact Temp	Water Contact Material
Oxidative Media			
Pyrolox Advantage	18 x 45 mesh	CLD 23	OTHER

NOTE: Certified for water treatment plant applications.
This product has not been evaluated for point of use applications.

Facility : Quincy, IL

Process Media

Trade Designation	Size	Water Contact Temp	Water Contact Material
Oxidative Media			
Pyrolox™	[1]	CLD 23	MNDOX

[1] Certified for the following US mesh sizes: 8 x 20, 20 x 40. Certified for the following UK mesh sizes: 18/44.

NOTE: Certified for water treatment plant applications.
This product has not been evaluated for point of use applications.

Facility : New Johnsonville, TN

Process Media

Trade Designation	Size	Water Contact Temp	Water Contact Material
Filtration Media			
Pyrolox Pro	20 x 40 mesh	CLD 23	MNDOX
Oxidative Media			
Pyrolox Pro	20 x 40 mesh	CLD 23	MNDOX

NOTE: Certified for water treatment plant applications.
This product has not been evaluated for point of use applications.

Number of matching Manufacturers is 1

Number of matching Products is 4

Processing time was 0 seconds

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PRINCEMINERALS®

MATERIAL SAFETY DATA SHEET
PYROLOX

Prince Minerals, Inc.
14 E 44th St
5th Floor
New York, NY 10017

CONTACT NUMBERS:
Prince Environmental, Health & Safety:
(646) 747-4175
CHEMTREC (24-hrs): (800) 424-9300

Section I: Product Information

Identity: **PYROLOX**
Synonyms: NO PRODUCT SYNONYMS
Revision Date: 02/2009

CAS #: Mixture-See **Section II**
Product ID:
Product #:

Section II: Hazardous Ingredients

Chemical Name:	CAS #	OSHA PEL	ACGIH TLV	Percent
Pyrolusite (MnO_2)	1313-13-9	N/A	0.2 (as Mn)	75-80
Quartz (SiO_2)	14808-60-7	10/(%SiO_2+2)	0.05	3-5
Barium Compounds (as Ba), comp. of Mn ore	7440-39-3	0.5 (as Ba)	0.5	1-2
Lead (Pb, inorganic compounds)	7439-92-1	0.05	0.05	0.7-0.9

Section III: Physical/Chemical Characteristics

Bulk density:	110-120 lbs/ft^3	**Freeze Point:**	Solid at STP	**% volatile by vol:**	1-2% H_2O
Water solubility:	Slight	**Melting Point:**	>2800 ^oF	**Vapor Density**:	N/A
pH: (10% aqueous slurry)	9-10	**Boiling Point:**	N/A	**Vapor Pressure:**	N/A

Appearance and Odor: A uniform, brownish-black, granular material. Odorless.

Section IV: Fire and Explosion Hazard Data

Emergency Overview: Not a fire or spill hazard. Low toxicity; dry dust is a nuisance particulate. Generally, health effects are provided for exposure to dust that may be generated during product transfer and handling.

Flammable Properties: Material will not burn. Although not combustible, this material is a strong oxidizing agent, which liberates oxygen during thermal decomposition. It may increase the burning rate of combustibles with a flare-burning effect. It may cause re-ignition after a fire is extinguished.

Extinguishing Media: Use dry chemical or CO_2 to extinguish fires involving this material.

Protection for Firefighters: Material should be kept out of eyes and off skin. As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Do not release runoff from fire control methods to sewers or waterways.

Section V: Reactivity Data

Stability: Stable under normal conditions of storage.

Conditions to Avoid:	None under normal conditions.
Incompatibility (materials to avoid):	Pyrolusite (MnO_2) is a powerful oxidizer, hence it should not be heated or rubbed with organic matter or other easily oxidizable substances, e.g., sulfur, sulfides, phosphides, hypophosphides, etc. Material is flammable by chemical reaction. Incompatible with hydrogen peroxide and sodium peroxide. Keep away from heat and flammable materials.
Hazardous Decomposition or Byproducts:	None under normal conditions.
Hazardous Polymerization:	Will not occur.

Section VI: Health Hazard Data

Primary Route of Exposure:	Inhalation
Relevant Routes of Exposure:	**EYE CONTACT:** Particulate may cause slight to moderate irritation. Abrasive action of dust particulate can damage eye. **SKIN CONTACT:** Prolonged or repeated contact may cause slight to moderate irritation. **INHALATION:** Overexposure by inhalation of airborne particulate, dust, or fumes is irritating to the nose, throat, and respiratory tract. Inhalation of excessive levels of dust or fumes may be harmful. **INGESTION:** Unlikely route of exposure; no hazard in normal industrial use. Small amounts (< tablespoonful) swallowed during normal handling operations are not likely to cause injury, however, swallowing larger amounts may cause injury. If ingested in sufficient quantity, may cause gastrointestinal disturbances. Symptoms may include irritation, nausea, vomiting, abdominal pain, and diarrhea.
Acute and Chronic effects of Exposure:	Excessive, short-term exposure to airborne mineral dusts and particulate may cause upper respiratory and eye irritation. Exposure via inhalation to high concentrations of dusts containing manganese compounds for as little three months have effected the central nervous system. Excessive, long-term inhalation of airborne mineral dusts and particulate may contribute to the development of bronchitis, reduced breathing capacity, and may lead to the increased susceptibility to lung disease. **Manganese poisoning:** The excessive, chronic inhalation of manganese compounds usually begins with complaints of languor and sleepiness. This is followed by weakness in the legs and the development of stolid, mask-like faces. The patient speaks with a slow monotonous voice. Then muscular twitching appear, varying from a fine tremor of the hands to coarse, rhythmical movements of the arms, legs, and trunk. There is a slight increase in tendon reflexes, ankle and patellar clonus, and a typical Parkinsonian slapping gate.
Signs and Symptoms of Exposure:	(Dust) tearing of eyes, burning sensation in the throat, cough, chest discomfort.
Aggravation of Pre-existing Conditions:	The excessive inhalation of mineral dust may aggravate pre-existing chronic lung conditions such as, but not limited to, bronchitis, emphysema, and asthma.
Reproductive Hazards:	Not a reproductive hazard.
Emergency and First Aid Procedures:	**EYE CONTACT:** Flush eyes immediately with water for at least 15 minutes. Seek medical attention if irritation persists. **SKIN CONTACT:** Immediately wash affected area with mild soap and water to remove any dust adhering to the skin. Seek medical attention if irritation develops or persists. **INHALATION:** If exposed to excessive levels of dust or fumes, remove to fresh air and seek medical attention if cough or other symptoms develop. If not breathing, give artificial respiration or give oxygen by trained personnel, and get medical attention. **IF INGESTED:** Unlikely route of exposure. If ingested in sufficient quantity and victim is conscious, give 1-2 glasses of water or milk. Never give anything by mouth to an unconscious person. Leave decision to induce vomiting to qualified medical personnel, since particles may be aspirated into the lungs. Seek immediate medical attention.

Section VII: Precautions for Safe Handling and Use

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:	**CONTAINMENT:** Product is dry solid (granular or powder) and not readily soluble in water. However, prevent spilled product from entering streams, water bodies, and wastewater systems.

CLEANUP: Vacuum or sweep up dry material and place in a container for reuse. Avoid creating excessive airborne dust. Cleanup personnel need to wear approved respiratory protection (air-purifying or air-supply), gloves, long-sleeved clothing and goggles to prevent irritation from contact and inhalation.
EVACUTATION: Isolate hazard area. Keep unnecessary and unprotected personnel from entering.
POTENTIAL ENVIRONMENTAL EFFECTS: Derived from natural ores; no adverse environmental effects known. However, prevent spilled product from entering streams, water bodies, and wastewater systems. This material is used as an agricultural product.

Waste Disposal Method:

COLLECTION: If possible, collect and reuse spilled product.
RCRA: This product, as manufactured, is not a RCRA listed hazardous waste and does not exhibit any characteristics of a hazardous waste, including toxicity (by EPA TCLP method).
DISPOSAL METHOD: This product is generally suited for landfill disposal. Follow all applicable Federal, State, and local laws, rules, and regulations regarding the proper disposal of this material. If this product has been altered or contaminated with other hazardous materials, appropriate waste analysis may be necessary to determine proper disposal method. A qualified environmental professional should determine waste characterization, disposal, and treatment methods for this material in accordance with applicable Federal, State, and local regulations and requirements.

Handling and Storing Precautions:

Minimize dust generation and accumulation. Avoid breathing dust. Avoid contact with skin and eyes. Store in a cool, dry area. Keep container closed when not in use. Product or component is a powerful oxidizer, hence it should not stored near organic matter or other easily oxidizable substances, e.g., sulfur, sulfides, phosphides, hypophosphides, etc. or incompatible materials such as hydrogen peroxide and sodium peroxide.

USDOT DATA:

This product is not regulated by USDOT as a hazardous material (49 CFR part 172.101). No UN code assigned. No placard required for transportation.

Other Precutions:

None

Section VIII: Control Measures

Engineering Controls:

If user operations generate dust, fume, or mist, use ventilation to keep exposure to airborne contaminants below the exposure limits listed in **Section 2**.

Eye Protection:

Corrosive to eyes. Wear protective safety goggles when dust generation is likely.

Skin Protection:

Wear clothing sufficient to cover the skin, safety shoes, and leather gloves for hand protection against dry material.

Respiratory Protection:

Use NIOSH/MSHA approved respiratory protection (air purifying or air supplying) when concentrations are above exposure limit value. A respiratory protection program that meets OSHA 29 CFR part 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant the use of a respirator.

Work and Hygienic Practices:

Wash thoroughly after using product. Wash contaminated clothing. Wash hands before eating or drinking.

Section IX: Regulatory Data

COMPONENTS LISTED IN FEDERAL REGULATIONS AND STATE "RIGHT-TO-KNOW" LAWS:

COMPONENT	CAS #	FEDERAL					STATE (Right-to-Know)			
		RCRA	CERCLA	SARA	SARA EHS	TSCA	PA	NJ	MA	CA
Pyrolusite (MnO_2)	1313-13-9	NO	YES[1]	YES (as compound)	NO	YES	NO	NO	NO	NO
Nonhazardous Ingredients / Inert Materials / Proprietary	N/A	NO	NO	NO	NO	NO	NO	NO	NO	NO
Quartz (SiO_2)	14808-60-7	NO	NO	NO	NO	YES	YES	NO	YES	NO
Barium Compounds (as Ba), comp. of Mn ore	7440-39-3	NO	NO	YES	NO	YES	YES	YES	YES	NO
Lead (Pb, inorganic compounds)	7439-92-1	NO	YES[2]	YES	NO	YES	YES	YES	YES	YES

NOTES:

1. Listed as Compound per CAA Section 112
2. Listed per CWA Section 307(a) RQ: 10 lb (4.535 kg)
3. Listed as compound

DISCLAIMER:

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The Public Health and Safety Organization

NSF Product and Service Listings

These NSF Official Listings are current as of **Wednesday, March 29, 2017** at 12:15 a.m. Eastern Time. Please contact NSF International to confirm the status of any Listing, report errors, or make suggestions.

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NSF/ANSI 61
Drinking Water System Components - Health Effects

NOTE: Unless otherwise indicated for Materials, Certification is only for the Water **Contact Material shown in the Listing. Click here for a list of Abbreviations used in these Listings. Click here for the definitions of Water Contact Temperatures denoted in these Listings.**

Silica Resources, Inc.

3190 Enterprise Court
P.O. Box 167
Loomis, CA 95650
United States
916-652-1704

Facility : Marysville, CA

Process Media

	Water Contact	Water Contact

Trade Designation	Size	Temp	Material
Filtration Media			
SRI	60 mesh - 1.5"	CLD 23	SLDOX
SRI Supreme	60 mesh - 1.5"	CLD 23	SLDOX

NOTE: Certified for water treatment plant applications.
This product has not been evaluated for point of use applications.

Number of matching Manufacturers is 1

Number of matching Products is 2

Processing time was 0 seconds

atec systems associates, inc.

APPENDIX C

COATING SYSTEM DOCUMENTATION

ATEC BACKWASH FILTERS

FOR

ATEC SYSTEMS TREATMENT EQUIPMENT FOR PUBLIC DRINKING WATER

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atec systems associates, inc.

COATING SYSTEM DOCUMENTATION FOR ATEC SYSTEMS PUBLIC DRINKING WATER TREATMENT EQUIPMENT

ATEC Systems Associates, Inc.
Filter Vessel and Manifold Coating System

This booklet presents the technical specifications and data for the coating systems that we use for our drinking water systems.

ATEC Systems uses the same high-quality coating system for every filter vessel it manufactures for use in public drinking water systems. Based on over twenty years of experience, we have found that the system described below, while not the least expensive in terms of initial cost, is the most reliable and cost-effective system generally available when life-cycle costs are taken into account.

The basic system involves coating all immersed surfaces and high-wear external surfaces with 10-12 mils dry film thickness (DFT) of ScotchKote 134 Fusion Epoxy Coating. External surfaces are primed with a rust inhibiting primer and finished with a color coat consisting of 1.5-to 2.5 mil DFT of high solids polyurethane.

Surface Preparation

After pressure testing, filter vessels, piping, and parts are sandblasted as recommended by the coating manufacturer to assure optimal coating adhesion. Immediately after sandblasting, the filters are cleaned of all blasting debris and heated to approximately 425^{o}F. Heating the vessels and piping serves several purposes in addition to preparing the surface for powder coating: (1) it helps to assure that no “flash” rust forms on the substrate before it can be coated; and (2) it helps to remove (standardize) the stress formed around weld seams as part of the manufacturing process which results in stronger welds than would otherwise be the case.

Immersed Surface Coating

All immersed surfaces are coated with an electrostatic spray applied 10-12 mil coating of ScotchKote 134 Fusion Epoxy Coating (powder coating). After the exterior coating is applied, the filters remain in the oven to gradually cool before being removed to complete the curing process.

Exterior Coating

After the application of the powder coating, the metal is prepped and primed with rust inhibiting primer and a top coat of polyurethane. Both coatings are applied with a low pressure, high volume spray gun in an approved paint booth.

Quality Control

All vessels, pipes, and fittings are subject to quality control and quality assurance inspections throughout the coating process. If you wish to have a representative present during the coating process for your filter system, please contact us and we will be happy to coordinate your representative's visit. Visits and/or inspections during the coating process need to be arranged in advance to assure that our production schedule is maintained.

Standard Top Coat Colors

We can match almost any color used in the water treatment business. However, the colors listed below are our standard colors and are generally appropriate for most applications.

True Blue (Federal Safety Blue)		Cardinal 6407-J02-500-U
Baby Blue		Cardinal 6407 JO3 645-U
ANSI Gray (valves and fittings)		Cardinal 6407-GR16-U
Desert Tan		Cardinal 6407-J02-XXX
Grouse Tan		Cardinal 6408-J02-774
Twine (backwash manifolds)	[1]	Cardinal 6407-J02-804-U
Clover (raw water manifolds)	[1]	Cardinal 6407-J02-805-U

Touch-up paint is available in aerosol spray cans for the colors listed above except Twine and Clover.

[1] Normally filter vessels and manifolds are painted a single color. There is an up-charge for painting manifolds a different color.

LIST OF DOCUMENTS

1. 3M Corp., ScotchKote 134 Technical Data
2. 3M ScotchKote Fusion Bonded Epoxy 134, Material Safety Data Sheet
3. 3M ScotchKote Fusion Bonded Epoxy 134, Information, Properties and Test Results
4. Cardinal Industrial Finishes, 6400/340 HP Series Product Information
5. Cardinal Industrial Finishes, Cardinal 6407-6409 Series Material Safety Data Sheet

Scotchkote™

134 Fusion Bonded Epoxy Coating

Product Description

3M™ Scotchkote™ 134 Fusion Bonded Epoxy Coating is a one-part, heat curable, thermosetting epoxy coating designed for corrosion protection of metal. The epoxy is applied to preheated steel as a dry powder which melts and cures to a uniform coating thickness. This bonding process provides excellent adhesion and coverage on applications such as valves, pumps, pipe drains, hydrants and porous castings. Scotchkote 134 coating is resistant to wastewater, corrosive soils, hydrocarbons, harsh chemicals, and sea water. Powder properties allow easy manual or automatic application by electrostatic or air-spray equipment.

Product Features

- No primer required.
- Particularly suitable for electrostatic or air-spray application on preheated metal articles.
- Can be electrostatically applied to unheated metal parts and subsequently cured by baking.
- Long gel time allows application on large or complex articles, minimizing fear of runs, sags, laminations, or unsightly overspray.
- Especially useful for coating the inside of pipe or other fabrications where a smooth, corrosion resistant coating is required.
- Can be machined by grinding or cutting to meet close tolerance requirements.
- Allows easy visual inspection of coated articles.
- Can be painted with alkyd paint, acrylic lacquer, or acrylic enamel for color coding.
- Will not sag, cold flow, or become soft in storage. Long term storage under most climatic conditions.
- Lightweight for lower shipping costs.
- Protects over wide temperature range.
- Resists direct burial soil stress.
- High adhesion and toughness.
- Resists cavitation and cathodic disbondment.
- Excellent chemical resistance.
- Suitable for elevated temperature service in presence of H_2S, CO_2, CH_4, crude oil and brine when applied over phenolic primers.
- Long-term performance history in water, sewage, and other service environments.
- Scotchkote 134 coating has been tested and certified to ANSI/NSF Standard 61, Drinking Water System Components.
- Scotchkote™ 134 FBEC meets the requirements of AWWA Standard C213 and C550.

General Application Steps

1. Remove oil, grease and loosely adhering deposits.
2. Abrasive blast clean the surface to NACE No.2/SSPC-SP 10 near-white metal, ISO 8501-Sa2.5.
3. Apply mechanical masks or mask with Scotch™ Glass Cloth Tape 361 or Scotch Aluminum Foil Tape 425 as required.
4. Preheat article to the desired application temperature per cure specifications.
5. Deposit Scotchkote 134 coating by powder spray to the specified thickness.
6. Cure according to cure specifications.
7. Visually and electrically inspect for coating flaws after the coating has cooled.
8. Repair all defects.

Cure Specifications

Scotchkote 134 coating may be applied to metal articles which have been preheated to a temperature of 300°F/149°C to 450°F/232°C. After application, 134 coating must be cured according to the cure guide to achieve maximum performance properties.

If 134 coating is electrostatically applied to unheated parts, the cure time should be measured from the time the coated part reaches the cure temperature. After cure, the coating may be force cooled using air or water to facilitate inspection and handling.

3M™ Scotchkote™ 134 Fusion Bonded Epoxy Coating Cure Guide

Temperature of Article at Time of Powder Application	Typical Gel Time	Cure Time
475°F/246°C	40 seconds	7 minutes
450°F/232°C	60 seconds	10 minutes
400°F/204°C	120 seconds	15 minutes
350°F/177°C	330 seconds	25 minutes

Typical Properties

Property	Value
Color	Forest Green
Specific Gravity - Powder (Air Pycnometer)	1.51
Coverage	127 ft^2/lb/mil (0,66 m^2/kg/mm)
Fluid Bed Density	33 lbs/ft^3 (530 kg/m^3)
Shelf Life at 80°F/27°C	18 months
Average Gel Time 400°F/204°C	120 seconds
Edge Coverage	12% to 18%
Minimum Explosive Concentration	0.03 oz/ft^3 (30,6 g/m^3)
Ignition Temperature	986°F/530°C

Chemical/Pressure/Temperature Resistance

All tests performed on Scotchkote™ 134 Fusion Bonded Epoxy Coating applied over a 1 mil/25,4 µm phenolic primer. Liquid phase for all test conditions: 33% kerosene, 33% toluene, 34% brine solution of 5% NaCl.

Test Conditions	Gas Phase	Results
Autoclave, 120°F/49°C 48 hours, 1500 psi/10.3 MPa	99.5% CO_2 0.5% H_2S	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon, or gas phase
Autoclave, 150°F/66°C 48 hours, 2200 psi/15.2 MPa	80% CH_4 12% CO_2 8% H_2S	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon, or gas phase
Autoclave, 200°F/93°C 24 hours, 3300 psi/22.8 MPa	86% CH_4 8% CO_2 6% H_2S	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon, or gas phase
Autoclave, 300°F/149°C 24 hours, 3000 psi/20.7 MPa	90% CH 10% CO_2 Trace H_2S	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon, or gas phase

Chemical Resistance Exposure at 73°F/23°C*

Acetic Acid up to 25%
Acetone (softened)
Aluminum Chloride
Aluminum Hydroxide
Aluminum Nitrate
Aluminum Sulfate
Ammonium Carbonate
Ammonium Chloride
Ammonium Hydroxide up to 100%
Ammonium Nitrate
Ammonium Phosphate
Ammonium Sulfate
Amyl Alcohol
Barium Carbonate
Barium Chloride
Barium Hydroxide
Barium Nitrate
Barium Sulfate
Benzene
Boric Acid
Borax
Butyl Alcohol
Cadmium Chloride
Cadmium Nitrate
Cadmium Sulfate
Calcium Carbonate
Calcium Chloride
Calcium Hydroxide
Calcium Nitrate
Calcium Sulfate
Calcium Disulfide
Carbon Tetrachloride
Caustic Potash
Caustic Soda
Chlorine 2%
Citric Acid up to 25%
Copper Chloride
Copper Nitrate
Copper Sulfate
Crude Oil
Cyclohexane
Cyclohexene
Cyclopentane
Detergent
Diesel Fuel
Diethylene Glycol
Dipropylene Glycol
Ethanol (softened)
Ethylbenzene
Ethylene Glycol
Ferric Chloride up to 50%
Ferric Nitrate
Ferric Sulfate
Ferrous Nitrate
Ferrous Sulfate
Formaldehyde up to 100%
Formic Acid up to 10%
Freon; gas and liquid
Gas (Mfg)
Gas (Natural)
Gasoline Leaded
Gasoline Unleaded
Glycerine
Heptane
Hexane
Hexylene Glycol
Hydrochloric Acid up to 25%
Hydrofluoric Acid up to 40%
Hydrogen Sulfide
Isopropyl Alcohol
Jet Fuel
Kerosene
Linseed Oil
Lubricating Oil
Magnesium Carbonate
Magnesium Chloride
Magnesium Hydroxide
Magnesium Nitrate
Magnesium Sulfate
MEK (softened)
Mercuric Chloride
Methanol (softened)
MIBK (Methyl Isobutyl Ketone)
Mineral Oil
Mineral Spirits
Molasses
Motor Oil
Muriatic Acid
Naphtha
Nickel Chloride
Nickel Nitrate
Nickel Sulfate
Nitric Acid up to 30%
Nonane
Octane
Oxalic Acid
Pentane
Perchloroethylene
Phosphoric Acid up to 50%
Phosphorous Trichloride
Potassium Aluminum Sulfate
Potassium Bicarbonate
Potassium Borate
Potassium Carbonate
Potassium Chloride
Potassium Dichromate up to 10%
Potassium Hydroxide
Potassium Nitrate
Potassium Sulfate
Propylene Glycol
Sewage
Silver Nitrate
Soap Solution
Soaps
Sodium Bicarbonate
Sodium Bisulfate
Sodium Carbonate
Sodium Chlorate
Sodium Chloride
Sodium Hydroxide
Sodium Meta Silicate up to 5%
Sodium Nitrate
Sodium Sulfate
Sodium Thiosulfate up to 5%
Stannic Chloride
Sulfur
Sulfuric Acid up to 60%
Synthetic Sea Fuel (60% Naphtha, 20% Toluene, 15% Xylene, 5% Benzene)
Synthetic Silage
Tetrapropylene
Toluene
Trichloroethylene
Triethylene Glycol
Trisodium Phosphate
Turpentine
Undecanol
Urea
Urine
Vinegar
Water
- Chlorinated
- Demineralized
- Distilled
- Salt
- Sea

Xylol
Zinc Chloride
Zinc Nitrate
Zinc Sulfate
10-10-10 Fertilizer, Saturated

***Tests conducted for two years on similar products. No effect unless otherwise stated.**

3M™ Scotchkote™ 134 Fusion Bonded Epoxy Coating Test Data - Coating

Property	Test Description	Results
Adhesion	Elcometer	> 3000 psi (glue failure) 210 kg/cm^2
Adhesion to Steel (Shear)	ASTM D 1002 10 mil/254 µm glue line	4300 psi/302 kg/cm^2
Impact	Gardner 5/8 in/1,6 cm diameter tup 1/8" x 3" x 3" (0,32 cm x 7,6 cm x 7,6 cm) steel panel	160 in-lbs 1,8 kg•m
Hardness	Barcol ASTM D 2583	23
Abrasion Resistance	ASTM D 4060 CS-17 1000g weight / 5000 cycles	0,07 g loss
Thermal Shock	310°F/154°C to -100°F/-73°C 4" x 4" (10,2 cm x 10,2 cm) coated panel	10 cycles, no effect
Penetration	ASTM G 17 -40°F/-40°C to 240°F/116°C	0
Tensile Strength	ASTM D 2370	7300 psi/512 kg/cm^2
Elongation	ASTM D 2370	4.2%
Compressive Strength	ASTM D 695	12800 psi/900 kg/cm^2
Coefficient of Friction	APIRP5L2-1968, App 8	23°
Electric Strength	ASTM D 149	1000 volts/mil (39,4 kv/mm)
Hot Water Resistance	160°F/71°C immersion / 120 days	Good adhesion, no blistering
Electrical Resistivity	ASTM D 257	1.2 x 10^{15} ohm•cm
Thermal Conductivity	MIL-I-16923E	7 x 10^{-4} cal/sec/cm^2/C°/cm
Water Absorption	3M 10 mil/254 µm free film 30 days	6,5 g/m^2
Fungus Resistance	MIL-STD 810-B Method 508	Funginert
Salt Fog	MIL-E-5272C	No effect
Weatherometer	ASTM G 23 5000 hours	Surface chalk
Soil Stress - Burial	Bureau of Reclamation 25 cycles	No effect
Salt Crock	30 day, 5 volt, 5% NaCl sand crock 230°F/110°C	Disbondment diameter 24 mm average
Bendability	3/8"/9,5 mm coupon mandrel bend at 73°F/23°C	30 pipe diameters 1.9° / diameter length

Handling and Safety Precautions

Read all Health Hazard, Precautionary, and First Aid statements found in the Material Safety Data Sheet, and/or product label of chemicals prior to handling or use.

For ordering information, technical information, product information or to request a copy of the Material Safety Data Sheet: phone: 1-800-722-6721 or 1-512-984-1038
fax: 1-877-601-1305 or 1-512-984-6296

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3M

Scotchkote™ 134 Fusion Bonded Epoxy Coating

Information, Properties and Test Results

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3M™ Scotchkote™ 134 Fusion Bonded Epoxy Coating

1 - Introduction

The cost of the coating is only a small fraction of the cost of a tubing string, yet the coating is the major means of assuring extended operation by preventing deterioration and service disruption due to corrosion loss. 3M™ Scotchkote™ Fusion Bonded Epoxy Coatings represent a significant improvement in internal coating technology for the oil, gas and water industries.

2 - Description

Scotchkote 134 fusion bonded epoxy coating (FBEC) is a one - part, heat curable, thermosetting epoxy coating designed for corrosion protection of steel. The epoxy is applied to cleaned, preheated steel as a dry powder which melts and cures to a uniform, coating thickness. This bonding process provides excellent adhesion and coverage on applications such as valves, pumps, pipe drains, hydrants and castings. Scotchkote 134 FBEC is resistant to waste water, corrosive soils, hydrocarbons, harsh chemicals and sea water. Powder properties allow easy manual or automatic application by electrostatic or airspray equipment. When applied over a suitable primer, it is appropriate for operation at moderate temperatures and pressures in the presence of H_2O, CO_2 and CH_4, crude oil and brine.

Scotchkote 134 FBEC consists of a blend of epoxy resin and curing agent, additives, pigments, catalysts, filler and flow control agents. Possible combinations of raw materials are extensive; hence careful selection has been made by 3M so that the resultant coating will operate in a broad range of environments. Scotchkote 134 FBEC has been designed to allow trouble-free, consistent production application at the coating plant. Selection of the chemical elements for the fusion bonded epoxy coating is very important. The molecular structure of the epoxy resin, the type and reactivity of the hardener, catalyst and additives all play an important role in the ultimate coatability and performance of the fusion bonded epoxy.

3M Company maintains a divisional laboratory group dedicated to the research and development of fusion bonded epoxy coating. The group's personnel have many years of experience in the formulation and evaluation of epoxy coatings. This effort is assisted by 3M staff laboratories with broad-based expertise in scientific disciplines applicable to coating and surface technology. In addition, 3M synthesizes and manufactures specialized epoxy resins, hardeners, catalysts and additives used to formulate Scotchkote FBE coatings to meet unusual performance and operational requirements.

3 - History

Scotchkote 134 FBEC has been used extensively in the oil and gas industry to coat the exterior and interior of line pipe. Over 40,000 miles (65,000 km) of Scotchkote coated pipe have been installed thoughout the world. This technology has been expanded through 3M research to develop chemically stable, high temperature/pressure resistant internal linings for use in drill pipe, primary and secondary recovery tubing, and pipe for oil, gas and water transportation. Coating properties have been proven by rigorous 3M autoclave testing, and the results verified by independent laboratory and customer investigation. Scotchkote 134 coating has been tested and certified to ANSI/NSF Standard 61 Drinking Water Components.

4 - Manufacturing

All Scotchkote fusion bonded epoxy coating powders are made using the fusion blend process developed by 3M. Ingredients are first pulverized, properly proportioned and homogeneously dry mixed. Next, the blended materials are carefully and thoroughly mixed in the molten state using a continuous melt mixer. The fused blend is cooled and then pulverized into the final powdered form. Particle size distribution is carefully monitored to meet optimum application standards required by the various coating plants. The fusion blend process assures that each particle of the coating powder contains all active ingredients, thus eliminating changes in reactivity due to separation or stratification of ingredients during transportation and application.

5 - Process and Quality Control

Process control is essential to the quality of the finished product. 3M maintains rigid incoming quality requirements of raw materials, precise measurement and metering of critical components, controlled environmental conditions and processing temperatures for the chemical constituents, and a discerning outgoing inspection of the finished coating powder to assure uniformity of product application and performance. Among the quality control tests performed on 3M powder coatings are: gel time, cure, flow, fluidization, particle distribution, adhesion, impact, appearance and moisture content.

6 - Packaging, Storage and Shipping

Scotchkote 134 FBEC is packaged in a heavy duty, polyethylene bag in a stout, easy open, fiberboard carton which is clearly labeled with product number and manufacturing identification. This package protects the coating powder from humidity and contamination during shipment and storage. The net weight is 65 U.S. lbs. (29.5 kg). The sealed cartons are palletized on wooden pallets with net weight of 1170 lbs. (530 kg) and securely banded for shipment. The packaged product must be shipped and stored at temperatures not exceeding 80˚F (27˚C).

7 - Properties of the Powder

3M™ Scotchkote™ 134 Fusion Bonded Epoxy Coating

Property	Test Method	Value
Classification	ASTM D 1763	Type 1, Grade 2
Color	–	Forest Green
Gloss	Gardener 60˚ gloss meter, 350˚ (177˚C) application temperature	34 average
Specific Gravity (Powder)	Air Pycnometer	1.51
Coverage	Calculated from air pycnometer specific gravity of powder	125 ft^2/lb/mil 0.66 m^2/kg/mm
Gel time at 400˚F (204˚C)	Hot plate	70 sec average
Glass Plate Pill Flow	3M glass slide 300˚F (149˚C) 12 mm diameter, 0,85 gram pill, 1 min horizontal, 15 min. at 63˚ angle	75 - 100 mm average flow
Moisture Content at time of manufacture	Computrac 3000 Computrac 200	<0.3%
Particle size	Alpine sieve analysis	>177 µm 1% <44 µm 45 - 60%
Heat of Polymerization	Differential Scanning Calorimeter	70 J/gm typical
Glass Transition Temperature of Cured Coating	Differential Scanning Calorimeter (midpoint)	107˚C (225˚F) typical

8 - Properties of the Coating

All tests have been conducted at 73˚F (23˚C) on unprimed surfaces unless otherwise noted.

8.1 Hardness

Property	Test Method	Test Results
Hardness	Barcol, ASTM D 2583	23
	ASTM D 785	89
	Rockwell M	55

8.2 Tensile Strength

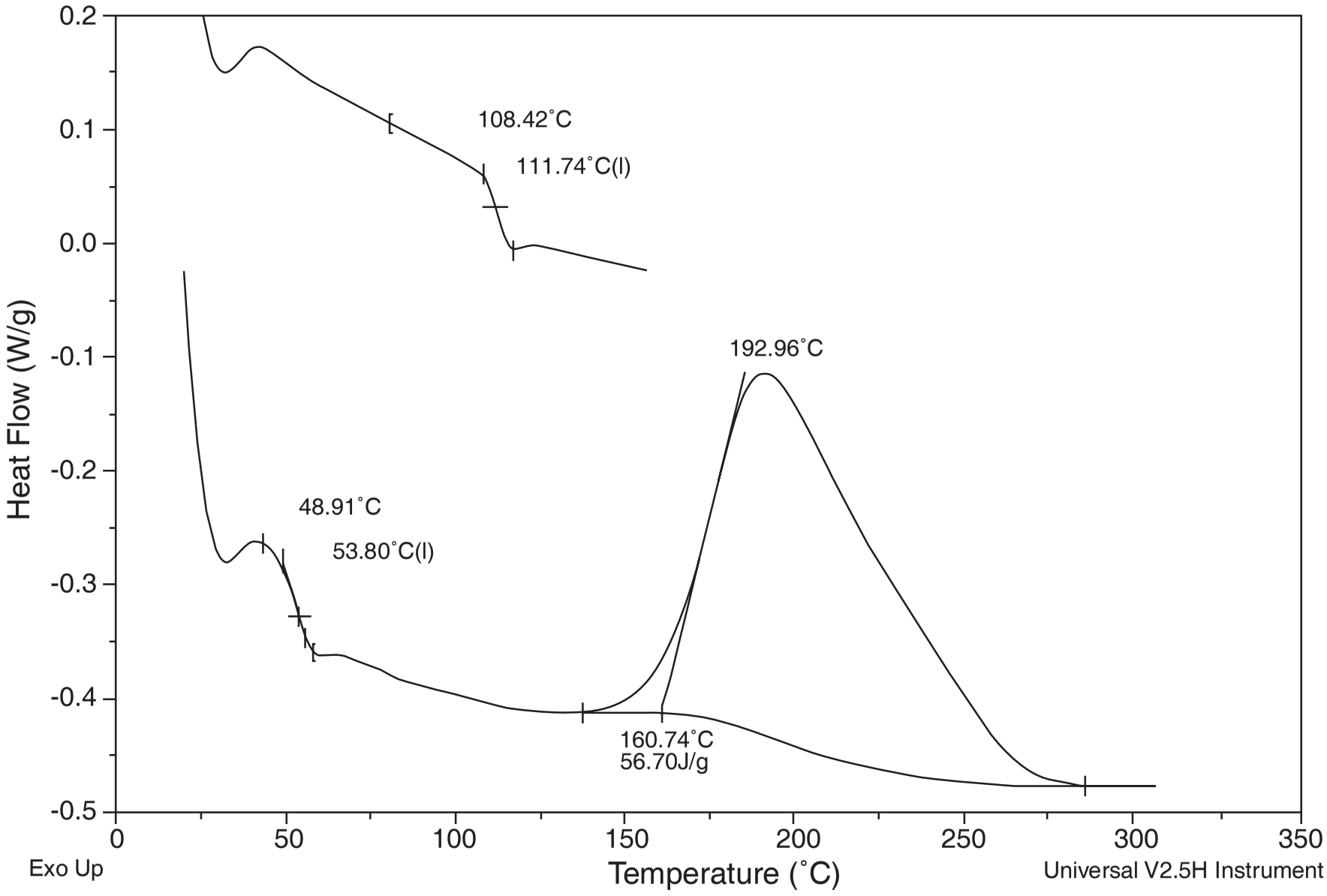
Property	Test Method	Test Results
Tensile Strength	ASTM D 2370	7300 psi
	free film	513 kg/cm^2

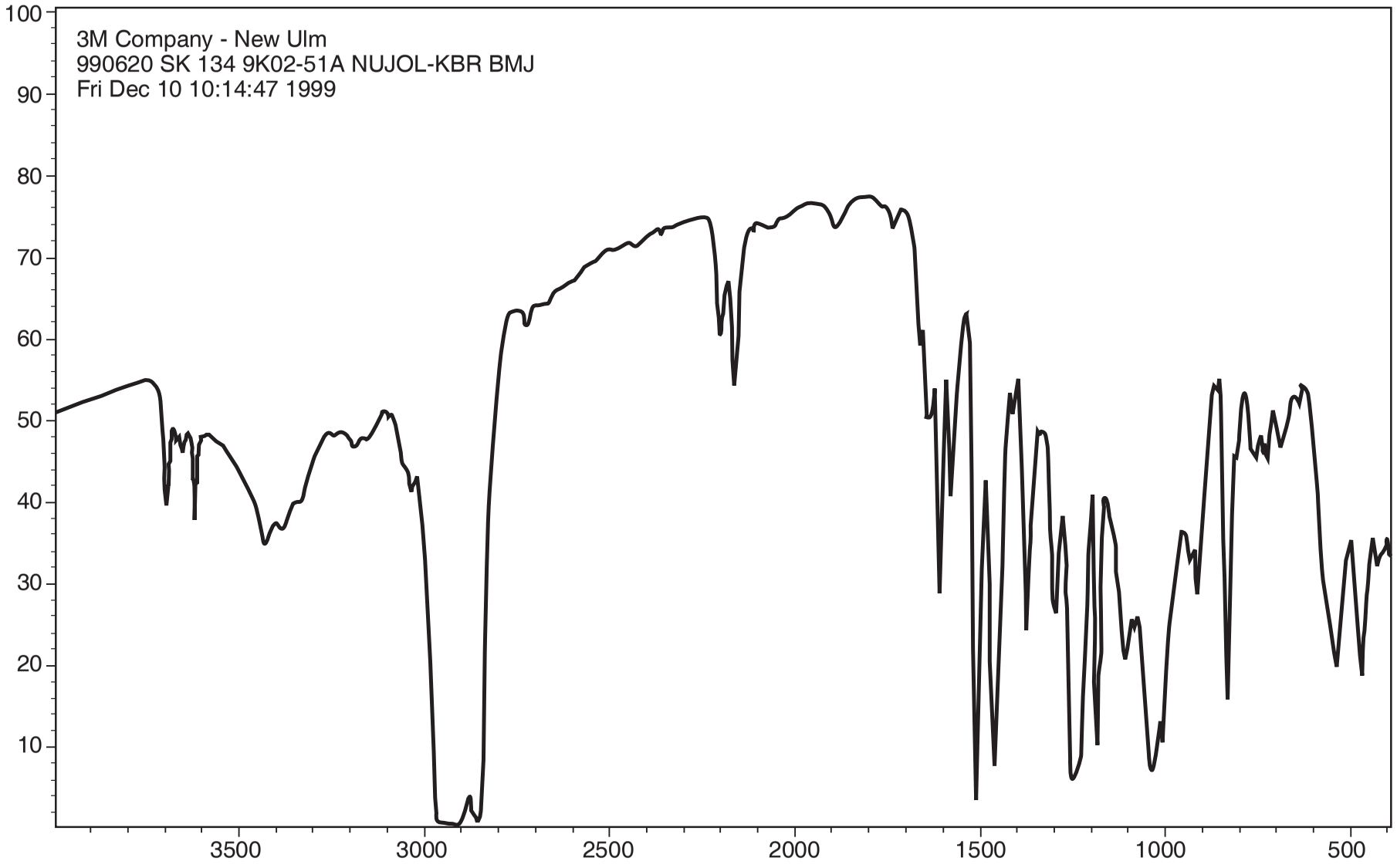
Sample: TR 997 SK 134 9K02-51A
Size: 10.2000mg
Method: 2920-134
Comment: EQUIL 0˚C, 20˚C-70, 20˚C-310˚C, 20˚C-160˚C, N2

DSC

File: 992949 TR 997 SK 13

Run Date: 9-Dec-99 17:59




3M Company - New Ulm
990620 SK 134 9K02-51A NUJOL-KBR BMJ
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3000
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2000
1500
1000
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8.3 Elongation

Property	Test Method	Test Results
Elongation	ASTM D 2370	4.2%
	free film	

8.4 Impact Resistance

Property	Test Method	Test Results
Impact	Gardener, 5/8 in.	160 in - lbs.
	(16 mm) diameter tup,	18,1 J
	0,125 in (3.2 mm) panel	

8.5 Adhesive Strength

Property	Test Method	Test Results
Shear	ASTM D 1002, 10 mil	4300 psi
	(254 µm glue line)	302 kg/cm^2

8.6 Penetration Resistance

Property	Test Method	Test Results
Penetration	ASTM G 17 - 40˚F to 240˚F (- 40˚C to 116˚C)	0
Compression strength	ASTM D 695	12800 psi 900 kg/cm^2

8.7 Bendability

Property	Test Method	Test Results
Bend	3/8 in. (9,5 mm) primed and unprimed coupon mandrel bend	Pipe Dia.=30 Elongation (%)=17 Angle of Deflection (˚/PDL) =1.9

8.8 Coefficient of Friction

Property	Test Method	Test Results
Coefficient of Friction	API RP5L2 - 1968 Appendix 8	23˚

8.9 Thermal - Mechanical

Property	Test Method	Test Results
Thermal Conductivity	MIL - I - 16923E	7x10 - 4 cal/sec/cm^2/C˚/cm
Thermal Shock	3M, 10 cycles - 70˚C to 150˚C - 100˚F to 300˚F	Unaffected by thermal shock

8.10 Volume Resistivity

Property	Test Method	Test Results
Volume Resistivity	ASTM D 257	1.2×10^{15} ohm•cm

8.11 Electric Strength

Property	Test Method	Test Results
Electric Strength	ASTM D 149	1000 V/mil 40 kV/mm

8.12 Weathering Resistance

Property	Test Method	Test Results
Weathering Resistance	Weatherometer ASTM G 23, 5000 hrs.	Surface chalk
Salt Fog	MIL - E - 5272C	No blistering No discoloration No loss of adhesion

8.13 Cathodic Disbondment Resistance

Property	Test Method	Test Results
Cathodic Disbondment Resistance	30 day, 5 volt 5% NaCl, sand crock 230˚F (110˚C)	Disbondment radius 10 mmr average
	4 day 3 volt 3% NaCl 160˚F (71˚C)	5 mmr average

8.14 Moisture Resistance

Property	Test Method	Test Results
Water Immersion	ASTM D 570 free film, 30 day 10 mil (250 mm)	6,5 g/m 2 weight gain

Notes on Autoclave Testing

Notes: All tests conducted on coatings applied over 1 mil (25.4 μm) liquid phenol primer.

'Pass' means excellent adhesion, no blisters, no swelling in a phases, i.e.: aqueous, hydrocarbon or gas phase.
'Fail' means loss of adhesion, or blisters, or excessive swelling in any phases.

