Final Draft
Operation and Maintenance Manual

Weak-Base Anion Exchange Chromium(VI) Removal Demonstration Facility

City of Glendale, California

AECOM Project No. 114116.01

Submitted to:
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October 2009

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ACRONYMS AND ABBREVIATIONS

µg/L	microgram per liter
<	less than
>	greater than
%	percent
ºF	degree Fahrenheit
ASME	America Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
atm	atmosphere
AWWA	American Water Works Association
Bac-t	analytical test for presence or absence of coliform bacteria and *E. coli*
CalOSHA	California Occupation Health and Safety Administration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDPH	California Department of Health Services
cf	cubic foot
CFR	Code of Federal Regulations
City	City of Glendale
CO_2	carbon dioxide
CP	control panel
CPVC	chlorinated polyvinyl chloride
Cr(VI)	hexavalent chromium
CWET	California Water Extraction Test
DOT	Department of Transportation
EBACT	empty-bed contact time
ELAP	Environmental Laboratory Accreditation Program
EMT	Emergency Medical Technician
FS	flow switch
ft	foot
ft^3	cubic foot
GAC	granular activated carbon
gpm	gallons per minute
GWP	Glendale Water and Power
GWTP	Glendale Water Treatment Plant
HASP	Health and Safety Plan
HDPE	high-density polyethylene
HHL	high high level
HL	high level
HMI	Human-Machine Interface
HOA	HAND-OFF-AUTOMATIC
HP	horsepower
Hz	Hertz
lb	pound
lb/hr	pound per hour
LL	low level
MCC	Motor Control Center
MCL	maximum contaminant level
mg/L	miilligram per liter
mg/kg	milligram per kilogram

ACRONYMS AND ABBREVIATIONS

mm	millimeter
MSDS	material safety data sheet
NA	not applicable
NDBA	N-Nitrosodi-n-butylamine
NDEA	N-Nitrosodiethylamine
NDMA	N-Nitrosodimethylamine
NDPA	N-Nitrosodi-n-propylamine
NMEA	N-Nitrosomethylethyamine
NO_3	nitrate
NPIP	N-Nitrosopiperidine
NSF	National Sanitation Foundation
NTU	nephelometric turbidity unit
NYPR	N-Nitrosopyrrolidine
O&M	operation and maintenance
OIU	operator interface unit
OSHA	Occupational Health and Safety Administration
P&ID	process and instrumentation diagram
PCE	tetrachloroethene (perchloroethylene)
PDSH	pressure differential switch high
pH	negative log of the hydrogen ion concentration
PID	proportional-integral-differential
PLC	programmable logic controller
PMP	Preventive Maintenance Plan
PO_4	phosphate
PPD	pound per day
PPE	personal protective equipment
ppm	part per million
PSH	pressure switch high
psi	pound per square inch
psid	pound per square inch, differential
psig	pound per square inch, gauge
PSL	pressure switch low
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
SCADA	supervisory control and data acquisition
sf	square foot
SiO_2	silicon dioxide
SO_4	sulfate
TCE	trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
TCP	1,2,3-trichloropropane
TDS	total dissolved solids
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
VFD	variable frequency drive
VOC	volatile organic compound

ACRONYMS AND ABBREVIATIONS

WBA	weak-base anion (exchange resin)
WBA Facility	Weak-Base Anion Exchange Chromium(VI) Removal Demonstration Facility
TIC	tentatively identified compounds
GC/MS	gas chromatography/mass spectrometry

1. INTRODUCTION

AECOM prepared this Operation and Maintenance Manual (Manual) for the Weak-Base Anion Exchange (WBA) Chromium(VI) [Cr(VI)] Removal Demonstration Facility (WBA Facility) for the city of Glendale (City).