8.15 Autoclave Testing

Property	Test Method	Test Results
Pressure / Temperature Duration	1500 psi (10.3 MPa) 120˚F (49˚C) 24 hours	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon or gas phase
Gas Phase	99.5% CO_2 0.5% H_2S	
Liquid Phase	33.0% Kerosene 33.0% Toluene 34.0% Brine Solution (5% NaCl)	
Discharge	Discharge Rapid at Test Temperature	

Autoclave Test #1

Property	Test Method	Test Results
Pressure/Temperature Duration	5 psi (0.03 MPa) 68˚F (20˚C) 72 hours	Pass
Gas Phase	100% H_2S	
Liquid Phase	Turks Island Sea Water	
Discharge	Release pressure over 5 min. @ test temperature	

Autoclave Test #2

Property	Test Method	Test Results
Pressure/Temperature Duration	60 psi (0.4 MPa) 150˚F (66˚C) 24 hours	Pass
Gas Phase	100% CO_2	
Liquid Phase	5% NaCl Brine	
Discharge	Release pressure over 1/2 hour period @ test temperature	

Autoclave Test #3

Property	Test Method	Test Results
Pressure/Temperature	450 psi (3.1 MPa)	Pass
Duration	185˚F (85˚C) 24 hours	
Gas Phase	15% CO_2 84.9% N_2 0.1% H_2S 71˚C (160˚F)	
Liquid Phase	Deionized Water Crude Oil	
Discharge	Release pressure over 5 min. @ test temperature	

Autoclave Test #4

Property	Test Method	Test Results
Pressure/Temperature	2000 psi (13.8 MPa)	Pass
Duration	200˚F (93˚C) 16 hours	
Gas Phase	5% CO_2 94.5% Methane 0.5% H_2S	
Liquid Phase	5% NaCl Brine	
Discharge	Cool for 4 hours then rapidly release pressure	

Autoclave Test #5

Property	Test Method	Test Results
Pressure/Temperature	3300 psi (22.8 MPa)	Pass
Duration	200˚F (93˚C) 24 hours	
Gas Phase	34% Brine (5% NaCl) 33% Kerosene 33% Toluene	
Liquid Phase	8% CO_2 86% Methane 6% H_2S	
Discharge	Cool overnight to ambient release pressure over 1/2 hr. period	

Autoclave Test #6

Property	Test Method	Test Results
Pressure/Temperature	2500 psi (17.2 MPa)	Pass
Duration	200˚F (93˚C) 24 hours	
Gas Phase	10% CO_2 90% N_2	
Liquid Phase	Wasia Water	
Discharge	Release pressure over 1/2 hr. period @ test temperature	

Autoclave Test #7

Property	Test Method	Test Results
Pressure/Temperature	1500 psi (10.3 MPa)	Pass
Duration	120˚F (49˚C) 48 hours	
Gas Phase	95.5% CO_2 0.5% H_2S	
Liquid Phase	34% Brine (5% NaCl) 33% Kerosene 33% Toluene	
Discharge	Instant pressure release @ test temperature	

Autoclave Test #8

Property	Test Method	Test Results
Pressure/Temperature	35 psi (0.2 MPa)	Pass
Duration	200˚F (93˚C) 24 hours	
Gas Phase	Air	
Liquid Phase	15% HCl	
Discharge	Force cool to ambient release pressure over 5 min. period	

Autoclave Test #9

Property	Test Method	Test Results
Pressure/Temperature	2200 psi (15.2 MPa)	Pass
Duration	150˚F (66˚C) 24 hours	
Gas Phase	12% CO_2 80% Methane 8% H_2S	
Liquid Phase	34% Brine (5% NaCl) 33% Kerosene 33% Toluene	
Discharge	Release pressure over 1/2 hr. period @ test temperature	

Autoclave Test #10

Property	Test Method	Test Results
Pressure/Temperature	4000 psi (27.5 MPa)	Pass
Duration	225˚F (107˚C) 24 hours	
Gas Phase	100% CO_2	
Liquid Phase	5% NaCl Solution saturated with H_2S	
Discharge	Cool to ambient release pressure over 45 sec.	

Autoclave Test #11

Property	Test Method	Test Results
Pressure/Temperature	150 psi (1.0 MPa)	Pass
Duration	250˚F (121˚C) 24 hours	
Gas Phase	25% $C0_2$ 55% H_2S 10% Methane 10% N_2	
Liquid Phase	28% NaCl Solution	
Discharge	Cool for 2 hours release pressure over 15 min.	

Autoclave Test #12

Property	Test Method	Test Results
Pressure/Temperature	3000 psi (20.7 MPa)	Slight swell
Duration	300˚F (149˚C) 24 hours	
Gas Phase	10% $C0_2$ 90% Methane Trace H_2S	
Liquid Phase	34% Brine (5% NaCl) 33% Kerosene 33% Toluene	
Discharge	Cool to 104˚F (40˚C) release pressure over 1/2 hr.	

8.16 Taste and Odor Production Potential

Property	Test Method	Test Results
Threshold Odor Number (TON) (Ton of 10 or less is passing)		**TON** 5 days / 10 days 20˚C: 1 / 1 60˚C: 1 / 1 Results: Pass Type Odor: None

8.17 VOC Production Potential

Property	Test Method	Test Results
VOC Analysis	5 day soak cycle	Pass. Appears clean and free of significant VOC contamination

Handling and Safety Precautions

Read all Health Hazard, Precautionary, and First Aid statements foudn in the Material Safety Data Sheet (MSDS) and/or product label of chemicals prior to handling or use.

Important Notice

All statements, technical information, and recommendations related to 3M's products are based on information believed to be reliable, but the accuracy or completeness is not guaranteed. Before using this product, you must evaluate it and determine if it is suitable for your intended application. You assume all risks and liability associated with such use. Any statements related to the product which are not contained in 3M's current publications, or any contrary statements contained on your purchase order shall have no force or effect unless expressly agreed upon, in writing, by an authorized officer of 3M.

Warranty; Limited Remedy; Limited Liability.

This product will be free from defects in material and manufacture for a period of one year from the date of purchase. 3M MAKES NO OTHER WARRANTIES INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. If this product is defective within the warranty period stated above, your exclusive remedy shall be, at 3M's option, to replace or repair the 3M product or refund the purchase price of the 3M product. Except where prohibited by law, 3M will not be liable for any loss or damage arising from this 3M product, whether direct, indirect, special, incidental or consequential regardless of the legal theory asserted.

3M

Corrosion Protection Products
6801 River Place Blvd.
Austin, TX 78726-9000
http://www.3M.com/corrosion

40% Pre-consumer waste paper
10% Post-consumer waste paper

Litho in USA.

Material Safety Data Sheet

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: SCOTCHKOTE 134 Fusion Bonded Epoxy Coating
MANUFACTURER: 3M
DIVISION: Corrosion Protection Products Dept

ADDRESS: 3M Center
St. Paul, MN 55144-1000

EMERGENCY PHONE: 1-800-364-3577 or (651) 737-6501 (24 hours)

Issue Date: 03/04/2004
Supercedes Date: 11/15/2001

Document Group: 10-2546-9

Product Use:
Specific Use: Coating for Metal

SECTION 2: INGREDIENTS

Ingredient	C.A.S. No.	% by Wt
DI(4-HYDROXYPHENOL) ISOPROPYLIDENE DIGLYCIDYL ETHER-DI(4-HYDROXYPHENOL) ISOPROPYLIDENE COPOLYMER	25036-25-3	55 - 75
QUARTZ SILICA	14808-60-7	10 - 20
POTASSIUM ALUMINOSILICATE	1327-44-2	5 - 15
MICA-GROUP MINERALS	12001-26-2	5 - 15
TITANIUM DIOXIDE	13463-67-7	1 - 10
CYANOGUANIDINE	461-58-5	1 - 10
C.I. PIGMENT GREEN 7	1328-53-6	1 - 10
4,4'-ISOPROPYLIDENEDIPHENOL	80-05-7	0.1 - 1

SECTION 3: HAZARDS IDENTIFICATION

3.1 EMERGENCY OVERVIEW

Specific Physical Form: Powder
Odor, Color, Grade: Dark Green Powder

General Physical Form: Solid
Immediate health, physical, and environmental hazards: May cause allergic skin reaction. Contains a chemical or chemicals which can cause cancer.

3.2 POTENTIAL HEALTH EFFECTS

Eye Contact:
Moderate Eye Irritation: Signs/symptoms may include redness, swelling, pain, tearing, and blurred or hazy vision.

Skin Contact:
Moderate Skin Irritation: Signs/symptoms may include localized redness, swelling, itching, and dryness.

Allergic Skin Reaction (non-photo induced): Signs/symptoms may include redness, swelling, blistering, and itching.

Inhalation:
Upper Respiratory Tract Irritation: Signs/symptoms may include cough, sneezing, nasal discharge, headache, hoarseness, and nose and throat pain.

Prolonged or repeated exposure, above recommended guidelines, may cause:
Silicosis: Signs/symptoms may include breathlessness, weakness, chest pain, persistent cough, increased amounts of sputum, and heart disease.

Ingestion:
Gastrointestinal Irritation: Signs/symptoms may include abdominal pain, nausea, diarrhea and vomiting.

Carcinogenicity:
Contains a chemical or chemicals which can cause cancer.

Ingredient	C.A.S. No.	Class Description	Regulation
QUARTZ SILICA	14808-60-7	Group 1	International Agency for Research on Cancer
QUARTZ SILICA	14808-60-7	Known human carcinogen	National Toxicology Program Carcinogens
SILICA, CRYSTALLINE (AIRBORNE PARTICLES OF	NONE	Group 1	International Agency for Research on Cancer

RESPIRABLE SIZE)			
SILICA, CRYSTALLINE (AIRBORNE PARTICLES OF RESPIRABLE SIZE)	NONE	Known human carcinogen	National Toxicology Program Carcinogens

SECTION 4: FIRST AID MEASURES

4.1 FIRST AID PROCEDURES

The following first aid recommendations are based on an assumption that appropriate personal and industrial hygiene practices are followed.

Eye Contact: Flush eyes with large amounts of water. If signs/symptoms persist, get medical attention.

Skin Contact: Remove contaminated clothing and shoes. Immediately flush skin with large amounts of water. Get medical attention. Wash contaminated clothing and clean shoes before reuse.

Inhalation: Remove person to fresh air. If signs/symptoms develop, get medical attention.

If Swallowed: Do not induce vomiting. Give victim two glasses of water. Never give anything by mouth to an unconscious person. Get immediate medical attention.

SECTION 5: FIRE FIGHTING MEASURES

5.1 FLAMMABLE PROPERTIES

Autoignition temperature	*No Data Available*
Flash Point	*Not Applicable*
Flammable Limits - LEL	*Not Applicable*
Flammable Limits - UEL	*Not Applicable*

5.2 EXTINGUISHING MEDIA

Ordinary combustible material. Use fire extinguishers with class A extinguishing agents (e.g., water, foam). Use fire extinguishers with class B extinguishing agents (e.g., dry chemical, carbon dioxide).

5.3 PROTECTION OF FIRE FIGHTERS

Special Fire Fighting Procedures: Wear full protective equipment (Bunker Gear) and a self-contained breathing apparatus (SCBA).

Unusual Fire and Explosion Hazards: Dust clouds of this material in combination with an ignition source may be explosive.

Note: See STABILITY AND REACTIVITY (SECTION 10) for hazardous combustion and thermal decomposition information.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Accidental Release Measures: Observe precautions from other sections. Call 3M- HELPS line (1-800-364-3577) for more

information on handling and managing the spill. Evacuate unprotected and untrained personnel from hazard area. The spill should be cleaned up by qualified personnel. Ventilate the area with fresh air. Collect as much of the spilled material as possible. Use wet sweeping compound or water to avoid dusting. Sweep up. Place in a closed container approved for transportation by appropriate authorities. Dispose of collected material as soon as possible.

In the event of a release of this material, the user should determine if the release qualifies as reportable according to local, state, and federal regulations.

SECTION 7: HANDLING AND STORAGE

7.1 HANDLING

Avoid eye contact with dust or airborne particles. Avoid breathing of dust. Avoid breathing of vapors created during cure cycle. Avoid breathing of dust created by cutting, sanding, grinding or machining. For industrial or professional use only. Avoid skin contact. Avoid skin contact with hot material. Do not eat, drink or smoke when using this product. Wash exposed areas thoroughly with soap and water. Keep out of the reach of children. Resin dust collection equipment should be provided with adequate explosion release.

7.2 STORAGE

Keep container tightly closed. Store away from heat. Store at temperatures which are below 80 degrees F (26 degrees C).

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 ENGINEERING CONTROLS

Provide ventilation adequate to control dust concentrations below recommended exposure limits and/or control dust. Provide appropriate local exhaust when product is heated. Provide ventilated enclosure for heat curing. Curing enclosures must be exhausted to outdoors or to a suitable emission control device. Provide appropriate local exhaust for cutting, grinding, sanding or machining. Provide local exhaust ventilation at transfer points. Use general dilution ventilation and/or local exhaust ventilation to control airborne exposures to below Occupational Exposure Limits and/or control dust, fume, or airborne particles. If ventilation is not adequate, use respiratory protection equipment. When dust and/or vapor is present, the use of respiratory protection is recommended.

8.2 PERSONAL PROTECTIVE EQUIPMENT (PPE)

8.2.1 Eye/Face Protection

Avoid eye contact.
The following eye protection(s) are recommended: Indirect Vented Goggles.

8.2.2 Skin Protection

Avoid skin contact with hot material. Wear appropriate gloves, such as Nomex, when handling this material to prevent thermal burns. Avoid skin contact. Select and use gloves and/or protective clothing to prevent skin contact based on the results of an exposure assessment. Consult with your glove and/or protective clothing manufacturer for selection of appropriate compatible materials.

8.2.3 Respiratory Protection

Avoid breathing of vapors created during cure cycle. Avoid breathing of dust created by cutting, sanding, grinding or machining. Avoid breathing of fumes.
Select one of the following NIOSH approved respirators based on airborne concentration of contaminants and in accordance with OSHA regulations: Half facepiece air-purifying respirator with organic vapor/acid gas cartridges and P95 particulate prefilters, Half facepiece air-purifying respirator with organic vapor/acid gas cartridges and N95 particulate prefilters, Half facepiece air-purifying respirator with organic vapor/acid gas cartridges and P100 particulate prefilters, Half facepiece or fullface air-purifying respirator with organic vapor cartridges and P95 particulate prefilters. Consult the current 3M Respiratory Selection Guide for additional information or call 1-800-243-4630 for 3M technical assistance.

8.2.4 Prevention of Swallowing

Do not ingest. Do not eat, drink or smoke when using this product. Wash exposed areas thoroughly with soap and water. Wash hands after handling and before eating.

8.3 EXPOSURE GUIDELINES

Ingredient	Authority	Type	Limit	Additional Information
4,4'-ISOPROPYLIDENEDIPHENOL	CMRG	TWA	5 mg/m3	
MICA-GROUP MINERALS	ACGIH	TWA - respirable	3 mg/m3	
MICA-GROUP MINERALS	OSHA	TWA - respirable	3 mg/m3	Table Z-1A
QUARTZ SILICA	ACGIH	TWA - respirable	0.05 mg/m3	Table A2
QUARTZ SILICA	OSHA	TWA - respirable	0.1 mg/m3	Table Z-1A
TITANIUM DIOXIDE	ACGIH	TWA	10 mg/m3	Table A4
TITANIUM DIOXIDE	CMRG	TWA - specific form	5 mg/m3	as respirable dust
TITANIUM DIOXIDE	OSHA	TWA, Vacated - as dust	10 mg/m3	
TITANIUM DIOXIDE	OSHA	TWA - as total dust	15 mg/m3	Table Z-1

VAC Vacated PEL:Vacated Permissible Exposure Limits [PEL] are enforced as the OSHA PEL in some states. Check with your local regulatory agency.

SOURCE OF EXPOSURE LIMIT DATA:
ACGIH: American Conference of Governmental Industrial Hygienists
CMRG: Chemical Manufacturer Recommended Guideline
OSHA: Occupational Safety and Health Administration
AIHA: American Industrial Hygiene Association Workplace Environmental Exposure Level (WEEL)

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Specific Physical Form:	Powder
Odor, Color, Grade:	Dark Green Powder
General Physical Form:	Solid
Autoignition temperature	*No Data Available*
Flash Point	*Not Applicable*
Flammable Limits - LEL	*Not Applicable*
Flammable Limits - UEL	*Not Applicable*
Boiling point	*Not Applicable*
Density	*No Data Available*
Vapor Density	*Not Applicable*
Vapor Pressure	*Not Applicable*
Specific Gravity	1.51 [*Ref Std:* WATER=1]
pH	*Not Applicable*
Melting point	*No Data Available*
Solubility in Water	Nil
Evaporation rate	*Not Applicable*

Volatile Organic Compounds	0 %
Percent volatile	0 %
VOC Less H2O & Exempt Solvents	0 %
Viscosity	*Not Applicable*

SECTION 10: STABILITY AND REACTIVITY

Stability: Stable.

Materials and Conditions to Avoid: None known

Hazardous Polymerization: Hazardous polymerization will not occur.

Hazardous Decomposition or By-Products

Substance	Condition
Aldehydes	During Combustion
Carbon monoxide	During Combustion
Carbon dioxide	During Combustion
Oxides of Nitrogen	During Combustion

SECTION 11: TOXICOLOGICAL INFORMATION

Please contact the address listed on the first page of the MSDS for Toxicological Information on this material and/or its components.

SECTION 12: ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION

Not determined.

CHEMICAL FATE INFORMATION

Not determined.

SECTION 13: DISPOSAL CONSIDERATIONS

Waste Disposal Method: Cure (harden, set, or react) the product according to product instructions.
Dispose of completely cured (or polymerized) wastes in a sanitary landfill.
As a disposal alternative, incinerate uncured product in an industrial or commercial incinerator in the presence of a combustible

material.

EPA Hazardous Waste Number (RCRA): Not regulated

Since regulations vary, consult applicable regulations or authorities before disposal.

SECTION 14:TRANSPORT INFORMATION

ID Number(s):
80-6101-5431-4

Please contact the emergency numbers listed on the first page of the MSDS for Transportation Information for this material.

SECTION 15: REGULATORY INFORMATION

US FEDERAL REGULATIONS

Contact 3M for more information.

311/312 Hazard Categories:
Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No Immediate Hazard - Yes Delayed Hazard - Yes

STATE REGULATIONS

Contact 3M for more information.

CHEMICAL INVENTORIES

The components of this product are in compliance with the chemical notification requirements of TSCA.

Contact 3M for more information.

INTERNATIONAL REGULATIONS

Contact 3M for more information.

This MSDS has been prepared to meet the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200.

SECTION 16: OTHER INFORMATION

NFPA Hazard Classification

Health: 2 **Flammability:** 1 **Reactivity:** 0 **Special Hazards:** None

National Fire Protection Association (NFPA) hazard ratings are designed for use by emergency response personnel to address the hazards that are presented by short-term, acute exposure to a material under conditions of fire, spill, or similar emergencies. Hazard ratings are primarily based on the inherent physical and toxic properties of the material but also include the toxic properties of combustion or decomposition products that are known to be generated in significant quantities.

HMIS Hazard Classification

Health: 2 **Flammability:** 1 **Reactivity:** 0 **Protection:** X - See PPE section.

Hazardous Material Identification System (HMIS(r)) hazard ratings are designed to inform employees of chemical hazards in the workplace. These ratings are based on the inherent properties of the material under expected conditions of normal use and are not intended for use in emergency situations. HMIS(r) ratings are to be used with a fully implemented HMIS(r) program. HMIS(r) is a registered mark of the National Paint and Coatings Association (NPCA).

Reason for Reissue: The MSDS has been revised because 3M has adopted the 16-section ANSI/ISO format. The potential hazards of the product have not changed. We encourage you to reread the MSDS and review the information.

No revision information is available.

DISCLAIMER: The information in this Material Safety Data Sheet (MSDS) is believed to be correct as of the date issued. 3M MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR COURSE OF PERFORMANCE OR USAGE OF TRADE. User is responsible for determining whether the 3M product is fit for a particular purpose and suitable for user's method of use or application. Given the variety of factors that can affect the use and application of a 3M product, some of which are uniquely within the user's knowledge and control, it is essential that the user evaluate the 3M product to determine whether it is fit for a particular purpose and suitable for user's method of use or application.

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3M MSDSs are available at www.3M.com

Cardinal's 6400 Series catalyzed with 340HP is a High Solids Aliphatic two-component polyurethane coating ideally suited for use on metal and plastic where exterior durability, color control, and ease of application are essential. The 6400 Series was formulated to meet stringent air quality regulations, while maintaining the benefits of a conventional polyurethane coating. Cardinal's 6400 Series High Solids Polyurethane coatings are available in a full selection of colors and glosses, including Federal Standard 595b colors, metallics, hammertone finishes and clears.

TYPICAL USES:

- Top coat for decorative and protective use on metal, plastic and interior wood products.
- Top coat of maintenance coating system.
- Electronic enclosures.
- Trailers and vehicles.
- Machinery.
- Marine equipment.

BENEFITS:

- Low VOC – 340 grams / liter.
- Very high gloss.
- Excellent chemical and solvent resistance.
- UL approved (phosphatized steel electronics enclosures)
- Complete range of colors, glosses, textures and hammertones are available.

CURED FILM PROPERTIES:

Unless otherwise indicated, testing conducted on 6409-10 gloss white catalyzed with 340HP at 1.5 mils DFT over 20 gauge Bonderite 1000 cured 30 min. at 180° and air dried 14 days.

TEST	METHOD	PARAMETERS	RESULT
Adhesion	ASTM D3359	Cross-hatch tape	0% failure
Hardness	ASTM D3363	Pencil	H
Abrasion	ASTM D4060	CS-17 wheels, 1 kg, 1000 cycles	Less than 100 mg loss
Humidity	ASTM D2247	168 hrs	No effect
Salt Spra	ASTM B117	1000 hrs 95°, 5% salt solution	Less than 3/16" creepage along scribe, otherwise, no effect
UV Light	ASTM G53	1000 hrs	90.3% gloss retention
Solvent Resistance	ASTM D4752	MEK 100 rubs IPA 200 rubs	No effect No effect
Chemical & Stain Resistance	ASTM D1308 30 min. spot A: No effect B: Slight dulling C: Moderate effect D: Discolored & softened	A – 0.1N HCl, 30 wt. motor oil, ammonia, butyl carbitol, butyl cellosolve, Cascade, Clorox, Coca Cola, coffee, diethyl ether, Drano, Fantastic, fiber pen ink, floor stripper, gasoline, IPA, Ivory Liquid, lanolin lotion, lemon juice, Snap, Spic & Span, tap water, vegetable oil, water base ink, WD-40. B – TCA, ball point pen ink, carbon disulfide, correction fluid, Freon TF, MEK, methylene chloride, nail polish, tetrahydranfuran. C – chloroform. D – solvent base ink.	

FOR INDUSTRIAL USE ONLY
NOT FOR RESIDENTIAL USE

(Continued on page 2)

TYPE: Aliphatic (linear) polyester polyurethane.

COMPONENTS: Two.

COLORS: Full range including Fed. Std. 595b.

GLOSS: High, semi and flat.

MINIMUM ORDER: 1 gal. Of 6400 base; 1 qt. Of 340HP.

COVERAGE: At 2.0 mils DFT at 65% transfer efficiency.
Mixed paint, VOC at 340 gms/liter: 310 ft^2/gal
Mixed paint, VOC at 420 gms/liter: 260 ft^2/gal

VOC MIXED: 340 grams/liter (2.8 lbs/gal) minimum. See mix ratio table below.

VOLUME SOLIDS:

		(VOC)
6409 gloss base	53%	(395 gms/l)
6400 S/G base	60%	(337 gms/l)
340HP	87%	(114 gms/l)
Mixed to 340 gms/l	60%	
Mixed to 420 gms/l	49%	

FLASH POINT:: 6400 = 24°F TCC; 340HP = 72°F TCC.

SHELF LIFE: 1 year from date of manufacture on the unopened container.

APPLICATION: After preparing the surface, mix the components together well in the amount needed for use within the sprayable pot life. The base to catalyst proportion must be measured accurately to obtain optimum film properties. Do not use reducers that contain water or alcohol – these react with the catalyst and can cause a variety of problems. Brushing, rolling dipping are not recommended.

VISCOSITY: Will vary depending on color and gloss at a given VOC. At 340 gms/l, most gloss colors will be in the range of 25"-30" #3 Zahn cup. Most semi gloss colors will be in the 30"-40" #3 Zahn range. At 420 gms/l, 28"-32" #2 Zahn can be expected for most colors.

MIX RATIOS: Two components must be mixed properly to obtain a cured film. Thinning depends on applicator's regulatory limitations.

Parts are by volume	COLORS FULL GLOSS	COLORS SEMI GLOSS	CLEARS ALL GLOSS
6400 base	4	5	4
340HP catalyst	1	1	1
1600-0# reducer			
for 340 gms/l	0	½	0
for 420 gms/l	1	1 ½	1

RECOMMENDED FILM THICKNESS: 1.5 – 2.5 mils

CURE:

	Air Dry	Force Dry *
Tack free	2 hrs.	1 hr at 120° F
Dry to handle	24 hrs.	30 min at 140° F
Dry hard	72 hrs.	15 min at 180° F

(At 1.5 mils dry film thickness, 78° F, 50% RH)

* Some air quality regulations require a maximum temp. of 194° F to qualify as an "air dry" system which generally have higher VOC limits than baking systems.

SPRAYABLE POT LIFE: 2-3 hrs. at 340 gms/l
4-5 hrs. at 420 gms/l

(Continued on page 2)

SURFACE PREPARATION AND PRIMING: The most important steps in a successful coating process are cleaning, pretreatment and priming. The following is a brief outline of some basics for unpainted substrates. It is not intended to be all-inclusive. For more information on your particular application, do not hesitate to call Cardinal.

Cleaning the substrate: All surfaces to be coated must be free of dirt, grease, oil, oxidation, mill scale, and all other contaminants. The surface must be thoroughly dry before painting. Air quality regulations have limited the allowable emissions from cleaning operations, eg., SCAQMD Rule 1171 Solvent Cleaning Operations. Cardinal supplies products that comply with this rule.

Steel — A phosphate chemical conversion coating is highly recommended. When this is not possible, a vinyl acid wash pretreatment primer is recommended such as Cardinal's 4860 series primers. UL approval on our product requires a minimum of a three stage phosphatizing process.

Aluminum — A chemical conversion coating is highly recommended. When this is not possible, a vinyl acid wash pretreatment primer is recommended such as Cardinal's 4860 series primers.

Galvanized — Cardinal's W-303-A surface preparation solution helps improve adhesion followed by a vinyl acid wash pretreatment primer such as Cardinal's 4860 series primers.

Stainless Steel — Brush-off blast clean per SSPC-SP 7 to a uniform profile of 1.5 mils. Cardinal's W-303-A surface preparation solution can help improve adhesion followed by a vinyl acid wash pretreatment primer such as Cardinal's 4860 series primers.

Plastic — Any mold release should be completely removed. 6400 series polyurethane is compatible with a variety of plastics, however, since there are numerous different formulations of plastic, a trial sample should be painted and checked before running production. If 6400 attacks or weakens the plastic, a barrier coat of 3777-1 clear waterborne acrylic enamel may help.

Wood — 6400 series is not recommended for exterior wood applications. Because of the wide variety of woods and possible appearance variations, it is recommended that your particular application be discussed with a Cardinal sales representative or our in-house technical service staff.

PRIMER SELECTION:

PRODUCT NO.	DESCRIPTION	FUNCTION
6460-4702	Polyurethane Gray	Corrosion resistance, some surfacing
7063-20	Epoxy Mastic Gray	Very high build, corrosion resistance, abrasion resistance, chemical resistance
7160-4702	Epoxy Gray	Corrosion resistance, chemical resistance
3777-1	Waterborne Acrylic Clear	Barrier coat for some plastics

TROUBLE SHOOTING:

PROBLEM	CAUSE	REMEDY
Blisters, pin holes or solvent pop	Water contamination. Entraped air. Entraped solvent	Eliminate water – Chck air lines. Use fresh catalyst. Use urethane grade thinners. Increase atomization, decrease ffilm build.
Craters	Contaminated abient air, ie., silicone mist, dust.	Locate and eliminate source of contamination.
Fish-eyes	Substrate contamination.	Clean and prepare substrate.
Not drying	Alcohol in reducer. Wrong catalyst ratio.	Use Cardinal's 1600 series or urethae grade reducetrs only. Double check mix ratio.
Poor adhesion	Improper surface preparation.	See surface preparation section.
Gloss variation	Variation in application, cure schedule, catalyst ratio,	Consistent gloss depends upon consistent process, eg., air dried parts will not have some

PRODUCT IDENTIFICATION

6 4 0 9 – 1 1 3 5 0 (example)

- 1 1 3 5 0 — Color number
- 9 — Gloss: 0 = flat; 1 = 10°; 2 = 20° . . . etc.; 70° - 90°+ = high gloss
- 0 — Special: eg., 2 = metallic; 3 = hammer; 4 = texture; 6 = primer; 7 = clear
- 6 4 — Product type

EQUIPMENT: Most air quality regulations require the paint application transfer efficiency to be 65% of better. This generally means using electrostatic or high volume low pressure (HVLP) spray guns. Otherwise, conventional pressure feed, airless or air assisted airless spray equipment can be used. Air supply lines need water and oil traps.

CLEAN-UP: Clean up should be done as soon as possible keeping in mind the pot life of the mixed paint. Avoid leaving catalyzed paint in the lines. The drier the paint, the more resistant it is to clean up. Air quality regulations have limited the allowable emissions from cleaning operations.

PRODUCT LIMITATIONS:

- Catalyst reacts with water. Air supply should be dry. Containers should be kept tightly closed. Use urethane grade thinners only.
- Alcohols and glycols interfere with curing chemistry and should be avoided. They ca be found in some lacquer thinners and certain synthetec reducers.
- Optimum film properties are dependent upon proper mixing of paint and catalyst.
- Orders for semi gloss must specity cure method - air dry or force dry. Force drying will yeild a lower gloss that air drying.

SAFETY: Refer to the product's Material Safety Data Sheet (MSDS) for complete safety information.
Contains organic solvents. Use with adequate ventilation - do not breath vapors or spray mists. If component TLVs are exceeded, a NIOSH approved air supplied respirator is advised. See MSDS for TLV information.
Contents are FLAMMABLE. Keep from heat, sparks or open flame.
Allergic reactions are possible. Avoid se by persons with repiratory problems.
Avoid contact with eyes, skin, and clothing. Wash thoroughtly after handling.
FIRST AID:
Eye contact: flush immediately with plenty of water for at least 15 min. and get medical attention.
Skin contact: wash thoroughly with soap and water for 5 minutes.
If swallowed, do not induce vomiting and get medical attention immediately.

RELATED PRODUCTS:

PRODUCT NO.	DESCRIPTION
1600 Series Reducers	Thinners. Urethane grade. 1600-01, fast; 1600-02, medium; 1600-03, slow; 1600-06, very slow.
EL-005	Accelerator. Speeds up dry time (and shortens pot life).
J-3081	Surfactant. Helps eliminate blisters, bubbles, pin holes, solvent-pop.
P-5033	Surfactant. Helps eliminate craters and fish-eyes.
340LASG	Aromatic catalyst. For interior applications. See data sheet.
"G" series	Anti-Grafiti modification. High gloss only.
UV additive	Provides extra protection against ultraviolet degredation.

CARDINAL INDUSTRIAL FINISHES **EMERGENCY PHONE:** (800) 424-9300 CHEMTREC
1329 POTRERO AVE PREPARED BY: Richard A. Stewart
S. EL MONTE, CA 91733

INFORMATION PHONE: (626) 444-9274 or (323) 283-9335 FAX: (626) 444-0382

HMIS Codes

H	F	R	P
2 *	3	0	X

SECTION I PRODUCT INFORMATION

PRODUCT: 6407-6409 SERIES POLYURETHANE EXTREME HIGH GLOSS
GENERAL DESCRIPTION: Industrial Solventborne Paint

SECTION II HAZARDOUS INGREDIENTS

INGREDIENT	EXPOSURE LIMITS	V. P. (mmHg @ 20°C)	CAS No.	% WT
Methyl Amyl Ketone	OSHA PEL: 100 PPM; ACGIH TLV: 50 PPM	2.1	110-43-0	15% - 20%
n-Butyl Acetate -U.G.	OSHA PEL: 150 PPM; ACGIH TLV: 150 PPM	10	123-86-4	10% - 15%
*> Methyl Ethyl Ketone, U.G.	OSHA PEL: 200 PPM; ACGIH TLV: 200 PPM	70	78-93-3	1% - 5%

* Indicates toxic chemical(s) subject to the reporting requirements of section 313 of Title III (de min. 1.0%).
> Indicates a chemical regulated by EPA Clean Air Act Section 112(b) - Hazardous Air Pollutants.
! Indicates a substance regulated by AB2588 Air Toxic Hot Spots for which emissions must be quantified.

SECTION III PHYSICAL DATA

BOILING RANGE: 175 deg F - 304 deg F
VAPOR DENSITY: Heavier than air **SPECIFIC GRAVITY:** 1.37
EVAPORATION RATE: Slower Than Ether **WEIGHT PER GALLON:** 8.50 - 11.0 lb/gl
% VOLATILE BY VOLUME: 46 - 48 **% VOLATILE BY WEIGHT:** 30 - 39
% SOLIDS BY VOLUME: 52 - 54 **% SOLIDS BY WEIGHT:** 61 - 70
% EXEMPT BY VOLUME: 0.000 **% EXEMPT BY WEIGHT:** 0.000
VOC CONTENT: EXCLUDING EXEMPT: 3.30 lb/gl 396 g/l
INCLUDING EXEMPT: 3.30 lb/gl 396 g/l
MIX 4 PARTS PAINT TO 1 PART 340-HP CATALYST TO 1 PART 1600-02 REDUCER:
EXCLUDING EXEMPT: 3.50 lb/gl 420 g/l
INCLUDING EXEMPT: 3.50 lb/gl 420 g/l

SECTION IV FIRE AND EXPLOSION RISKS

FLAMMABILITY CLASSIFICATION: Flammable Liquid Class 1B
FLASH POINT: 24 deg F **METHOD:** TCC **L.E.L.:** 1.1 **U.E.L.:** 11.4
EXTINGUISHING MEDIA: Foam, alcohol foam, CO2, dry chemical, water fog.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Containers may deform or explode when exposed to extreme heat. Decomposition products may yield oxides of carbon and nitrogen.

SPECIAL FIREFIGHTING PROCEDURES: Self-contained breathing apparatus with full facepiece operated in pressure demand or other positive pressure modes.

SECTION V HEALTH HAZARD DATA

EFFECTS OF OVEREXPOSURE:
SKIN CONTACT: Moderate irritation possible from prolonged exposure; defatting and dermatitis.
EYE CONTACT: Moderate irritation, redness, tearing and itching sensation.
INHALATION: May cause nasal irritation, headache, dizziness, nausea, weakness or vomiting. Loss of consciousness.
INGESTION: Can cause gastrointestinal irritation, headache, dizziness, nausea and weakness.
ACUTE: Can cause moderate skin irritation, defatting, dermatitis and tingling sensation. Can cause moderate eye irritation, redness, tearing and blurred vision.
CHRONIC: May produce liver and kidney damage, persistent coughing, brain damage and may even cause death.

CARCINOGENICITY: This product contains: NONE
(No carcinogenic chemicals are present)

MEDICAL CONDITIONS PRONE TO AGGRAVATION BY EXPOSURE: Pre-existing respiratory conditions, Pre-existing skin disorders, liver and kidney disorders and allergies.

PRIMARY ENTRY ROUTES OF EXPOSURE: Dermal and Inhalation

EMERGENCY AND FIRST AID PROCEDURES:
EYE CONTACT: Flush with large quantities of water for 15 to 30 minutes. Get medical attention.
SKIN CONTACT: Wash exposed area with mild soap and water for 15 minutes. Remove contaminated clothing.
INHALATION: Remove victim to fresh air. If breathing is difficult, administer oxygen. If breathing has stopped, give artificial respiration. Get immediate medical attention.
INGESTION: < DO NOT INDUCE VOMITING > Keep victim warm and seek immediate medical attention.

SECTION VI REACTIVITY DATA

STABILITY: Stable.
HAZARDOUS POLYMERIZATION: Will not occur.
CONDITIONS TO AVOID: Extremely high temperatures.
INCOMPATIBILITY (MATERIALS TO AVOID): Avoid contact with strong oxidizing agents.
HAZARDOUS DECOMPOSITION OR BY PRODUCTS: Hazardous decomposition may produce carbon dioxide and/or carbon monoxide.

SECTION VII SPILL AND LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Refer to Sections IV, V, VI, VII and VIII. Eliminate all sources of ignition; absorb liquid in absorbent material and prevent spreading to ground water.

WASTE DISPOSAL METHOD: Recycle whenever possible or destroy by liquid incineration in accordance with applicable regulations. Contaminated absorbent should be incinerated or sent to an approved landfill in accordance with Local, State, and Federal Regulations.

SECTION VIII SAFE HANDLING AND USE INFORMATION

RESPIRATORY PROTECTION: If TLV of the product or any component is exceeded, a NIOSH approved Air Supplied Respirator is advised in absence of environmental control. OSHA Regulations also permit other NIOSH Respirators under specified conditions. (See your Safety Equipment Supplier) Engineering or administrative controls should be implemented to reduce exposure. When coating is catalyzed, low levels of isocyanates are present. See MSDS sheet for catalyst specific information on compounds present in catalyst. In lieu of air monitoring, air supplied respirators are suggested for spray application.

VENTILATION: Provide sufficient mechanical (General and/or local exhaust) Ventilation to maintain exposure below the TLV's.

PROTECTIVE GLOVES: Wear resistant gloves such as: polyvinyl alcohol coated or polyethylene.

EYE PROTECTION: Wear OSHA approved chemical splash goggles. (Consult your safety equipment supplier)

OTHER PROTECTIVE EQUIPMENT: Prevent repeated or prolonged skin contact with GB Protective Handcream, wear impervious clothing and chemical resistant boots.

HYGIENIC PRACTICES: "Wash hands before eating or using the rest room, smoke in smoking areas only."

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Containers may be hazardous when emptied, since emptied containers may retain product residuals (Vapors, Liquid, and/or Solids), All precautions given in this data sheet must be observed. Store at room temperature away from heat sources, and have lids tightly closed.

OTHER PRECAUTIONS: Paint and solvents have been linked liver abnormalities, kidney and lung damage. For Industrial Use Only with adequate ventilation. Follow precautions of this Material Safety Data Sheet to prevent exposure.

SECTION X SHIPPING INFORMATION

D.O.T. SHIPPING NAME : Paint
D.O.T. HAZARD CLASS : 3
UN/NA NUMBER : UN1263
PACKAGING GROUP : PG II
D.O.T. LABELS REQUIRED : Flammable

SECTION XI OTHER REGULATORY INFORMATION

Toxic Control Act: All components of this product are listed on the EPA TSCA Inventory or exempt from notification.

Canadian Environmental Protection: All of the components of this product are approved and listed on the Canadian Domestic Substance List or exempt from notification requirements.

California Proposition 65:
This product contains no chemicals reportable under Proposition 65.

The information contained in this Material Safety Data Sheet is considered to be true and accurate. Cardinal Industrial Finishes makes no warranties, expressed or implied, as to the accuracy and adequacy of this information. This data is offered solely for the user's consideration, investigation and verification.

atec systems associates, inc.

APPENDIX D

BACKWASH COMPONENTS DOCUMENTATION

ATEC BACKWASH FILTERS

FOR

ATEC SYSTEMS TREATMENT EQUIPMENT FOR PUBLIC DRINKING WATER

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BACKWASH SYSTEM DOCUMENTATION

ATEC SYSTEMS TREATMENT EQUIPMENT FOR PUBLIC DRINKING WATER

ATEC Systems Associates, Inc.
Backwash Valve and Control System Documentation

This booklet presents the technical specifications and data as well as performance characteristics for the backwash systems that we use in our drinking water systems.

ATEC Systems uses the same high-quality components for every filter system it manufactures for use in public drinking water systems. The system includes either an AlexTronix controller (F4/F8, FM8 or F12/F16) or a PLC; Peter Paul solenoid valves; and Bermad backwash valves. We have chosen the components for the reliability, easy of maintenance, and availability.

Controller

Whether your controller is our standard F series AlexTronix controller or our PLC, the controller is responsible for initiating the backwash cycle and the duration of the backwash. (The flow is controlled by a restrictor valve on the discharge side of the backwash line.) The backwash cycle can also be initiated by your SCADA system or the site PLC. The controller is mounted in a NEMA 4X box and is UL labeled. The controller box comes with a fiberglass see through hinged cover so the operator can see what is going on while reducing the possibility of the controller getting wet.

Solenoids

The backwash valves are actuated by electronic solenoids attached to a tree on the filter system or board mounted with the controller on the wall. The standard solenoid is a series 73 Peter Paul solenoid. A signal from the controller actuates an electromagnet, opening the solenoid and supplying air or water pressure to the front of the backwash valve.

Backwash Valves

ATEC Systems uses Bermad Series 350 backwash hydraulic valves on its filter vessels. The Series 350 Valves are diaphragm actuated 3-port valves in a tee configuration. The diaphragm assembly keeps the supply port closed while opening the backwash port and visa versa.

Alex-Tronix
FILTER MASTER SERIES

FM-8UL Filter Backwash Controller Operation Manual

IMPORTANT: Prior to use, please read manual in order to avoid system damage.

REV. 040218

FM-8UL Operation Manual

Thank you for purchasing the Alex-Tronix filter controller-- manufactured in the U.S.A. The FM-8UL is our latest controller accommodating our digital differential pressure gauge (included), yet compatible to the Murphy switch gauge. Additionally, the FM-8UL features 'progressive backwashing' which allows every new cycle to start cleaning a different tank for better backwashing performance. Finally, the FM-8UL features an external start input for remote backwash initiation, making it easy for PLC control.

INSTALLATION:

Refer to separate Installation Manual prior to use.

CONTROLS:

Power: Use this switch to turn controller on or off. When power is removed from the unit by any means, all programmed settings are retained in flash memory. The FM-8UL always resumes operation at the point where the controller was turned off, when later powered back on. There is no "real time clock" in the controller.

Function Selector Knob: Use this knob to select which function you wish to view or program. There is no specific setting this knob must be set to for normal operation, and will normally operate as long as the FM-8UL is correctly programmed.

Select: This pushbutton selects what part of the function you will program. The cursor blinks when selected.

+ and - : These two pushbuttons allow you to edit any parameters up or down within a function.

Enter/Manual Start: Pressing this pushbutton sets the parameters desired. You must press **'ENTER'** after changing any parameters when programming the unit. Once programmed, if desired, you can manually initiate a backwash when the function knob is on the "STATUS" position.

PROGRAMMING (FUNCTIONS):

STATUS: This function displays what mode the controller is in. Typical modes can include: Filtering, Pre-dwell, Tank Backwashing Number, and Dwell. Unit shown in filtering mode below:

P.D. DIFFERENTIAL SETTING: Use this setting to set the trigger point for the sensor gauge based on the SENSOR/GAUGE TYPE function. If the function is set for *"P.D. GAUGE"* then this display will show: *"SET DIFFERENTIAL PSI ON GAUGE"* and no adjustable parameter is available. If the SENSOR/GAUGE TYPE function is set for *"SENSOR"*, then a differential trigger setting will be available for adjustment. Press SELECT, +, and - to set the backwash trigger point of the sensor.

7 PSI is the default setting if programmed for 'SENSOR'. Set as needed. Press ENTER when finished.

SENSOR SET POINT: 07.0 PSI	**OR**	SET DIFFERENTIAL PSI ON GAUGE

PRE-DWELL TIME: This is a delay time used to build system pressure in orchestration with the pressure sustaining master valve, in order to ensure valves open and close on systems with smaller pumps. Press SELECT, +, and - to set the delay time (up to 255 seconds) before the unit goes into backwash mode.

BACKWASH TIME: This sets the cleaning duration for each filter tank. Press SELECT, +, and - to set the time (up to 255 seconds) per tank. Press ENTER when finished. If the unit has no backwash time programmed, NO BACKWASH TIME is displayed.

DWELL TIME: This sets idling time between tank backwashes in order to maintain system pressure, and allow valves enough time to open and close as backwashing progresses. Press SELECT, +, and - to set the delay time (up to 99 seconds). Press ENTER when finished.

PERIODIC TIME: This sets backwashing *cycle intervals*. It is independent from the P.D. gauge initiation; however, if the gauge triggers a backwash cycle before a periodic interval initiates one, the periodic's internal time clock will reset to zero when a backwash starts, and begins timing up again. After a cycle is complete, the controller reverts back into filtering mode, the periodic time resets to zero, and periodic timing begins again. **NOTE: If the set periodic time (including dwell) is less than the total backwash cycle time, the controller will continuously start another backwash (loops).**

P.D. DELAY TIME: Intermittent surge pressure in a filter system can trigger the controller which could cause 'nuisance triggering' of a backwash cycle unnecessarily. Adding P.D. delay time alleviates unnecessary backwashing, and allows 'gauge bouncing' to stabilize before a legitimate pressure reading is taken. Press SELECT, +, and - to set the delay time (up to 255 seconds). Contact filter manufacturer for recommended settings.

TANK ASSIGN: Depending on how many filter tanks there are, you can activate/deactivate any of them --up to eight. Press select, and move along to each tank number, then use "+" or "-" to activate or deactivate that tank; when finished, press enter. If all tanks have been unassigned, "TANKS UNASSIGNED" will be shown on the display. By default, all tanks are assigned on.