1.1 BACKGROUND

The City of Glendale's groundwater supply in the San Fernando Valley has been contaminated with a variety of chemicals, including hexavalent chromium, trichloroethylene (TCE), tetrachloroethene (PCE), 1,2,3-trichloropropane (TCP), and others, mainly as a result of the improper disposal of industrial waste products.

In Glendale and other cities such as Los Angeles and Burbank in the San Fernando Valley, public concern about Cr(VI) in the groundwater supply led the City to embark on a multi-phase study to identify and install Cr(VI) treatment in anticipation of a Cr(VI) maximum contaminant level (MCL) lower than the current total Cr MCL in California.

The Phase III Demonstration-Scale Study will finalize the treatment evaluation, residuals assessment, and cost estimate development by implementing one or more Cr(VI) removal technologies. For the demonstration facilities, the City selected the construction of the WBA Facility to treat water from Well GS-3 at a design capacity of 425 gallons per minute (gpm) and a 100-gpm, reduction with ferrous sulfate, coagulation, and filtration system adjacent to the existing Glendale Water Treatment Plant (GWTP) to treat water from the North Operable Unit.

1.2 MANUAL SCOPE AND ORGANIZATION

This Manual is intended to allow owners and operators of the facility to easily establish and have available in a common location the necessary site information, procedures, manuals and charts used by and for:

- Plant personnel (employees and contractors) as ready reference for support and guidance in emergency situations, plant operations (including startup and shutdown), and maintenance activities.
- Record keeping associated with the required inspection and maintenance activities.
- The authority having jurisdiction to verify the continuing safety of the facility.

Before using this Manual, all facility personnel should be familiar with its organization and contents. The Record Drawings (presented in Appendix A) are available to all facility personnel to familiarize themselves with the design and operation of the Treatment System.

This Manual was written for water systems personnel and assumes a substantial level of knowledge and competence of the operator as required by the City's permit amendment provided by the California Department of Public Health (CDPH). A copy of the permit amendment is attached in Appendix B.

2. SAFETY CONSIDERATIONS AND EMERGENCY RESPONSE

Site health and safety and emergency response procedures are addressed in the Health and Safety Plan (HASP) and site-specific Draft Contingency Plan prepared under separate cover. General safety considerations and emergency response procedures are presented in this section.

2.1 CAUTIONS

- No maintenance of any kind should be performed on any part of the treatment plants without prior reference to the Manual, and the appropriate manufacturer's manual(s).
- Non-routine maintenance, such as component overhaul, is not covered in this Manual. Proper preventive maintenance should be performed regularly. Failure to do so could result in premature failure and pose a significant safety hazard. Consult the manufacturer before attempting any detailed maintenance procedure not covered in the Manual.
- In order to prevent hydraulic shock and possible damage to pipes, valves and other fittings, all valves must be opened and closed slowly. Maximum pressures listed in the Manual and/or on vessels, should not be exceeded for any reason. Possible rupture and other damage may result, endangering human life.
- All Federal, State, and local regulations for occupational health and human safety must be strictly enforced and adhered to by all personnel at the facility.
- All pump shafts and other moving parts must be covered by appropriate shields. The entire facility, especially the concrete pads, must be kept clean and free of obstructions, spills, and foreign materials.
- This Manual is NOT a substitute for good judgment and common sense. All personnel performing operations and maintenance at this facility should have proper training and supervision prior to working on this site.

2.2 WARNINGS

Failure to adhere to the following warnings could result in severe injury or death:

- Before opening electrical enclosures, disconnecting electrical wires or disconnecting pipes and valves, all power supplies must be disconnected following appropriate lock-out/tag-out procedures outlined in the HASP, and pressure must be relieved in the vessels.
- All safety devices and interlocks must be in place prior to operation of the equipment.
- Never remove any safety and cautionary tags on the equipment. Strict adherence to all warnings must be enforced.