BACKWASH TANK SEQUENCE: There are two orders for backwashing --*Sequential* and *Progressive. Sequential* backwashing traditionally starts with Tank 1, 2 ...8 *in order* every time a new cycle starts. *Progressive* backwashing starts by cleaning (rotates) a *different tank* every time a new cycle starts i.e. 1,2,3,4...8 then 2-8,1 then 3...8,1,2, etc, etc. This can be used to help all tanks clean evenly and keep water flow consistent through all tanks while filtering.

BACKWASH CYCLE COUNT: This function displays how many backwashes have occurred since it was last cleared. To reset the count to zero, press select, then select over to 'Y', and ENTER/MANUAL START push button.

SOLENOID TYPE: The FM-8UL is compatible to 24VAC, 12VDC non-latching, and 12VDC latching solenoids. Default solenoid setting is 'NON-LATCHING' mode. To change to Latching mode (12VDC input only), press select twice, and press enter. You must also set the output switch (located on rear panel) to the correct configuration. Referring to earlier discussion, your options are as follows: For 120/240VAC power supply input, the output switch can be set for AC or DC. For 12VDC power supply

input, whether from a DC generator or solar panel set up, set the output switch to DC.

SENSOR/GAUGE TYPE: If you will using the traditional 'Murphy switch gauge' choose **GAUGE.** If using the Alex-Tronix sensor, choose **SENSOR** and press the ENTER/MANUAL START push button.

OPERATING CHARACTERISTICS

NOTE: **It is important to always have backwash time and a tank assignments properly set, otherwise system damage may result.** The FM-8UL initiates a backwash cycle by: Manual start, differential pressure, and/or periodic time. When backwashing initiates, the FM-8UL moves out of filtering mode, and individually cleans each tank. Note the 'M' (master output terminal) remains active during the whole backwash cycle, then turns off when the unit goes back into filtering mode. The filter system's differential pressure drops when a cycle is complete, and the tanks are deemed washed. If the pressure does not drop after a backwash cycle, troubleshooting of the filter system itself should be performed, beginning with solenoid and valve maintenance. Additional troubleshooting resources on controls can be sought out on the tech support page on the web at: www.alextronix.com. Contact the manufacturer for filter system maintenance or service.

FUSE WARNING: Should the output fuse ever blow, a red LED on the front panel next to the output fuse will illuminate. This fuse is located on the front panel. The following symptoms should be examined before replacing the fuse:

- Solenoids defective or become defective when heated for long periods.
- Primary voltage too high.
- Short circuit in solenoid wiring.
- If a newly installed system is in place, incorrect wiring should be considered.
- Power surge damage.

The display will clear the fault, after the short circuit is resolved, fuse is replaced, and a backwash cycle is initiated.

CAUTION: Replace fuse with same type only! – 3A ATO fuse.

For any questions or help regarding this controller please contact us at 1-888-224-7630.
For questions regarding you filter system, contact the manufacturer.

ALEX-TRONIX --A DIV. OF GNA INDUSTRIES, INC.
4761 W. Jacquelyn Ave., Fresno CA. 93722
TEL: 559-276-2888 FAX: 559-276-2890 Toll Free: 888-224-7630 www.alextronix.com

WARRANTY

Suppliers and end users of this product agree to the following terms, conditions and limitations of warranty and liability coverage:

Alex-Tronix warrants the FM-8UL to be free from original defects for two years from the date of original sale. The manufacturer shall replace, free of charge any part found defective under normal use and service within the guarantee period, provided the product is installed, used, and maintained in accordance with any applicable instructions or limitations issued by Alex-Tronix. Components supplied replacement parts are warranted for 90 days from the date of shipment. The manufacturer assumes no liability for incidental or consequential damage sustained in the adoption or use of our engineering data, service, or products. Liability is therefore limited to the repair of the product manufactured by Alex-Tronix. No agent or representative of Alex-Tronix has the authority to waive or add to this agreement. Altered products, or use of products in a manner not intended shall void this warranty. For warranty service, ship unit pre-paid to the address below. Controllers damaged in transit due to improper packaging are not covered by warranty.

For warranty repair, send defective product freight pre-paid to:

Alex-Tronix Controls Div. GNA Industries - 4761 W. Jacquelyn Ave. Fresno, CA. 93722 - Tel: (888)-224-7630 Fax: (559) 276-2890
www.alextronix.com - orders@alextronix.com

Alex-Tronix
FILTER MASTER SERIES

FM-8UL Filter Backwash Controller Installation Manual

IMPORTANT: Prior to use, please read manual in order to avoid system damage.

REV. 040218

FM-8UL Installation Manual

Thank you for purchasing the Alex-Tronix FM-8UL filter controller-- manufactured in the U.S.A. The FM-8UL is our latest accommodating our digital differential pressure gauge (included), yet compatible to the Murphy switch gauge. Additionally, the FM-8UL features 'progressive backwashing' which allows every new cycle to start cleaning a different tank for better backwashing performance. Finally, the FM-8UL features an external start input for remote backwash initiation, making it easy for PLC control.

INSTALLATION:

The FM-8UL's enclosure is a UL listed filter backwash controller that meets or exceeds NEMA 4X IP66 specifications. There are a few ways to install the enclosure, and must be done prior to wiring.

After unpacking, place the unit face down on a soft surface, and choose one of two mounting styles from the pictorial below. You can use 4 tabs 'E' or both braces 'D' as the enclosure's mounting support mechanism. 'D' brackets should be used if matching the mount for an existing metal Alex-Tronix enclosure. Attach mounting brackets using the provided #10 x 5/8" plastic threading screws. Fasten to mounting surface both top and bottom. See Fig. 1 below:

Ensure the unit's mount is level, and test by opening the enclosure's door by turning both catch lock knobs 90 degrees, then unsnap both catches, and swing the door open. Ensure the door opens and closes freely with no obstructions.

Using a phillips screwdriver, remove the two screws on the right side of the front panel, then swing out the front panel. The wiring terminal is now exposed, and is ready for wiring.

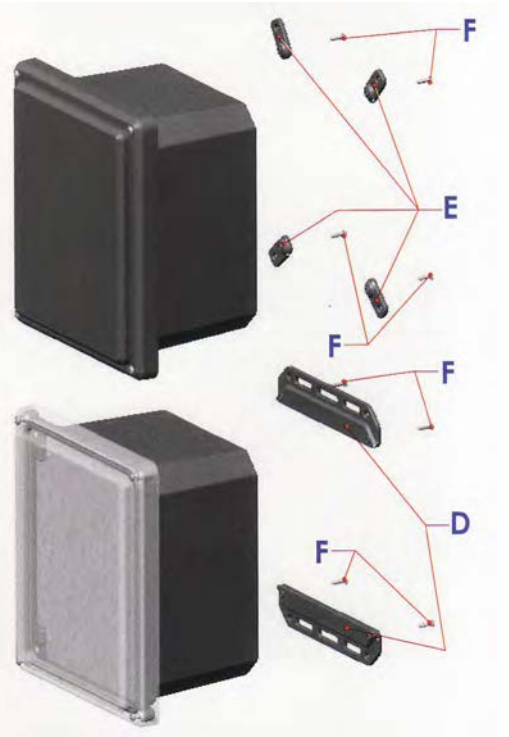


Fig. 1

Output selector: Prior to operating, on the rear of the main panel circuit board (bottom right), set the solenoid output selector switch to match the solenoid type you have– Compatible to: 24VAC (left position) or 12VDC or 12VDC Latching (right position) marked in white:

Fig. 2

Pressure Differential Gauge: Depending on the gauge type you have– Murphy Switch Gauge or the Alex-Tronix digital gauge, locate a mounting area either on the filter manifold, or the FM-8UL's enclosure itself (mounting bracket required for Murphy). You may require extra color coded (20-18 AWG) wire to reach controller terminals.

WIRING: (Refer to Figures 3-8)

NOTE: Wiring must be performed by a certified electrician, and done in a manner to adhere to all local electrical and or building codes. Incorrect wiring may damage unit, and makes the unit exempt from factory warranty coverage. Safety is first priority. In order to maintain NEMA 4x rating please utilize a liquid tight and corrosion resistant conduit system. Prior to wiring, consult with local code enforcement to ensure compliancy.

INPUT VOLTAGE WIRING:

The FM-8UL accommodates a single phase input voltage of: 115VAC or 230VAC @50/60HZ.

PRIMARY SUPPLY CONNECTIONS: A/C wiring connections are made within the primary wiring compartment (See Fig. 3). To maintain the NEMA 4x requirement, use liquid tight conduit, flexible, non metallic conduit –Type NM, LFNC-B or FNMC-B. A 1/2" conduit hub is provided (See Fig. 4). For other conduit systems, consult with local code enforcement.

Branch circuit wire must be of minimum size per NFPA requirements. A minimum of 12AWG --Type THHN or THWN is recommended.

Remove the control panel and then the primary wiring compartment cover. Connect both black and white primary transformer wires to the branch circuits **HOT** and **NEUTRAL** wire; primary transformer wires have no polarity. Next, connect the safety ground (**GREEN** wire-- attached to chassis) to the branch circuits ground wire. The transformer's secondary wires are pre-connected from the factory. Use safety listed wire nuts (not provided) for branch circuit conductors.

FIELD WIRING: Wire used for both solenoids and pressure differential gauge/sensor should be a minimum of 20AWG, and must comply with CLASS II low voltage wiring methods. Multiconductor cable may be used so long as solenoid wires are bundled separate from pressure sensor conductors. To maintain the NEMA 4X standard the following conduit requirements must be observed:

- Liquid tight- Corrosion resistant, made for outdoor use.
- Safety listed for suitable use outdoors.
- UV/Sunlight resistant for above ground installations.

For non NEMA 4X standard installations, use of 'gland cable fittings' recommended if conduit pipe or raceways are not used.

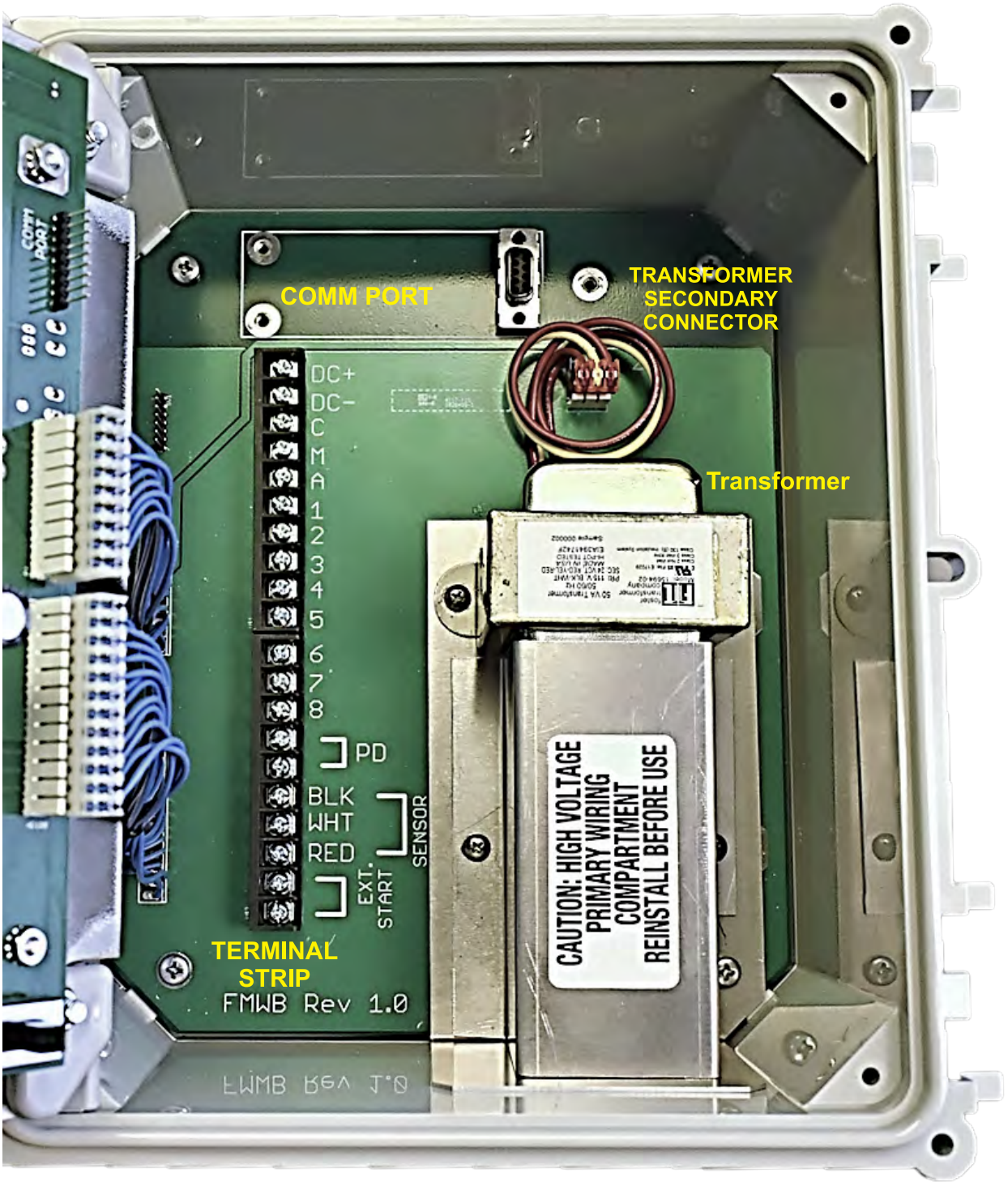
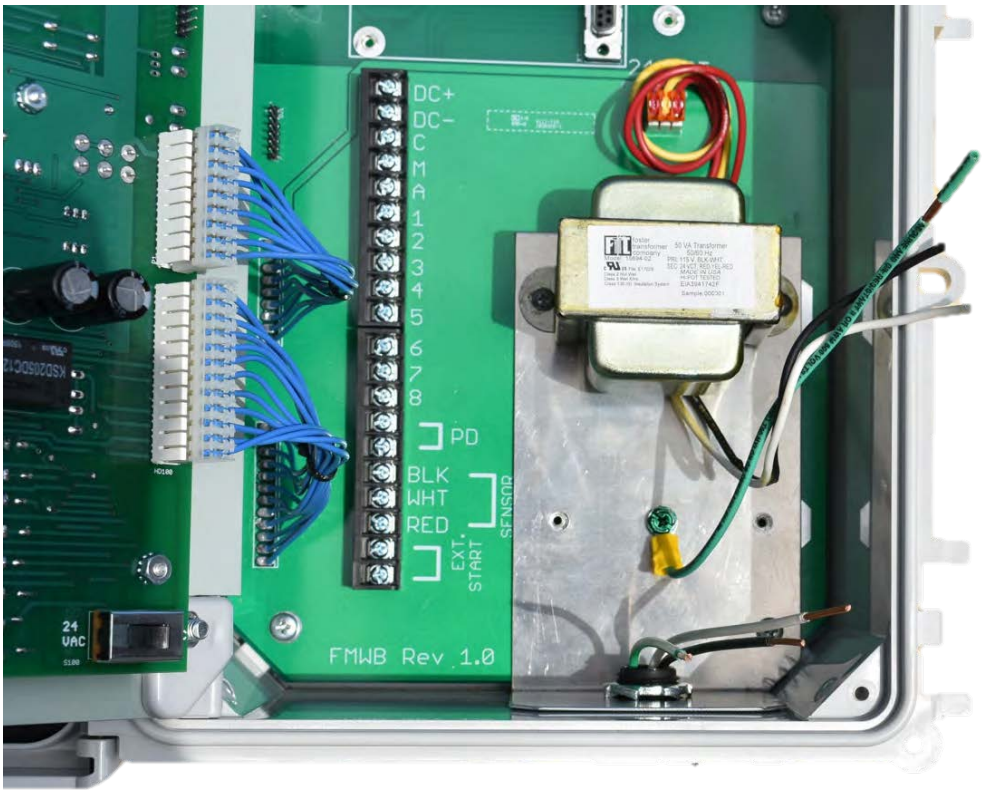


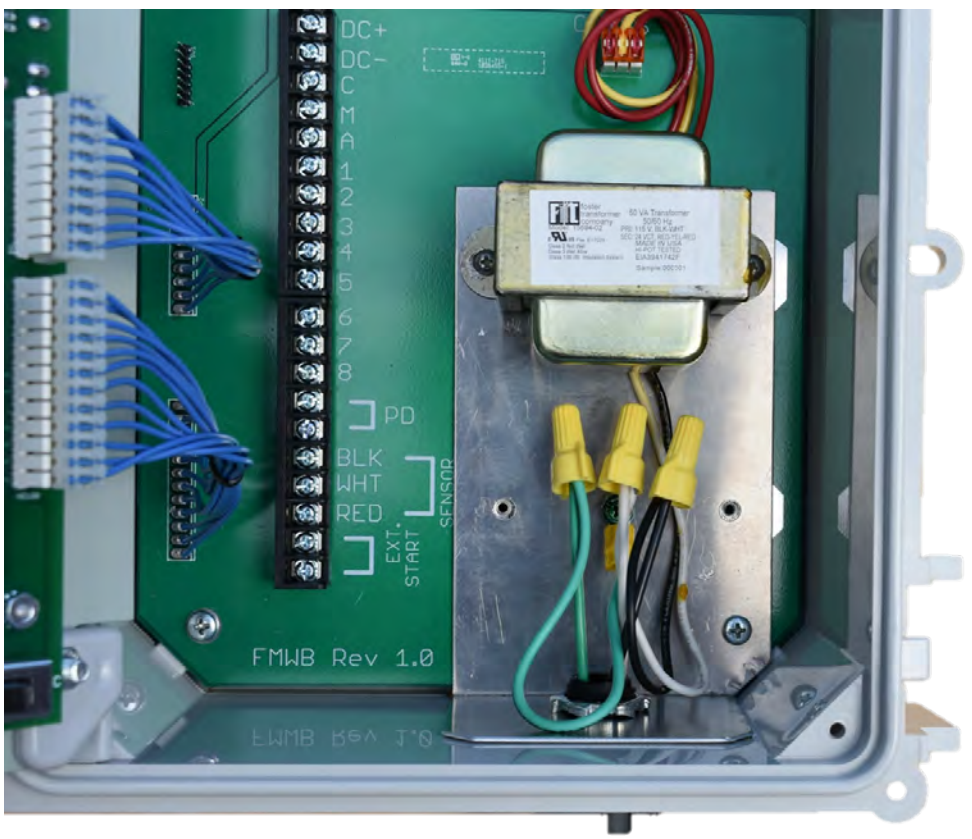
FIG 3 INTERNAL VIEW OF FM-8UL

Fig. 4



Remove Wiring Compartment Cover

Fig. 5



Connect Wires, Replace Cover.

OUTPUT BOARD:

MASTER OUTPUT: This special output is used to *turn off* a field's main water valve in order to maintain sufficient pressure within the filter system for adequate backwashing. This output remains active throughout the backwash cycle and deactivates when the controller moves back to filtering mode. The output voltage corresponds to what the tank outputs are set to -- i.e. AC or DC.

ALARM OUTPUT: This output terminal works in accordance with the status of P.D. Gauge/Sensor, and activates when immediate, and consecutive backwashes occur. In other words, when the P.D. still remains triggered after a backwash cycle (indicating the filter system was not properly cleaned), the output will activate on the fourth consecutive backwash start cycle. When activation has occurred, "**P.D. ALARM PRESS + TO RESET**" is displayed. Press the "**+**" pushbutton, and the alarm output will reset, and the display clears. It will be important to know why the alarm has activated, so a filter system diagnostic should be performed to prevent any possible damage to the filter(s) themselves. This terminal may be used to drive a small lamp, alarm bell, PLC, etc., via relay. The output voltage is set according to what the tank outputs are set to -- i.e. AC or DC.

STATION OUTPUTS: For 24VAC or 12VDC or 12VDC latching solenoids, one wire from each solenoid all are connected to "C" (common) terminal. The remaining wires from each solenoid connect to station terminals 1-8 including "M" (master) valve if used. For latching solenoids, the same wiring scheme is followed, except note that latching solenoids *have a polarity*; all negative "-" wires are connected to the "C" terminal; the remaining positive "+" wires are connected to the station terminals, including the "M" terminal. Refer to Fig. 7 for wiring details.

PRESSURE DIFFERENTIAL GAUGE/SENSOR: Referring to fig. 8, this unit can function using two types of P.D. gauges -the traditional Murphy switch gauge (optional), and the new Alex-Tronix digital sensor (included). For the Murphy gauge, connect the N.O. and C on the gauge to the FM-8UL terminals both marked: "P.D.". These two connections have no polarity. Protect either gauge from freezing temperatures.

For the digital (SPD) sensor, match color and connect the wires to the three terminals: Black to "B", White to "W", and Red to "R" --noted under 'SENSOR' on the terminal strip. Tubing ports must be pointed towards the ground to help eliminate stagnant water prone to freezing within sensor. Refer to Fig. 3 for wiring details. Mount externally from controller and protect sensor from freezing temperatures.

DO NOT WIRE BOTH THE SENSOR AND GAUGE AT THE SAME TIME.

EXTERNAL START: The FM-8UL has two terminals located at the bottom of the terminal strip marked "EXT. START". These are "dry contact" control inputs, so no power is applied to these terminals. Shorting the two contact terminals can remotely initiate a backwash start irrelevant of where the function selector is positioned, and can also be repetitively triggered to move forward to the next tank. External start can be initiated by switch, or a PLC controlled relay. A minimum time of at least 100mS of switch closure is required to initiate a backwash. If the contacts remain closed, any further control actuations cease, and the unit will not respond. The contacts must open for at least ½ of a second and then close to move forward in backwashing the next tank. An external programmable logic controller (PLC) may be programmed to repetitively open and close the contacts to move to a specific station. A 0.5A switch/relay contact rating or higher is recommended. See Fig. 5 for wiring details.

FIG. 6 POWER WIRING CONFIGURATION.

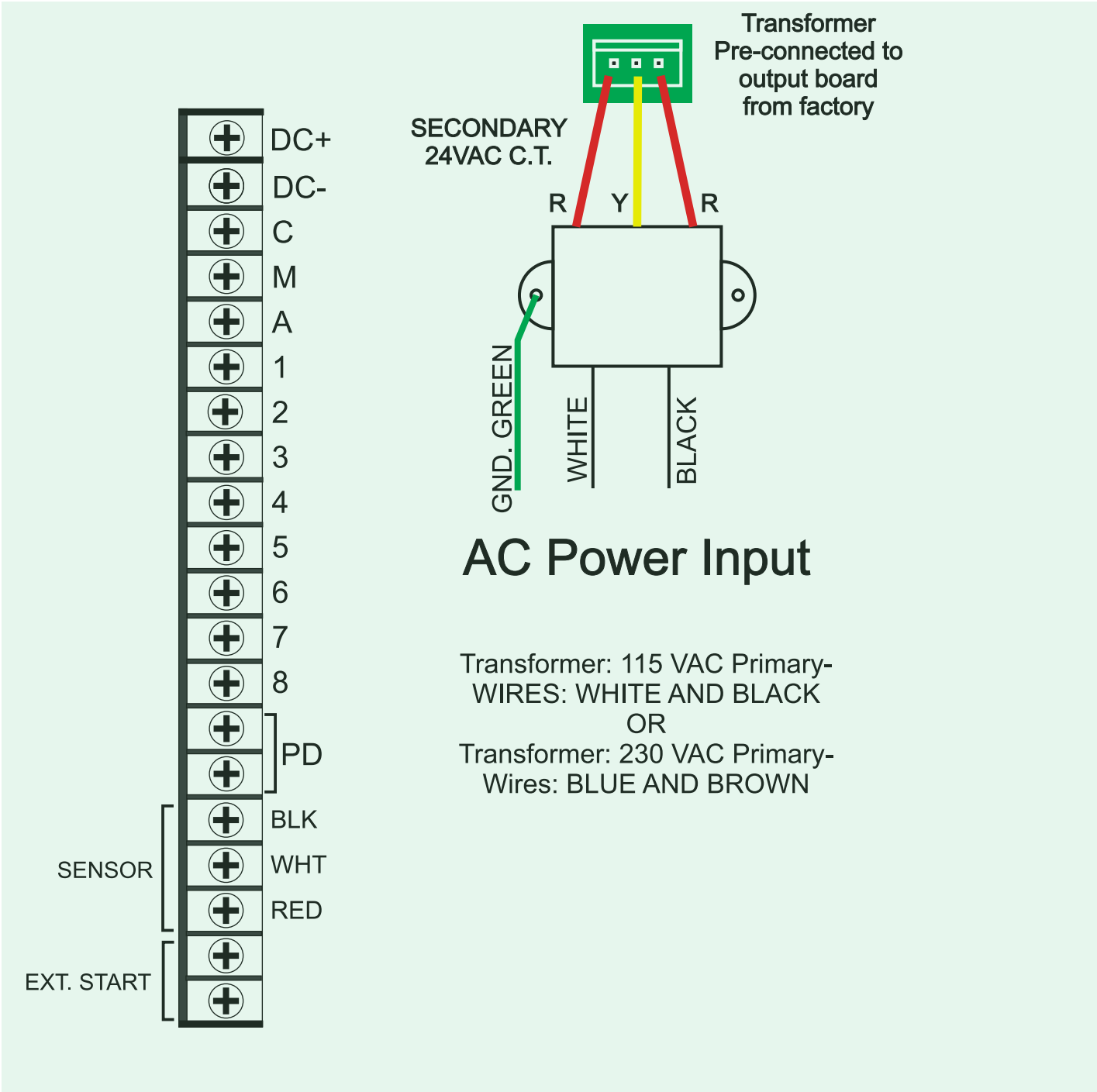


Fig. 7 - Solenoid Wiring

A/C solenoids will most likely have differing wire colors.

Master (M) and Alarm (A) Any alert device must be same voltage as output selector setting.

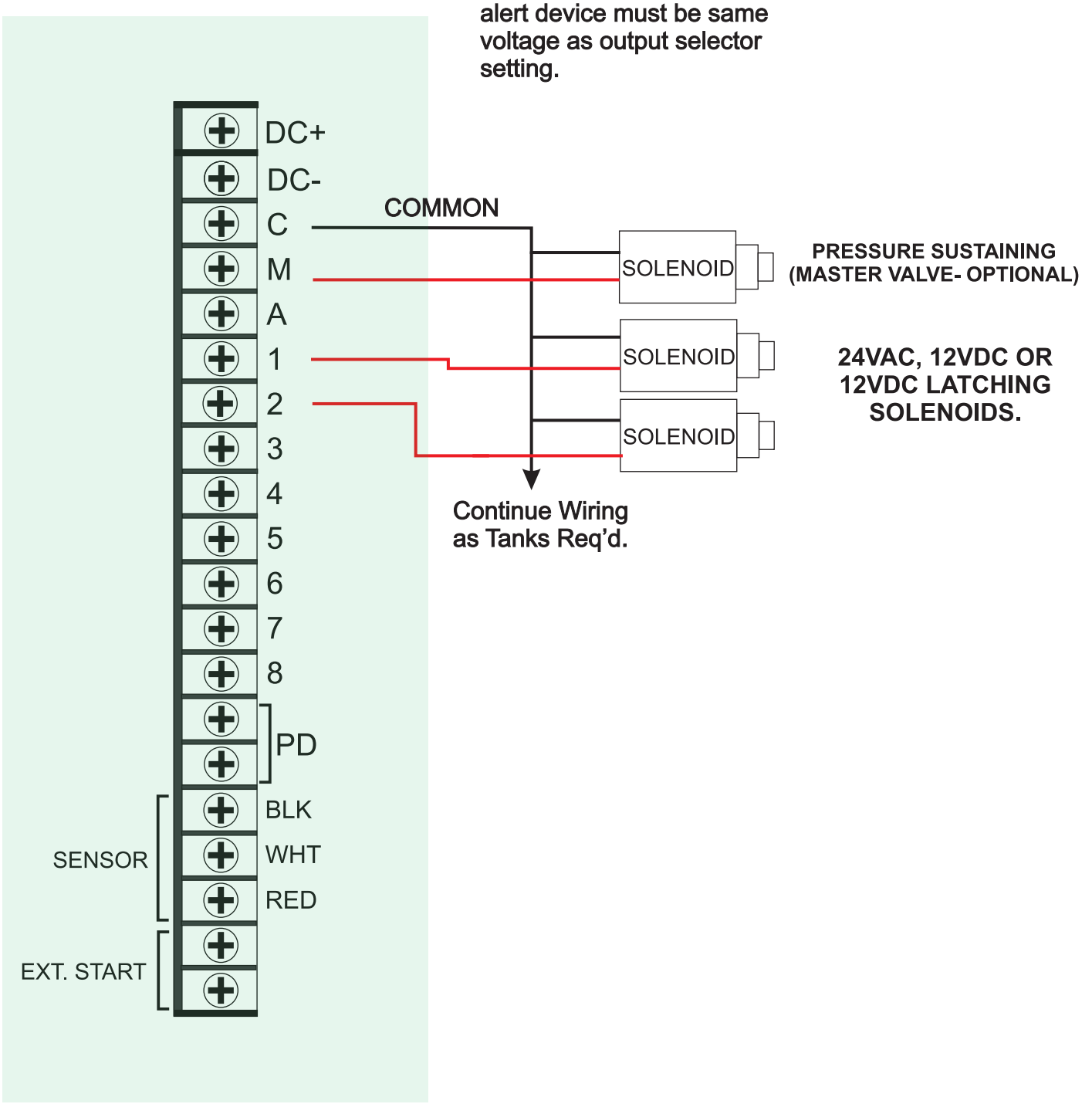
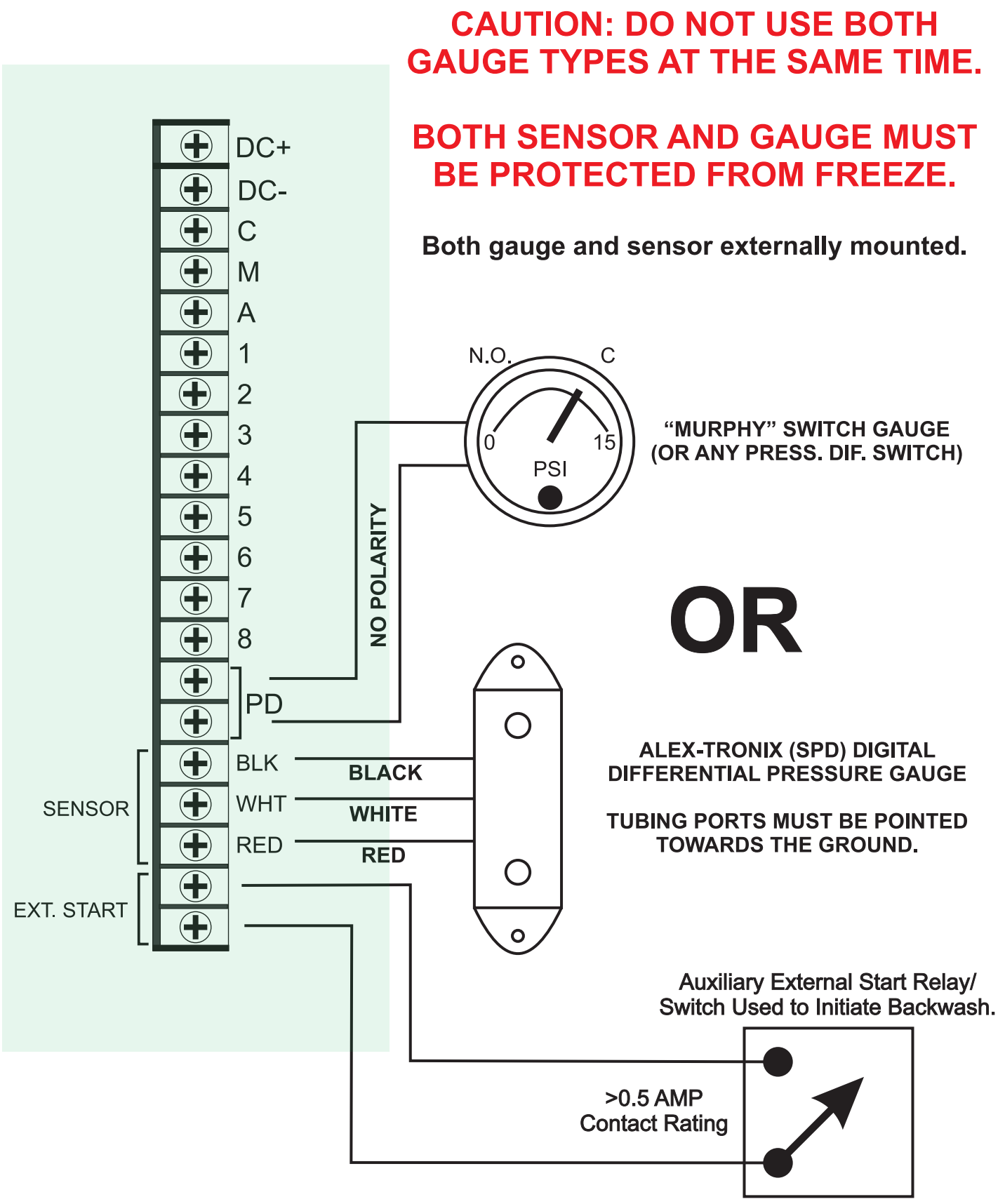


Fig. 8 -- Sensor or Gauge Wiring



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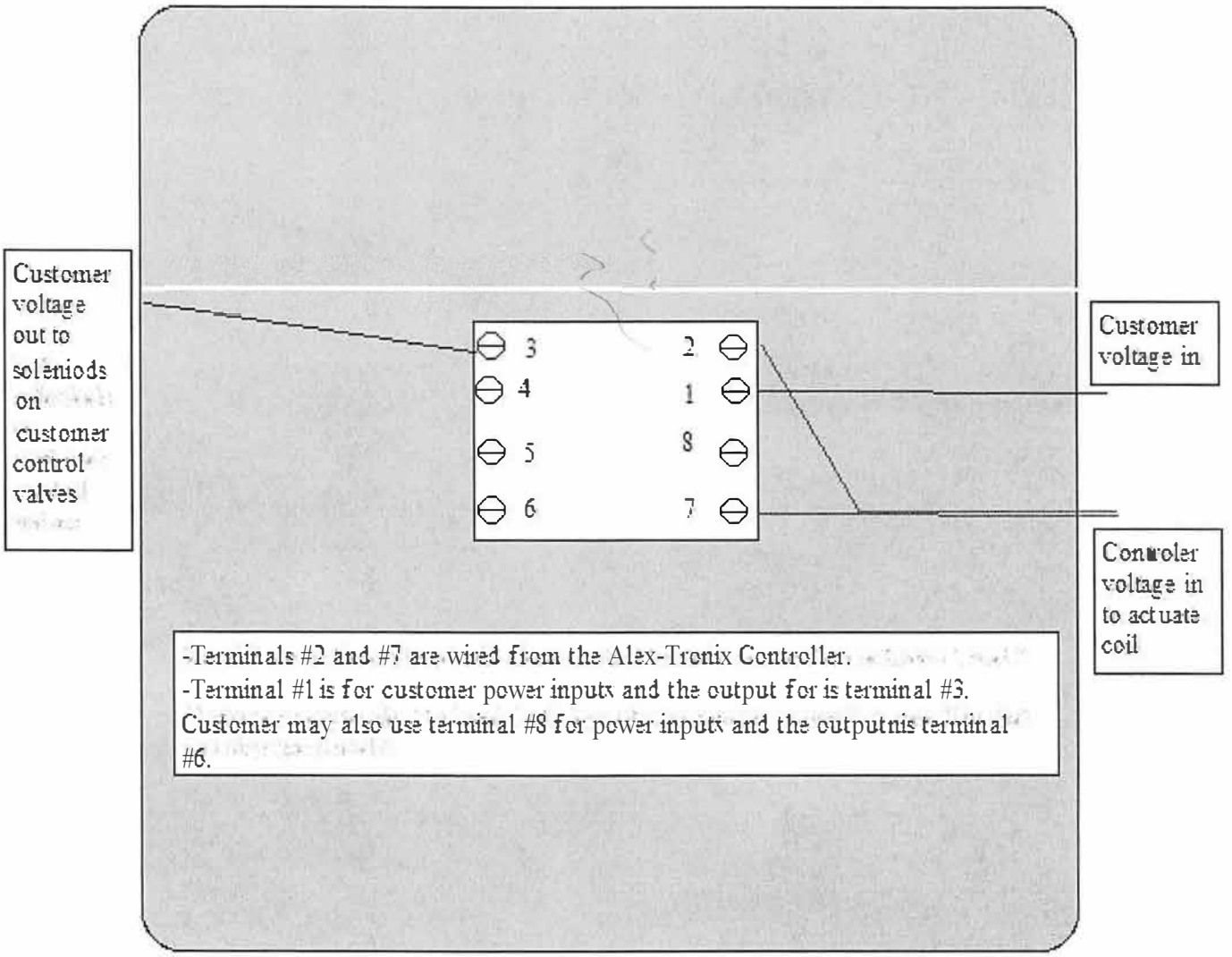
ICE CUBE RELAY WIRING SKETCH



NOTE: The ice cube relay will be mounted in a NEMA4 box and pre-wired from the controller. When the controller initiates a backwash, the relay will be activated and allow customer supplied power to cross the terminals of the relay. The relay is 10 amps. If all customer solenoids are using the same voltage, one may wire power into terminal #1, and output power from terminal #3 to the customer supplied solenoids. If the solenoids are different voltages, one will need to use terminals #8 and #6. as well

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PETER PAUL electronics co., inc.

480 John Downey Drive
P. O. Box 1180
New Britain, CT 06050
Phone (860) 229-4884

MAINTENANCE, CLEANING, INSTRUCTIONS & WARRANTY

PETER PAUL Solenoid valves are guaranteed free from defects in material and workmanship, under normal use, subject to the following:

This warranty shall be limited to repairing or replacing, F.O.B. New Britain, Connecticut, the valve or part thereof which our examination shows to be defective. Of course, normal wear and tear must be considered and exempted.

All standard and most PETER PAUL Solenoid valves have spring loaded plungers with spring loaded soft-inserts, used to provide dependability of sealing. The life of the soft plunger insert, without leakage, will vary, depending on actual operating conditions.

Should excessive amounts of dirt, foreign matter or solids be present in the media running through the valve, a filter should be installed in the pressure line, so that the inserts will not be subjected to undue strain and damage.

If may not be necessary to install a filter to prevent leakage if the media is commercially clean air, water, oil, or inert gasses, at normal temperature.

Great care and all necessary precautions are taken in the manufacture of all component parts. However, these cannot parts cannot be guaranteed except when specific application was made know to our Engineering Department, and our examination shows defective material or workmanship.

This warranty will not apply to any part of valve which, in our opinion, may have been subjected to misuse, abuse, or altered in any way.

PETER PAUL ELECTRONICS CO., INC. PRODUCTS ARE COVERED BY ONE OR MORE OF THE FOLLOWING PATENT NUMBERS:

3,082,359 – 3,307,129 – 3,840,959 – 3,965,923 – 4,027,850 – 4,268,009

INSTRUCTIONS FOR EXAMINING OR CLEANING PETER PAUL VALVES

1. Should the valve fail to operate, check the electrical circuit and replace with a new coil, only if necessary.
2. To examine the inside of the valve, first shut off electrical current and pressure. PETER PAUL valves do not need to be removed from the line.
3. Remove nut at top of solenoid valve. Name plate, coil, and housing may now be removed from the body. If the valve leaks at the seat, or the plunger sticks in the energized position, use the PETER PAUL WRENCH GP-010 for Series 20 or 30, GP-07 for Series 50, orGP-191 for Series 70 to remove sleeve assembly and examine the soft inserts in the plunger for the presence of dirt or wear and inside of the sleeve assembly for dirt or foreign matter. Should the inserts show excessive wear, the plunger should be replaced? Should the valve develop a loud buzzing noise, the inside of the sleeve and upper portion of the plunger should be scrutinized and all foreign matter imbedded the these parts removed, using great care not to damage sleeve seat or plunger face. Should you mar either surface, replace with new sleeve and plunger assembly.

DO NOT CLEAN OR SEALS WITH ANY TYPE OF CLEANING FLUID

Should the complete valve be taken off the line, use great care when reconnecting, so that no chips from the pipe threads can get into the valve. Malfunctioning can be expected when chips will work their way into either the seat or the soft inserts.

RE-ASSEMBLY

The valves are to be reassembled by following the disassembly procedure in reverse order. Special care should be taken that the Flange Seal and the return spring are in place when the sleeve assembly is tightened into body. After the sleeve assembly is screwed into body and before connecting the electrical circuit to the valve, it is advisable to apply pressure to that port which leads to the body chamber and check for leakage. If the valve has a sleeve port, this must be capped, in order to make this test. If the media is air or gas, leakage can be noted by applying water to the joint and watching for air bubbles. Should the media be liquid, leakage will be readily apparent.

The nut at the top of the solenoid valve, or housing, should not be tightened excessively, as doing so will put an unnecessary strain on the sleeve assembly or the coil under the housing.

When ordering replacement parts, specify valve number, voltage, and frequency from name plate, and part needed.

PETER PAUL VALVES AND SOLENOID OPERATORS THAT ARE U.L. LISTED & CSA CERTIFIED OR THAT ARE U.L. AND CSA RECOGNIZED COMPONENTS ARE APPROVED FOR THE FOLLOWING FLUIDS, FLUID TEMPERATURES, AND AM BIENT TEMPERATURE

AMBIENT TEMPERATURE	FLUID TEMPERATURES	FLUID CODES
77° F. FOR ALL AGENCY APPROVED	150° F—FOR ALL AGENCY APPROVED	A -AIR
VALVES AND OPERATORS	VALVES AND OPERATORS EXCEPT AS	F -COMMON REGRIGERANTS EXCEPT AMMONIA
	FOLLOWS:	NG -CITY GAS
	77° F MAX. – FORHYDRAULIC OILS	Ga -GASOLINE
	77° F—FOR "EH21", "EH22" & "EH23"	HO -HYDRAULIC OIL (PETROLEUM BASE)
	VALVE SERIES	LP -LIQUID PROPANE GAS
	125°F. MAX—FOR VALVE MODEL "TD32"	02 -NO. 2 OIL S -STEAM
	77° F.—MAX FOR REFRIGERANT APPS	W -WATER OX -OXYGEN, INERT GAS

FLUIDS FOR VARIOUS PETER PAUL U.L. AND C.S.A. VALVES AND OPERATORS

VALVE OR OPERATOR SERIES—STD. CATALOG NO'S	FLUID CODE		NOTES
"15", "20", "30", "50", & "70", "E20", "E50", "015", "020", "030", "OE20", "050", OE50", & "070" WITH STANDARD CATALOG NUMBERS	A, NG, LP, O2, HO, W, AND INERT GAS		1
HIGH PRESSURE "EH21", "EH22", & "EH23" SERIES VALVES	A, NG, LP, HO, W, AND INERT GAS		-
VALVE OR OPERATOR SERIES WITH "Z" NUMBERS	FLUID GROUP LETTERS	FLUID CODES	NOTES
SERIES: "15Z", "20Z","EH21Z", "EH22Z", "EH23Z", "E20Z", "30Z", "50Z", "E50Z", "70Z", "015Z", "020Z", "OE20Z", "030Z", "OE50Z", & "070Z"	J or L	A, NG, LP, 02, HO, W, AND INERT GAS	2
	R or K	A, W, AND INERT GAS	2
	T or N	A,NG, LP, OX, AND INERT GAS	2
	U or D	A, NG, LP, 02, HO, W, AND INERT GAS	2
	Z or A	A, W, S, AND INERT GAS	2
	Y or 2	A, W, AND INERT GAS	2
	M or B	A, NG, LP, AND INERT GAS	2
	H or F	Ga	2
	P or C	OX	2
	O or X	A, NG, LP, 02, HO, W, AND INERT GAS	2
VALVES FOR USE WITH REFRIGERANTS	W or E	A, F, W	2

NOTES

1. Not all series 15 valves or operators are agency approved. Consult Peter Paul for voltages and frequencies.
2. A letter to designate the fluid groups will appear in the fifth position after the letter "Z" in the valve operator number "Z" numbered valves or operators have a set of letters or letters and numbers before the "Z" to designate the type of valve or operator and the series. For example, "22Z". The "22" designates to two way normally closed valve in the 20 series. There are five positions after the "Z" consisting of four numbers and one fluid group. There may be suffix letters after the fluid group designation to indicate various options. For example, "22Z100KCM". The "C" would indicate a conduit housing and the "M" would indicated a molded coil. The voltage and frequency (if needed) are the last items in the "Z" number. For example, "22Z1004KCM 120/60".
3. Each fluid group uses agency approved static and dynamic seal materials. To obtain the best combination for a particular fluid, please consult Peter Paul before selecting a valve.

NOTE: ATEC IRON AND MANGANESE RMEOVAL SYSTEMS USE PETER PAUL ELECTRONICS CO. PART No. 73Z0157LCM, 24 VAC/60 HZ.

The material on this and the preceding page constitute the contents of Peter Paul Electronics Co., Inc. Form 026 – Rev. A which is made available with every Peter Paul valve or operator shipped. *ATEC Systems* has included it in this Operations and Maintenance Manual so that it will be available should it be needed.

Maintenance and Trouble Shooting for Peter Paul Solenoid Valves

Peter Paul Solenoid valves are a 3-way valve used as a pilot valve to control backwash valves and or other valves on the ATEC Iron and Manganese Removal System. The valve body is a machined stainless steel body with a manual override to allow for activation without energizing the solenoid.

In the event of a malfunction the following should allow you to repair the valve in the field.

No power to solenoid:	Check output of controller Check wiring to coil.	Replace control board Repair wiring
Power to solenoid But not energizing:	Check for debris in stem and plunger If not dirty	Cleanout stem and plunger Replace Coil
Filter continues to flush when not energized	Check for jammed plunger If clean check rubber seal on top end of plunger	Clean stem and plunger. If protruding above end of plunger cut off with razor or replace plunger
	Check "C" spring in valve It may be dislodged	Return spring to machined groove with ends in cutout for manual operator with "loop" over operator pin

Peter Paul Solenoid valves are a very durable part. The epoxy potted coil is rarely a problem and, in most cases, the valve can be repaired with replacement parts in the field at minimal cost with very little effort and down time.

The ALEX-TRONIX Controllers ATEC Systems uses has a separate output relay to power each solenoid. Therefore, it is possible that all but one of the solenoid valves are working. If this is the case the circuit board in the backwash controller may require replacing.

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ELECTRICAL SPECIFICATIONS:

INPUT: 115/230 VAC 50/60 HZ 46VA

OUTPUT: 24 VAC 1.6A OR 12 VDC 2A

For any questions or help regarding the installation of this controller please contact us at 1-888-224-7630. For questions regarding you filter system, contact the manufacturer.

ALEX-TRONIX --A DIV. OF GNA INDUSTRIES, INC.
4761 W. Jacquelyn Ave., Fresno CA. 93722
TEL: 559-276-2888 FAX: 559-276-2890 Toll Free: 888-224-7630
www.alextronix.com

WARRANTY

Suppliers and end users of this product agree to the following terms, conditions and limitations of warranty and liability coverage:

Alex-Tronix warrants the FM-8UL to be free from original defects for two years from the date of original sale. The manufacturer shall replace, free of charge any part found defective under normal use and service within the guarantee period, provided the product is installed, used, and maintained in accordance with any applicable instructions or limitations issued by Alex-Tronix. Components supplied replacement parts are warranted for 90 days from the date of shipment. The manufacturer assumes no liability for incidental or consequential damage sustained in the adoption or use of our engineering data, service, or products. Liability is therefore limited to the repair of the product manufactured by Alex-Tronix. No agent or representative of Alex-Tronix has the authority to waive or add to this agreement. Altered products, or use of products in a manner not intended shall void this warranty. For warranty service, ship unit pre-paid to the address below. Controllers damaged in transit due to improper packaging are not covered by warranty.

For warranty repair, send defective product freight pre-paid to:

Alex-Tronix Controls Div. GNA Industries - 4761 W. Jacquelyn Ave. Fresno, CA. 93722 - Tel: (888)-224-7630 Fax: (559) 276-2890
www.alextronix.com - orders@alextronix.com

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Note: This valve also available as an operator. Refer to following page.

Series 70 >> Model 73

3-Way Normally Closed — Exhaust to Atmosphere

Super valves that have ratings that formerly required valves of much greater size. Air, water, and other fluids compatible with standard Buna seals. Hot water, steam, gasoline, and many oils require special seal materials.

- ***Largest direct acting (non-piloted) valve we manufacture.***
- ***Large orifice.***
- ***High flow.***
- ***Will operate effectively at very low pressures or vacuum.***

OPERATING CONDITIONS

Media: Air, water, and other fluids compatible with standard Buna seals. Hot water, steam, gasoline, and many oils require special seal materials. (Series 70 pressure ratings may change due to the viscosity of the liquid.)*

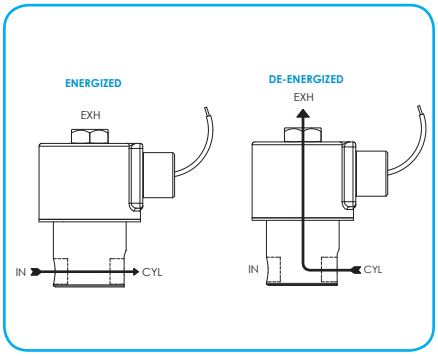
Valve Temperature Range: Standard Valves - 0˚F (-18˚C) to 104˚F (40˚C) ambient; 0˚F (-18˚C) to 150˚F (65˚C) media. Optional Valves - can tolerate much higher or much lower ambient and media temperatures.*

Maximum Operating Pressure Differentials: See table on proceeding page.

Burst Pressure: 4000 PSI

Leakage: Bubble tight for standard valves.

Vacuum: To 5 Microns*



ELECTRICAL CHARACTERISTICS

Coil Voltage: 12 to 1150V AC 60 HZ. and 11 to 1035V AC 50 HZ. — 2.5 to 220V DC

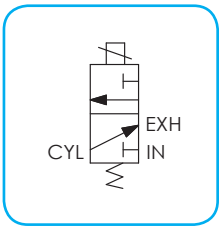
Nominal Power: AC — 18.0 Watts DC — 16.0 Watts

Coil Construction: Molded (Std.), Non-molded Class A and potted Class F. (Class H optional)

Typical Response Time on Air: 4 - 16 Milliseconds

Operating Speed: Up to 600 CPM

Duty Cycle: Continuous



MECHANICAL CHARACTERISTICS

Body: Stainless Steel (Std.) or Brass (Opt.)

Internal Components: Stainless Steel

Elastomers: Nitrile (Buna) (Std.). Many other elastomers available.*

Orifice Diameter: See table on proceeding page.

Porting: Standard 1/4" NPT (other ports available).*

Housing: Grommet and 1/2" NPT conduit - many options available.*

Listings: Most valves are UL and CSA listed.*

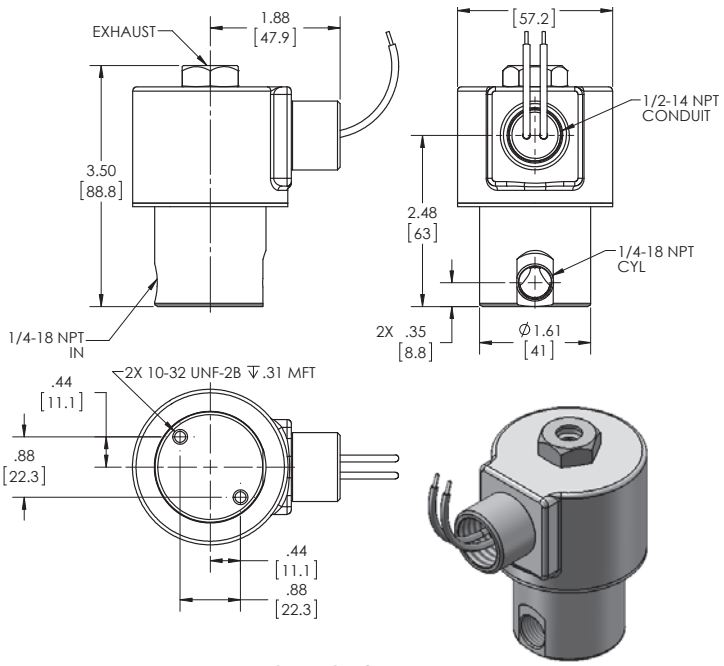
Life Expectancy: Millions of cycles, depending on application, lubrication, etc.

Valve Weight: Grommet Valve: 2.00 lb Conduit Valve: 2.06 lb

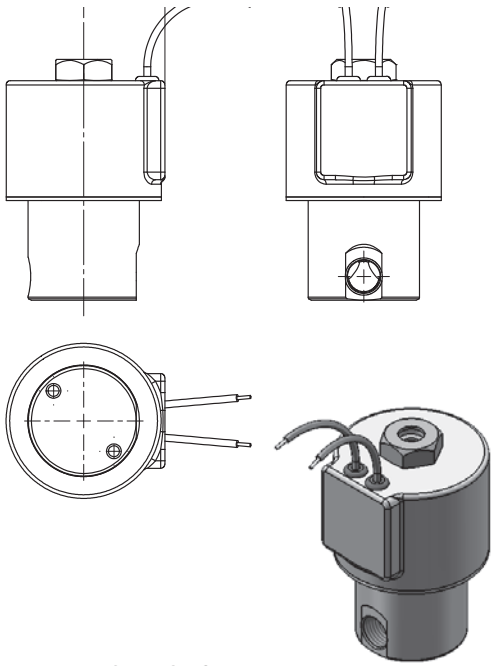
Repair Packs: See table on proceeding page.

Options: Alternate Port Locations, Metering and Alternate Elastomers

** Consult representative or factory for options and specifications.*



SERIES 70
MODEL 73 1/4-18 NPT
3WNC EXHAUST TO ATMOSHPERE
CONDUIT CONNECTION



SERIES 70
MODEL 73 1/4-18 NPT
3WNC EXHAUST TO ATMOSHPERE
GROMMET HOUSING WITH LEADS

VALVE SPECIFICATIONS

MAX. OPER. PRESS. DIFF.		ORIFICE SIZE		CV FACTOR		VALVE NUMBER	
						GROMMET HOUSING	CONDUIT HOUSING
AC	DC	N.C.	N.O.	N.C.	N.O.	1/4 NPT PORTS	1/4 NPT PORTS
350	350	1/16	1/16	.09	.09	73JJ9DGM	73JJ9DCM
250	250	3/32	3/32	.22	.22	73KK9DGM	73KK9DCM
175	175	1/8	1/8	.35	.35	73NN9DGM	73NN9DCM
125	125	5/32	5/32	.45	.45	73OO9DGM	73OO9DCM
100	100	3/16	3/16	.50	.50	73PP9DGM	73PP9DCM
50	50	1/4	3/16	.78	.50	73RP9DGM	73RP9DCM

ORDERING INFORMATION:

WHEN ORDERING VALVES OR REPAIR PACKS ADD VOLTAGE AND FREQUENCY TO COMPLETE VALVE NUMBER. EXAMPLES: VALVE (73OO9DGM 120/60) REPAIR PACK (K73OOD AC)

WHEN ORDERING OPERATORS ADD THE LETTER "O" TO THE FRONT OF THE VALVE NUMBER, REPLACE BODY PORT NUMBER WITH THE LETTER "D": EXAMPLE: OPERATOR (O73OO9DGM 120/60)

ATEC SYSTEMS ASSOCIATES
atecwatersystems.com ~ (360) 414-9223

Maintenance and Trouble Shooting for Peter Paul Solenoid Valves

Peter Paul Solenoid valves are a 3 way valve used as a pilot valve to control backwash valves and or other valves on an ATEC Filter system. The valve body is a machined stainless steel body with a manual override to allow for activation without energizing the solenoid. In the event of a malfunction the following should allow you to repair the valve in the field.

No power to solenoid:	Check output of controller Check wiring to coil.	Replace control board Repair wiring
Power to solenoid but not energizing:	Check for debris in stem and plunger If not dirty	Cleanout stem and plunger Replace Coil
Filter continues to flush when not energized.	Check for jammed plunger If clean check rubber seal on top end of plunger Check “C” spring in valve It may be dislodged	Clean stem and plunger. If protruding above end of plunger cut off with razor or replace plunger Return spring to machined groove with ends in cutout for manual operator with “loop” over operator pin

Note: Peter Paul Solenoid valves are a very durable part, the epoxy potted coil is rarely a problem in most cases the valve can be repaired with replacement parts in the field at a minimum cost and with a very short amount of effort and down time.

Note: The ALEX-TRONIX Controller has a separate relay for the output power to each solenoid therefore it may be possible that all but 1 of the solenoid valves are working. If this is the case the board may need replacing.

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Filter Backwash Hydraulic Valve

3x3 Plastic

IR-3x3-350-P

Angle Flow

Straight Flow

The BERMAD Model IR-3x3-350-P is a compact 3-port valve, in a T configuration. It is double chambered, hydraulically operated, and diaphragm actuated. Designed for automatic backwashing of filtration systems, the BERMAD Model IR-3x3-350-P is available in Angle flow (A) and Straight flow (S) configurations.

Features and Benefits

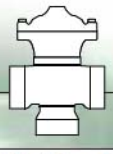
- Line Pressure Driven
- Double Chambered Design
  - Wide application range
  - Requires low actuation pressure
  - Protected diaphragm
- Dynamic Sealing
  - Seals at very low pressure
  - Prevents seal friction and erosion
- Engineered Plastic Valve Design
  - Highly durable, chemical and cavitation resistant
- Short Valve Travel
  - Smooth changes of flow direction
  - Eliminates mixing of supply and waste water
- User- Friendly
  - Can be installed in various orientations
  - Simple in-line inspection and service

Typical Applications

- Automatic Backwash of Filter Batteries
  - Gravel Filters
  - Sand Filters
  - Disk Filters
  - Screen Filters
- Single Filter Autonomic Backwash System
- Angled or Straight Installations

[1] BERMAD Model IR-3x3-350-S-P allows flow into the filter, switches closed upon pressure rise command blocking inlet to filter and enables backwash flow from the filter.
[2] BERMAD Hydrompter Model IR-900-M0
[3] BERMAD Air Valve Model ARA-A-I-P

BERMAD Irrigation



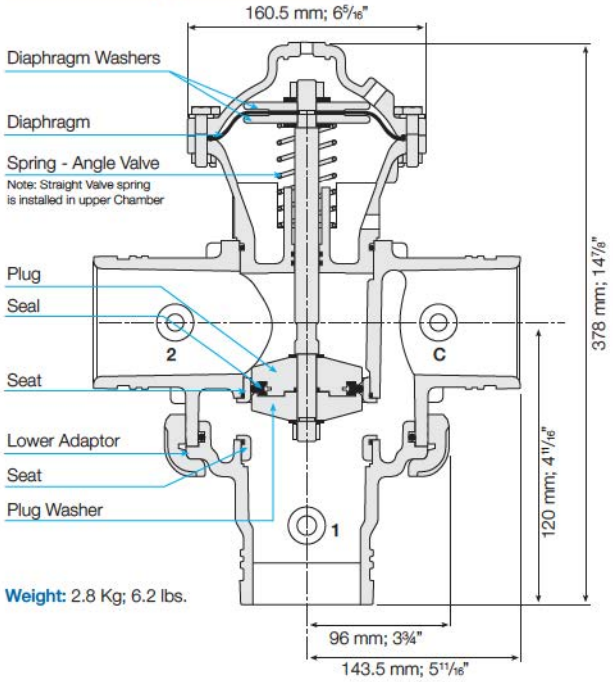
IR-3x3-350-P

350 Series

Filter Stations

For full technical details, refer to Engineering Section.

Technical Specifications



Weight: 2.8 Kg; 6.2 lbs.

Technical Data

Control Chamber Displacment Volume: 0.34 liter; 0.09 gallon
Operating Pressure: 0.7-10 bar; 10-145 psi
External Operating Pressure: 85%-100% of operating pressure
Maximum Temperature: 65°C;150°F
End Connections: Grooved
Flow Patterns:
Angled Flow, Reverse Angled Flow, Straight Flow, Reverse Straight Flow

Materials

Valve Body, Separating Partition & Lower Adaptor:
Polyamide 6 – 30GF Black
Cover: Polyamide 6 – 30GF
Angle Flow – Black
Straight Flow – Gray
Diaphragm: NR-AL52 Nylon Fabric Reinforced
Seats, Diaphragm Washers: Brass
Plug, Plug Washer: Acetal Copolymer Black
Stopper Disk: PVC-U
Seal, O-Rings: NBR
Spring: Stainless Steel AISI 302
Shaft: Stainless Steel AISI 303
External Bolts, Studs, Nuts & Disks: Stainless Steel

Hydraulic Data

Angle Flow	Filtartion 1⇒C		Backwash C⇒2	
	Kv=110	Cv=127	Kv=100	Cv=115
Straight Flow	Filtartion 2⇒C		Backwash C⇒1	
	Kv=93	Cv=107	Kv=122	Cv=141

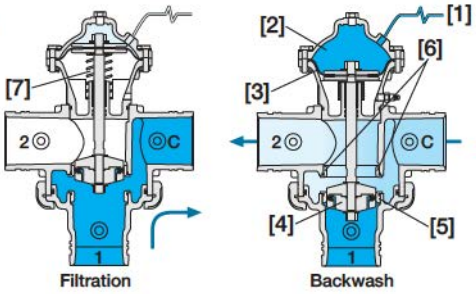
$\Delta P = \left(\frac{Q}{Kv}\right)^2$
Kv = m³/h @ ΔP of 1 bar
Q= m³/h
ΔP = bar

$\Delta P = \left(\frac{Q}{Cv}\right)^2$
Cv = gpm @ ΔP of 1 psi
Q= gpm
ΔP = psi

Cv = 1.155 KV

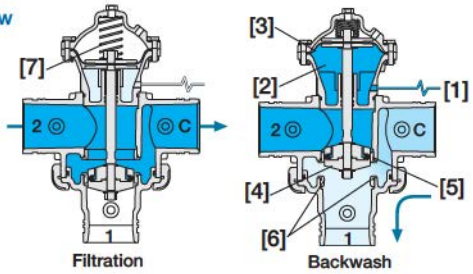
Operation

Angle Flow



A Hydraulic Command **[1]**, which pressurizes the Upper Control Chamber **[2]**, forces the Diaphragm **[3]** actuated Plug Assembly **[4]** to move towards the Supply Port Seat **[5]**, eventually sealing it drip tight. This allows flow from the filter through the Drain Port Seat **[6]**. Venting the upper control chamber causes the line pressure, together with the Spring **[7]** force, to move the Valve back to filtration mode.

Straight Flow



A Hydraulic Command **[1]**, which pressurizes the Lower Control Chamber **[2]**, forces the Diaphragm **[3]** actuated Plug Assembly **[4]** to move towards the Supply Port Seat **[5]**, eventually sealing it drip tight. This allows flow from the filter through the Drain Port Seat **[6]**. Venting the upper control chamber causes the line pressure, together with the Spring **[7]** force, to move the Valve back to filtration mode.

How to Order

Please specify the requested valve in the following sequence: (for more options, refer to Ordering Guide.)

Sector	Size	Primary Feature	Additional Feature	Pattern/ Flow Option	Construction Materials	Drain Connections	End Connections	Additonal Attributes	Coating	Voltage & Position	Tubing & Fittings
IR	3X3	350	00	S	P	V	VI	-	UC	00	PP

Angle Flow	A	Grooved	V	Grooved ANCI C606-81	V1	Uncoated	UC	Plastic Tubing & Fillings	PP		
Straight Flow	S										
Straigh & Reverse Flow	S-O										
Angle & Reverse Flow	A-O										

info@bermad.com • www.bermad.com

Maintenance Instructions

Backwash Filter Valve

Model 350-3x3

Water Control Solutions

1 | Disassembling the actuator from the valve

A.

Disconnect the control tube.

B.

Turn the actuator counter clockwise.
(If necessary, use a suitable wrench or spanner.)

C.

Pulling gently upwards, slide the actuator out of the valve body.

2 | Replacing the seal

A.

Using two 13/19mm wrenches, release the closure locking nut.

B.

Remove the plug washer and then remove the seal.
Check the condition of the seal and replace as required.

C.

Replace the components of the closure assembly in the order shown here, frombottom to top.
Pay attention to the position of the parts and their direction according to the different models (Angular model - black cover; Straight model - gray cover).

Angle Flow Model

Straight Flow Model

D.

Tighten the closure nut to ensure locking.
Use OMNIFIT 200M or similar glue

E.

Check the condition of the actuator O-ring and replace as required.

F.

Apply a sillicon lubricant on the O-ring and thread when fitting the actuator onto the valve body.

3. Replacing the diaphragm

A.

Using two 13mm wrenches, open the 12 bolts of the closure assembly.

B.

Remove the cover. Pay attention to the position of the parts and their direction according to the different models (Angular model - black cover; Straight model - gray cover).

Angle Flow Model

Straight Flow Model

C.

Pulling gently, slide the shaft out of the separation partition.

Angle Flow Model

Straight Flow Model

D.

Open the locking nut with the aid of two wrenches - a 17mm spanner and 13mm spanner.

E.

Remove the diaphragm washer.
Check and replace diaphragm as required.

F.

Reassemble the diaphragm assembly, paying attention to the order of the parts and their position in accordance with the type of model.
Use a suitable type of glue to ensure locking of the shaft nut.

4. Replacing the Shaft Seals

A.

Using a suitable tool, remove both shaft O-rings from the separation partition. Replace them with new ones as required.

Use a silicon lubricant when reassembling the shaft.

5. Replacing the seats

A.

Using a suitable wrench, open the Cover Ring by turning clock-wise.

Straight Flow Model

31a | with 2" thread

Angle Flow Model

31c | lower adaptor groove

B.

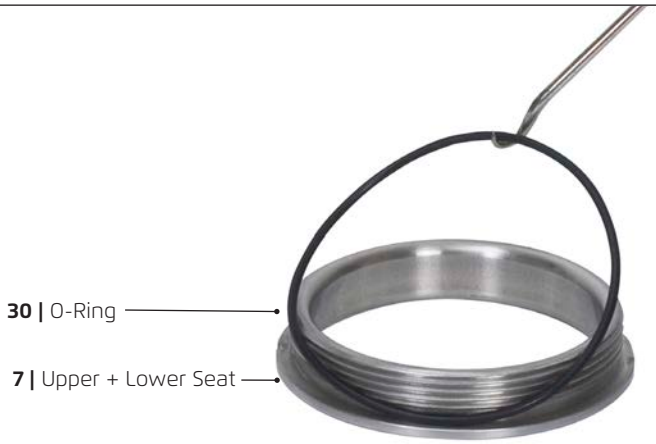
Using a screwdriver, separate the valve body assembly from the lower adaptor assembly.

C.

Inspect the seats visually. In case of damage, go tonext step (C).

D.

Ensure that O-Ring (26) is in place before closing.
Check the condition of the seat and of the seal, and replace as required.



E.

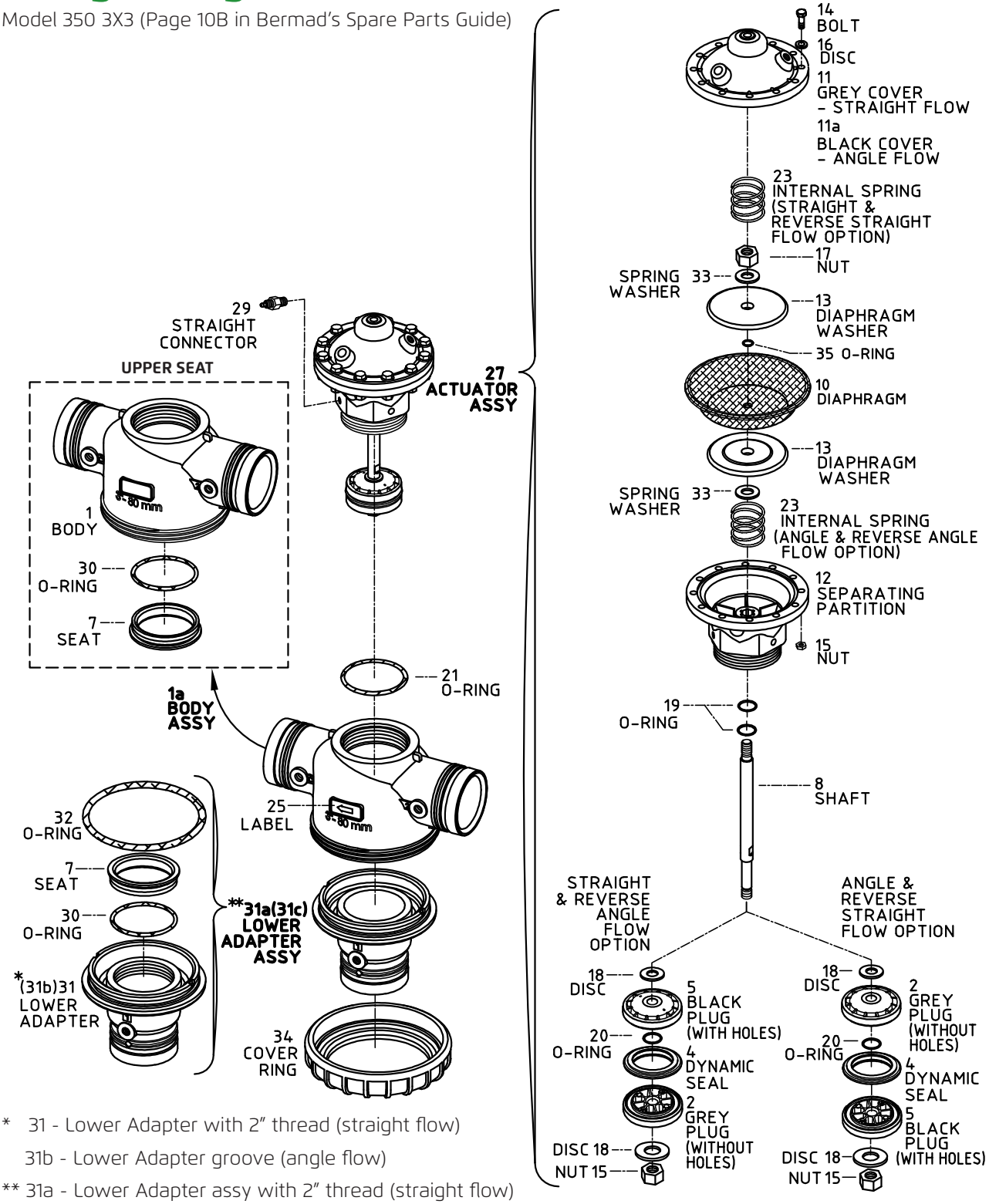
Check the condition of the lower adaptor seal and replace as required.

F.

Reconnect the lower adaptor to the valve body.

Plastic Backwash Filter Valves, Double Chamber, Straight/Angle & Reverse Flow -

Model 350 3X3 (Page 10B in Bermad's Spare Parts Guide)



* 31 - Lower Adapter with 2" thread (straight flow)
31b - Lower Adapter groove (angle flow)

** 31a - Lower Adapter assy with 2" thread (straight flow)
31c - Lower Adapter assy groove (angle flow)

When ordering please mention page no 10B

BERMAD

www.bermad.com

atec systems associates, inc.

Sight Glass and Backwash Assembly

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1 1/2" brass sight glass, brass and acrylic

The sight glass shall be a 1-1/2-inch transparent acrylic pipe, 2-inches long, encapsulated between two brass fittings, one that screws into the backwash pipe and the other a cap held in place with a through bolt, Part No. A41198-0, manufactured by S. R. Smith, LLC.

S. R Pool Products
1017 SW Berg Parkway
P.O. Box 400
Canby, OR 97013

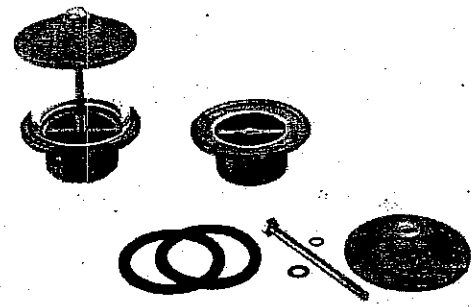
Part No. A41198-0

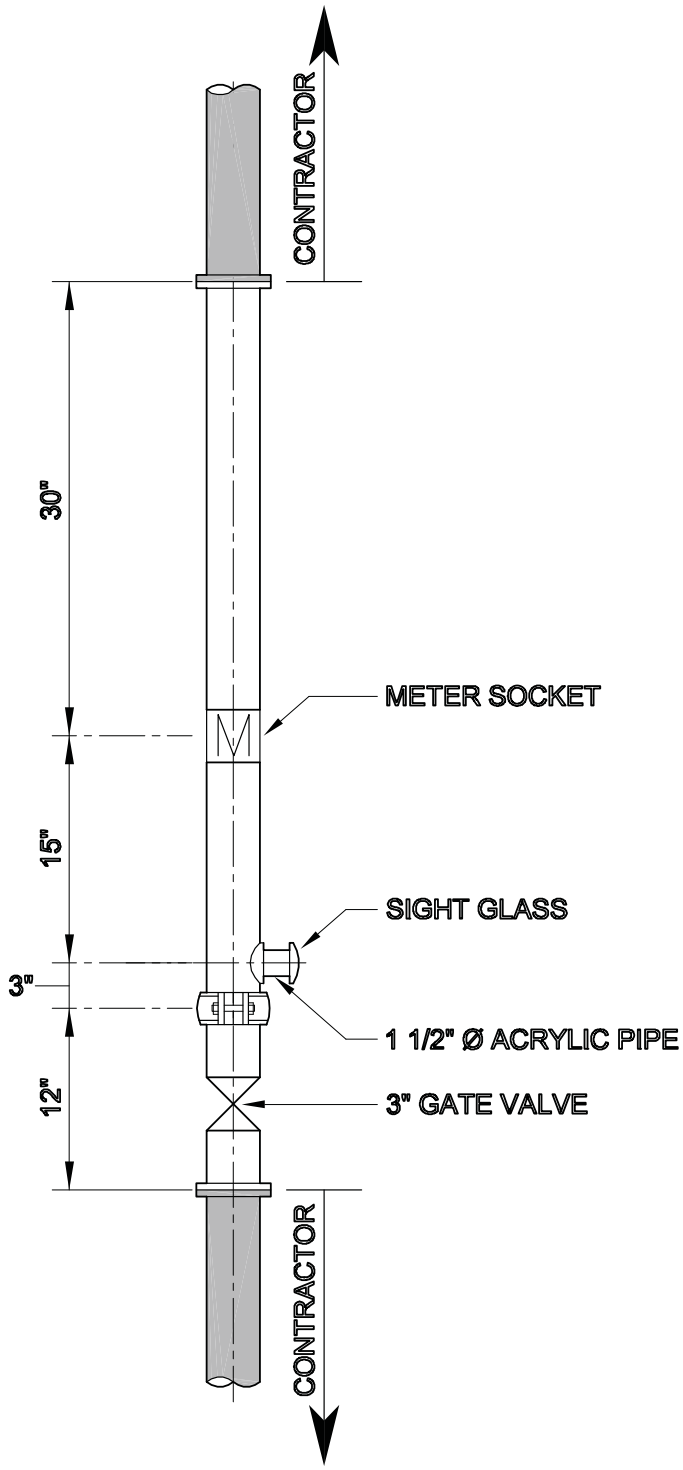
BACKWASH SIGHT GLASS — Clear sight glass installs into backwash line to inspect discharge water. Vertical style.

Heavy-Duty Controlled Flow Sight Glass

- Base and top are cast brass
- Sight glass is clear plexiglass
- Heavy-duty neoprene seals
- Threaded for insertion into a 1.5" female thread

Part No.	Description	Shipping Wt.
A41198-0	Sight glass	1.5 lbs





BACKWASH ASSEMBLY

(SHIPPED LOOSE)

atec systems associates, inc.

Badger/Data Industrial Flow Meter

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LIST OF DOCUMENTS

1. a er Data n ustr al 22 Ser es Fl Sens r S e at ns
2. a er Data n ustr al 22 Ser es Fl Sens r nstallat n an Ma ntenan e Manual
3. a er Data n ustr al FC5 Ser es C m uter Data Sheet
4. a er Data n ustr al FC5 Ser es C m uter Manual

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Impeller
Data Industrial®

Flow Sensors

Series 220BR Insertion Style Flow Sensors

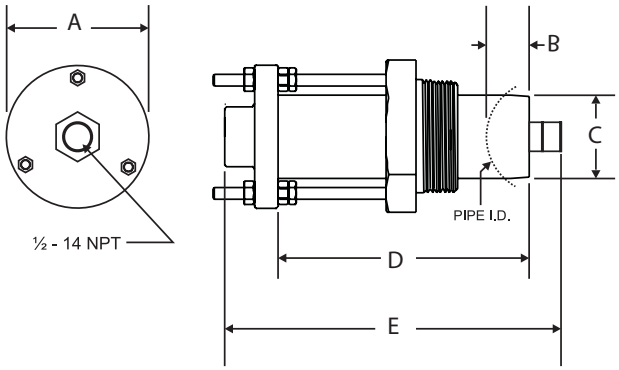
DESCRIPTION

The Data Industrial® Series 200 flow sensors from Badger Meter® feature a six-bladed impeller design with a proprietary non-magnetic sensing mechanism. The forward swept impeller shape provides higher, more consistent torque and is less prone to be fouled by waterborne debris. The forward curved shape coupled with the absence of magnetic drag provides improved operation and repeatability at lower flow rates. This is especially true where the impeller is exposed to metallic or rust particles found in steel or iron pipes. As the liquid flow turns the impeller, a low impedance square wave signal is transmitted with a frequency proportional to the flow rate. The signal can travel up to 2000 feet between the flow sensor and the display unit without the need for amplification. All sensors except irrigation versions are supplied with 20 feet of Belden type 9320 2-conductor shielded cable.

MODEL 220BR (BRASS)

220BR sensors are used in most general flow measuring applications in metallic or non-metallic pipes. The sensor mounts in a 2 inch NPT pipe saddle or Threadolet® for installation in pipe sizes from 3 inches to more than 40 inches. Positioning nuts on the three threaded retaining rods allow the sensor to be accurately positioned to a standard insertion depth of 1-1/2 inches into the pipe. When this insertion depth is maintained, and there are at least 10 upstream and 5 downstream diameters of straight uninterrupted flow, an accuracy of +/–1 percent of full scale can be obtained from flow velocities of 0.5…30 feet/second (± 4.0 percent of reading within calibration range).

DIMENSIONS



A	B	C	D	E
3 in.	1-1/2 in.	1-3/4 in.	5-1/4 in.	7-1/8 in.
76 mm	38 mm	44 mm	133 mm	181 mm

Figure 1: Dimensions for 220BR

SPECIFICATIONS

Wetted Materials for all Sensors	See *"Part Number Construction" on page 2*	
Sensor Sleeve and Hex Adapter	Sleeve: Admiralty brass, UNS C44300	
	Hex adapter: Lead-free brass, C89833	
Temperature Ratings	Standard version: 221° F (105° C) continuous service	
	High temperature version: 285° F (141° C) continuous service; 305° F (150° C) peak temperature (limited duration)	
Pressure Ratings	**At 100° F**	**At 300° F (High Temperature Version Only)**
	400 psi	325 psi
Recommended Design Flow Range	0.5…30 ft/sec (0.15…9.1 m/sec) Initial detection below 0.3 ft/sec (0.09 m/sec)	
Accuracy	± 1.0% of full scale over recommended design flow range	
Repeatability	± 0.3% of full scale over recommended design flow range	
Linearity	± 0.2% of full scale over recommended design flow range	
Transducer Excitation	Supply voltage = 8V DC min. 35V DC max.	
	Quiescent current = 600 uA (typical)	
	OFF State (V_{High}) = Supply voltage – (600 µ * Supply impedance)	
	ON State (V_{Low}) = 1.2V DC @ 40 mA (15 Ω + 0.7V DC)	
Output Frequency	3.2…200 Hz	
Output Pulse Width	5 msec ±25%	
Electrical Cable for Standard Sensor Electronics	20 ft (6 m) of 2-conductor 20 AWG shielded UL type PTLC wire provided for connection to display or analog transmitter unit. Rated to 221° F (105° C). May be extended to a maximum of 2000 ft (610 m) with similar cable and insulation appropriate for application.	
Electrical Cable for IR Sensor Electronics	48 in. (122 cm) of UL style 116666 copper solid AWG 18 wire with direct burial insulation. Rated to 221° F (105° C).	
Certifications	CE certified	

Badger Meter

Product Data Sheet

PART NUMBERING CONSTRUCTION

Standard Sensor

	Example: 2	20	BR	00	0	5	-	1	2	1	1
STYLE											
Standard Flow		20									
MATERIAL											
Brass			BR								
SIZE											
Insert Style for pipe sizes 3" and up				00							
ELECTRONICS HOUSING											
PPS					0						
ELECTRONICS											
Standard Flow (STANDARD)						5					
IR-Irrigation						6					
O-RING											
Viton®								0			
EPDM (STANDARD)								1			
Buna N								8			
SHAFT											
Zirconia Ceramic									0		
Tungsten Carbide (STANDARD)									2		
316 Stainless Steel									6		
IMPELLER											
Nylon (STANDARD)										1	
Tefzel®										2	
BEARING											
UHMWPE (STANDARD)											1
Tefzel®											2
Teflon®											3

High Temperature Sensor

	Example: 2	20	BR	00	4	8	-	0	2	2	3
STYLE											
Standard Flow		20									
MATERIAL											
Brass			BR								
SIZE											
Insert Style for pipe sizes 3" and up				00							
ELECTRONICS HOUSING											
PEEK					4						
ELECTRONICS											
High Temperature						8					
O-RING											
Viton®								0			
SHAFT											
Tungsten Carbide (STANDARD)									2		
IMPELLER											
Tefzel®										2	
BEARING											
Teflon®											3

Control. Manage. Optimize.

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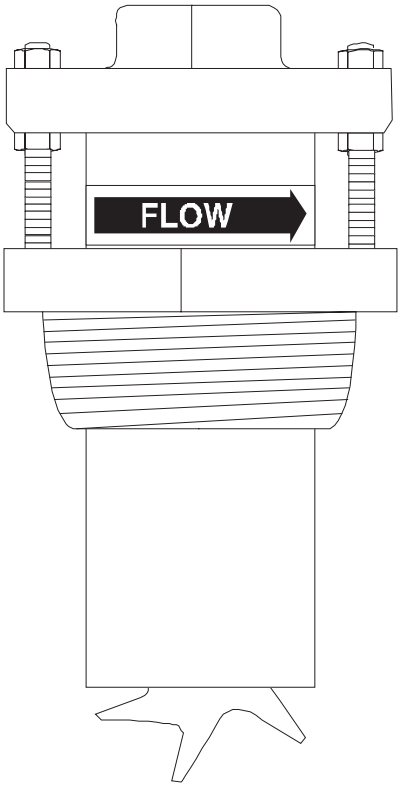
México | Badger Meter de las Americas, S.A. de C.V. | Pedro Luis Ogazón N°32 | Esq. Angelina N°24 | Colonia Guadalupe Inn | CP 01050 | México, DF | México | +52-55-5662-0882
Europe, Eastern Europe Branch Office (for Poland, Latvia, Lithuania, Estonia, Ukraine, Belarus) | Badger Meter Europe | ul. Korfantego 6 | 44-193 Knurów | Poland | +48-32-236-8787
Europe, Middle East and Africa | Badger Meter Europa GmbH | Nurtinger Str 76 | 72639 Neuffen | Germany | +49-7025-9208-0
Europe, Middle East Branch Office | Badger Meter Europe | PO Box 341442 | Dubai Silicon Oasis, Head Quarter Building, Wing C, Office #C209 | Dubai / UAE | +971-4-371 2503
Slovakia | Badger Meter Slovakia s.r.o. | Racianska 109/B | 831 02 Bratislava, Slovakia | +421-2-44 63 83 01
Asia Pacific | Badger Meter | 80 Marine Parade Rd | 21-06 Parkway Parade | Singapore 449269 | +65-63464836
Switzerland | Badger Meter Swiss AG | Mittelholzerstrasse 8 | 3006 Bern | Switzerland | +41-31-932 01 11

Excerpt from Legacy Document Number: SEN-DS-01553-EN

Badger® 200 Series	Insert Style Flow Sensors	Installation & Operation Manual



INTRODUCTION
Used in conjunction with any Badger Meter Impeller flow monitor or transmitter, Badger Meter non-magnetic flow sensors provide an accurate reading of the rate of liquid flow as well as total accumulated flow. A number of sensor models are offered, which cover applications for a wide range of pipe sizes and pressure/temperature specifications.

The flow sensors generate a frequency which is proportional to flow rate. An internal preamplifier allows the pulse signal to travel up to 2000 feet without further amplification. Power to operate the sensor is provided by the flow monitor. The impeller bearing assembly, shaft and O-rings are replaceable in the field.

Badger Meter flow sensors feature a closed, six-bladed impeller design, using a proprietary, non-magnetic sensing technology. The forward-swept impeller shape provides higher, more constant torque than four-bladed impeller designs, and is less prone to fouling by water-borne debris. The forward-curved shape, coupled with the absence of magnetic drag, provides improved operation and repeatability, even at lower flow rates. As the liquid flow turns the impeller, a low impedance signal is transmitted with a frequency proportional to the flow rate.
Sensors of similar type are interchangeable, so there is no need for recalibration after servicing or replacement.

ELECTRONIC TYPES
Badger Meter provides several basic sensor configurations using the same impeller element. This allows for a wide range of applications and pipe sizes. Sensors are normally supplied with 20 feet of 2-conductor 20 AWG shielded U.L. type PTLC 105°C cable. Optional sensors designated with the prefix "IR" feature two single conductor 18 AWG solid copper wire leads 48 inches in length with U.L. Style 116666 direct burial insulation. These IR models are used in below grade applications such as irrigation, municipal, and groundwater monitoring. All Series 200 sensor electrical components are self-contained. Pressure/temperature ratings for the various models are contained in the *Specifications* section of this manual. These models can be further described as follows:

"Standard" Sensor
Designed for indoor or protected area applications such as HVAC, pump control, and industrial process monitoring where the flow rates are between 0.5-30 feet/second and temperatures are below 221°F. Standard sensors are supplied with 20 feet of 2-conductor 20 AWG shielded U.L. type PTLC 105°C cable.

"IR" Sensor
Designed for below grade applications such as irrigation, municipal, and groundwater monitoring where the flow rates are between 0.5-30 feet/second and temperatures are below 180°F. IR sensors are supplied with two single conductors, 18 AWG solid copper wire leads 48 inches in length with U.L. Style 116666 direct burial insulation.

* CE * FM APPROVED * CSA® Exia

* These items must be special ordered

"High Temperature" Sensor
Designed for indoor or protected area applications such as hydronic heating loops, boiler feed, and condensate return line monitoring where the flow rates are between 0.5-30 feet/second and temperatures may be up to 285 deg. F. High temperature Series 228 and 250 sensors are supplied with 12 inches of 2-conductor 20 AWG shielded U.L. type PTLC 105°C cable inside the electronics housing.

"FM/CSA" Sensor
Designed for indoor or protected area applications where intrinsic safety is required and the flow rates are between 0.5-30 feet/second and temperatures are below 221 deg. F. FM/CSA sensors are supplied with 20 feet of 2-conductor 20 AWG shielded U.L. type PTLC 105°C cable. These sensors must be used with an approved safety barrier.

"Magnetic" Sensor
Designed for use with the Badger® Series 1400 battery powered flow monitor in above or below or grade applications such as irrigation, municipal, and groundwater monitoring where the flow rates are between 1-30 feet/second and temperatures are below 221 deg. F.

Models 220BR, 220PVS, 225BR, 226BR, 220SS and 226SS
Model 220BR
This insert style sensor has a 5 1/4 inch long sleeve length, and uses brass and bronze hardware. It is used in all pipe sizes from 2.5 inch to 40.0 inch in diameter. A bronze 2 inch NPT externally threaded hex adapter is provided. The adapter may be mounted to the pipe using a welded-on threaded fitting such as a Thredolet® or pipe saddle.

Model 220PVS
This insert style sensor has an 8 inch long sleeve length, and uses PVC and stainless steel hardware. It is used in all pipe sizes from 2.5 inch to 40.0 inch in diameter. A PVC 2 inch NPT externally threaded hex adapter is provided. The adapter may be mounted to the pipe using a pipe saddle.