Table 2-1: General and Emergency Information

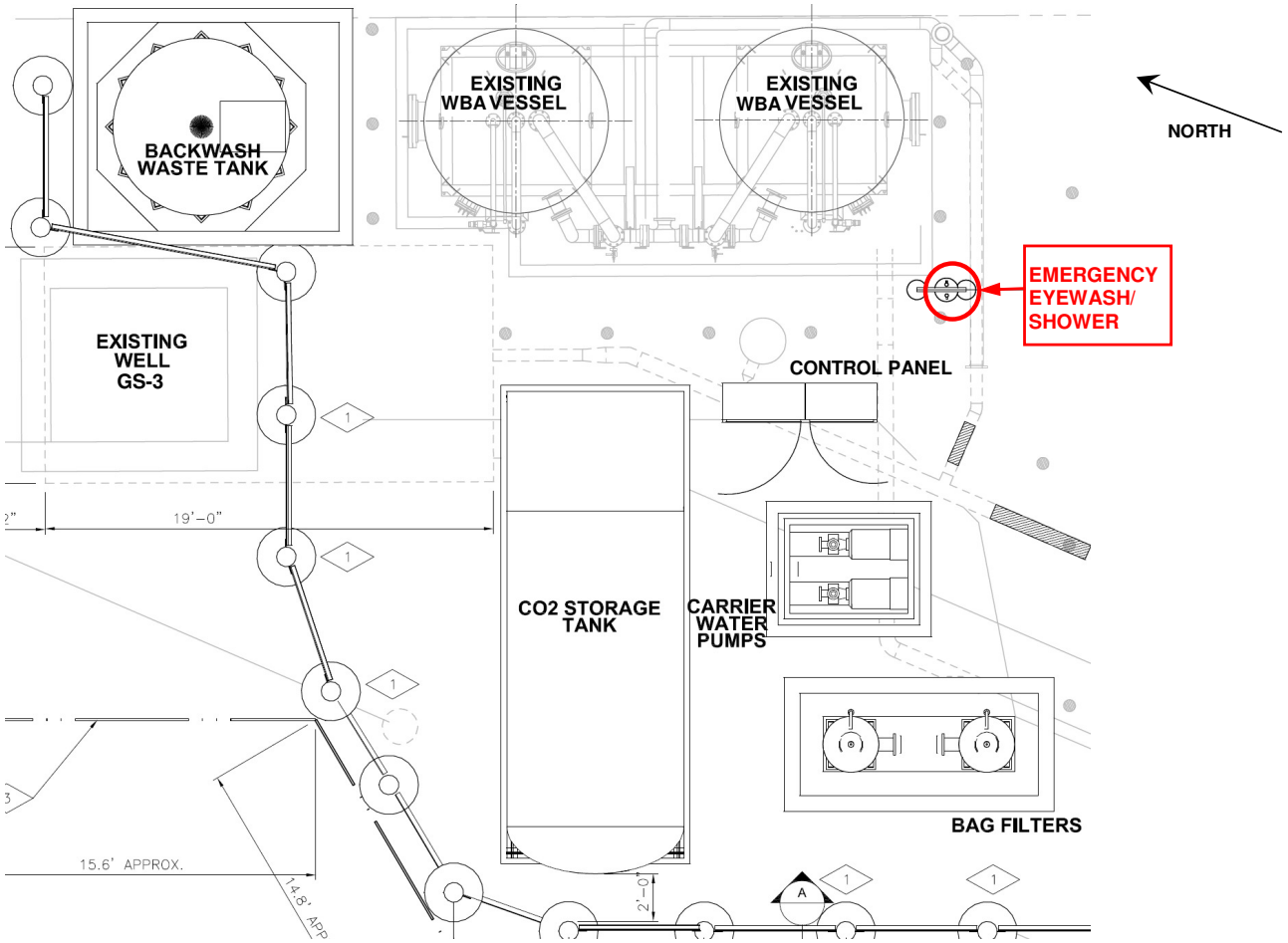
General Information					
Facility Name:	Weak-Base Anion Exchange Chromium(VI) Removal Demonstration Facility				
Address:	4041½ Goodwin Avenue, Los Angeles, California, 90039				
Facility Telephone Number:	818 550-5975				
Owner/Operator:	Glendale Water and Power				
Address:	Glendale, California				
Representative:	Peter Kavounas				
Title:	Assistant General Manager				
Telephone:	818 548-2137				
CDM Project Manager:	Dan Hutton				
Telephone:	562 577-1212				
Chief Plant Operator	Charles Cron (CDM)				
Telephone:	818-550-5975	Mobile:	562-755-0905	Fax:	
WBA Media Supplier and Waste Management Vendor::	Siemens Water Technologies Corp.				
Contact:	Mai Tran, Project Manager				
Telephone:	714-228-8828	Mobile:	562-458-6828	Fax:	714-521-9046