Model 220SS
This is the same as Model 220BR, except that the sensor, sleeve and hex adapter are made of Series 300 stainless steel.

Models 225BR
This insert style sensor has a 16 3/8 inch long sleeve length, and uses brass and bronze hardware for hot tap installations. It has a bronze isolation gate valve for applications where the pipe is drained for initial installation but cannot be drained for service.

Models 226BR
This is the same as Model 225BR, except that it has a ball type isolation valve. The ball valve allows for higher pressure use. We recommend this sensor when installation is to be made under pressure, in a true “hot tap” installation. The ball valve cannot be fouled by the tailings from the cutting operation.

200 Series Insert Style Matrix (sizes 2½" and up)

Example:	2	x	x	x	x	x	-	x	x	x	x	
STYLE												
Short Insert	20											
Hot Tap Insert-Gate Valve	25											
Hot Tap Insert-Ball Valve	26											
MATERIAL												
Brass		BR										
Stainless Steel		SS										
PVC Sleeve w/Stainless Steel Trim		PVS										
Size												
Insert Style			00									
Electronics Housing												
PPS				0								
ELECTRONICS												
Magnetic					2							
FM/CSA Approved					4							
Standard					5							
IR-Irrigation					6							
High Temperature					8							
O-RING												
Viton®								0				
EPDM								1				
Kalrez®								2				
Food Grade Silicon								3				
Neoprene								4				
Chemraz®								5				
Teflon Encapsulated Viton								6				
Teflon Encapsulated Silicone								7				
Buna N								8				
SHAFT												
Zirconia Ceramic									0			
Hastalloy® C									1			
Tungsten Carbide									2			
Titanium									3			
Monel®									5			
316 Stainless Steel									6			
Tantalum									7			
IMPELLER												
Nylon										1		
Tefzel®										2		
BEARING												
Pennlon®											1	
Tefzel											2	
Teflon®											3	

Models 226SS, IR226SS
This is the same as Model 226BR respectively, except that the hot tap hardware, ball valve, and sensor sleeve are made of Series 300 stainless steel.

Model HTT
This is the insertion tool for use with any of the hot tap sensor units. It is used to insert and remove the sensor while under pressure. Generally, only one HTT tool is needed on each job site.

MECHANICAL INSTALLATION
General
The accuracy of flow measurement for all flow measuring devices is highly dependent on proper location of the sensor in the piping system. Irregular flow velocity profiles caused by valves, fittings, pipe bends, etc. can lead to inaccurate overall flow rate indications even though local flow velocity measurement may be accurate. A sensor located in the pipe where it can be affected by air bubbles, floating debris, or sediment may not achieve full accuracy and could be damaged. Badger Meter flow sensors are designed to operate reliably under adverse conditions, but the following recommendations should be followed to ensure maximum system accuracy:

1) Choose a location along the pipe where 10 pipe diameters upstream and 5 pipe diameters downstream of the sensor provide no flow disturbance. Pipe bends, valves, other fittings, pipe enlargements and reductions should not be present in this length of pipe.

2) The preferred location around the circumference of a horizontal pipe is on top. If trapped air or debris will interfere, then the sensor should be located further around the pipe from the top but not more than 45 degrees from top dead center. The sensor should never be located at the bottom of the pipe, as sediment may collect there. Locations off top dead center cause the impeller friction to increase, which may affect performance at low flow rates. Any circumferential location is correct for installation in vertical pipes.

3) An insertion depth of 1 1/2 inches for pipe sizes 2.5 inches and larger is required for accurate flow rate calibration. Detailed installation instructions for various sensor mounting configurations on the following pages include methods for ensuring correct insertion depth.

4) Alignment of the sensor to ensure that impeller rotation is parallel to flow is important. Alignment instructions are also included on the following pages.

INSTALLATION FOR 220BR, 220SS
Installation Procedure
The insertion depth and alignment of the sensor assembly are critical to the accuracy of the flow measurement. The flat end of the sensor tube assembly MUST BE INSTALLED 1-1/2 inches from the inside wall of the pipe. In order to allow for variations in wall thickness, lining, or coatings the depth adjustment is controlled by the position of the Hex Nuts on the three (3) threaded studs of the hex mounting adapter. The hex mounting adapter is provided with a 2 inch male NPT connection.

There are two methods of mounting these Badger Meter sensors in a 2.5 inch or larger pipe. One is with a 2 inch NPT threaded pipe saddle. The other is with a welded-on fitting such as a Thredolet®, also tapped for a 2 inch NPT connection. In either case, cut a 2 inch hole through a depressurized pipe and then secure the saddle or weld-on fitting to the pipe. (For drilling into a pressurized pipe, see instructions for Series 225 and 226 sensors.) Install the 2 inch NPT adapter provided, using a thread sealant to prevent leakage. Tighten as necessary. Badger Meter insert style sensors are calibrated with the sensor inserted 1 1/2 inches into the pipe flow.

To determine the proper insertion depth, proceed as follows:

1) **Apply anti-seize thread lubricant , supplied with the sensor, to the threaded studs of the mounting adaptor.**

2) Insert the depth gauge into the mounting adapter and set it against the inside wall of the pipe as shown. Set the top of the upper adjusting nut to 3¾ inches as measured. Lock it in place with the bottom nut on the same stud. Repeat for the other adj. nuts.
Note: For Model 220PVS: Set nuts 6.5 inches above inside wall of pipe.

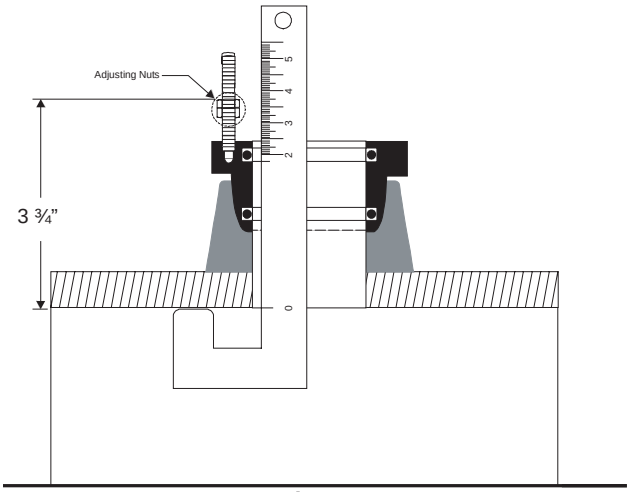


Figure 1
Installation for 220BR and 220SS

3) Clean O-rings and flow sensor sleeve, and lightly lubricate O-rings with silicone grease from the packet provided or some other acceptable lubricant. Take care not to get grease on the impeller or bearing.

4) Insert the flow sensor into the 2 inch NPT adapter so that the mounting holes in the positioning collar fit over the studs on the adapter. Lower the sensor onto the previously adjusted nuts. Install the lock nuts on top of the positioning collar and tighten. Now tighten the lower jam nuts firmly against the upper adjusting nuts to secure them for future removal of the sensor for inspection or service.

Alignment of Flow Sensor

1) Loosen positioning collar set screws with a 3/32 inch Allen wrench. Place the alignment rod through the sight holes in the flow sensor. Refer to Figure 2. Using the alignment rod as a guide, align the flow sensor so that the flow label arrow matches pipe flow direction and so that the alignment rod is exactly parallel to the pipe. This procedure aligns the impeller directly into the fluid flow.

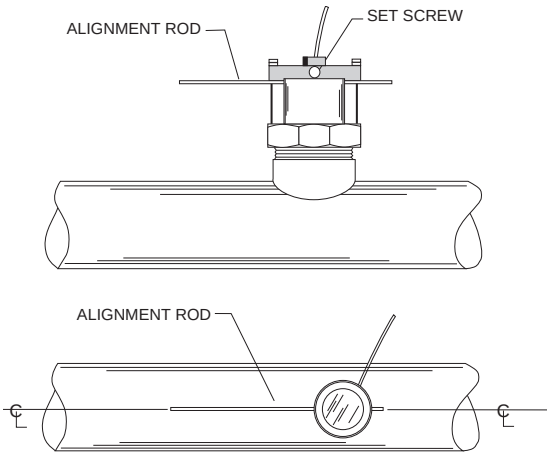


Figure 2
Alignment of Flow Sensor in 220BR and 220SS

2) As a backup to the flow arrow label, there is a small hole next to the larger sighting hole of the upstream side. With a 3/32 inch Allen wrench, tighten positioning collar set screws.

3) Double check that the sighting holes in the sleeve are parallel down the pipe and that the flow arrow label matches pipe liquid flow direction.

4) Cable routing: The positioning collar is threaded for connection of a standard 1/2 inch electrical conduit (flex cable) or a wire strain relief. Route cable as required. Be sure to leave enough flex in cable or conduit to allow future removal of sensor for service or cleaning if necessary.

Hot Tap Installation for 225BR, 226BR, and 226SS

Badger Meter Series 200 hot tap style liquid flow sensors are designed for use in cases where pipelines will be in continuous service and depressurizing or draining the system for installation or service is not practical.

The Badger® Series 200 hot tap sensors are designed to be installed either in a depressurized pipe by hand or “Hot Tapped” into a pressurized pipeline. Both installation procedures are listed in this installation and operation manual. If there is the slightest possibility that the pipe could be full or pressurized, **FOLLOW THE INSTALLATION FOR PRESSURIZED PIPE.**

Refer to Figure 3 for location or identification of the various parts described in the following procedures.

The insertion depth and alignment of the sensor assembly are critical to the accuracy of the flow measurement. The flat end of the sensor tube assembly MUST BE INSTALLED 1 1/2 inches from the inside wall of the pipe. In order to allow for variations in wall thickness, lining or coatings the depth adjustment is controlled by the position of the hex nuts on the three threaded studs of the hex mounting adapter. The hex mounting adapter is provided with a 2 inch male NPT connection. Both gate and ball valve units are provided with 2 inch nipples for mounting onto saddles, weld-o-lets, etc.

Depth setting is accomplished by positioning the hex nuts 14 7/8 inches minus the thickness of the pipe, from the outside diameter of the pipe. For example, measure the wall thickness of the pipe from the coupon removed when the 1 7/8 inch hole was cut into the pipe. If the pipe was 1/8 inch thick, subtract 1/8 inch from 14 7/8 inch, or position the nuts 14 3/4 inch from the outside diameter of the pipe. This will allow the 16 3/8 inch sensor to protrude 1 1/2 inch into the pipe.

Apply anti-seize thread lubricant, supplied with the sensor, to the threaded studs of the mounting adaptor.

The alignment of the impeller with the flow in the pipe is accomplished by aligning the two “sight holes” at the top of the sensor tube assembly with the center line of the pipe. **Make sure the alignment is made to the pipe and not to a wall or surface near the sensor.** To adjust, loosen the two set screws in the positioning collar with a 3/32 inch Allen wrench provided in the Series 200 hot tap installation kit. Slip one end of the 1/4 inch x 18 inch steel rod (also supplied in the installation kit) through the holes in the sensor tube. Rotate the sensor tube until the rod is centered on the pipe. Ensure the flow label “Arrow” on the sensor matches

the liquid flow direction. Tighten the positioning collar Allen screws to lock the sensor tube assembly in position. Note: As a backup to the flow direction arrow label on the tube assembly, there is a smaller hole located beside one of the sighting holes in the tube, to also indicate the upstream side of the tube assembly.

If the pipe is depressurized and drained

1) Drill or cut a 1 7/8 inch hole in the pipe with a drill or hole saw. Note the pipe wall thickness for use in calculating sensor assembly depth. A location on the top of the pipe is best for overall performance and service life; however, any radial location on the top half of the pipe is acceptable. Allow a minimum of ten pipe diameters upstream and five downstream from the sensor of straight unobstructed pipe to allow full development of the flow profile.

2) Install either a service saddle or welded pipe fitting (2 inch female NPT) on the outside diameter of the pipe over the 1 7/8 inch hole.

3) Install the Badger Meter isolation valve and nipple onto the fitting using pipe thread sealant or Teflon® tape on all threads.

4) Install the Badger Meter hex mounting adapter onto the valve assembly. Use pipe thread sealant on the adapter. Tighten the hex adapter so that no stud is aligned with the center-line of the pipe. This could interfere with final sensor alignment. Measure depth and set the height of the nuts of the hex mounting adapter.

5) Open the bleed petcock valve on the hex adapter to relieve the pressure as the sensor tube is installed. Carefully hand insert the Badger Meter hot tap flow sensor tube into the hex mounting adapter. The sleeve should be inserted past the top two O-rings in the adapter (approx. 1 - 1 1/4 inches). **Take care not to push the tube in too far as the impeller could be damaged if it strikes the closed valve.**

6) Even if the sensor is installed with system drained, Badger Meter recommends that a HTT, hot tap insertion/removal tool be purchased for future service. This tools allows the sensor tube assembly to be removed from the pipe line without draining the entire loop where the sensor is mounted.

7) In a fully depressurized and drained pipe, the sensor tube assembly may be installed by hand. **Carefully and very slowly** open the isolation valve to relieve any pressure that may have built up. Fully open the isolation valve. Push the sensor tube into the pipe with a slight twisting motion. Guide the sensor collar holes over the three hex adapter studs until the collar rests on the nuts. Hex nuts should have been previously set to the correct height. Install the three lock nuts onto these studs at the top of the positioning collar and securely tighten.

8) Loosen the two set screws in the positioning collar with a 3/32 inch Allen wrench. Align the sensor sight holes along the pipe axis using the alignment rod provided in the installation kit supplied with the sensor. Ensure that the flow label arrow on the sensor matches the liquid flow direction inside the pipe. Tighten the positioning collar set screws. Note: As a backup to the flow label arrow, there is a small hole located beside one of the sighting holes to also indicate the upstream side of the sensor.

INSTALLATION INTO A PRESSURIZED PIPELINE USING MODEL HTT.

For information on installing hot tap sensor with older 225H consult technical bulletin DID-001

For pipe sizes 2½" and above; all Badger Meter sensors are inserted 1 1/2" from the inside wall of the pipe. The insertion depth is controlled by the position of the hex nuts on the three threaded rods. The formula below defines the distance between the top of the sensor hex mounting adaptor and the bottom of the positioning collar (the top of the hex nut). Reference Figure 3.

D = 16 3/8" - (H + Pipe Wall Thickness + 1.5 ")

Example: If sensor is installed in a 8 inch Sch 80 pipe with a pipe wall thickness of 1/2 inch and the "H" dimension is 10 inches then the calculation would be as below:

D = 16 3/8 - (10 inches + 0.5 inches + 1.5 inches)
D = 4 3/8"

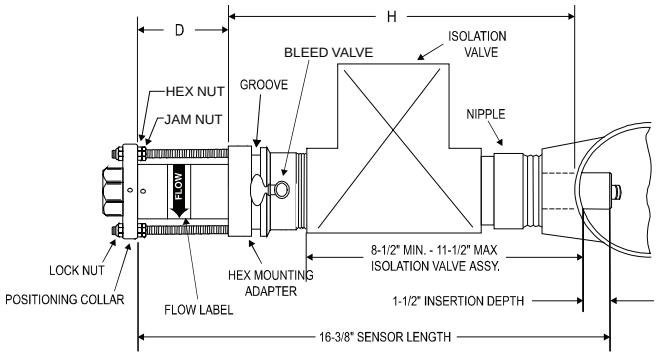


Figure 3

1. Set one set of hex/jam nuts so that the distance between the top surface of the hex nut and the top surface of the hex mounting adaptor is equal to the “D” dimension calculated above. Then adjust the other two sets of hex/jam nuts 1½ inches below the first jam nut to allow clearance for the tool top yoke.

2. Remove the tool split ring and clevis pin and slide tool bottom yoke into the groove on the sensor hex mounting adaptor and secure by replacing the clevis pin and split ring.

3. Mark sleeve 2¾ inches from impeller end of metal sleeve. This mark is a stopping point to insure that impeller/bearing is not damaged. Open the bleed petcock valve on the hex adapter to relieve the pressure resulting from the sensor tube insertion. Carefully hand insert the Badger Meter hot tap flow sensor sleeve assembly into the hex mounting adapter until the mark lines up with the top of the hex mounting adapter. At this point the sleeve will have been inserted past the top two “O”-rings in the adapter (approx. 1 1-1/4 inches). Take care not to push the sensor past the mark on the sleeve as the impeller could be damaged if it strikes the closed valve.

4. Fully extend tool by turning drive nut counterclockwise with a 15/16 inch socket or box wrench (not provided) until drive nut contacts tool and slide the positioning collar into the tool top yoke.

5. Rotate tool so the threaded rod with the adjusted hex/jam nuts is centered in the top yoke of hot tap tool.

6. Rotate sensor sleeve so positioning collar holes align with the threaded rods and flow direction label is in general direction making sure the positioning collar is located in the recessed area of the top yoke. Slide the top yoke of the tool over the positioning collar and secure by tightening the two thumbscrews on the top of the yoke.

7. Close the bleed petcock and slowly open the isolation valve. Slowly turn the 15/16 inch drive nut clockwise to insert the sensor tube assembly through the valve and into the pipeline. Carefully guide the three threaded studs of the hex mounting adapter through the holes of the sensor positioning collar. Carefully lower the sensor until the positioning collar contacts the hex nut preset for the correct depth adjustment. Install the three lock nuts onto the threaded rods, tightening only the lock nut on the threaded rod with the preset hex/jam nut; then, bring the two remaining lock nuts down until they just contact the positioning collar. Do not tighten at this time

8. Remove the Model HTT Insertion/Removal Tool, by loosening the two thumbscrews, removing the clevis pin and then sliding the insertion tool off the sensor. Then bring the two remaining sets of hex/jam nuts up to the underside of the positioning collar, and tighten.

9. Align the sensor by first loosening the two set screws in the side of positioning collar with a 3/32 inch Allen wrench. Then align the sensor sight holes along the pipe axis using the alignment rod provided in the sensor installation kit. Ensure that the flow label arrow on the sensor matches the liquid flow direction inside the pipe. Tighten the positioning collar set screws. Note: As a backup to the flow label arrow, there is a small hole located beside the sight hole on the upstream side of the sensor.

Electrical Installation "Standard" sensors

1) The metal collar on the top of the 220 sensors or an optional conduit cap on the Series 250 sensors will accept 1/2 inch threaded conduit fittings.

2) Route the cable from the sensor to a Badger Meter flow monitor/transmitter. The cable may be extended up to 2000 feet, using 2-conductor shielded 20 AWG or larger stranded copper wire. Be sure to leave enough flexibility in the cable or conduit to allow for future service of sensor, if necessary.

3) When connecting to a Badger Meter flow monitor/transmitter, locate the section of terminal strip on the monitor labeled **“SENSOR INPUT”** or **“SENSOR”**. Connect the red wire to **“ IN”**, "**SIGNAL(+)**" or "**SIGNAL**" terminal and the black wire to **“GND", "SIGNAL(-)”**, or "**COM**" terminal and the shield drain wire (if applicable) to **“SLD”**.

4) When interfacing with other equipment consult manufacture for input designations. The signal wave forms and power requirements are as shown in the specifications section. Refer to Technical Bulletin DTB-058 at www.badgermeter.com

Electrical Installation "IR" sensors

The sensor leads are supplied with watertight caps over the ends. See Application Note DAB-031 and Technical Bulletin DID-003 at www.badgermeter.com

1) **DO NOT** remove the plastic caps from the sensor leads until ready to splice.

2) Use a **twisted pair** cable suitable for direct burial to connect the sensor to the transmitter, monitor, or controller. Multi-pair telecommunication cable or direct burial cables may be used.

3) Make a water tight splice. Two part epoxy type waterproof kits are recommended. Be sure the epoxy seals the ends of the cable jacket.

4) Make sure the epoxy is hardened before inverting the splice or dropping it in standing water.

5) **DO NOT** make an underground splice unless absolutely necessary.

6) Route the cable from the sensor to a Badger Meter flow monitor/transmitter. The cable may be extended up to 2000 feet, using 2-conductor shielded 20 AWG or larger stranded copper wire with appropriate ratings. Be sure to leave enough flexibility in the cable or conduit to allow for future service of sensor, if necessary.

7) When connecting to a Badger Meter flow monitor/ transmitter, locate the section of terminal strip on the monitor labeled **“SENSOR INPUT”** or **“SENSOR”**. Connect the red wire to **“IN”**, "**SIGNAL(+)**" or "**SIGNAL**" terminal and the black wire to **“GND", "SIGNAL(-)”**, or "**COM**" terminal and the shield drain wire (if applicable) to **“SLD”**.

8) When interfacing with other equipment, the signal wave forms and power requirements are as shown in the specifications section. Refer to technical bulletin DTB-058 at www.badgermeter.com

Electrical Installation "High Temperature" sensors

1) Route a cable from the sensor to a Badger Meter flow monitor/transmitter. The cable may be run up to 2000 feet, using 2-conductor shielded 20 AWG or larger stranded copper wire. Be sure to leave enough flexibility in the cable or conduit to allow for future service of sensor, if necessary.

2) Connect to cable inside sensor electronic housing on Series 220 sensors or attach to the sensor cable on the Series 225/226 and connect with standard wire nuts.

3) When connecting to a Badger Meter flow monitor or transmitter, locate the section of terminal strip on the monitor labeled **“SENSOR INPUT”** or **“SENSOR”**. Connect the red wire to **“ IN”**, "**SIGNAL(+)**" or "**SIGNAL**" terminal and the black wire to **“GND", "SIGNAL(-)”**, or "**COM**" terminal and the shield drain wire (if applicable) to **“SLD”**.

4) When interfacing with other equipment, the signal wave forms and power requirements are as shown in the specifications section.

Electrical Installation "Magnetic" sensors

The magnetic sensor has a custom wire connector tha connects to the series 1400 monitor only. The cable may be extended up to 100 feet from the sensor. If extension cables are needed they may be ordered from Badger Meter.

Cable Length	Part #
5'	7101
10'	7108
20'	7102
50'	7109

Electrical Installation (FM Sensors)

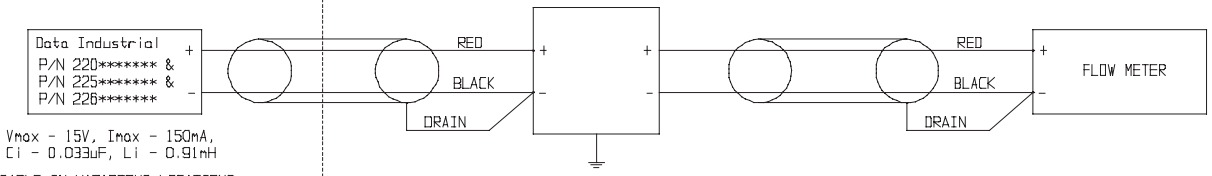
The Badger® Series 200 sensor is approved, as an entity, as intrinsically safe when installed in conformance with Badger Meter installation drawings 06-480-001 or 06-480-002 (samples shown on Page 10) as specified on the blue label identifying an intrinsically safe sensor.

Entity approval implies that only the sensor is approved as intrinsically safe. Unless power supplies, equipment, and instruments connected to the sensor are each rated either explosion-proof or intrinsically safe, these devices cannot be installed in a hazardous area. The referenced installation drawing shows such apparatus located in a non-hazardous location. Proper interfacing between the hazardous and non-hazardous areas must be provided. It is of absolute importance that this interface be constructed and that all wiring be performed by qualified contractors. To ensure the intrinsic safety of the installation, the connection of the intrinsically safe sensor to instruments and or power supplies must take place using an approved intrinsically safe barrier located in a non-hazardous area. These barriers, listed below, are readily available from various suppliers.

Manufacturer:	Barrier:
Crouse-Hinds Spec 504	Cat No.SB19140M0715
Measurement Technology Ltd.	MTL 715+ 15 V
R Stahl Intrinspak	9001/1-158-150-10

REVISIONS			
REV	DESCRIPTION	DATE	BY
A	RELEASED ECO 3250		
B	ECO 3263	7-6-94	
C	ECO 3292	12/27/94	
D	ECO 3649	11/10/98	R.G.

HAZARDOUS LOCATION | NONHAZARDOUS LOCATION



Vmax = 15V, Imax = 150mA,
Ci = 0.033uF, Li = 0.91mH

USABLE IN HAZARDOUS LOCATIONS
⚠ CLASS I, DIVISION 1,
CLASS II, DIVISION 1,
CLASS III, DIVISION 1,
GROUPS A, B, C, D, E, F, G

FMRC APPROVED ENTITY
INTRINSIC SAFETY BARRIER

NOTES

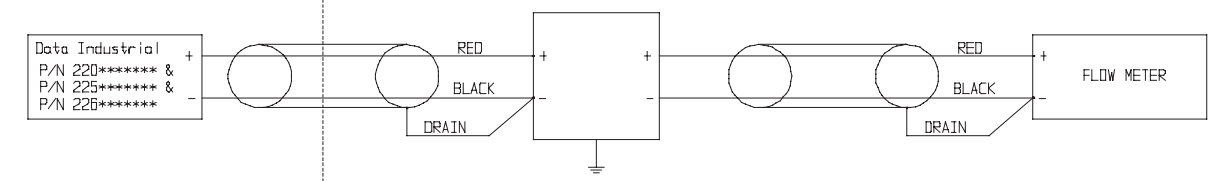
1. FMRC APPROVED BARRIER PARAMETERS MUST MEET THE FOLLOWING CONNECTION REQUIREMENTS:
   - Voc OR Vt MUST BE LESS THAN Vmax
   - Isc OR It MUST BE LESS THAN Imax
   - Ci PLUS INTERCONNECTION WIRING MUST BE LESS THAN THE Ca OF THE FMRC APPROVED BARRIER
   - Li PLUS INTERCONNECTING WIRING MUST BE LESS THAN THE La OF THE FMRC APPROVED BARRIER
2. INSTALLATION SHALL BE IN ACCORD WITH THE MANUFACTURER'S INSTRUCTIONS AND THE NATIONAL ELECTRICAL CODE (ANSI/NFPA 70).
3. FOR GUIDANCE ON INSTALLATION, SEE ANSI/ISA RP12.6 "INSTALLATION OF INTRINSICALLY SAFE INSTRUMENT SYSTEMS IN CLASS I HAZARDOUS LOCATIONS"
4. NO CHANGES TO THIS DRAWING WITHOUT PRIOR WRITTEN AUTHORIZATION FROM FMRC.

DO NOT SCALE DRAWING

DRAWN BILL HEELAN 04/20/94	DATE	Data Industrial®	11 INDUSTRIAL DRIVE MATTAPOISETT, MA 02739 (508)-758-6390
CHECKED	DATE	PROJECT: FM APPROVED SENSORS	
APPROVAL	DATE	PART: INSTALLATION DRAWING FOR FMRC APPV'D 220CP,220PV,220BR*-,220SS*-,225*-,&226*-SENSORS	
FMRC APPROVAL	DATE	SIZE B / FSCM NO. / DWG NO. 06-480-001 / REV D	
		SCALE NONE / 06480001D.PRT / SHEET 1 OF 2	

REVISIONS			
REV	DESCRIPTION	DATE	BY
A	RELEASED ECO 3250		
B	ECO 3263	7-6-94	
C	ECO 3292	12/27/94	
D	ECO 3649	11/10/98	R.G.

HAZARDOUS LOCATION | NONHAZARDOUS LOCATION



USABLE IN HAZARDOUS LOCATIONS
⚠ CLASS I, DIVISION 1,
CLASS II, DIVISION 1,
CLASS III, DIVISION 1,
GROUPS A, B, C, D, E, F, G

CSA CERTIFIED
INTRINSIC SAFETY BARRIER

CROUSE-HINDS, SPEC 504, CAT. NO. SB19140M0715
MEASUREMENT TECHNOLOGY LTD. MTL 715+ 15 V,
R. STAHL INTRINSPAK 9001/01-158-150-10

NOTES:

1. INSTALLATION SHALL BE IN ACCORD WITH THE INTRINSIC SAFETY BARRIER MANUFACTURERS INSTRUCTIONS AND CANADIAN ELECTRICAL CODE
2. NO CHANGES TO THIS DRAWING WITHOUT PRIOR WRITTEN AUTHORIZATION FROM CSA

DO NOT SCALE DRAWING

DRAWN BILL HEELAN 04/20/94	DATE	Data Industrial®	11 INDUSTRIAL DRIVE MATTAPOISETT, MA 02739 (508)-758-6390
CHECKED	DATE	PROJECT: CSA CERTIFIED SENSORS	
APPROVAL	DATE	PART: INSTALLATION DRAWING FOR CSA CERTIFIED 220CP,220PV,220BR*-,220SS*-,225*-,& 226*-SENSORS	
FMRC APPROVAL	DATE	SIZE B / FSCM NO. / DWG NO. 06-480-001 / REV D	
		SCALE NONE / 06480001D.PRT / SHEET 2 of 2	

Calibration
Badger Meter sensors use unique K and Offset numbers for calibration. These numbers are derived from calibration runs using NIST traceable instruments. Using both a K and an Offset number provides higher accuracy than using a K (pulse/gal) factor alone. K and Offset numbers for each tee configuration are listed in the following tables.

Calibration Tables

The table on pages 12 and 13 provides calibration and operation data for most scheduled pipe sizes from 3 inches through 18 inches. For tee-mounted sensors, see either Metal Tee (Manual Number 872021), or (Plastic Tee Manual Number 872022).

Description of Column Information for Pipe Sizes 3 inches through 36 inches

Column 1 — Nominal Pipe Size

Column 2 — Pipe O.D. as defined by ASA B36.10 and other standards

Column 3 — Pipe I.D. as defined by ASA B36.10 and other standards

Columns 4 and 5 — The K value and Offset that should be used in our frequency equation:

This equation describes the frequency

$$\text{Freq} = \frac{\text{Gpm}}{K} - \text{Offset}$$

of the output signal of all Badger Meter flow sensors. By substituting the appropriate K and Offset values from the table, the sensor's output frequency can be calculated for each pipe size. This information is required when calibrating an output board or when using the raw sensor data as direct output to interface with a device that is not a Badger Meter product.

Column 6 — This column indicates the suggested flow range of sensors in each pipe size. Badger Meter sensors will operate both above and below the indicated flow rates. However, good design practice dictates the use of this range for best performance.

Sensors should be sized for flow rather than pipe size. To prevent disturbances to the flow profile always connect the sensor tee to pipe nipples measuring at least ten pipe diameters in length on the up stream (supply) side and at least five pipe diameters in length on the downstream (delivery) side before making the transition in pipe size.

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Pipe Size	Pipe O.D.	Pipe I.D.	K	Offset	Suggested Operating Range (GPM)
3 inch Sch 10S	3.500"	3.260"	5.009	.090	12-400
Std. Wt., Sch 40	3.5"	3.068"	4.362	.063	12-400
Extra Strong, Sch 80	3.5"	2.900"	3.858	.043	12-400
PVC Class 125	3.5"	3.284"	5.094	.093	12-400
PVC Class 160	3.5"	3.230"	4.902	.085	12-400
PVC Class 200	3.5"	3.166"	4.682	.076	12-400
4 inch Sch 10S	4.5"	4.260"	9.597	.241	20-600
Std. Wt., Sch 40	4.5"	4.026"	8.34	.229	20-600
Extra Strong, Sch 80	4.5"	3.826"	7.354	.188	20-600
PVC Class 125	4.5"	4.224"	9.396	.240	20-600
PVC Class 160	4.5"	4.154"	9.013	.240	20-600
PVC Class 200	4.5"	4.072"	8.578	.239	20-600
5 inch Sch 10S	5.563"	5.295"	16.305	.250	30-900
Std. Wt., Sch 40	5.50"	5.047"	14.674	.248	30-900
Extra Strong, Sch 80	5.50"	4.813"	13.165	.246	30-900
6 inch Sch 10S	6.625"	6.357"	24.089	.260	50-1,500
Std. Wt., Sch 40	6.5"	6.065"	21.574	.257	50-1,500
Extra Strong, Sch 80	6.5"	5.761"	19.457	.254	50-1,500
PVC Class 125	6.625"	6.217"	22.853	.258	50-1,500
PVC Class 160	6.625"	6.115"	21.968	.257	50-1,500
PVC Class 200	6.625"	5.993"	21.068	.256	50-1,500
8 inch Sch 10S	8.625"	8.329"	43.914	0.286	80-2,500
Sch 20	8.625"	8.125"	41.653	0.283	80-2,500
Sch 30	8.625"	8.071"	41.063	0.283	80-2,500
Std. Wt., Sch 40	8.625"	7.981"	40.086	0.281	80-2,500
Sch 60	8.625"	7.813"	38.288	0.279	80-2,500
Extra Strong, Sch 80	8.625"	7.625"	36.315	0.276	80-2,500
PVC Class 125	8.625"	8.095"	41.324	0.283	80-2,500
PVC Class 160	8.625"	7.961"	39.869	0.281	80-2,500
PVC Class 200	8.625"	7.805"	38.203	0.279	80-2,500
10 inch Sch 10S	10.75"	10.420"	70.195	0.321	125-4,000
Sch 20	10.75"	10.250"	67.668	0.318	125-4,000
Sch 30	10.75"	10.136"	66.069	0.316	125-4,000
Sch 40, Std.Wt.	10.75"	10.020"	64.532	0.314	125-4,000
Extra Strong, Sch 60	10.75"	9.750"	61.016	0.309	125-4,000
Sch 80	10.75"	9.564"	58.644	0.306	125-4,000
PVC Class 125	10.75"	10.088"	65.431	0.315	125-4,000
PVC Class 160	10.75"	9.924"	63.272	0.312	125-4,000
PVC Class 200	10.75"	9.728"	60.733	0.309	125-4,000
12 inch Sch 10S	12.75"	12.390"	104.636	0.367	175-5,000
Sch 20	12.75"	12.250"	102.553	0.364	175-5,000
Sch 30	12.75"	12.090"	99.347	0.36	175-5,000
Std. Wt., Sch 40S	12.75"	12.000"	97.576	0.358	175-5,000
Sch 40	12.75"	11.938"	96.369	0.356	175-5,000
Sch 60	12.75"	11.625"	90.441	0.348	175-5,000
Extra Strong	12.75"	11.750"	92.775	0.351	175-5,000
Sch 80	12.74"	11.376"	85.922	0.342	175-5,000
PVC Class 125	12.75"	11.966"	96.912	0.357	175-5,000
PVC Class 160	12.75"	11.770"	93.152	0.352	175-5,000
PVC Class 200	12.75"	11.538"	88.842	0.346	175-5,000

CALIBRATION TABLE FOR PIPE SIZES 3 INCHES THROUGH 36 INCHES

Continued on Next Page

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Pipe Size	Pipe O.D.	Pipe I.D.	K Value	Offset	Suggested Operating Range (GPM)
14 inch Sch 10S	14.00"	13.500"	122.307	0.391	200-6,000
Sch 20	14.00"	13.375"	120.216	0.388	200-6,000
Std. Wt., Sch 30	14.00"	13.250"	118.151	0.385	200-6,000
Sch 40	14.00"	13.124"	116.096	0.382	200-6,000
Sch 60	14.00"	12.814"	111.148	0.376	200-6,000
Extra Strong	14.00"	13.00"	114.098	0.33	200-6,000
Sch 80	14.00"	12.50"	106.299	0.369	200-6,000
16 inch Sch 10S	16.00"	15.500"	159.243	0.44	300-9,000
Sch 20	16.00"	15.375"	156.742	0.436	300-9,000
Std. Wt., Sch 30	16.00"	15.250"	154.267	0.433	300-9,000
Sch 60	16.00"	14.688"	143.456	0.419	300-9,000
Extra Strong, Sch 40	16.00"	15.000"	149.394	0.427	300-9,000
Sch 80	16.00"	14.314"	136.548	0.41	300-9,000
18 inch Sch 10S	18.00"	17.500"	202.739	0.498	350-10,000
Sch 20	18.00"	17.375"	199.828	0.494	350-10,000
Sch 30	18.00"	17.124"	194.061	0.486	350-10,000
Std. Wt.	18.00"	17.250"	196.943	0.49	350-10,000
Sch 40	18.00"	16.876"	188.464	0.479	350-10,000
Sch 60	18.00"	16.500"	180.171	0.469	350-10,000
Extra Strong	18.00"	17.000"	191.25	0.482	350-10,000
Sch 80	18.00"	16.126"	172.152	0.457	350-10,000
20 inch Std. Wt., Sch 20	20.00"	19.25"	246.179	0.555	400-12,000
Sch 40	20.00"	18.812"	234.836	0.540	400-12,000
Extra Strong, Sch 30	20.00"	19.000"	239.666	0.547	400-12,000
Sch 80	20.00"	17.938"	213.14	0.511	400-12,000
22 inch Std. Wt., Sch 20	22.00"	21.25"	301.975	0.621	500-15,000
Extra Strong, Sch 30	22.00"	21.00"	294.642	0.616	500-15,000
Sch 80	22.00"	19.75"	259.513	0.573	500-15,000
24 inch Std. Wt., Sch 20	24.00"	23.25"	364.331	0.666	600-18,000
Extra Strong	24.00"	23.00"	356.178	0.660	600-18,000
Sch 40	24.00"	22.624"	344.109	0.652	600-18,000
Sch 80	24.00"	21.562"	311.271	0.628	600-18,000
26 inch Sch 10	26.00"	25.376"	437.809	0.719	700-21,000
Std. Wt.	26.00"	25.25"	433.247	0.716	700-21,000
Sch 20, Extra Strong	26.00"	25.00"	424.274	0.709	700-21,000
28 inch Sch 10	28.00"	27.376"	513.698	0.774	900-23,000
Std. Wt.	28.00"	27.25"	508.723	0.770	900-23,000
Extra Strong, Sch 20	28.00"	27.00"	498.930	0.763	900-23,000
30 inch Sch 10	30.00"	29.376"	596.147	0.833	1,000-30,000
Std. Wt.	30.00"	29.25"	590.759	0.829	1,000-30,000
Sch 20, Extra Strong	30.00"	29.00"	580.146	0.822	1,000-30,000
32 inch Sch 10	32.00"	31.376"	685.156	0.897	1,200-35,000
Std. Wt.	32.00"	31.25"	679.355	0.893	1,200-35,000
Sch 20, Extra Strong	32.00"	31.00"	667.922	0.885	1,200-35,000
Sch 40	32.00"	30.624"	650.919	0.873	1,200-35,000
34 inch Sch 10	34.00"	33.312"	777.566	0.964	1,300-40,000
Std. Wt.	34.00"	33.25"	774.511	0.962	1,300-40,000
Extra Strong, Sch 20	34.00"	33.00"	762.258	0.953	1,300-40,000
Sch 40	34.00"	32.624"	744.022	0.940	1,300-40,000
36 inch Sch 10	36.00"	35.376"	882.855	1.040	1,500-45,000
Std. Wt.	36.00"	35.25"	876.227	1.035	1,500-45,000
Sch 20, Extra Strong	36.00"	35.00"	863.154	1.025	1,500-45,000
Sch 40	36.00"	34.50"	837.315	1.007	1,500-45,000

CALIBRATION TABLE FOR PIPE SIZES 3 INCHES THROUGH 36 INCHES

Impeller Assembly and Shaft Replacement
If you are replacing an existing Badger Meter sensor and have already calibrated your flow monitor/transmitter, no calibration changes are necessary. For installation of a new flow monitor or for relocation of a sensor in a new pipe size, please refer to the calibration instructions in flow monitor manual.

1) Depressurize pipe from which sensor is to be removed. If the sensor is one of the Series 225/IR225 or 226/ IR226, consult the installation section on hot tap sensors.

NEVER disturb the securing lock nuts with pipe under pressure without hot tap insertion tool Model HTT installed.

2) Remove the three lock nuts that secure the positioning collar to the threaded rods of metal sensor.

NOTE: Before removing lock nuts, record the dimension from top of 2 inch NPT adapter to the bottom of the positioning collar. This dimension will be required later to reinstall.

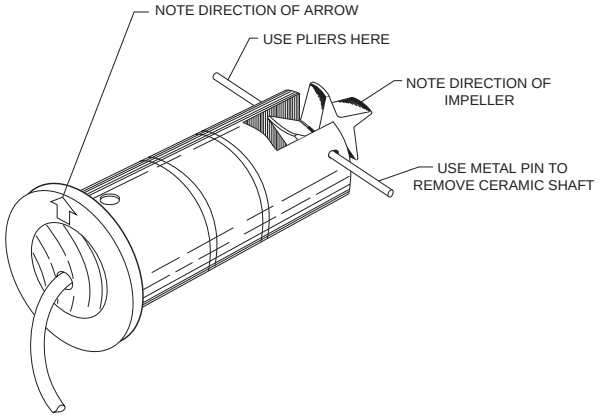


Figure 4
Impeller Assembly and Shaft Replacement

3) Remove the sensor from the hex adapter or the tee.

4) Note the impeller blade orientation relative to flow arrows and the alignment hole in metal sensors beside one of the sighting holes. In order to maintain proper calibration, the impeller will have to be reinstalled in the same manner with the impeller blades pointing toward the small alignment hole, and into the flow direction as indicated by the flow arrows.

5) To remove the old impeller blade assembly, push the old shaft out of the sleeve with the new shaft (or small diameter rod) just far enough to grab the end with a pair of pliers and pull the shaft completely out. The impeller assembly will now be free and will drop out.

6) Inspect the shaft and bearings for wear, and replace as necessary.

7) Refer to figure 4. To reinstall, position the impeller in the cavity oriented as in step 4 so that the impeller blades point into the flow direction and toward the small alignment hole located beside one of the sighting holes on metal sensors.

8) Carefully push the shaft through the sleeve and impeller taking care not to damage the bearings. Make sure that the shaft is inserted far enough so that it clears the sleeve on each side of the impeller housing.

NOTE: If shaft is not carefully installed, the bearing can be deformed preventing free rotation.

9) Inspect the O-rings for damage and replace as necessary. Clean the O-rings and the sleeve and relubricate with silicone grease from the packet provided or some other acceptable lubricant.

10) Install the sensor into the 2 inch NPT adapter or tee so that alignment hole is facing upstream and flow arrows point in the direction of the actual flow. Since the positioning collar was not loosened during this operation, the studs should all line up perfectly when the sighting holes are parallel to pipe. If this has been accidentally loosened, please refer to the installation instructions for the alignment of the flow sensor unit.

11) Install and tighten the nuts.

12) For metal sensors, double check that the distance from the top of the 2 inch NPT adapter to the bottom of the positioning collar equals the dimension as measured in step 2, and holes in sleeve sight exactly down the pipe, the arrows point in direction of flow and alignment holes located beside one sighting hole is pointing towards the source. If not, refer to *installation* section in this manual.

13) This completes the replacement procedure. The system may now be repressurized and tested.

TROUBLESHOOTING

1) If the voltage at the sensor input is less than 7 VDC in a no flow situation, disconnect the sensor from the barrier strip and measure the voltage at the sensor input terminals of the barrier strip again. It should be between 8 VDC and 20 VDC. If the voltage at the sensor input is still below 7 VDC or 3 VDC, the problem may be with the monitor (hardware or programming).

2) If you suspect that the sensor is bad, you can test the monitor circuitry by connecting a piece of wire to one of the sensor input terminals and tap the other side of the wire to the other sensor input terminal. Shorting across the sensor input terminals ON and OFF repeatedly allows the display to respond by trying to calculate a flow rate for the frequency of your shorting action. If the display does not show a change from 0.00, it indicates a problem with the monitor.

3) If the monitor tests ok and there are any splices in the cable, break the sensor cable at the splice closest to the sensor and retry the shorting test in step 2.

4) If the cable tests ok, drain the pipe line, verify the pressure is off, remove top lock nuts holding the sensor electronics. Spin the impeller by hand. If flows are noted on the display, and impeller spins freely then the flow rates may have been below our design minimums or the line was full of air. Try again. If the sensor fails to respond then replace sensor.

SPECIFICATIONS

Wetted Materials for all sensors
- (see ordering matrix)

Sensor Sleeve and Hex Adapter for 220BR, 225BR, and 226BR
- Sleeve: admiralty brass, UNS C44300; hex adapter: valve bronze, UNS C83600

Sensor Sleeve and Hex Adapter for 220SS and 226SS
- Series 300 stainless steel

Temperature Ratings
- Standard version:
  221 deg. F (105 deg. C) continuous service
- High temperature version:
  285 deg. F (140.6 deg. C) continuous service
  305 deg. F (150 deg. C) peak temperature (limited duration)

Pressure Ratings

	At 100 deg. F	At 300 deg. F
220SS	400 psi	325 psi
220B	400 psi	325 psi
225B	300 psi	210 psi
226B	400 psi	250 psi
226SS	400 psi	300 psi

Recommended Design Flow Range
- 0.5 to 30 ft/sec
- Initial detection below 0.3 ft/sec

Accuracy
- ± 1.0% of full scale over recommended design flow range

Repeatability
- ± 0.3% of full scale over recommended design flow range

Linearity
- ± 0.2% of full scale over recommended design flow range

Transducer Excitation
- Quiescent current 600uA@8VDC to 35VDC max.
- Quiescent voltage (V_{high})
  Supply Voltage -(600uA*Supply impedance)
- ON State (V_{Low}) Max. 1.2VDC@40mA current limit (15ohm+0.7VDC)

Output Frequency
- 3.2 Hz to 200 Hz

Output Pulse Width
- 5 msec ±25%

Electrical Cable for Standard Sensor Electronics
- 20 feet of 2-conductor 20 AWG shielded U.L. type PTLC wire provided for connection to display or analog transmitter unit. Rated to 105 deg. C. May be extended to a maximum of 2000 feet with similar cable and insulation appropriate for application.

Electrical Cable for IR Sensor Electronics
- 48 inches of U.L. Style 116666 copper solid AWG 18 wire with direct burial insulation. Rated to 105 deg. C.

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Data Industrial®

Please see our website at **www.badgermeter.com** for specific contacts.

Due to continuous research, product improvements and enhancements, Badger Meter reserves the right to change product or system specifications without notice, except to the extent an outstanding contractual obligation exists.

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Industrial Flow Computer

Model FC-5000 Flow Monitor

DESCRIPTION

The Badger Meter® FC-5000 is a microprocessor-driven flow computer designed for flow monitoring. The FC-5000 flow computer is compatible with the complete line of Badger Meter industrial flow meters, creating a solution to totalize and indicate fluid flows. Many years of experience in the industrial market has allowed Badger Meter to incorporate features indispensable in control operations.

Features	Benefits
Large, backlit graphical display	Easy viewing
Integrated softkeys and full numerical keypad	Easier navigation and programming
100 point linearization	Higher resolution for improved linearization
Sensor data display screen	View raw and calculated flow data, as well as relay and digital I/O status
Plug-and-play terminals	Easier, user-friendly installation
User-programmable relay configuration	Enable flow and totalization alarms to trigger high, low and outside of range
User-programmable scaled outputs	Transmit flow or totalization data via dedicated output channels
Robust enclosure, keypad and mechanical relays	Application ruggedness

OPERATION

Input signal—in the form of sine waves or pulses from open collector transistors or dry contact closures—can be scaled to any unit of measure for totalization and instantaneous rate-of-flow indication. Linearized volumetric flow rate and totals are examples of flow parameters that can be viewed on the panel display or through Modbus communications.

Units configured with temperature sensor inputs can compensate for changes is fluid viscosity when process temperature varies. The expansion and contraction of the flow meter housing is also compensated for, due to thermal effects, by means of proven Roshko/Strouhal algorithms.

Dedicated analog or frequency output channels provide scaled outputs that are assignable to parameters such as flow rate, total and temperature. Additionally, a user defined smoothing function can be applied for improved stability of the flow readings.

FLEXIBILITY

- Non-volatile memory preserves all configured settings and totalization values during power failure
- Low voltage AC/DC power
- Default sets all functions to factory-programmed values
- Ability to restore to factory programmed settings

ACCESSORIES

- 110…230V AC line power adapters
- NEMA-4X enclosure (for wall-mount applications)
- PC programming interface / USB cable

VIEWING CAPABILITIES

Quickly toggle views on the *Home* screen to switch from or to:

- FLOW RATE CH 1 (*Figure 1*)
- FLOW TOTAL CH 1 (*Figure 1*)
- FLOW RATE CH 1 + FLOW TOTAL CH 1 (Dual Display) (*Figure 2*)

The Sensor Inputs option P2 also allows for a second flow sensor, indicated by rate/total CH2:

- FLOW RATE CH2
- FLOW TOTAL CH2
- FLOW RATE CH2 + FLOW TOTAL CH2 (Dual Display)

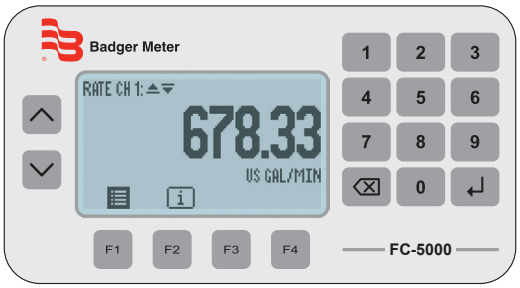


Figure 1: Single display

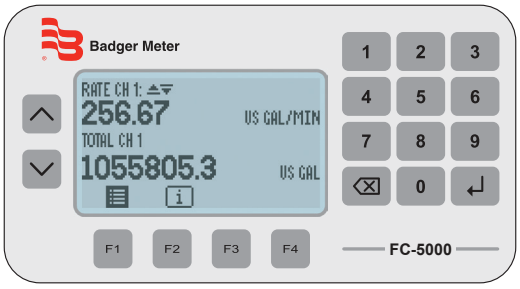


Figure 2: Dual display

Product Data Sheet

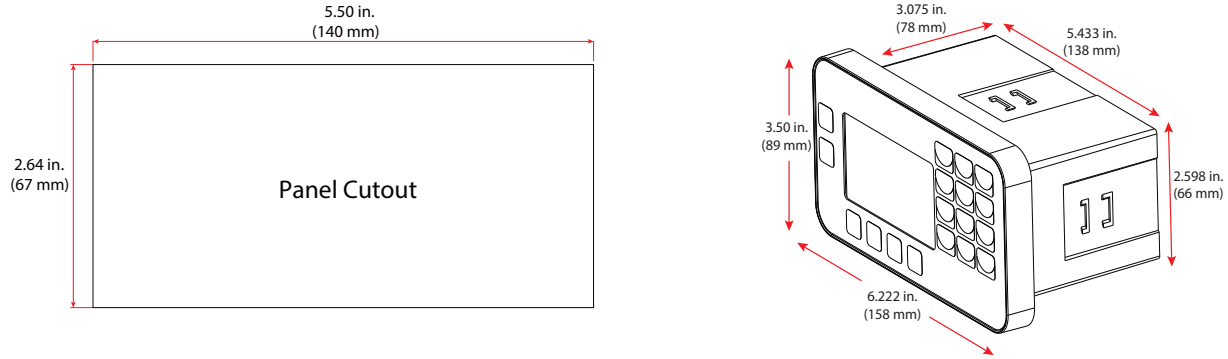
PROGRAMMABILITY

Fluid Properties	Custom fluid characteristics can be stored for calculations and reference.
Digital I/O	Reset relays, reset totals, reset relays and totals or inhibit flow channels, remotely via the 6 available I/O ports.
Scaled Outputs	Assignable to flow and/or total.
Relay Outputs	Assignable relay outputs that can be tied to flow or total. Option to enable/disable latching functionality.
Display Properties	Adjustable contrast and brightness for readability and controlling power consumption.
Stored or Custom Units of Measure	Select from a list of standardized units of measure, or complete the customized option with labels and quantity assignments.
Passwords	User-defined passcodes to manage configuration parameters and reset functions.
Sensor Inputs	Select from a predefined list of flow and temperature sensor input types.

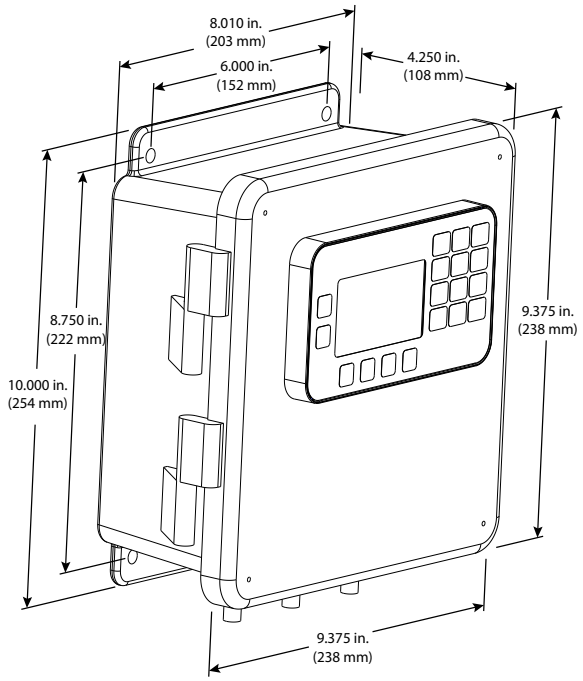
DIMENSIONS

Panel Mount Unit

Mounting clips can accommodate a maximum panel thickness of 1.5 in. (38.1 mm).



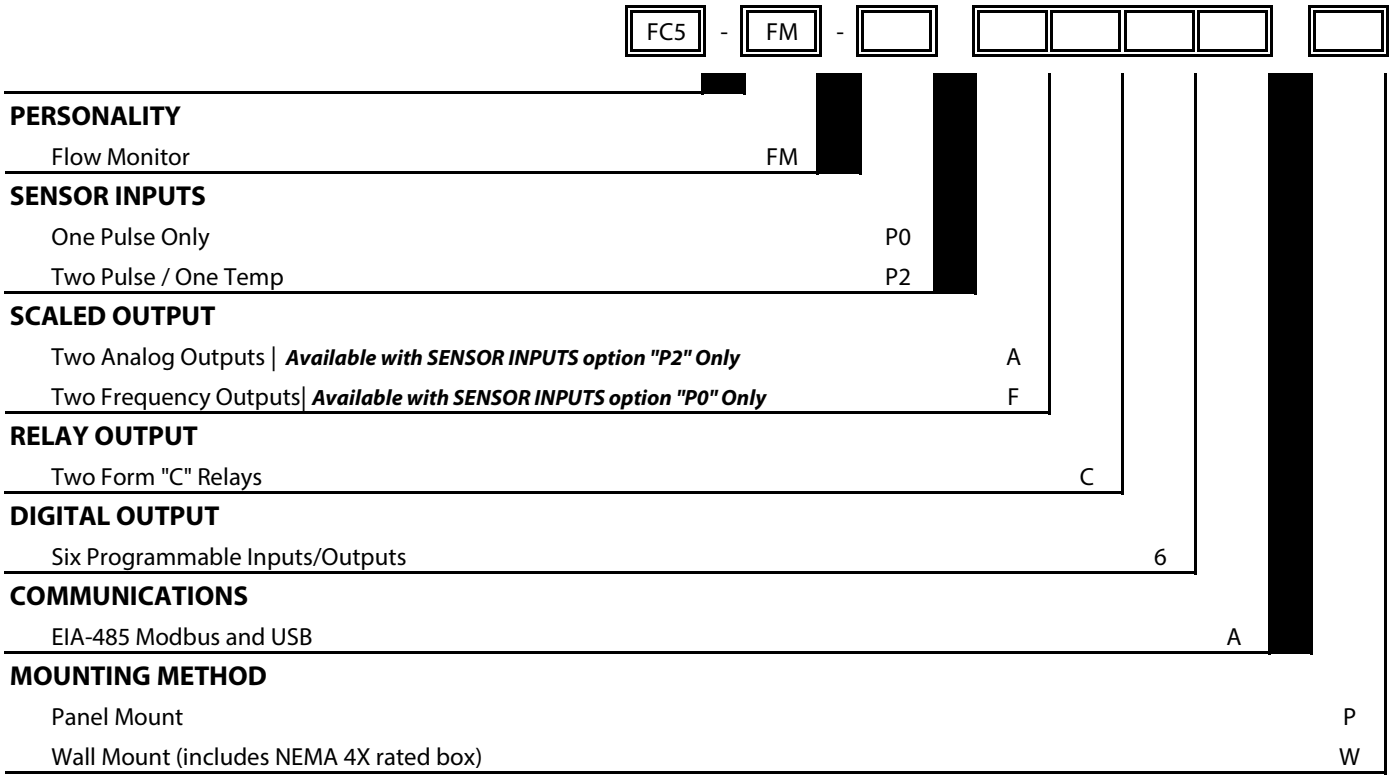
Wall Mount Unit



SPECIFICATIONS

Power Supply		Input range 10…40V DC and 9…28V AC RMS
		AC input voltage frequency range 50…60 Hz
		Maximum 8 Watts power consumption
		Isolated from power ground
		Over-voltage, transient and reverse polarity protected
Flow Meter Input		1 or 2 independent channels
		Configurable as square wave 0…30V pulse with 2.5 V threshold
		Configurable as sine wave, zero-centered with 200 mV amplitude and 45 mV threshold
		0…10 kHz frequency input range
		Configurable debounce
		Isolated from power ground
		Over-voltage, transient and reverse polarity protected
Frequency Outputs (Output Option F)		2 independent channels
		Isolated from power ground
		TTL, 1…4000 Hz, square wave
		Over-voltage, transient and reverse polarity protected
		Output is multiplexed on the process out pins
		Resolution 0.01 Hz
		Uncertainty ±0.01% RDG
Analog Outputs (Output Option A)		2 independent channels
		Isolated from power ground
		0…5V, 0…10V or 4…20 mA
		Over-voltage, transient and reverse polarity protected
		Output is multiplexed on the process out pins
		16-bit resolution (0…10V and 4…20 mA), 15-bit resolution (0…5V)
		200 ms, 90-10% step response
		Uncertainty ±0.1% of RDG
Field Configurable Digital I/O (Optional)		6 independent channels
		Isolated from power ground
		Over-voltage, transient and reverse polarity protected
		0…30 Volts as input
		De-bounce
		0…5V, TTL, 200 ms 90…10% step response, driving < 0.1 uF
Relay Outputs		2 Form C mechanical
		Isolated coil drivers
		Over-voltage, transient and reverse polarity protected
RS-485 Communications		4-wire interface/half duplex
		Over-voltage/ESD Protection
		Isolated from power ground
USB Communications		USB host interface (A connector)
		USB device interface (mini B connector)
		Over-voltage/ESD/transient protected
Display/User interface		Membrane keypad / domed tactile response
		128 × 64 pixel backlit graphical display
		Protected from EMI/RFI
		Keypad interface is protected from ESD
Flow Calculation		± 0.01% uncertainty
		Adjustable FIR/IIR filtering
Pollution Degree		2
Altitude Restriction		Up to 2000 m (6561 ft)
Over-Voltage Rating		Category II
Operator Functions		Unlatch Relays, Reset Totalizer, Unlatch Relays and Reset Totalizer, Inhibit Flow Channels
		Flow Rate, Total, Flow Rate and Total
Flow Total or Flow Rate	Digits	8 digits
	Units	US Gallons (US GAL), Imperial Gallons (I GAL), Mega US Gallons (US MGAL), Mega Imperial Gallons (I MGAL), Liters (L), Mega Liters (ML), Cubic Meters (M^3), Cubic Feet (FT^3), Acre Feet (ACFT), Oil Barrels (OBBL), Liquid Barrels (LBBL), US Ounces (US OZ), Imperial Ounces (I OZ), Custom (user-specified)
	Decimals	0…4
Flow Rate Only	Time unit	second (S), minute (M), hour (H), day (D)
Temperature	Digits	8 digits
	Units	°F (Fahrenheit), °C (Celsius), °R (Rankine) or °K (Kelvin)
	Decimals	0…4

PART NUMBER MATRIX



Control. Manage. Optimize.

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Badger Meter

Industrial Flow Computer

FC-5000 Flow Computer

CTL-UM-01723-EN-04 (September 2019)

User Manual

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SCOPE OF THIS MANUAL

This manual describes how to install and program the FC-5000 Flow Computer. The electronic version of this manual is available on our website at *www.badgermeter.com*.

IMPORTANT

Read this manual carefully before attempting any installation or operation. Keep the manual in an accessible location for future reference.

UNPACKING AND INSPECTION

Upon opening the shipping container, visually inspect the product and applicable accessories for any physical damage such as scratches, loose or broken parts, or any other sign of damage that may have occurred during shipment.

NOTE: If damage is found, request an inspection by the carrier's agent within 48 hours of delivery and file a claim with the carrier. A claim for equipment damage in transit is the sole responsibility of the purchaser.

SAFETY CONSIDERATIONS

Terminology and Symbols

⚠ DANGER Indicates a hazardous situation, which, if not avoided, will result in death or serious personal injury.

⚠ WARNING Indicates a hazardous situation, which, if not avoided, could result in death or serious personal injury.

⚠ CAUTION Indicates a hazardous situation, which, if not avoided, could result in minor or moderate personal injury or damage to property.

Please read the information in this manual in all cases where this symbol is used in order to find out the nature of potential hazards, and any actions which have to be taken to avoid them.

This symbol signifies that the FC-5000 Flow Computer may be powered by a DC power supply. Acceptable DC input voltage range is: 10…40V DC.

This symbol signifies that the FC-5000 Flow Computer may be powered by a AC power supply. Acceptable AC input voltage range is: 9…28V AC RMS (50…60 Hz).

- Operating temperature is 32…130° F (0…55° C) with a maximum humidity of 85% non condensing. Always select a mounting location with proper ventilation and environmental protection.
- Maximum operating altitude: 2000 meters (6561 feet)
- Pollution Degree 2: Only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is to be expected
- Over-Voltage Rating: CAT II

Safety Instructions

⚠ WARNING

- ***LIFE SUPPORT APPLICATIONS: THE FC-5000 IS NOT DESIGNED FOR USE IN LIFE SUPPORT APPLIANCES, DEVICES, OR SYSTEMS WHERE MALFUNCTION OF THE PRODUCT CAN REASONABLY BE EXPECTED TO RESULT IN A PERSONAL INJURY. CUSTOMERS USING OR SELLING THESE PRODUCTS FOR USE IN SUCH APPLICATIONS DO SO AT THEIR OWN RISK AND AGREE TO FULLY INDEMNIFY THE MANUFACTURER AND SUPPLIER FOR ANY DAMAGES RESULTING FROM SUCH IMPROPER USE OR SALE.***
- ***ELECTROSTATIC DISCHARGE INFLICTS IRREPARABLE DAMAGE TO ELECTRONICS! BEFORE INSTALLING OR OPENING THE UNIT, INSTALLERS MUST DISCHARGE THEMSELVES BY TOUCHING A WELL-GROUNDED OBJECT.***
- ***THIS UNIT MUST BE INSTALLED IN ACCORDANCE WITH THE EMC (ELECTROMAGNETIC COMPATIBILITY) GUIDELINES.***

Safety Rules and Precautionary Measures

The manufacturer accepts no responsibility whatsoever if the following safety rules and precaution instructions and the procedures as described in this manual are not followed.

- Modifications of the Flow Computer implemented without preceding written consent from the manufacturer will result in the immediate termination of product liability and warranty period.
- Installation, use, maintenance, and servicing of this equipment must be carried out by authorized technicians.
- Check the mains voltage and information on the manufacturer's nameplate before installing the unit.
- Check all connections, settings and technical specifications of the various peripheral devices with the Flow Computer supplied.
- Never open the enclosure.
- Never touch the electronic components (ESD sensitivity).
- Never expose the system to heavier conditions than allowed according to the casing classification (see manufacturer's nameplate).
- If the operator detects errors or dangers, or disagrees with the safety precautions taken, then inform the owner or the principal responsible.
- Adhere to the local labor and safety laws and regulations.

DESCRIPTION

The FC-5000 Flow Computer is a microprocessor-driven device that is designed for flow monitoring. The FC-5000 Flow Computer is compatible with the complete line of Badger Meter industrial flow meters and temperature sensors, creating a solution to totalize and indicate fluid flows. This manual was written for firmware version 1.2.8.655.

Functions and Features

This product is designed with a focus on:

- Large display for easy viewing
- Ease-of-use with softkeys and a full numeric keypad
- Ruggedness for its application with a robust enclosure, keypad and proper mechanical relays
- Info/sensor data—view raw and calculated flow data, as well as relay and digital I/O status
- User-friendly installation with quality plug-and-play terminals
- 100-point linearization
- A wide range of outputs and functions for a broad fulfillment in many applications
- User-programmable relay triggers for Flow and Total alarms—High, Low, High/Low

Additionally, the dual pulse input (Sensor Inputs option P2) version features:

- Single button toggling between flow meter channels
- Temperature compensaion
- Roshko/Strouhal algorithims

Flow Meter Input(s)

Depending on the configuration, one or two sensor inputs are available, allowing a passive or active pulse signal output to be connected. The input circuit supports low and high frequency (0.5…3500 Hz) flow meters. A 12V DC excitation terminal is available for flow meter sensors that require power.

Digital Inputs

The FC-5000 Flow Computer control inputs allow the following functions:

- Unlatch Relays
- Reset Totalizers
- Unlatch Relays and Reset Totalizers
- Inhibit Functions (dual sensor input configurations)

Relay Control Outputs

The FC-5000 Flow Computer has two relay outputs, either a mechanical Form C switch or a solid state Form A switch. The product configuration determines which switches are available. All control functions are always available by dedicated relay outputs. Unneeded outputs may be left disconnected or disabled within the firmware.

Relays can be used for alarm indication or as a totalizing output.

Form-C

- Can be powered directly from mains circuits rated up to 240V.
- Must be powered through circuits that are insulated from mains by at least basic insulation.
- Connected sources of power need to be limited to 240V AC and fused at 5A or less.
- Not suitable for connection to external circuits that are insulated from mains by at least double insulation (SELV).

Form A

- Located on TB4 and recommended to use, if configured as a high-rate, totalizing output.
- Relay energizes (contact closes) with a minimum input current of 3 mA through the input LED.
- The relay turns off (contact opens) with an input voltage of 0.8V or less.

Power Supply

The power supply used must be isolated from mains by double or reinforced insulation (for instance, SELV power supply).

The FC-5000 Flow Computer operates on 10…40V DC or 9…28V AC supplied by any suitable source that also meets the requirement listed above. Badger Meter has power supplies available for the FC-5000 Flow Computer.

Power Supply Part Numbers:

- 68334-001: includes wall mount (wall wart) power supply and various adapters
- 68334-002: power module that allows discrete power wiring

A power supply not sourced from the factory must be capable of supplying a minimum of 8 Watts.

Configuring the Unit

The FC-5000 Flow Computer is designed for many types of applications. See *"Advanced Setup" on page 35* for instructions on configuring your FC-5000 Flow Computer to your specific requirements.

All information is stored in EEPROM memory and will not be lost in the event of power failure.

Display Information

The FC-5000 Flow Computer has a large transflective LCD with a bright LED backlight that displays symbols and digits for measuring units, status information and keyword messages. See *"Display" on page 30*.

INSTALLING THE FLOW COMPUTER

⚠CAUTION

MOUNTING, ELECTRICAL INSTALLATION, STARTUP AND MAINTENANCE OF THIS INSTRUMENT MAY ONLY BE CARRIED OUT BY TRAINED PERSONNEL AUTHORIZED BY THE OPERATOR OF THE FACILITY. PERSONNEL MUST READ AND UNDERSTAND THIS OPERATING MANUAL BEFORE CARRYING OUT ITS INSTRUCTIONS.

⚠CAUTION

THE FC-5000 FLOW COMPUTER MAY ONLY BE OPERATED BY PERSONNEL WHO ARE AUTHORIZED AND TRAINED BY THE OPERATOR OF THE FACILITY. OBSERVE ALL INSTRUCTIONS IN THIS MANUAL.

⚠CAUTION

OBEY ALL SAFETY PRECAUTIONS MENTIONED IN *"SAFETY CONSIDERATIONS" ON PAGE 5***.**

NOTE: For a complete list of parts and accessories, refer to *"Replacement Parts/ Accessories" on page 53*.

Mounting Options

The FC-5000 Flow Computer can be mounted on a wall, shelf or instrumentation panel. Wall-mount units are shipped in a NEMA 4X enclosure, ready to mount.

Panel-Mount Installations

NOTE: Mounting clips can accommodate a maximum panel thickness of 1.5 in. (38.1 mm).

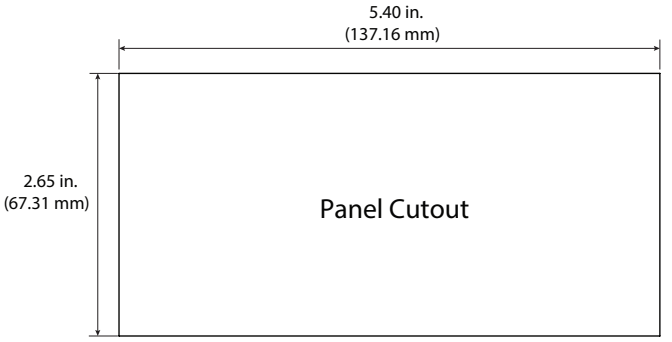


Figure 1: Panel cutout

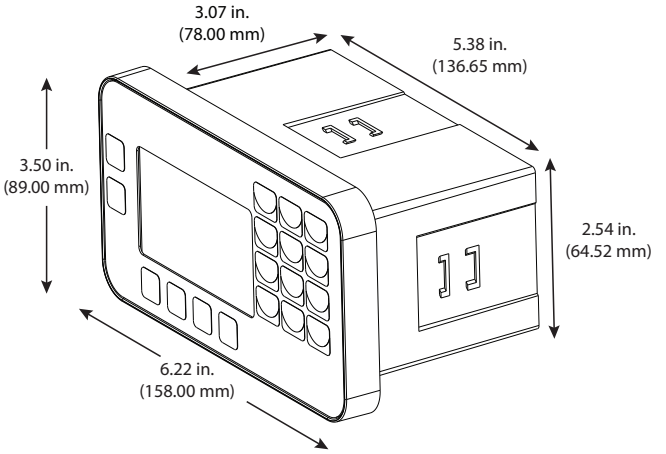


Figure 2: Mounting dimensions

To install:

1. Measure and cut a mounting hole to the dimensions shown in *Figure 1*.
2. Verify that the gasket is secure inside the mounting bezel.
3. Insert the unit through the panel cutout.
4. Secure the unit to the panel with the provided mounting clips.

Wall-Mount Installations

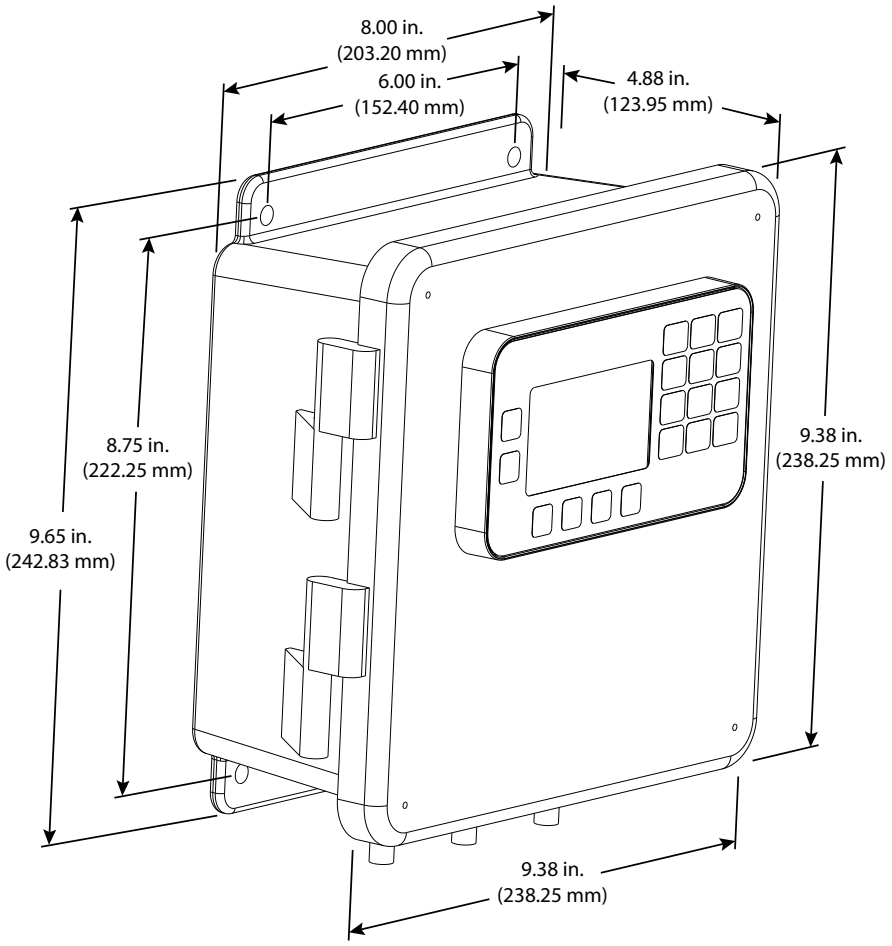


Figure 3: FC-5000 Flow Computer in an enclosure

To install the FC-5000 Flow Computer on a wall, secure the enclosure to the wall with four mounting screws (customer-supplied).

Wiring the Flow Computer

At installation, be sure to comply with the following requirements:

- Disconnect power to the unit before attempting any connection or service to the unit.
- Avoid using machine power service for AC power. When possible, use a dedicated circuit or a lighting circuit.
- Observe all local electrical codes.
- The unit must be wired with wires and/or cables with a minimum temperature rating of 167° F (75° C).

⚠CAUTION ***TO PREVENT ACCIDENTS, DO NOT APPLY POWER UNTIL ALL OTHER CONNECTIONS HAVE BEEN COMPLETED.***

Terminal Connectors

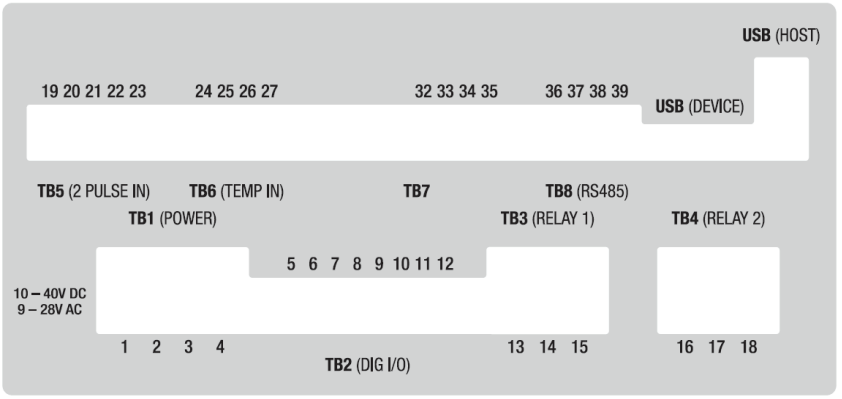


Figure 4: Terminal Connectors, dual sensor inputs, temperature compensation

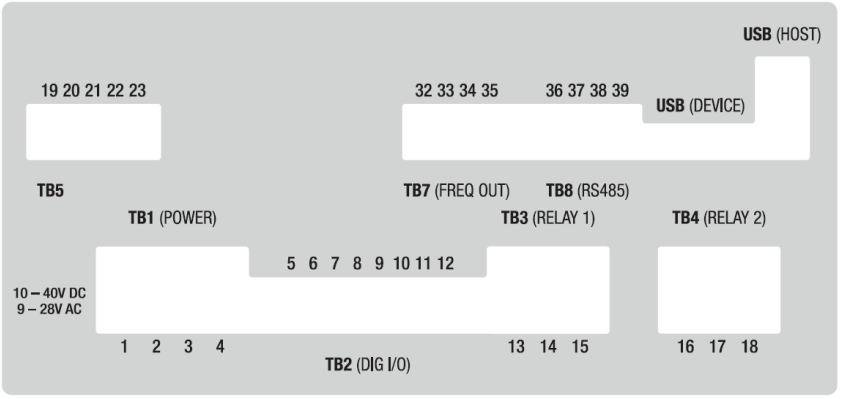


Figure 5: Terminal connectors, single or dual sensor inputs, no temperature compensation

NOTE: Terminal/pin description shown in the following tables.

The plug-in connectors on the rear panel of the FC-5000 Flow Computer are:

Dual Sensor Input with Temperature Compensation

Terminal Block	Connection Pin	Configurations/Part Numbers			
		FC5-FM-P2-FC6A-*	FC5-FM-P2-FA6A-*	FC5-FM-P2-AC6A-*	FC5-FM-P2-AA6A-*
TB1 Power	1	+			
	2	SHLD			
	3	-			
	4	I/O GND			
TB2 Digital I/O	5	PWR +			
	6	I/O 1			
	7	I/O 2			
	8	I/O 3			
	9	I/O 4			
	10	I/O 5			
	11	I/O 6			
	12	I/O GND			
TB3 Relay 1	13	N.O.			
	14	COM			
	15	N.C.			
TB4 Relay 2	16	N.O.	X1	N.O.	X1
	17	COM	N.C.	COM	N.C.
	18	N.C.	X2	N.C.	X2
TB5 Pulse Input	19	EXCI +			
	20	IN 1 +			
	21	SNS GND			
	22	IN 2 +			
	23	SHLD			
TB6 Temperature Input	24	EXCI +			
	25	SENS +			
	26	SENS -			
	27	EXCI -			
TB7 Scaled Outputs	32	OUT 1		OUT 1	
	33	OUT 2		OUT 2	
	34	OUT GND		A GND	
	35	SHLD		SHLD	
TB8 Comms	36	SHLD			
	37	-			
	38	+			
	39	485 GND			
USB	Device	Mini-B Receptacle (Used for Firmware Updates)			
	Host	Type-A Receptacle (Not Used)			

Table 1: Single input with temperature compensation

Single or Dual Input with no Temperature Compensation

Terminal Block	Connection Pin	Configurations/Part Numbers			
		FC5-FM-P0-FC6A-*	FC5-FM-P0-FA6A-*	FC5-FM-P3-FC6A-*	FC5-FM-P3-FA6A-*
TB1 Power	1	+			
	2	SHLD			
	3	-			
	4	I/O GND			
TB2 Digital I/O	5	PWR +			
	6	I/O 1			
	7	I/O 2			
	8	I/O 3			
	9	I/O 4			
	10	I/O 5			
	11	I/O 6			
	12	I/O GND			
TB3 Relay 1	13	N.O.			
	14	COM			
	15	N.C.			
TB4 Relay 2	16	N.O.	X1	N.O.	X1
	17	COM	N.C.	COM	N.C.
	18	N.C.	X2	N.C.	X2
TB5 Pulse Input	19	EXCI +		EXCI +	
	20	IN +		IN 1 +	
	21	SNS GND		SNS GND	
	22	SHLD		IN 2 +	
	23	NOT APPLICABLE		SHLD	
TB7 Scaled Outputs	32	OUT 1			
	33	OUT 2			
	34	OUT GND			
	35	SHLD			
TB8 Comms	36	SHLD			
	37	-			
	38	+			
	39	485 GND			
USB	Device	Mini-B Receptacle (Used for Firmware Updates)			
	Host	Type-A Receptacle (Not Used)			

Table 2: Single or dual input

Power Input

⚠CAUTION

The FC-5000 Flow Computer power input is internally fused and protected from common line noise by a filtering network.

TB1 - Power Input Terminal

Connector Pin	Function		Reference Pin
	AC Power	DC Power	
1	Line (L)	Positive (L+)	1
2	Shield (Chassis GND)		2
3	Neutral (N)	Negative (L–)	3
4	Digital I/O GND		4

Table 3: Power input terminal

⚠CAUTION ***THE FC-5000 IS MICROPROCESSOR CONTROLLED. IT IS VERY IMPORTANT THAT THE POWER SUPPLY BE FREE OF ELECTRICAL NOISE. AVOID USING POWER LINES THAT FEED HEAVY LOAD ELECTRICAL DEVICES SUCH AS PUMPS AND MOTORS.***

Flow Sensor Input

The FC-5000 Flow Computer is designed to accept pulses from open collector transistors or dry contact closure transmitters.

Before making any connections:

- Always use shielded wire to protect the signal line from external noise (ground shield to terminal #3).
- Make sure the signal lines are not bundled with or touching power lines.

NOTE: In the table below, **RF Pin** refers to RF type pickups/amplifiers.

TB5 (PULSE IN)

Connector Pin	Function	Reference Pin	RF Pin
1	Sensor Exitation (+)	19	A
2	Sensor Input (+)	20	C
3	Sensor Input/Common (–)	21	B
4	Shield (Chassis GND)	22	—

Table 4: Flow sensor input

TB5 (2 PULSE IN)

Connector Pin	Function	Reference Pin	RF Pin
1	Sensor Excitation (+)	19	A
2	Sensor 1 Input (+)	20	C
3	Sensor Input/Common (–)	21	B
4	Sensor 2 Input (+)	22	C
5	Shield (Chassis GND)	23	-

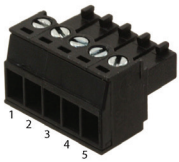


Table 5: Dual sensor input

Powering Radio Frequency (RF) Type Pickups

Radio Frequency (RF) type pickups require a power source to generate a radio frequency field. Similar to magnetic pickups, as fluid velocity provides rotational energy on the flow meter rotor, the field generated by the pickup is disturbed, producing output pulses that are proportional to flow rate.

NOTE: Maximum current draw from the Excitation pin cannot exceed 200 mA. RF style pickups will require a signal conditioning amplifier.

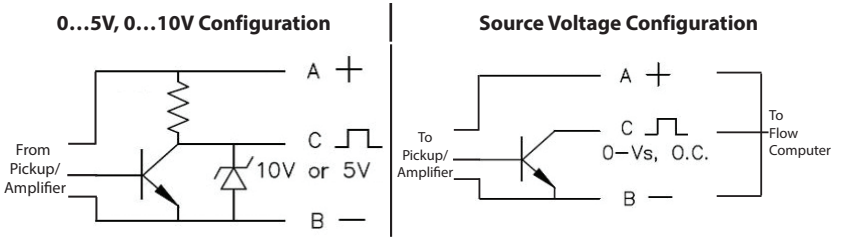


Table 6: Pickup configurations

Temperature Input

A single temperature input allows the FC-5000 Flow Computer to compensate for changes in fluid viscosity.

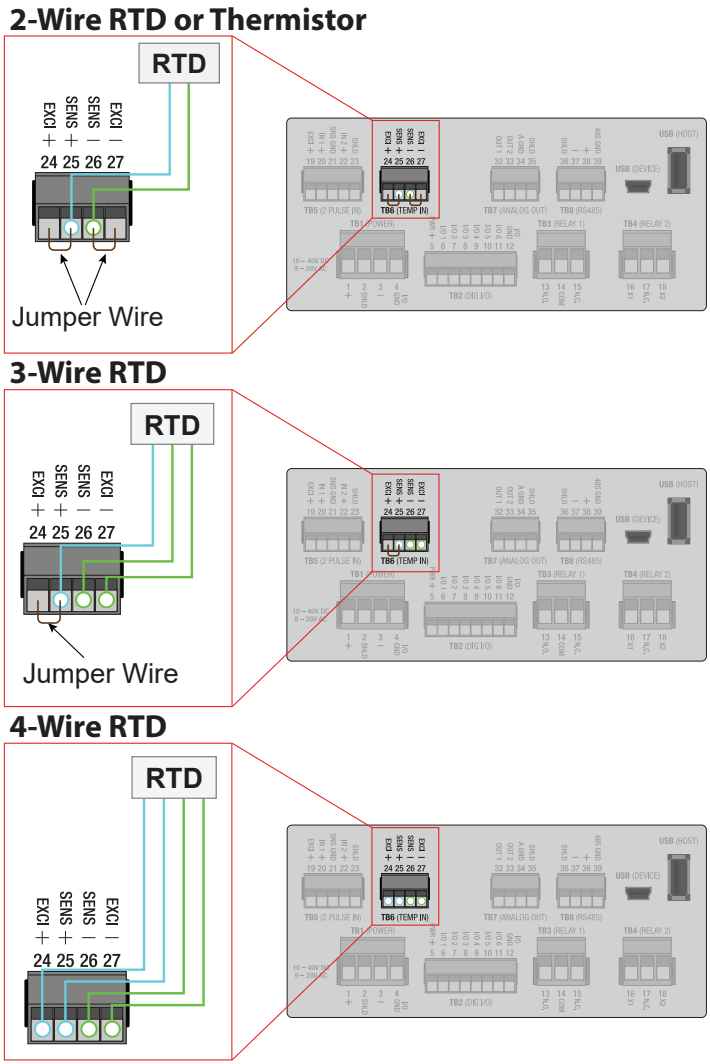
NOTE: Applies to configurations with temperature input only.

TB6 (TEMP IN)

Connector Pin	Function	Reference Pin
1	T1 Excitation (+)	24
2	T1 Sensor Input (+)	25
3	T1 Sensor Input (–)	26
4	T1 Excitation (–)	27

Table 7: Temperature inputs

See *Figure 6* for the wiring diagram.



NOTE: The wires in your application may not be the same color as the wires in the diagram. The number of each color represents the number of a color of wire that your application will have. For example, the 3-Wire RTD diagram has two green wires and one blue wire. Your application may have two yellow wires and one red wire. To wire the system you would wire the two yellow wires the same way the green wires are in the diagram, and the same with the red and blue wires.

Figure 6: RTD Wiring Diagram

Scaled Outputs

The FC-5000 Flow Computer has two scaled output channels for use in applications requiring remote data collection and/or monitoring. The outputs are firmware configurable, and can be tied to parameters such as rates, temperature or totalizer values.

TB7 (FREQ OUT) or (ANALOG OUT)

Connector Pin	Function	Reference Pin
1	Output 1 Signal	32
2	Output 2 Signal	33
3	Output Ground	34
4	Shield (Chassis GND)	35

Table 8: Scaled output channels

ANALOG OUTPUT CONFIGURATIONS ARE DESIGNED TO PROVIDE A SOURCING OUTPUT SIGNAL. THE RECEIVING DEVICE MUST NOT PROVIDE POWER TO THE LOOP.

Communication

The FC-5000 Flow Computer comes with Modbus (RTU or ASCII) and BACnet communication protocols. Signals are transmitted over an EIA-485 (RS-485) physical layer.

TB8 (RS-485)

Connector Pin	Function	Reference Pin
1	Shield (Chassis GND)	36
2	Negative (–)	37
3	Positive (+)	38
4	Output Ground	39

Table 9: Communications input

Digital Inputs

The FC-5000 Flow Computer has six independent channels available for digital input. The channels accept TTL voltage signals in the 0…5V DC range. The control inputs are triggered when the voltage signal on the pin is pulled low (active low). Input range for a logic low signal is 0…1V, logic high is 4…5V.

TB2 (DIG I/O)

Connector Pin	Function	Reference Pin
1	Excitation or Power	5
2	Input/Output 1 Signal	6
3	Input/Output 1 Signal	7
4	Input/Output 1 Signal	8
5	Input/Output 1 Signal	9
6	Input/Output 1 Signal	10
7	Input/Output 1 Signal	11
8	Ground or Neutral	12

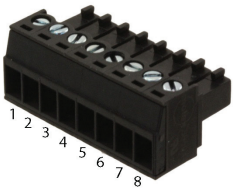


Table 10: Digital inputs

Relay Outputs

The FC-5000 Flow Computer has either two Form C relay output terminals or one Form C and one Form A terminal.

Two Form C

TB3 (RELAY 1) and TB4 (RELAY 2)

Connector Pin	Function	Reference Pin	
		Relay 1	Relay 2
1	Normally Open (N.O.)	13	16
2	Signal Common	14	17
3	Normally Closed (N.C.)	15	18

Table 11: Relay output connectors, relay option "C"

One Form C and One Form A

TB3 (RELAY 1) - Form C

Connector Pin	Function	Reference Pin
		Relay 1
1	Normally Open (N.O.)	13
2	Signal Common	14
3	Normally Closed (N.C.)	15

Table 12: Form C Relay Output Connector

TB4 (RELAY 2) - Form A

Connector Pin	Function	Reference Pin
		Relay 2
1	Connection Point 1	16
2	Not Used (No Contact)	17
3	Connection Point 2	18

Table 13: Form A Relay Output Connector

OPERATOR INTERFACE

Keypad and Soft Keys

The keypad and soft keys are for programming, editing and changing views.

Scrolling

The screens can display up to four lines at a time. Some menus have more than four items to display. To see the off-screen items, press **UP/DOWN** to scroll through the entire list.

⚠CAUTION

THE FLOW COMPUTER MAY BE OPERATED ONLY BY PERSONNEL WHO ARE AUTHORIZED AND TRAINED BY THE FACILITY. OBSERVE ALL INSTRUCTIONS IN THIS MANUAL. OBEY ALL SAFETY PRECAUTIONS MENTIONED IN *"SAFETY CONSIDERATIONS" ON PAGE 5****.**

Control Panel Keys

NOTE: Always press ↵ (ENTER) to save a new value.