Local Emergency Responder Contact Information		
Organization / Agency		**Telephone**
EMERGENCY	Police	911
	Fire Department	911
	Ambulance (EMT will determine appropriate hospital for treatment)	911
Hospital, Glendale Memorial (Use by site personnel is only for non-emergency cases)		818- 502-1900
Poison Control Center (if a toxic substance has been ingested, inhaled, injected through or come in contact with the skin)		800-222-1222
National Response Center (for toxic chemical and oil spills)		800-424-8802

Notes:
EMT = Emergency Medical Technician

2.3 EMERGENCY EQUIPMENT INFORMATION

An emergency eyewash and shower is located next to the ion-exchange (WBA) vessel pad, at the southeast corner of the facility. A fire extinguisher is also provided.



Note: CO_2 = carbon dioxide

Figure 2-1: Site Plan

2.4 GENERAL SAFETY

One of the principal responsibilities of the facility staff is to ensure that proper procedures are followed to avoid injuries. Total elimination of accidents must be a primary objective, because lower standards tend to tolerate accidents rather than prevent them.

Managerial personnel must encourage safety-conscious work habits among facility staff members. However, all employees have a joint responsibility to follow, and therefore, make safety procedures work. All personnel are expected to become familiar with the location and operation of all facility safety equipment.

Failure to adhere to the following safety guidelines could result in severe injury or death and/or damage to equipment and facilities:

- No maintenance of any kind is to be performed on any part of this system without prior reference to this manual, and the appropriate manufacturer's manual(s). Non-routine maintenance, such as component overhaul, is not covered in this manual but must be covered using task-specific task hazard analyses. Proper preventive maintenance must be performed regularly. Failure to do so may result in premature failure and pose a significant safety hazard. Consult the manufacturer before attempting any detailed maintenance procedures not covered in this manual.
- In order to prevent hydraulic shock and possible damage to pipes, valves and other fittings, all valves must be opened and closed slowly. Maximum pressures listed in this manual, in manufacturer's literature, and/or on the vessels, should not be exceeded for any reason. Possible rupture and other damage may result, endangering human life or health.
- All applicable Federal, State and local regulations for occupational health and human safety must be strictly enforced and adhered to by all personnel at the facility. All pump shafts and other moving parts must be covered by appropriate guards. Each facility component walking or working area should be kept clean and free of obstructions.
- The Operation and Maintenance (O&M) Manual is NOT a substitute for good judgment and common sense. No maintenance may be performed, and no operation may be initiated, by personnel without proper training and supervision.
- Before opening electrical enclosures, disconnecting electrical wires or disconnecting pipes and valves, all power supplies must be disconnected and/or pressure must be relieved in the pipes or vessels.
- All energy and isolating safety devices must be locked and tagged-out prior to servicing any equipment. All lockout and tag out procedures are to be documented and logs kept of all uses of such procedures.
- Never remove any safety and/or cautionary tags on the equipment. Strict adherence to all warnings must be enforced.