1 2 3 4 5 6 7 8 9 0	The numbered keys are used to enter or change parameter values.
⌫	In editing mode, **BACKSPACE** deletes the character to the left of the cursor. While navigating, **BACKSPACE** moves to a previous menu selection.
↵	Depending on the current screen, **ENTER**: • Saves the current value and ends the editing session • Advances deeper into the menu structure • Toggles enumerations
^ v	The **UP/DOWN** keys: • Toggle the display views on the home screen • While editing, use **UP/DOWN** to advance the cursor to the right or left • In the menu structure, scroll through the menus and parameters
F1 F2 F3 F4	The **F1**-**F4** function keys are soft keys that change function to whichever icon is present above them. See *"Icon Functionality" on page 22*.

Table 14: Control panel keys

Icon Functionality

Depending on the task being performed, one or more of the following icons may appear on the screen. To activate an icon, press the Function key (**F1**, **F2**, **F3** or **F4**) directly under the icon, where applicable.

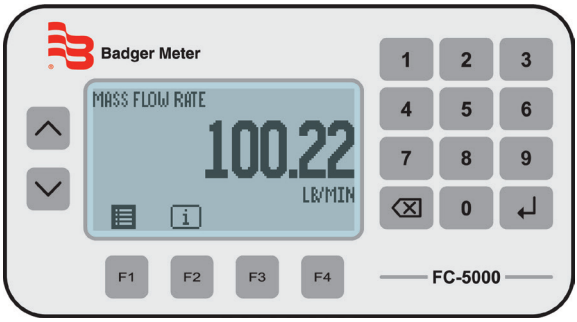
Icon	Function
	Display the *Home* screen or cancel an edit (if you press the button without saving first)
	Display the menu structure
	Create a custom label (name) for unit of measure
	Return to Setup menu
	Cycle through alpha characters
	Enter a decimal point
	Cycle through special characters
	Reveal raw and calculated info/sensor data for the Flow Computer
	Enter frequency-in-hertz calibration data
	Enter K-factor in multi-point calibration table
	Clear the selected value or cancel edit (press twice, consecutively)
	Enter conversion factor for custom unit of measure
	Change selected value to positive (+) or negative (–)
	Enter viscosity value
	Enter frequency-over-viscosity value on multi-point calibration table
	Enter density value
	Set totalizer rollover point
	Appears on *Home* screen for various events. Refer to *"Troubleshooting" on page 48* for details.
	Toggle flow sensor channels (dual sensor input configuration
	Enter temperature value

Table 15: Icon functionality

Navigating the Menus

The *Home* screen display shows rates and totals, either separately or simultaneously. Status and alarm messages or alarm icons appear on the display when appropriate.

Press **UP/DOWN** to toggle views on the *Home* screen:



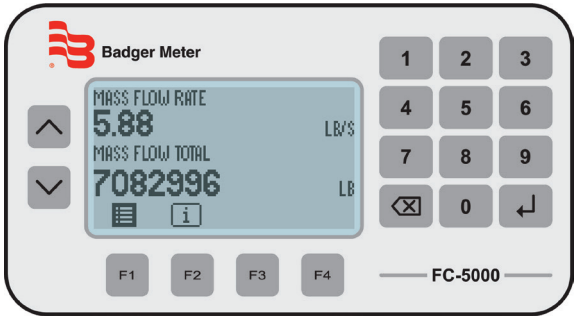
Single Pulse Input Configurations

- Flow Rate
- Flow Total
- Mass Flow Rate
- Mass Flow Total

Dual Pulse Input Configurations

- Flow Rate 1 or 2
- Flow Total 1 or 2
- Mass Flow Rate 1 or 2
- Mass Flow Total 1 or 2

Figure 7: Single display



Single Pulse Input Configurations

- Flow Rate and Flow Total
- Mass Flow Rate and Mass Flow Total

Dual pulse Input Configurations

- Flow Rate 1 and Flow Total 1
- Flow Rate 2 and Flow Total 2
- Mass Flow Rate 1 and Mass Flow Total 1
- Mass Flow Rate 2 and Mass Flow Total 2

Figure 8: Dual display

Press **F1** to enter the *Main* menu to access *Setup* and *System Information*.

Press **F2** to enter the *INFO/SENSOR DATA* menu.

For dual pulse input configurations, press **F3** to toggle between sensor input 1 and 2.

Numeric Editing

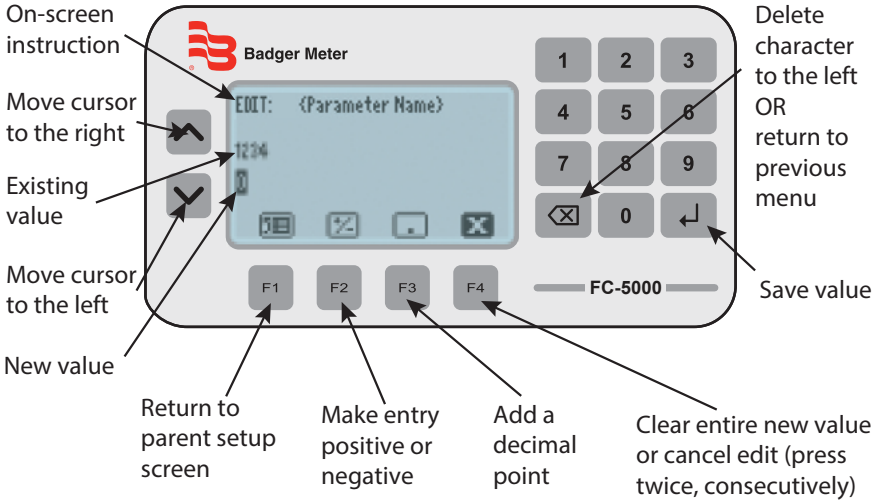


Figure 9: Numeric editing

Alpha-Numeric Editing

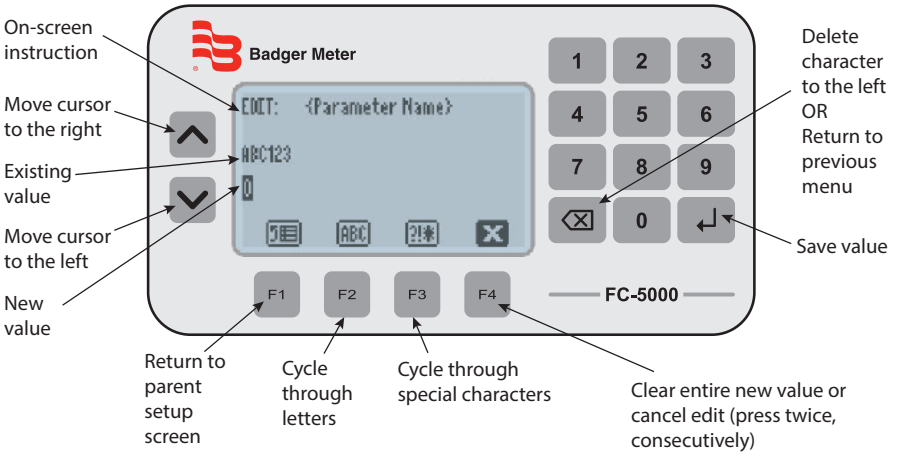


Figure 10: Alpha-numeric editing

Selection/Enumeration Editing

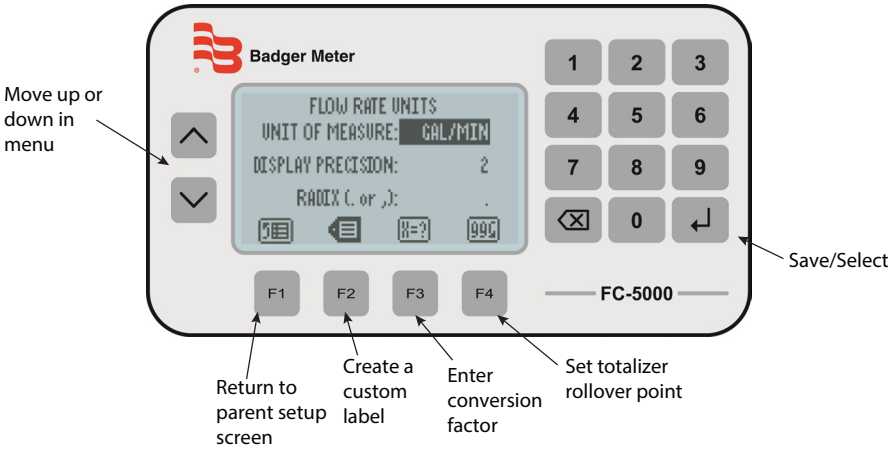


Figure 11: Selection editing

Confirmation Screen

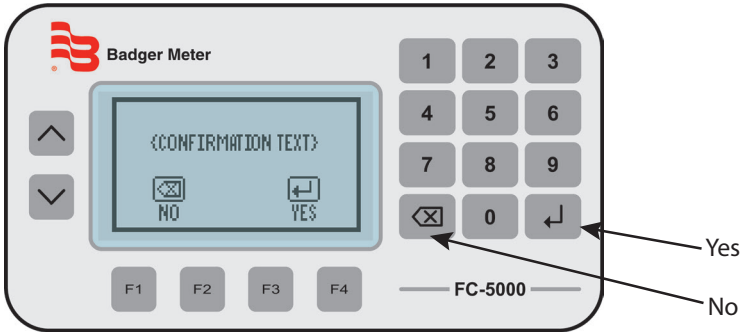


Figure 12: Confirmation screens

MENU STRUCTURE

The available menu items depend on the Flow Computer configuration. Each menu item is explained in detail in the following pages.

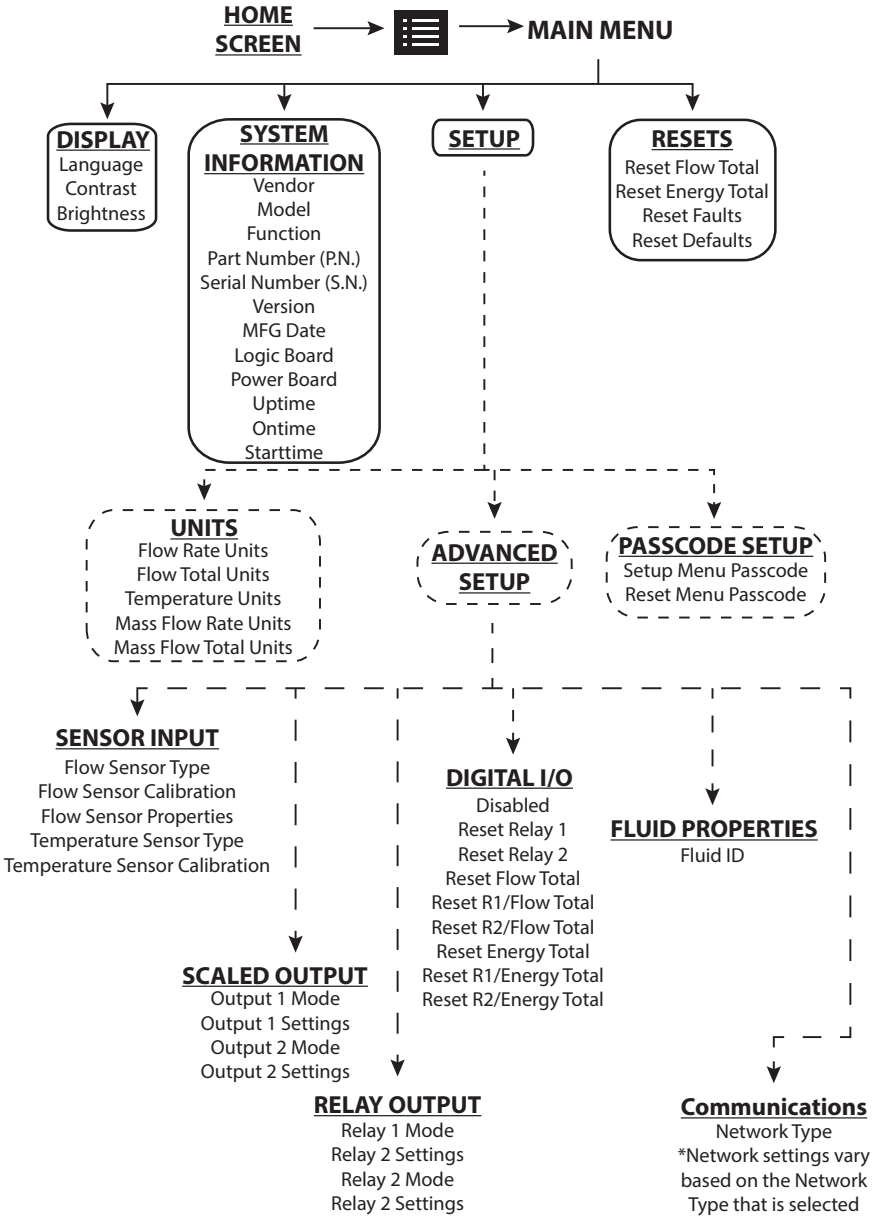


Figure 13: Menu structure

INFO/SENSOR DATA

The FC-5000 Flow Computer features a quick method to view measured data transmitting to and from the device. You can use the data for informational purposes or for troubleshooting. The type of data displayed can include raw input frequency, relay status or calculated data, such as flow rate.

Item	Description
FLOW FREQ	Raw frequency of the flow sensor
FLOW COUNT	Raw pulse count of the flow sensor
FLOW RATE	Calculated flow rate of the flow sensor
FLOW TOT	Calculated flow total of the flow sensor
MASS FLOW RATE	Calculated mass flow rate
MASS FLOW TOT	Calculated mass flow total
FLOW FREQ 1*	Raw frequency of flow sensor 1
FLOW COUNT 1*	Raw pulse count of flow sensor 1
FLOW RATE 1*	Calculated flow rate of flow sensor 1
FLOW TOT 1*	Calculated flow total of flow sensor 1
MASS FLOW RATE 1*	Calculated mass flow rate of flow sensor 1
MASS FLOW TOT 1*	Calculated mass flow total of flow sensor 1
FLOW FREQ 2*	Raw frequency of flow sensor 2
FLOW COUNT 2*	Raw pulse count of flow sensor 2
FLOW RATE 2*	Calculated flow rate of flow sensor 2
FLOW TOT 2*	Calculated flow total of flow sensor 2
MASS FLOW RATE 2*	Calculated mass flow rate of flow sensor 2
MASS FLOW TOT 2*	Calculated mass flow total of flow sensor 2
TEMP 1	Displays the calculated temperature and raw resistance (ohms) value of temperature sensor 1. Displays "NO SENSOR" if no sensor is connected.
DENSITY	Density of the fluid (Programmed)
RELAY 1	ENERGIZED/OFF status of relay 1
RELAY 2	ENERGIZED/OFF status of relay 2
D-I/O 1	ENABLED/DISABLED status of digital I/O port 1
D-I/O 2	ENABLED/DISABLED status of digital I/O port 2
D-I/O 3	ENABLED/DISABLED status of digital I/O port 3
D-I/O 4	ENABLED/DISABLED status of digital I/O port 4
D-I/O 5	ENABLED/DISABLED status of digital I/O port 5
D-I/O 6	ENABLED/DISABLED status of digital I/O port 6
*For Dual pulse input configurations, rate and total data appear with a 1 or 2 to indicate which flow meter/sensor it's depicting.	

Table 16: Sensor data

To return to the home screen, press **BACKSPACE** or **F1** (home).

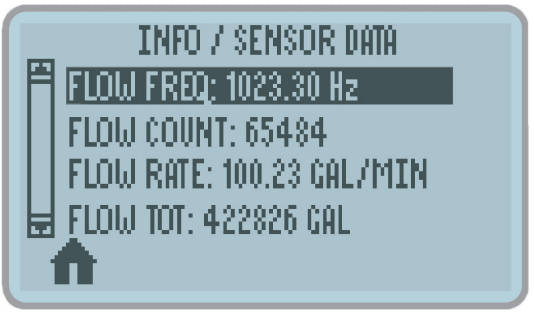


Figure 14: Info/sensor data screen

SYSTEM INFORMATION

The *System Information* menu contains build information specific to the configuration of the unit.

To view your system information, navigate to *System Information* from the *Main* menu.

Item	Description
VENDOR	Manufacturer of the product
MODEL	Product family/series
FUNCTION	For factory/diagnostic purposes only
P.N.	Configured part number
S.N.	Serial number
MFG DATE	The original manufacture/build date
VERSION	Loaded firmware version
LOGIC BRD	For factory/diagnostic purposes only
POWER BRD	For factory/diagnostic purposes only
UPTIME	Time, in seconds, since last power-on session start
ONTIME	Total lifetime power-on, in seconds
STARTTIME	Ontime at start of power-on session

Table 17: System information menu

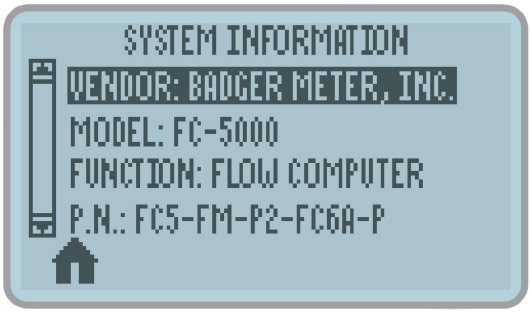


Figure 15: System information screen

BASIC SETUP

Display

Use this menu to change the display settings for *Language*, *Contrast* or *Brightness*.

1. Navigate to *Display* from the main menu.
2. Press **UP/DOWN** to scroll through the available display parameters, then press **ENTER**.
3. Scroll through available options, then press **ENTER** to select and save your changes.

Figure 16: Display configuration screen

Resets

Use this menu to reset *Totalizers*, *Faults*, *Defaults* and *latched relays*:

1. Navigate to *Resets* from the main menu.

NOTE: If a passcode was configured, enter the passcode, then press **ENTER** to access this menu.

2. Press **UP/DOWN** to scroll through the available reset options, then press **ENTER**.
3. On the confirmation screen press **ENTER** to confirm the reset.

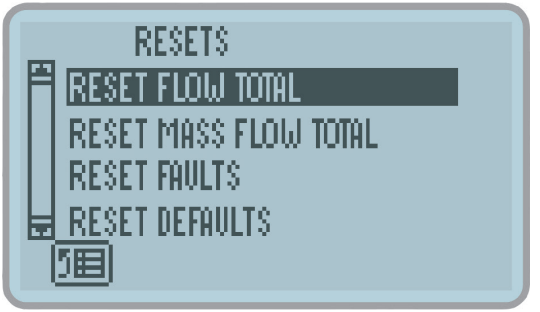


Figure 17: Resets menu

Clearing a Latched Relay

To clear a relay that latches after a trigger:

1. Navigate to the main menu.
2. Press **UP/DOWN** to scroll to *UNLATCH R1* or *UNLATCH R2*, then press **ENTER**.

Passcode Setup

Enabling Passcodes

FC-5000 units are shipped without passcode protection enabled. You can enable a unique password for the *Setup Menu* and the *Reset Menu*. To enable a passcode:

1. Navigate to *SETUP > PASSCODE SETUP*.
2. Press **UP/DOWN** to scroll to the passcode you want to enable, then press **ENTER**.

Figure 18: Enable passcode screen

3. Enter a numeric passcode from 4 to 8 digits in length, then press **ENTER**.
4. On the confirmation screen, press **ENTER** again to confirm the passcode.

NOTE: An asterisk (*) appears next to each passcode if it is enabled.

Figure 19: Asterisk indicates enabled passcode

Disabling a Passcode

1. Navigate to *SETUP > PASSCODE SETUP*.
2. Press **UP/DOWN** to scroll to the passcode you want to delete, then press **F4** (clear).
3. On the confirmation screen, press **ENTER** to confirm removal of the passcode.

Forgotten Passcodes

If you have forgotten your passcode, call Badger Meter customer service and they will be able to assist you in resetting the passcode.

1. Navigate to *System Information* from the main menu.
2. Locate and write down the valves shown for "STARTTIME" and "S.N. (Serial Number)".
3. Call Badger Meter customer service. See *"Troubleshooting" on page 48* for contact information.

Units

Use the *UNITS* menu to configure units of measure, display precision (resolution) and radix (comma or decimal point). You can configure these settings for each Parameter Unit: Flow (Rate and Total), Temperature and Energy (Rate and Total).

1. Navigate to *SETUP > UNITS*.
2. Press **UP/DOWN** to scroll through the available parameter units.
3. Scroll to *Unit of Measure*, *Display Precision* or *Radix*, then press **ENTER** to activate the drop-down menu for that setting.

Unit of Measure

The *Unit of Measure* setting determines the engineering unit and/or time interval for calculated measurements of the selected parameter unit.

1. Press **UP/DOWN** to scroll through the available units of measure, then press **ENTER** to select and save the new setting.

NOTE: For most rate measurements, all options are available in time intervals of seconds (S), minutes (M), hours (H) and days (D).

For any of the *Flow* parameters (*Rate* or *Total*), the available units are:

Unit	Description	Unit	Description
US GAL	US Gallon	M^3	Cubic Meters
IG	Imperial Gallon	AC-FT	Acre Feet
MG	US Million Gallons	BBL	Oil Barrels [42 US Gallons]
MIG	Imperial Million Gallons	FBBL	Liquid Barrels [31.5 US Gallons]
L	Liters	US OZ	US Ounces
ML	Million Liters	I OZ	Imperial Ounces
FT^3	Cubic Feet	CUST	Custom

Table 18: Flow units

For either of the *Mass* parameters (*Rate* or *Total*), the available units are:

Unit	Description
lb	pounds
Kg	Kilograms
CUST	Custom

Table 19: Mass units

For *Temperature* the available units are:

Unit	Description	Unit	Description
°F	Degrees Fahrenheit	°C	Degrees Celsius
K	Kelvin	R	Rankine

Table 20: Temperature units

Creating Custom Units for Rate or Total Measurement

1. Follow the procedure outlined in *"Unit of Measure" on page 32* to enter the Unit of Measure menu for a parameter.
2. Press **UP/DOWN** to choose *CUST*, then press **ENTER**.

NOTE: The display populates with additional icons that need to be modified for custom units.

3. Press **F2** (custom label). Use the soft keys in conjunction with the numeric keypad and **UP/DOWN** to create a custom label, then press **ENTER**.

NOTE: See *"Control Panel Keys" on page 21* and *"Icon Functionality" on page 22* for button functionality.

4. On the confirmation screen, press **ENTER** to confirm the new custom unit. The new label displays in the selection list.
5. Press **F3** (conversion) to assign a conversion factor for this custom unit. The number entered will be a factor related to the specific parameter.
   - ◊ FLOW RATE: GAL/MIN
   - ◊ FLOW TOTAL: GALLONS (GAL)
   - ◊ TEMPERATURE: ° F (Fahrenheit)
6. Press **ENTER** to save the change.

7. On the confirmation screen, press **ENTER** to confirm the change.

NOTE: For example, if making a custom unit for Flow Rate and 2 is programmed as a conversion factor, the custom unit is equivalent to 2 GAL/MIN. If 0.5 is entered, the custom unit is equivalent to 0.5 GAL/MIN.

Display Precision

The *Display Precision* setting determines the resolution of a value, indicated by the number of digits after the decimal place, for the selected parameter unit.

1. Press **UP/DOWN** to scroll to *DISPLAY PRECISION*, then press **ENTER**.
2. Scroll through the available options (0…4), then press **ENTER** to select and save the change.

Radix

The *Radix* parameter determines if a period or comma is used to represent a decimal place for the selected parameter unit.

1. Press **UP/DOWN** to scroll to *RADIX*, then press **ENTER**.
2. Scroll through available options (decimal point or comma), then press **ENTER** to select and save the change.

ADVANCED SETUP

Use the *ADVANCED SETUP* menu to configure flow meters, temperature sensors, outputs, relays and communication.

Configuring a Flow Sensor

To set up a flow meter, first select a sensor type, then edit the parameters available for that sensor type.

Flow Sensor Type

See *"Flow Sensor Types" on page 52* for more details on flow type selection for Badger Meter products. Use this menu to select the flow meter that the device is connected to.

1. Navigate to *SETUP > ADVANCED SETUP > SENSOR INPUTS*.
2. Press **UP/DOWN** to scroll to *FLOW SENSOR TYPE*, then press **ENTER**.
3. Scroll through the available sensor types, then press **ENTER** to select and save the new settings.
   The flow sensor types are shown in *Table 21*.

Option	Description
No Sensor/ Disabled	No sensor is connected to the input terminal
Sine: K-Factor	• Frequency input channel ◊ Examples: Mag pick-offs, Low level signals (~100 mV) • Single K-Factor entry
Pulse: K-Factor	• Pulse input channel ◊ Any pulse producing sensor ◊ Examples: TTL, RF carriers w/ amplifier • Single K-Factor entry • Active sensor: No pullup resistor
Pulse: K-Factor Pullup	• Pulse input channel ◊ Any pulse producing sensor ◊ Examples: TTL, RF carriers w/ amplifier • Single K-Factor entry ◊ Pulses per unit of volume • Passive sensor: Pullup resistor to 12V for excitation
Pulse: DIC	• Unique to the Data Industrial (DIC) product line • Pulse input channel ◊ Any pulse producing sensor ◊ Examples: TTL, RF carriers w/ amplifier • K & Offset values entered ◊ K = unit of volume per pulse • Active sensor: No pullup resistor

Option	Description
Pulse: Debounce K-Factor	• Unique to products with raw reed switches • Pulse input channel ◊ Any pulse producing sensor coupled with a reed switch ◊ Examples: Industrial Oval Gear • Single K-Factor entry ◊ Pulses per unit of volume • Passive sensor: Pullup resistor to 12V for excitation
Sine: UVC Fixed v	• Viscosity is manually programmed for a given process temperature • Frequency input channel ◊ Examples: Mag pick-offs, Low level signals (~100 mV) • Multi-point linearization
Pulse: UVC Fixed v	• Viscosity is manually programmed for a given process temperature • Pulse input channel ◊ Any pulse producing sensor ◊ Examples: TTL, RF carriers w/ amplifier • Multi-point linearization • Active sensor: No pullup resistor
Sine: UVC	• Temperature input required • Viscosity is automatically calculated for a given process temperature measurement • Frequency input channel ◊ Examples: Mag pick-offs, Low level signals (~100 mV) • Multi-point linearization
Pulse: UVC	• Temperature input required • Viscosity is automatically calculated for a given process temperature measurement • Pulse input channel ◊ Any pulse producing sensor ◊ Examples: TTL, RF carriers w/ amplifier • Multi-point linearization • Active sensor: No pullup resistor
Sine: UVC RS	• Temperature input required • Viscosity is automatically calculated for a given process temperature measurement • Roshko/Strouhal calculation accommodates changes to meter bore based on process temperature measurement • Frequency input channel ◊ Examples: Mag pick-offs, Low level signals (~100 mV) • Multi-point linearization

Option	Description
Pulse: UVC RS	• Temperature input required • Viscosity is automatically calculated for a given process temperature measurement • Roshko/Strouhal calculation accommodates changes to meter bore based on process temperature measurement • Pulse input channel ◊ Any pulse producing sensor ◊ Examples: TTL, RF carriers w/ amplifier • Multi-point linearization • Active sensor: No pullup resistor
Sine: Multi-Point Cal	• Frequency input channel ◊ Examples: Mag pick-offs, Low level signals (~100 mV) • Multi-point linearization
Pulse: Multi-Point Cal	• Pulse input channel ◊ Any pulse producing sensor ◊ Examples: TTL, RF carriers w/ amplifier • Multi-point linearization • Active sensor: No pullup resistor

Table 21: Flow sensor configuration options

Flow Sensor Calibration

Use this menu to change the calibration settings (K-factor, offset and low flow cutoff) for the selected Flow Meter Type.

1. Navigate to *SETUP > ADVANCED SETUP > SENSOR INPUTS*.
2. Press **UP/DOWN** to scroll to *FLOW SENSOR CAL*, then press **ENTER**.
3. Scroll to and edit each option, as necessary. The options include:

Option	Description
K-FACTOR	A singular K-factor entry point.
OFFSET	Used to apply an offset to sensor input calibration
LOW FLOW CUTOFF	The point at which the display reads zero. Represented in configured unit of measure
MULTI-POINT TABLE	A multi-point calibration table used when any sine/pulse UVC type is selected for flow sensor type

Table 22: Flow sensor calibration options

100-Point Linearization

The FC-5000 Flow Computer can be set up to linearize the output from an eligible flow meter. The calibration data for a particular flow meter are included when the meter, calibration and FC-5000 unit are ordered from the factory. The calibration data is represented by either:

- Curve-fitted FREQUENCY/VISCOSITY (f/v) vs K-FACTOR (KFct) or
- FREQUENCY (f: Hz) vs K-FACTOR (KFct),

To manipulate or enter the linearization parameters:

1. See *"Flow Sensor Type" on page 35* for an explanation of these flow sensor input types:
   Sine UVC Fixed v *Pulse UVC Fixed v*
   Sine UVC *Pulse UVC*
   Sine UVC RS *Pulse UVC RS*
   Sine Multi-Point Cal *Pulse Multi-Point Cal*
2. Navigate to *SYSTEM SETUP > ADVANCED SETUP > SENSOR INPUT > FLOW SENSOR CAL*.
3. Press **UP/DOWN** to scroll to **MULTI-POINT TABLE**, then press **ENTER**.
4. For each calibration point, press **F2** (which represents either *f/v* or *frequency*) to enter or edit the corresponding value, then press **F3** (kFct) to enter or edit the *K-factor* value.
5. On the numeric entry screens, enter the value and press **ENTER** to save the value and return to the previous screen.

NOTE: Each entry, 1…100, represents each calibration data point. Any number of points can be entered, up to 100. Leave the fields at 0.000 if no data exists.

Flow Sensor Properties

Use this menu to change flow meter properties, such as material, damping or identification.

1. Navigate to *SETUP > ADVANCED SETUP > SENSOR INPUTS*.
2. Press **UP/DOWN** to scroll to *FLOW SENSOR PROP*, then press **ENTER**.
3. Select and edit each option, as necessary.
   The flow sensor properties are:

Option	Description
Bore Diameter	Bore diameter of connected flow meter
Diameter Unit	Unit of measure (in. or mm) associated with bore diameter
Sensor Material	Construction material of the connected flow meter. • Aluminum • Brass • SS 302/3 • SS 304 • SS 316 • Cast iron
Sensor ID	Descriptive, user-defined text string for the sensor
Fixed Temp	A fixed temperature value of the fluid medium going through the flow meter. Used instead of a temperature sensor. Ignore this value if a temperature sensor is used.
Damping	Smoothing coefficient. As the number increases, averaging becomes greater. As the number decreases, it approaches the raw reading

Table 23: Flow sensor properties

Configuring a Temperature Sensor

Temperature Sensor Type

Use this menu to select the temperature sensor type the device is connected to.

1. Navigate to *SETUP > ADVANCED SETUP > SENSOR INPUTS*.
2. Press **UP/DOWN** to scroll to *TEMP SENSOR TYPE*, then press **ENTER**.
3. Scroll through the available sensor types, the press **ENTER** to select and save the new setting.
   The temperature sensor types are shown in *Table 24*.

NOTE: TCR is the temperature coefficient of resistance.

Option	Description
NO SENSOR/DISABLED	No sensor. Disables the input in the firmware
2-WIRE RTD: PT100 (385)	2-Wire RTD; 100 Ohm; Platinum; 0.0385 TCR
2-WIRE RTD: CUSTOM	2-Wire RTD; Custom Calibration
3-WIRE RTD: PT100 (385)	3-Wire RTD; 100 Ohm; Platinum; 0.0385 TCR
3-WIRE RTD: CUSTOM	3-Wire RTD; Custom Calibration
4-WIRE RTD: PT100 (385)	4-Wire RTD; 100 Ohm; Platinum; 0.0385 TCR
4-WIRE RTD: CUSTOM	4-Wire RTD; Custom Calibration
4-WIRE RTD: PT1000 (385)	4-Wire RTD; 1000 Ohm; Platinum; 0.0385 TCR
2-PT RTD: CUSTOM	Platinum RTD with 2-point calibration
THERMISTOR: DI TYPE	Data Industrial thermistor configuration
THERMISTOR: CUSTOM	Custom Thermistor

Table 24: Temperature sensor types

Temperature Sensor Calibration

Use this menu to change calibration settings for the Temperature Sensor Type.

NOTE: This menu is only available when a custom temperature sensor type is selected.

1. Navigate to *SETUP > ADVANCED SETUP > SENSOR INPUTS*.
2. Press **UP/DOWN** to scroll to the temperature sensor calibration setting for the temperature sensor type, then press **ENTER**.
3. Scroll to and edit each option, as necessary.

The calibration setting options are described below. The settings that appear on the device are relative to the sensor type and will only show if a sensor type is chosen.

Temperature Sensor Type	Option	Description
2, 3 and 4-Wire RTDs	ALPHA COEFF	Callendar-Van Dusen coefficients
	BETA COEFF	
	DELTA COEFF	
2-PT RTD: Custom	OHMS: LOW	Resistance (Ω) at 0° C / Resistance (Ω) at "TEMP: LOW"
	TEMP: LOW	Temperature at "OHMS: LOW" (° C)
	OHMS: HIGH	Resistance (Ω) at temperature "TEMP: HIGH"
	TEMP: HIGH	Temperature at "OHMS: HIGH" (° C)
Thermistor	OFFSET	Temperature calibration offset
	COEFF A	Steinhart-Hart coefficients
	COEFF B	
	COEFF C	

Table 25: Temperature sensor calibration descriptions

Configuring Outputs

Scaled Outputs: Output Mode

Use this menu to change the mode of one or both scaled outputs. The mode defines the behavior of the output.

1. Navigate to *SETUP > ADVANCED SETUP > SCALED OUTPUTS*
2. Press **UP/DOWN** to scroll to an output mode, then press **ENTER**.
3. Scroll through the available modes, then press **ENTER** to select and save the setting.
   The *Output Mode* options will vary based on device configuration.

Device Configuration	Option	Description
Frequency Output FC5-FM-**-F***-*	NO OUTPUT/DISABLED	Disables Output
	PULSE: TOTAL	Sends pulse(s)-per-total unit of measure
	PULSE: RATE	Sends pulse(s)-per-rate unit of measure
Analog Output FC5-FM-**-A***-*	NO OUTPUT/DISABLED	Disables Output
	ANALOG: 0…5V	0…5V output signal, scaled to an output source
	ANALOG: 0…10V	0…10V output signal, scaled to an output source
	ANALOG: 4…20 mA	4…20 mA output signal, scaled to an output source

Table 26: Output mode options

Scaled Outputs: Output Settings

Use this menu to change the output settings for the respective output mode.

1. Navigate to *SETUP > ADVANCED SETUP > SCALED OUTPUTS*.
2. Press **UP/DOWN** to scroll to the applicable output settings, then press **ENTER**.
3. Scroll to and edit each option, as necessary.
   a. If using the frequency output configuration

Output Mode	Option	Description
PULSE: RATE	OUTPUT SOURCE	Parameter assignment of the output (such as rate, total or temperature)
	SCALE MINIMUM	Minimum parameter value associated with output minimum
	SCALE MAXIMUM	Maximum parameter value associated with output maximum
	MAXIMUM FREQUENCY	Maximum frequency output value
	OUTPUT FREQ	(Read Only) Real-time output frequency
PULSE: TOTAL	OUTPUT SOURCE	Parameter assignment of the output (such as rate, total or temperature)
	SCALING FACTOR	Units of measure transmitted, per pulse
	SCALED PULSE COUNT	(Read Only) Number of transmitted pulses

Table 27: Frequency output settings

   b. If using the analog output configuration

Option	Description
OUTPUT SOURCE	Parameter assignment of the output (such as rate, total or temperature)
ANALOG FULL SCALE	Maximum value associated with output maximum
ANALOG LOW SCALE	Minimum value associated with output minimum

Table 28: Analog output settings

Relay Outputs: Relay Mode

Use this menu to change the mode of one or both relay outputs. The mode defines the behavior of the output.

1. Navigate to *SETUP > ADVANCED SETUP > RELAY OUTPUTS*.
2. Press **UP/DOWN** to scroll to an output mode, then press **ENTER**.
3. Scroll through the available modes, then press **ENTER** to select and save the setting.

Option	Description
NO RELAY/DISABLED	Disables output
TOTALIZER	Totalizer output
ALARM: HIGH	On/Off function, energized at the high set point
ALARM: LOW	On/Off function, energized at the low set point
ALARM: RANGE	On/Off function, energized beyond high and low set points
MANUAL	On/Off function of manual operation

Table 29: Relay mode options

Relay Outputs: Relay Settings

Use this menu to change the relay settings for the respective relay mode.

1. Navigate to *SETUP > ADVANCED SETUP > RELAY OUTPUTS*.
2. Press **UP/DOWN** to scroll to the applicable relay setting, then press **ENTER**.
3. Scroll to and edit each option, as necessary.

NOTE: Alarm icons "R1" and "R2" will appear in the upper right section of the Home Screen to provide a local indication when a relay condition has been met and when the relay has be energized.

Output Mode	Option	Description
TOTALIZER	OUTPUT SOURCE	Parameter assignment (e.g. Flow Total or Mass Total)
	SCALING FACTOR	Pulse(s) transmitted per unit of measure
	UNITS	Converts output unit of measure
	PULSE WIDTH	Time between the rising and falling edges of a single pulse
ALARM: HIGH	OUTPUT SOURCE	Parameter assignment (such as Flow Rate or Temperature)
	HIGH SETPOINT	Instructs the device to energize the relay if this value reached/exceeded. This value is linked to the *OUTPUT SOURCE* and its unit of measure (for example, Flow Rate in GPM)
	HYSTERESIS HI	Creates a window/zone below the *HIGH SETPOINT* value where the relay remains in an energized state
	SET DELAY	Time in seconds that will elapse before the relay energizes, if the *HIGH SETPOINT* value is reached/exceeded
	RELEASE DELAY	Time in seconds that the relay will remain energized, if the *HYSTERESIS HI* value is reached/exceeded
	LATCHING	Leaves the relay in an energized state until it is manually cleared on the device, either through the keypad interface or through the Digital I/O channels

Output Mode	Option	Description
ALARM: LOW	OUTPUT SOURCE	Parameter assignment (such as Flow Rate or Temperature)
	LOW SETPOINT	Instructs the device to energize the relay if this value reached/exceeded. This value is linked to the *OUTPUT SOURCE* and its unit of measure (for example, Flow Rate in GPM)
	HYSTERESIS LO	Creates a window/zone above the *LOW SETPOINT* value where the relay remains in an energized state
	SET DELAY	Time in seconds that will elapse before the relay energizes, if the *LOW SETPOINT* value is reached/exceeded
	RELEASE DELAY	Time in seconds that the relay will remain energized, if the *HYSTERESIS LO* value is reached/exceeded
	LATCHING	Leaves relay in an energized state until it is manually cleared on the device, either through the keypad interface or through the Digital I/O channels
ALARM: RANGE	OUTPUT SOURCE	Parameter assignment (such as Flow Rate or Temperature)
	HIGH SETPOINT	Instructs the device to energize the relay if this value reached/exceeded. This value is linked to the *OUTPUT SOURCE* and its unit of measure (for example, Flow Rate in GPM)
	HYSTERESIS HI	Creates a window/zone below the *HIGH SETPOINT* value, where the relay remains in an energized state
	LOW SETPOINT	Instructs the device to energize the relay if this value reached/exceeded. This value is linked to the *OUTPUT SOURCE* and its unit of measure (for example, Flow Rate in GPM)
	HYSTERESIS LO	Creates a window/zone above the *LOW SETPOINT* value, where the relay remains in an energized state
	SET DELAY	Time in seconds that will elapse before the relay energizes, if either setpoint value is reached/exceeded
	RELEASE DELAY	Time in seconds that the relay will remain energized, if either hysteresis value is reached/exceeded
	LATCHING	Leaves relay in an energized state until it is manually cleared on the device, either through the keypad interface or through the Digital I/O channels
MANUAL	OVERRIDE	Bypasses any programmed triggers to trigger the relay, which will remain triggered until deactivated

Table 30: Relay settings

Configuring Digital I/O

The FC-5000 Flow Computer has remote reset capabilities for relays and totalizers through any one of six different channels.

All six channels are input-only and can be configured for any combination of the following.

Function	Description
DISABLED	The I/O channel will have no function
RESET: RELAY 1	Resets latch on Relay 1
RESET: RELAY 2	Resets latch on Relay 2
RESET: ALL RELAYS	Resets latches on Relays 1 and 2
RESET: FLOW TOTAL	Resets *Flow Total*
RESET: RELAY 1 AND FLOW TOTAL	Resets latch on Relay 1 and resets *Flow Total*
RESET: RELAY 2 AND FLOW TOTAL	Resets latch on Relay 2 and resets *Flow Total*
RESET: ALL RELAYS AND TOTALS	Resets Relay 1, Relay 2 and *Flow Total*.
INHIBIT CH1	Disables flow/total from Flow Sensor 1
INHIBIT CH2	Disables flow/total from Flow Sensor 2

Table 31: Digital I/O functions

Figure 20: Digital I/O menu

1. Navigate to *SETUP* > *ADVANCED SETUP* > *DIGITAL I/O*.
2. Press **UP/DOWN** to scroll to any of the six input channels.
3. Press **ENTER** repeatedly until the desired function appears. Each time **ENTER** is pressed, the channel toggles through the available functions.

To disable any channel, simply highlight the digital I/O channel, and press **ENTER** until *DISABLED* appears.

Configuring Fluid Properties

The Fluid Properties menu configures the device for the fluid medium that is being measured.

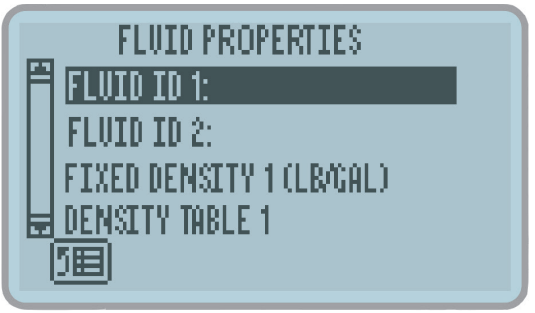


Figure 21: Fluid properties screen

Parameter	Description
Fluid ID 1	Custom text entry for the fluid name
Fixed Viscosity 1	Numeric entry for fixed fluid viscosity, in centistokes
Fixed Density 1	Numeric entry for fixed fluid density, in lb/gal
Viscosity Table 1	Temperature-compensated fluid viscosity table
Density Table 1	Temperature-compensated fluid density table
Fluid ID 2	Custom text entry for the fluid name
Fixed Viscosity 2	Numeric entry for fixed fluid viscosity, in centistokes
Fixed Density 2	Numeric entry for fixed fluid density, in lb/gal
Viscosity Table 2	Temperature-compensated fluid viscosity table
Density Table 2	Temperature-compensated fluid density table

Table 32: Fluid properties parameters

1. Navigate to *SYSTEM SETUP* > *ADVANCED SETUP* > *FLUID PROPERTIES*.
2. Highlight a parameter and press **ENTER**.
3. Use the soft keys and numeric keypad to enter a value and press **ENTER** to save the value.
4. On the confirmation screen, press **ENTER** to confirm the change.

Configuring Communications

The *Communications* menu configures the device to communicate to other systems via Modbus or BACnet.

The available communication settings vary based on Network Type.

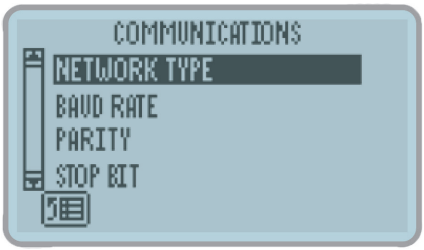


Figure 22: Modbus communications menu

Figure 23: BACnet communications menu

1. Navigate to *SETUP > ADVANCED SETUP > COMMUNICATIONS*.
2. Press **UP/DOWN** to scroll to *NETWORK TYPE*, then press **ENTER**.
3. Scroll through the available options, then press **ENTER** to select save the change.
4. Press **BACKSPACE** to return to the *COMMUNICATIONS* menu.
5. Scroll to and edit each option, as necessary. The options are:

Modbus RTU and Modbus ASCII

Settings	Options
BAUD RATE	1200, 2400, 4800, 9600, 14400, 19200, 28800, 34800, 57600, 76800 or 115200
PARITY	No Parity, Odd Parity or Even Parity
STOP BIT	No Stop Bit, One or Two Stop Bit
SLAVE ADDRESS	1…255
DEVICE NAME	User-defined ID

Table 33: Modbus settings

BACnet

Settings	Options
BAUD RATE	1200, 2400, 4800, 9600, 14400, 19200, 28800, 34800, 57600, 76800 or 115200
MSTP ADDRESS	1…255
MAX MASTER	
DEVICE INSTANCE	1…4,294,967,295
DEVICE NAME	User-defined ID

Table 34: BACnet settings

TROUBLESHOOTING

This section lists common problems that may be encountered with the Flow Computer, the possible causes and the recommended remedies. Most problems are due to improper wiring and/or programming procedures. The problem may also be in the flow meter, valve, pump or other piece of equipment.

Be sure that all other equipment is functioning properly. The FC-5000 Flow Computer is extensively tested at the factory before shipment. However, the unit may get damaged during transit or installation. If after all possible remedies have been tried and the problem persists, contact your local representative or Badger Meter.

Problem	Possible Causes	Remedies
Unit has power but display does not light up	1. Incorrect power wiring	1. Re-check power wiring
Transmitter is connected but the FC-5000 does not count	1. Incorrect transmitter wiring or broken wire	1. Check wiring diagrams
	2. Transmitter is defective	2. Replace parts or entire unit
	3. No sensory type selected	3. Select a sensor type. See *"Flow Sensor Type" on page 35*
	4. Wrong scale factor	4. Check scale factor calculation. For example, if programmed 0.001 instead of 0.100, unit will wait for 100 pulses before decrementing one count
	5. Low frequency input must be on terminal #7	5. Verify connection
	6. Meter is defective, rotor not turning	6. Disassemble meter, check rotor, replace if defective
Valve does not close at setpoints	1. Relay output is not properly connected	1. Reconnect relay wiring
	2. Relay is defective	2. Contact factory for replacement
	3. Valve components are defective	3. Check and replace valve components.
Counter accumulates too many counts	1. Wrong scale factor	1. Check scale factor calculation
	2. Electrical noise causing extra pulses.	2. Check wiring. Make sure power lines are not touching or close to pulse signal line. Always use shielded cable
	3. Excessive vibration.	3. Dampen vibration
Some of the keys on the control panel are not operational	1. Broken switch behind control panel	1. Replace the Flow Computer
	2. Function not available on this model	2. See *"Operator Interface" on page 21*
	3. Problem with internal components	3. Return the Flow Computer to the factory for repair
		4. Cycle the power to the Flow Computer
DISPLAY OVERRUN error	1. There are more than 8 digits in the display	1. Check that the unit of measure you entered will not result in a readout greater than 8 digits
		2. Check the display precision and reduce it, if possible

Problem	Possible Causes	Remedies
 Alarm notification from the *Home* screen	1. The rate or total values indicated on the Home Screen are in an overrun condition (value exceeds 8 digits) 2. Temperature sensor 1 and/or 2 is configured in the unit, but there is no sensor hardware detected	1. Change the unit of measure associated with the parameter (see *"Unit of Measure" on page 32*) or reset the totalizer (see *"Resets" on page 30*) 2. Make sure that the temperature sensor are appropriately wired to the unit
"R1" and/or "R2" appear on home screen	1. Relay 1 and/or Relay 2 are latched 2. Relay 1 and/or 2 are energized	1. See *"Clearing a Latched Relay" on page 31* 2. The programmed alarm conditions are met. Check process or programming
"TSENSERR" displayed on home screen	1. Temperature sensor not configured 2. Temperature sensor disconnected	1. Configure temperature sensor. See *"Configuring a Temperature Sensor" on page 40* 2. Check wiring to TB6
"DISABLED" displays on home screen	1. Flow sensor type setting set to "NO SENSOR/DISABLED"	1. Configure a flow sensor. See *"Configuring a Flow Sensor" on page 35*

Table 35: Troubleshooting

⚠CAUTION

THERE ARE NO FIELD-REPLACEABLE PARTS INSIDE. OPENING THE UNIT WILL VOID ALL WARRANTIES.

If a repair or evaluation from the factory is required, call your local representative or the factory to obtain a Return Material Approval (RMA).

The shipping address, RMA number and any other required information will be provided to send the unit to an appropriate location.

Company Website	www.badgermeter.com
Customer Service Email	indorders@badgermeter.com
Customer Service Number	(877) 243–1010

Table 36: Contact information

MODBUS INTERFACE

Modbus Function Code Support

The FC-5000 Flow Computer supports access through all four of the Modbus data types. Both single and multiple write-access commands are supported for register and coil data types. For multiple register writes, the command must initiate on a valid parameter address and end on last register of a valid parameter address. Multiple register writes that start in the middle of a multiple register parameter or do not end on the last register of a multiple register parameter are not supported. The table below lists the supported function codes.

Description	Function Code	Subcode
Read Coils	01	—
Read Discrete Inputs	02	—
Read Holding Registers	03	—
Read Input Registers	04	—
Write Single Coil	05	—
Write Single Register	06	—
Diagnostic – Return Query Data	08	00
Write Multiple Coils	15	—
Write Multiple Registers	16	—
Report Slave ID	17	—

Table 37: Supported modbus function codes

Modbus Register Map

Register Name	Register Address	Coil Addr.	Data Type	Read/Write	Access Type
Single Pulse Input					
Flow Rate	0x0000	—	Float	Read Only	Register
Flow Total	0x0002	—	Float	Read Only	Register
Flow Total Precision	0x0004	—	Double	Read Only	Register
Temperature	0x0200	—	Float	Read Only	Register
Fluid Density	0x0400	—	Float	Read Only	Register
Mass Flow Rate	0x0600	—	Float	Read Only	Register
Mass Flow Total	0x0602	—	Float	Read Only	Register
Mass Flow Total Precision	0x0604	—	Double	Read Only	Register
Dual Pulse Input					
Flow Rate 1	0x0000	—	Float	Read Only	Register
Flow Total 1	0x0002	—	Float	Read Only	Register
Flow Total Precision 1	0x0004	—	Double	Read Only	Register
Flow Rate 2	0x0008	—	Float	Read Only	Register
Flow Total 2	0x000A	—	Float	Read Only	Register
Flow Total Precision 2	0x000C	—	Double	Read Only	Register
Flow Rate Quad	0x0010	—	Float	Read Only	Register
Flow Total Quad	0x0012	—	Float	Read Only	Register
Flow Total Precision Quad	0x0014	—	Double	Read Only	Register
Temperature	0x0200	—	Float	Read Only	Register
Fluid Density	0x0400	—	Float	Read Only	Register
Mass Flow Rate 1	0x0600	—	Float	Read Only	Register

Register Name	Register Address	Coil Addr.	Data Type	Read/Write	Access Type
Mass Flow Total 1	0x0602	—	Float	Read Only	Register
Mass Flow Total Precision 1	0x0604	—	Double	Read Only	Register
Mass Flow Rate 2	0x0608	—	Float	Read Only	Register
Mass Flow Total 2	0x060A	—	Float	Read Only	Register
Mass Flow Total Precision 2	0x060C	—	Double	Read Only	Register
Mass Flow Rate Quad	0x0610	—	Float	Read Only	Register
Mass Flow Total Quad	0x0612	—	Float	Read Only	Register
Mass Flow Total Precision Quad	0x0614	—	Double	Read Only	Register

Table 38: Modbus register map

BACNET INTERFACE

BACnet Map

Object Description	BACnet Object ID	BACnet Object Type
Single Pulse Input		
Flow Rate	2	Analog Value
Flow Total	3	Analog Value
Flow Total Precision	4	Large Analog Value
Temperature	14	Analog Value
Fluid Density	16	Analog Value
Mass Flow Rate	18	Analog Value
Mass Flow Total	19	Analog Value
Mass Flow Total Precision	20	Large Analog Value
Dual Pulse Input		
Flow Rate 1	2	Analog Value
Flow Total 1	3	Analog Value
Flow Total Precision 1	4	Large Analog Value
Flow Rate 2	5	Analog Value
Flow Total 2	6	Analog Value
Flow Total Precision 2	7	Large Analog Value
Flow Rate Quad	8	Analog Value
Flow Total Quad	9	Analog Value
Flow Total Precision Quad	10	Large Analog Value
Temperature	14	Analog Value
Fluid Density	16	Analog Value
Mass Flow Rate 1	18	Analog Value
Mass Flow Total 1	19	Analog Value
Mass Flow Total Precision 1	20	Large Analog Value
Mass Flow Rate 2	21	Analog Value
Mass Flow Total 2	22	Analog Value
Mass Flow Total Precision 2	23	Large Analog Value
Mass Flow Rate Quad	24	Analog Value
Mass Flow Total Quad	25	Analog Value
Mass Flow Total Precision Quad	26	Large Analog Value

Table 39: BACnet register map

FLOW SENSOR TYPES

The table below lists the Badger Meter products suitable for use with the FC-5000 Flow Computer.

Meter Technology	Product Line	Output Type	Flow Sensor Input
Impeller	Impeller	Square Wave Frequency	PULSE: DIC
Oval Gear	Oval Gear	Reed Switch Pulse	PULSE: DEBOUNCE K-FACTOR
Positive Displacement	OP Meters	Unscaled Pulse	PULSE: DEBOUNCE K-FACTOR
		Scaled Pulse	PULSE: DEBOUNCE K-FACTOR
	Recordall	Unscaled Pulse	PULSE: DEBOUNCE K-FACTOR
		Scaled Pulse	PULSE: DEBOUNCE K-FACTOR
Turbine	Blancett	MAG Pickup	SINE K-FACTOR, SINE MULTI-POINT CAL
		MAG Pickup w/ K-Factor Scaler	PULSE K-FACTOR, PULSE MULTI-POINT CAL
	Cox	RF Pickup w/ Signal Conditioner	PULSE UVC FIXED v
		NOTE: Requires temperature sensor	SINE UVC, PULSE UVC, SINE UVC RS, PULSE UVC RS
		MAG Pickup	SINE UVC FIXED v
		NOTE: Requires temperature sensor	SINE UVC, PULSE UVC, SINE UVC RS, PULSE UVC RS
		MAG Pickup w/ Signal Conditioner	PULSE UVC FIXED v
		NOTE: Requires temperature sensor	SINE UVC, PULSE UVC, SINE UVC RS, PULSE UVC RS
	Turbo	Unscaled Pulse	PULSE DEBOUNCE K-FACTOR
		Scaled Pulse	PULSE DEBOUNCE K-FACTOR
	Flo-tech	MAG Pickup	SINE K-FACTOR, SINE MULTI-POINT CAL
		MAG Pickup w/ K-Factor Scaler	PULSE K-FACTOR, PULSE MULTI-POINT CAL
	Vision	Frequency	PULSE K-FACTOR PULLUP

Table 40: Flow sensor types

PART NUMBERING CONSTRUCTION

FC5 - FM - P2 - [ ][ ] 6 A - [ ]

FC-5000 Flow Computer

FUNCTION
- Flow Computer — FM

SENSOR INPUTS
- Two Pulse / One Temperature — P2

SCALED OUTPUTS
- Two Analog Outputs — A
- Two Frequency Outputs — F

RELAY OUTPUTS
- One Form C Relay / One Form A Relay — A
- Two Form C Relays — C

DIGITAL INPUTS/OUTPUTS
- Six Programable Inputs/Outputs — 6

COMMUNICATIONS
- EIA-485(RS-485); Modbus; BACnet; USB — A

MOUNTING METHOD
- Panel Mount — P
- Wall Mount | Includes NEMA 4X (IP67) Rated Enclosure — W

FC5 - FM - [ ] - F [ ] 6 A - [ ]

FC-5000 Flow Computer

FUNCTION
- Flow Computer — FM

SENSOR INPUTS
- One Pulse — P0
- Two Pulse — P3

SCALED OUTPUTS
- Two Frequency Outputs — F

RELAY OUTPUTS
- One Form C Relay / One Form A Relay — A
- Two Form C Relays — C

DIGITAL INPUTS/OUTPUTS
- Six Programable Inputs/Outputs — 6

COMMUNICATIONS
- EIA-485(RS-485); Modbus; BACnet; USB — A

MOUNTING METHOD
- Panel Mount — P
- Wall Mount | Includes NEMA 4X (IP67) Rated Enclosure — W

REPLACEMENT PARTS/ACCESSORIES

Part Number	Description
68334-001	P/S Plug; 100-264V AC In; 24V DC out
68334-002	P/S Module; 85-264V AC In; 24V DC out
809041	Panel mounting clips (2)
68788-001	Wall-mount enclosure kit

Part Number	Description
68231-001	Terminal connector kit (P2 configuration)
68231-004	Terminal connector kit (P0 configuration)
68231-005	Terminal connector kit

Consult factory for other parts/accessories.

SPECIFICATIONS

Power Supply	Input range 10…40V DC and 9…28V AC RMS		
	AC input voltage frequency range 50…60 Hz		
	Maximum 8 Watts power consumption		
	Isolated from power ground		
	Over-voltage, transient and reverse polarity protected		
Flow Meter Input	Input Range: 0.3 Hz…10 kHz		
	One (1) or two (2) independent channels		
	Configurable as square wave 0…30V pulse with 2.5V threshold		
	Configurable as sine wave, zero-centered with 45 mV threshold		
	Configurable debounce		
	Excitation Output	12V DC source	
	Voltage	Low: –0.3…1.85V DC	
		High: 2.5…25V DC	
	Impedance	Pullup to 12V DC	
	VDC Current	±50 mA, short circuit current	
	Response	100 µs/3.5 ms min pulse (high/low speed)	
Scaled Outputs	Two (2) independent channels		
	Isolated from power ground		
	Over-voltage, transient and reverse polarity protected		
	Output is multiplexed on the process out pins		
	Analog Output (option A)	Configurable to 0…5V, 0…10V or 4…20 mA	
		Uncertainty: ±0.1% of reading	
		16-bit resolution (0…10V and 4…20 mA), 15-bit resolution (0…5V)	
		200 ms, 90-10% step response	
		Sourcing analog output signal	
	Frequency Output (option F)	TTL, 1…4000 Hz, square wave	
		Uncertainty: ±0.01% reading	
		Resolution: 0.01 Hz	
Digital I/O	Six (6) independent channels		
	Isolated from power ground		
	Over-voltage, transient and reverse polarity protected		
	0…30 Volts as input		
	Debounce		
	0…5V, TTL, 200 ms 90-10% step response, driving < 0.1 uF		
Relay Outputs	2 Form C mechanical		
	Isolated coil drivers		
	Over-voltage, transient and reverse polarity protected		
Network Communications	**Network Types/Communication Protocols**		Modbus RTU, Modbus ASCII or BACnet
	Physical Layer		EIA-485 (RS-485)
	Baud Rates		1200…115.2K
	Two-wire (half-duplex)		
	Over-voltage/ESD Protection		
	Isolated from power ground		
USB Communications	**USB (HOST)**	Type-A Receptacle | Currently not supported	
	USB (DEVICE)	Mini-B Receptacle (used for field updates)	
	Over-voltage/ESD/transient protected		

Display/User interface	**Keypad**	Membrane overlay, domed tactile response keys	
	Display	128 × 64 pixel LCD graphical display, LED backlit	
	Protected from EMI/RFI		
	Keypad interface is protected from ESD		
Flow Calculation	Uncertainty: ± 0.01%		
	Adjustable FIR/IIR filtering		
Environmental Ratings	**Pollution Degree**		2
	Altitude Restriction		Up to 2000 m (6561 ft)
	Over-Voltage Rating		Category II (CAT II)
	Ambient Temperature Range		32…130° F (0…55° C)
	Storage Temperature Range		–40…160° F (–40…70° C)
	Humidity		0…85%, non-condensing
Weights (Approx.)	**Panel Mount**		1.25 lb (0.57 kg)
	Wall Mount (Including Unit)		4.54 lb (2.06 kg)
Operator Functions	Unlatch Relays, Reset Totalizer, Unlatch Relays and Reset Totalizer, Inhibit Flow Channels		
Parameters	**Maximum Displayed Digits**	**Rates**: Max 8 (7 with decimal)	
		Totals: Max 9 (8 with decimal)	
	Resolution/Display Precision	Configurable, 0…4	
	Volumetric Flow Rate Units Seconds (S), Minute (MIN), Hour (H), Day (D)	US Gallons (US GAL), Imperial Gallons (I GAL), Mega US Gallons (US MGAL), Mega Imperial Gallons (I MGAL), Liters (L), Mega Liters (ML), Cubic Meters (M3), Cubic Feet (FT3), Acre Feet (AC-FT), Oil Barrels (OBBL), Liquid Barrels (LBBL), US Ounces (US OZ), Imperial Ounces (I OZ), Custom (user-specified)	
	Volumetric Flow Total Units		
	Mass Units	Pounds (lb), Kilograms (Kg), Custom (CUST)	
	Temperature Units	° F (Fahrenheit), ° C (Celsius), R (Rankine) or K (Kelvin)	

Table 41: Specifications

STANDARDS AND CERTIFICATIONS

Agency Approval/Standards

- CE Marked for Low Voltage Directive and RoHS
- CSA Marked per Class C225286 and C225206, Process Control Equipment
- CSA C22.2 No. 61010-1-12, General requirements
- CAN/CSA-C22.2 No. 61010-1-12 Safety requirements for electrical equipment for measurement, control and laboratory use. Part 1: General requirements—Tri-national standard with UL 61010-1 and ANSI/ISA-61010-1 (82.02.01)

EMI/EMC Compliance

Conducted and Radiated Emissions per CISPR11:2009 / EN55011	Class A, Group 1
IEC 61000-4-2:2008 Electrostatic Discharge	2/4 kV - Contact Discharge, 2/4/8 kV Air Discharge Performance Criteria B
IEC 61000-4-3:2006 Radiated RF Immunity	Test levels: 80…1000 MHz & 1400…2000 MHz Performance Criteria A
IEC 61000-4-4:2004 EFT Immunity (Signal and Power lines)	Tested per specification to Performance Criteria B
IEC 61000-4-5:2005 Surge Protection	Tested per specification to Performance Criteria B
IEC 61000-4-6:2008 Conducted RF Immunity (Signal and Power lines)	Test Levels: 0.15…80 MHz Level 3, Performance Criteria A
IEC 61000-4-11:2004 Voltage Dips, Interruptions, and Dropouts	Tested per specification to Performance Criteria B & C

Table 42: EMI/EMC compliance

Enclosure Protection

- IEC/CSA/UL 60529-1: Degrees of protection provided by enclosures (IP65), when installed with all four mounting clips in a similarly rated enclosure, which includes the optional wall mount enclosure.
- Additional Protection (optional): NEMA 4X (wall mount enclosure only).

Control. Manage. Optimize.

www.badgermeter.com

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APPENDIX E

SYSTEM INSTALLATION INSTRUCTIONS

ATEC BACKWASH FILTERS

FOR

ATEC SYSTEMS TREATMENT EQUIPMENT FOR PUBLIC DRINKING WATER

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SYSTEM INSTALLATION INSTRUCTIONS

ATEC SYSTEMS TREATMENT EQUIPMENT FOR PUBLIC DRINKING WATER

Revised October 2011

SYSTEM INSTALLATION

Introduction

The assembly and installation of ATEC Iron and Manganese Removal Systems has been designed to minimize the time and the expense typically associated with the assembly and installation of other filtration systems. This is accomplished by preassembling our filters and mounting them on a skid, ready to be placed on the foundation or pad and connected. This modular design makes installation a snap.

Figure 1

Typical Set of 48” Filters

These *ATEC* Iron and Manganese filters are; 48” in diameter and 60” high; influent and effluent manifold sizes are 6”; backwash manifold are 4”. Gate valves are provided for the backwash line. All manifolds may be directed right or left.

How the filters arrive

ATEC Iron and Manganese Removal Systems are delivered on flat bed, over-the-road trucks. Normally, the appropriate media for the system to be installed is delivered on the same truck or set of trucks. Steps should be taken to assure that there is adequate room to maneuver the transport vehicle.

In all cases, it is important that the surface onto which the filters are being unloaded is level and adequately compacted to handle the weight of the filters and the vehicle being used to move them.

Filters should be offloaded and set in place with straps and protective pads (such as cardboard or carpet) to minimize damage to the filter's coating during offloading of the filters.

Figure 2

Filters and bulk bags loaded for delivery

It is also important to assure that there is adequate space to off-load and store the filter media until it is to be placed into the filter vessels. The media is either packed and shipped in woven PVC bulk bags, each containing 2,250 lbs. of media or it is shipped in 60 pound palletized (42 cubic foot) sacks. If the bags are to be stored for a long period, they should be protected from the weather to keep the media dry. Exposure to the elements and especially direct sunlight should be limited (in cases of prolonged storage, ultraviolet rays compromise the bags' tensile strength, reducing it by an average of 50% every six months).

Unloading the Filters When They Arrive

Figure 3

Crane unloading filters

ATEC Iron and Manganese filters arrive preassembled and skid mounted. Every skid is built with lifting eyes on each corner and forklift pockets positioned to accommodate a standard set of 5" forks. It is important to use a properly sized motor crane or forklift. If using a crane to lift the filters, it is important to have a properly sized set of straps and rigging.

Contact ATEC for appropriate assembly instructions for your system if not skid mounted.

Safety Precautions:

- **DO NOT** use an undersized crane or forklift to unload the filters
- **DO NOT** stand under or near filter skids while they are being unloaded;
- **DO NOT** try to unload the filters on uneven ground or on hillsides or slopes which will increase the chances of the filters, which are naturally top-heavy, tipping over;
- **DO** have a properly trained/certified equipment operator in control of the equipment;
- **DO** use properly sized rigging and equipment;

Locating the Filters

- The filters must be properly located on the foundation or pad as shown on the mechanical design drawings prepared by the project engineer.

Installing, Leveling and Aligning the Filters

Your ATEC filters will arrive on-site, pre-assembled and skid-mounted. It is recommended that you snap a line where the skids need to be set. The only requirement for these filters is that they be properly located, aligned with the stubbed out or planned mechanical connections, leveled, shimmed with steel or plastic shims as specified by the project. Proper location is also import so the mechanical connections line up properly and the influent, effluent and backwash manifolds fit.

Figure 4

Setting the filters

Supply and Discharge Piping Connections

1. Place the filter tanks on the pad in the proper position with top access ports on the same side.
2. Position the lower manifold under the tanks so the lower ports on the tanks match the ports on the manifolds.
3. Select the right sized coupling for this connection. Lubricate a groove type coupling gasket with gasket lubrication, spray silicone or soapy water.
4. Slip one gasket on each grooved pipe fitting on the bottom of each tank.
5. Raise the lower manifold and slip the gaskets over the pipe-fittings on the lower manifold. Assemble couplings around grooved fittings to attach the lower manifold.
6. Lubricate and slip gaskets onto grooved connections on valves. (Loosen valve-to-tank coupling to allow for alignment.) Locate upper manifold and attach to valve ports. Tighten all of the couplings on valves and upper and lower manifolds.
7. Repeat for upper manifolds.

Figures 5 & 6

Connecting the influent manifold

Connecting the backwash manifold

Backwash Piping Connections

A restrictor control valve on the back wash line is necessary for proper backwash adjustment. ATEC utilizes a gate valve for this purpose. This is the most economical solution as well as the most reliable and trouble free option.

Securing Filters to Foundation

The filters should be secured to the foundation per the structural engineers' recommendations. The attachment can be made through the flanges provided on the inside corners of the skid, through the angle brackets attached to the skid, or, on systems that are not skid-mounted, through the holes on the individual tank legs.

Loading the Media

Once the filters are set and the manifold connections are assembled, the media can be installed in the vessels. ATEC Systems ships its AS-741M filter media in 2,250 pound bulk bags and 60 pound (42 cubic foot) sacks. *Every effort is made to ship media for systems 24" in diameter and smaller in sacks.* Media for larger vessels is normally shipped in bulk bags for ease of installation. For example, a media depth of 36" in a 36" diameter filter vessel requires one bulk bag of media and a 36" depth in a 48" diameter filter vessel calls for two 2,250 pound bulk bags.

Chart 1

Pounds to Achieve Media Depth of:

FILTER DIAMETER	Media Depth/Weight 36”	42”	48”
48”	37.71 ft^3/4,525 lbs	44.0 ft^3/5,280 lbs	50.28 ft^3/6,034 lbs

With bulk bags, it is easiest to load the media with the crane or forklift used to unload the filters. Remove the top access cover and gasket; lift the bags with the straps on the top of the bulk bags above the opening. Untie the flap covering the sleeve, untie the sleeve and direct the media through the access port in the top of the vessels and put in the proper amount of media. *Prior to filling, check inside filter tanks for any foreign material.* The filter tanks should be filled to a level 18 inch below the top head and sidewall jacket seam. Clean access cover and gasket and replace. Lubricate and tighten bolt on access cover.

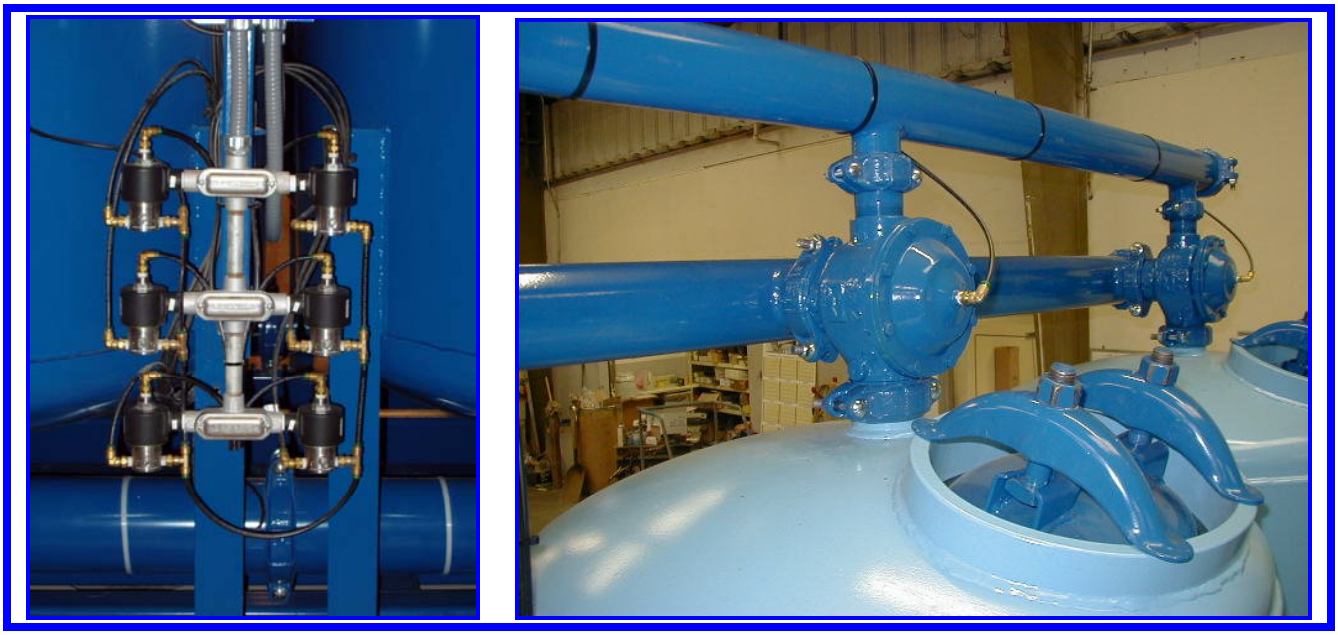
Figure 7

Loading the Media

Connecting Solenoids, Backwash Valves and Pressure Gauges

If the system is not pre-plumbed and pre-wired, install solenoid valves in threaded port on valve actuators. Connect tubing and fittings between valves and solenoid valves. The solenoid port marked “CYL” connects to the valve actuator. The port marked “IN” connects to the tube from the valve body port. Install tee and pressure gauges to upper and lower manifold threaded ports. Connect tubing from Prestolok tee to P.D. (pressure differential) switch. Note the high and low ports on the pressure differential switch in the control enclosure. Connect the air supply line to the supply side of the solenoid tree.

Figure 8



Connecting the Backwash Lines to the Valves

The backwash valves are connected to the left service port of the solenoid valves utilizing the ¼" tubing provided with you system. Insert the tubing completely into the Prestolok fitting to minimize the possibility of leaking air. Solenoid valves are numbered left to right, top to bottom, starting with the top left solenoid as #1. Backwash valves are numbered left to right, starting with #1. Insert the air supply line completely into the brass fitting on the right side of the solenoid. Neatly secure the tubing utilizing cable ties and/or tape.

Electrical Connections

The Alex-Tronix Model F8AC/DC/DCL-D, F12AC/DC/DCL-D and F16AC/DC/DCL-D can be operated on either AC or DC voltage. The default setting is AC, supplied at 120 VAC and stepped down to 24 VAC with a transformer located in the controller box. Therefore, the solenoid valves for this system are 24 VAC. Selecting the "DC" setting on the back of the circuit board will prevent the solenoid valves from operating. See the Owner's Manual supplied with your system for electrical design drawings and electrical connections. Connecting power to the transformer should be relatively simple for you electrician. The black wire is power and the white wire (and "C" circuit) is the common line. Do not wire the ground to the common line as it will damage the controller. No other electrical connections are required to operate the equipment provided by ATEC Systems for this installation. For a standard controller, power should be supplied when the well pump is running (just as your chlorine pump is powered). The PLC should be on constant power. The "M" circuit is powered approximately 15 seconds before backwash begins.

Figure 9 shows the standard configuration for the controller and solenoid valves on a six vessel filter system. There is one solenoid valve and one control valve per vessel. This control valve is operated pneumatically. (ATEC Systems Associates does not include an air supply with its systems.)

Figure 9

Controller and solenoid valves

Disinfecting and Cleaning the Media

The system should be disinfected[1] with chlorine prior to start up. For a 48" diameter filter vessel, add 2 quarts of 5¼% sodium hypochlorite (bleach) solution to each tank. Fill the tanks with water to a level just below the upper manifold. Hold for 12 or more hours and drain.[2] If this is not practical, chlorinate source water to ± 2 mg/L free chlorine residual during the initial backwash phase of the start-up process that will last several hours. In either case, the media and vessels will be disinfected.

---

1 These procedures are derived from and intended to meet AWWA Standard C653-03, (latest revision), Disinfection of Water Treatment Plants.

2 Regulatory authorities or discharge permits may require the de-chlorination of the drain effluent prior to discharge. If you are not familiar with the specific requirements in your area, check with local regulatory authorities or your consulting engineer for assistance in assuring compliance with these important regulations and policies.

The preferred method of filling the filter vessels is to allow water to flow back into the filter vessels from the distribution system rather than filling the vessels from the water well. The advantage of this method is that it reduces the possibility of water hammer and damage to the filter system or piping. It is recommended that the sodium hypochlorite (bleach) solution be added to the filters before the water to ensure the sodium hypochlorite is evenly distributed throughout the system. If the sodium hypochlorite is added after the system is filled, it is critical that you draw it down through the media until it is at a concentrated level in the distribution manifold as well as the top of the filter vessels.

When the media arrives it will need to be backwashed. There are two ways to backwash the media. The first is:

- It is critical when cleaning the media to use chlorinated water.
- Backwash for 5 minutes per vessel at a reduced rate for two cycles.
- Increase the backwash rate to 26-30 gpm/ft^2.
- Backwash until the media is clean, possibly up to 18-22 cycles.
- For a 4 vessel system, set the backwash time to 5 minutes per vessel and the frequency to once every 15 minutes. This will cause the system to backwash continually until halted.
- In situations where there is a problem disposing of large amounts of backwash water, the process can be spread over a period of several days or weeks.

The second methodology involves backwashing at a much lower rate and feeding air into the system. For an explanation of this methodology, please contact ATEC Systems Associates, Inc. The second methodology uses less water and takes les time to clean the media.

Please contact ATEC Systems for ant questions you may have or for additional assistance. Our contact information is listed here.

ATEC Systems Associates, Inc.
P.O. Box 10328
Seattle, Washington 98110-0329
(360) 414.9223 office
(360) 397.0375 fax

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MANUFACTURER'S LIMITED WARRANTY
ATEC IRON AND MANGANESE REMOVAL SYSTEMS

ATEC Systems, Inc. and/or ***ATEC Systems Associates, Inc.,*** hereinafter, ***ATEC Systems,*** warrants this product to the original purchaser to be free from defects in materials and workmanship for a period of thirty six (36) months from purchase date. ATEC Systems obligation under this warranty shall be limited to the repair or replacement, at ATEC System s' option, of any part that, upon inspection by the manufacturer, proves to be defective in material or workmanship under normal usage. All such repairs or replacements shall be performed upon the part's return *prepaid* to the manufacturer. This warranty is expressly conditioned upon the correct installation, application and operation of the product in the manner recommended by the manufacturer, which installation and operation is the responsibility of the purchaser. This warranty is not applicable to paints, coatings, finishes, rubber parts, altered or modified products or products that have experienced chemical corrosion.

This warranty is expressly in lieu of all other warranties, express or implied, including any warranty of "merchantability" or "fitness for purpose." ATEC Systems' liabilities under this warranty shall not exceed to incidental or consequential damages.

The remedy provided by this warranty shall be exclusive.

Prior to returning any equipment, it is the responsibility of the owner to obtain a return merchandise authorization (RMA) from ATEC Systems after which all parts and equipment on which a claim is being made should be shipped prepaid to:

ATEC Systems
Attn: Shipping and Receiving
191 Fallon Road
Hollister, CA 95023

Telephone: 831-637-9264
Facsimile: 831-637-2485

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atec systems associates, inc.

APPENDIX F

OPTIONAL EQUIPMENT

FOR

ATEC SYSTEMS TREATMENT EQUIPMENT
FOR PUBLIC DRINKING WATER

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LIST OF DOCUMENTS

1. ATEC Start-up Proceedures
2. Maintenance Schedule Sheet
3. ATEC Systems Summary Sheet

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Typical Procedures For Start-up

Before start-up is scheduled, the following need to be ready:

- Filters installed, connected to well, connected to system and/or reservoir;
- System/pipes pressure tested as needed;
- Media installed and hand holes secured;
- Provisions made for handling the backwash required to clean the media (140 gpm for about 45 minutes per vessel);
- Controller/PLC connected and powered (typically the controller is powered by a switched circuit same as the chemical feed pumps, PLC's are typically connected to constant power);
- Chemical feed pumps installed and powered;
- All chemicals present and ready to be dosed;
- Chemical injection ports installed and ready;
- Backwash flow meter, backwash sight glass, and/or air gap provided;
- Pre-chlorination/disinfection as per installation guide and/or AWWA disinfection procedures;
- Provisions for pumping to waste, while not strictly required, are advantageous during startup. The ability to pump to waste and filter to waste permits backwashing to clean the filter media using well water and allows for any discolored water in the finished water manifold to be discharged to waste rather than being sent to the system.

Day of Start-up, what to expect from the ATEC representative:

- The ATEC representative assists the client in cleaning the fines in the media;
- The ATEC representative assists the client in adjusting the chemical feed to properly dose the chemicals being used (directly pertaining to the treatment train);
- The ATEC representative provides training for the Utility in the basic process removal;
- The ATEC representative provides training for the Utility in the proper operation, maintenance and care of the treatment system;
- The ATEC representative provides training on the operation of an ATEC provided controller or PLC;
- The ATEC representative will be sure the backwash flow rate is set, and the filters are ready to be put on line;

Backwash procedure:

Using Well Water:

- This is the preferred method as it allows for water to flow both up through the vessels as well as down through the vessels;
- It is critical to be sure chlorine is dosed during this backwash process;
- If not dosing air, backwash should flow at 28 gpm/ft^2 for 5 minutes per vessel, then 10 minutes per vessel, and finally for 15 minutes per vessel;
- Repeat for 15 minutes per vessel until backwash appears clean (typically a dishwater brown or nearly clear);
- If dosing air, backwash should flow at 15 gpm/ft^2 for 5 minutes per vessel, then 10 minutes per vessel, and finally for 15 minutes per vessel;
- Connect the air line to the sample port for each vessel;
- Begin dosing air after the backwash flow is set (once air is dosed, the backwash flow meter will not read accurately) being careful to dose only enough to assist in the fluidization of the media without discharging media;
- Repeat backwash process until backwash appears clean (typically a dishwater grey/brown or nearly clear);
- When backwashing with air, you will still need to backwash each vessel at 28 gpm/ft^2 for 5 minutes each until clean;

Backwash procedure:

Using System Water:

- This is a less preferred method as it allows for water to only flow one way through the vessels and typically takes longer to clean the media;
- This method assumes the system water is pre-chlorinated, if not, arrangements to be made to chlorinate the water as it flows through the system;
- If not dosing air, backwash should flow at 28 gpm/ft^2 for 5 minutes per vessel, then 10 minutes per vessel, and finally for 15 minutes per vessel;
- Repeat for 15 minutes per vessel until backwash appears clean (typically a dishwater grey/ brown or nearly clear);
- If dosing air, backwash should flow at 15 gpm/ft^2 for 5 minutes per vessel, then 10 minutes per vessel, and finally for 15 minutes per vessel;
- Connect the air line to the sample port for each vessel;
- Begin dosing air after the backwash flow is set (once air is dosed, the backwash flow meter will not read accurately) being careful to dose only enough to assist in the fluidization of the media without discharging media;
- Repeat backwash process until backwash appears clean (typically a dishwater brown or nearly clear);
- When backwashing with air, you will still need to backwash each vessel at 28 gpm/ft^2 for 5 minutes each until clean.

OPERATION AND MAINTENANCE SUMMARY FORM

Project: Fawn lake Well 4

Equipment Item: Iron and Manganese Pressure Filters

Manufacturer: ATEC Systems, Inc

Manufacturer's Representative: Malcolm Pennington, (360) 901-4533

Maintenance Operation Comments	Frequency
Test chlorine free residual	Daily
Test iron raw and treated	Daily
Test manganese raw and treated	Daily
Observe backwash for flow rate and color	Weekly
Observe backwash valves for proper operation	Monthly
De-pressurize filters and check media level, fill if necessary	Every 6 months
Repair leaks as needed	As needed
Touch-up paint as needed	As needed
Check air line for condition/leaks (nylon)	Monthly
Replace grooved coupling gaskets	Every 6 years, or as needed
Rebuild Bermad (BWV1-BWV8)	Every 6 years, or as needed
Inspect Peter Paul solenoids, rebuild as needed (SV1-SV8)	Monthly
Inspect control panel for corrosion and integrity	Monthly

ATEC
SYSTEMS ASSOCIATES

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ATEC SYSTEMS TREATMENT SYSTEM SUMMARY TABLE Dockton Water Association, Sandy Shores Well, Iron and Manganese Removal System March 2020		
		Comments and Notes
Raw Water Quality (from pilot test)		
Iron	0.15 mg/L	Pilot Test, March 2-5, 2013
Manganese	0.163 mg/L	
Hydrogen Sulfide	≥1.00 mg/L	
Ammonia	≥0.167 mg/L	
Treated Water Quality Objective		
Iron	<0.15 mg/L	
Manganese	<0.010 mg/L	
Hydrogen Sulfide	N/D	
Ammonia	N/D	
Free Chlorine Residual	≤0.60 mg/L	
Design Parameters		
System Operating Pressure	±90 psig (working)	Maximum pressure/120 psig
Well Production (gpm)	100	
No. of Filter Vessels	4	
Filter Vessel Diameter (inches)	24	
Filter Surface Area (1 filter) (square feet)	3.14	
Side Wall Height (inches)	60	
Media	AS-741M	
Media Depth (inches)	42	
Media Volume (1 filter) (cubic feet)	10.99	
Recommended Application Rate (gpm/sf)	8.30	***Do not exceed except during backwash.***
Recommended Initial Cl_2 Dose	7.05 mg/L	***This is a critical variable.***
Free Residual Cl_2 Target	±0.60 mg/L	
Recommended Initial $KMnO_4$ Dose	0.210 mg/L	***This is a critical variable.***
Estimated Backwash Frequency	12 hours	***Based on production time.***
Recommended Initial Backwash Duration	5 minutes/vessel	***May require adjustment.***
Required Backwash Rate (gpm/sf)	28	***This variable is a critical variable.***
Required Backwash Flow-rate (gpm)	90	***This is a critical variable.***
Other System Characteristics		
Controller	Alex-Tronix	Model FM-8 AC/DC/DCL (115 VAC input to low voltage transformer)
Control Valves	Bermad	V-BF3-3x3x3
Solenoid Valve (Peter Paul Electronics Co.)	PN 73Z0157LCM	24 VAC
Pressure Sustaining Valve (if any)		
Backwash Flow rate Control Valve	3" Gate Valve	NIBCO
Coating System, Immersed Surfaces	SkotchKote 134	Force Cured.
Coating System, Exterior		
Base Coat	SkotchKote 134	Force Cured.
Top Coat	Cardinal, Series 6400	True Blue, 6407 JO2 500-U
System Weight (lbs) (empty)	3,400	
Media Weight (lbs) (all vessels)	5,320	
Weight of Water when Operating (lbs)	3,248	
Total System Weight (lbs)	11,968	
Repair Parts--All		
ATEC Systems, PO Box 1528, Hollister CA 95024	(831) 637-9264 parts@atecwatersystems.com	Repair parts ordered by noon are normally shipped the same day.

---WARNING---

PROPER CHLORINE DOSING IS CRITIAL TO SUCCESSFUL OPERATION

PROPER BACKWASHING IS ESSENTIAL TO PROPER OPERATION & REMOVAL

Troubleshooting Guide

Probable Cause	Solution
Poor Iron and Manganese Removal 1. Improper chlorine dose 2. Insufficient backwash flow or frequency 3. Inadequate media volume	1. Check chlorine residual; consider increasing it to 1.0 mg/L. 2. Check restrictor valves. Backwash more often. Check backwash flow rate. Check for line restrictons. 3. Add media to reach proper level or volume. This problem may be caused by excessive backwash flow rate. See Backwash Flow Control
Consistently High Pressure Differential? 1. Excessive contaminant load restricts flow through filters and prevents sufficient flow to properly backwash filters. 2. Insufficient backwash flow. 3. Sand in media bed.	1. Check pressure gauges for accuracy. 2. Drain tanks, remove hand-hole access covers and remove any excessive or caked contaminants on the media bed surface. Add media sand to proper level. 3. Adjust backflow wash control valve to allow for increased backwash volume. 4. Sample raw water for sand content.
Backwash Valves Leak? 1. Obstruction in valve seat. 2. Rubber poppet is worn or damaged 3. Diaphragm is damaged (leaking from bleed port of diaphragm chamber at rear of valve.	1. Remove obstruction 2. Replace rubber poppet 3. Replace diaphragm. Install pressure regulator is necessary to control problem.
Water Hammer? 1. Long backwash line causing vacuum. 2. Air in tanks.	1. Install vacuum breaker on backwash line. 2. Bleed off trapped air. Check for leaks in pump suction. Air bleed off valve may help.
Increasing Frequency of Backwash Cycle? 1. Duration of backwash or flow is inadequate to flush filter bed of contaminants. 2. Insufficient media volume. 3. Increased levels of contaminants in water supply. (Possibly seasonal problem.)	1. Readjust backwash flow. 2. Add media to achieve proper level. Check backwash flow. 3. Install Additional filter tank(s) to system.
Automatic Backwash Fails to Cycle? 1. Controller power off or circuit breaker tripped. 2. Improper setting of pressure differential switch. 3. Insufficient system pressure to actuate valves. 4. Solenoid(s) malfunctioning.	1. Turn power on. Assure that wiring is properly connected. Re-set circuit breaker. 2. Adjust as required. 3. Check system for pressure leaks (break in irrigation line, cracker pressure control tubing, etc. 4. Check connections. Clean parts. Check filter screen on high pressure control line for damaged screen and replace if necessary.
Decreasing iron or manganese removal 1. Improper backwashing 2. Improper chlorine residual 3. Change in raw water quality	1. Check backwashing rate, frequency and duration. Make sure all valves are operating. 2. Check chlorine residual on a daily basis. 3. Check raw water iron and manganese concentrations
Steadily increasing head-loss 1. Sand in raw water 2. Improper backwashing	1. Check raw water for sand content. 2. Check backwashing rate, frequency and duration