To reduce or eliminate hazards, practice the following safety guidelines:

- Block, flag, and/or isolate equipment being worked on to protect personnel from being injured, and make use of tags and lockouts to inform other personnel that repair work is in progress.
- Exercise care where slippery conditions exist.
- While working in confined spaces, proper safety procedures, safety harnesses, and standby help must be utilized and/or provided, consistent with California Occupational Health and Safety Administration's (CalOSHA) standard for confined spaces (8CCR5157).
- Keep safety, rescue, and first aid equipment close by.

2.5 MACHINERY

Anywhere machinery is in operation, a potentially hazardous situation exists. For safety, rotating or reciprocating shafts, rods, eccentrics, belt drives, couplings, fly wheels, and gears should be adequately protected by shields or guards to prevent any contact with the moving part.

Severe injuries or death can occur as the result of mishandling tools, machinery, and electrical equipment. To eliminate or reduce hazard, practice the following safety guidelines for machinery:

- Use positive lockout mechanisms and tagging procedures at electrical motor control centers and at remote or local control stations.
- Train all operating personnel in the correct use of machinery.
- Keep and use welding equipment in an assigned safe area away from combustibles. Shield such equipment properly to protect employees from eye injuries due to electric arcs or hot metals. A welding/burning (hot work) permit is required in all areas before striking an arc or lighting a torch in accordance with applicable CalOSHA regulations.
- Restrict the use of pneumatic, explosive-activated, high-speed or machine shop tools to properly trained mechanics.
- Properly maintain all mechanical equipment and work areas.
- Use warning signs at all openings or where machinery is being repaired.
- Institute a preventive maintenance program for all machinery.
- Use proper hearing protection when working in areas where the noise level exceeds 90 decibels.

2.6 ATMOSPHERIC HAZARDS

Dangerous oxygen deficiency exists at atmospheric concentrations below 19.5 percent oxygen by volume. Normal air contains approximately 21 percent oxygen. Oxygen deficiency can exist with or without the presence of an explosive, toxic, or noxious gas. Atmospheric hazards can exist in the ion exchange (WBA) vessels, and confined space restrictions are in effect during any work within the vessels.

To eliminate or reduce hazards caused by atmospheric conditions, the following O&M procedures must be used:

- Assign two or more workers trained in the potential hazards while working under conditions or in locations where those hazards exist.
- Use and maintain adequate ventilation systems.
- Test air quality with appropriate equipment before entering confined spaces and while physically inside the confined spaces.
- If workers are to enter a vessel containing treatment media, appropriate sampling and work procedures for potentially low oxygen spaces shall be followed, including applicable Federal and State requirements.

2.7 ELECTRICAL HAZARDS

A number of different voltages are used at the facility. All electrical systems are hazardous, and the hazard increases as the voltage increases, especially around electrical control centers, transformers, and energized circuits in damp and wet locations. To eliminate or reduce hazards, the following electrical safety practices are required:

- Schedule a regular and organized program of preventive maintenance of all electrical equipment.
- Ensure proper training of operator and maintenance personnel in the use of electrical machinery and equipment.
- To extinguish fires in electrical equipment, use only non-conducting extinguishing agents to minimize shock hazard to the operator. Use agents that do not permanently damage the equipment; e.g., carbon dioxide is preferred to dry chemical extinguishers. If feasible, de-energize the electrical equipment before attempting to extinguish a fire to eliminate hazards associated with accidental contact with electrical conductors.
- Properly size and set electrical overload devices that will function when an overload or a short circuit occurs.
- Use safety tools, special devices, and protective clothing when working on or near energized circuits.
- Allow only authorized and qualified electricians to work on any part of the electrical system.
- Ensure that electrical controls, switch boxes, and distribution panels are properly identified and easily accessible.
- Use wood or other non-conductors for ladders and do not attempt to work with or handle energized connections and conductors without locking out the equipment first.
- Use emergency stop buttons to isolate electrical equipment at locations remote from the main control center. Do not depend on a lockout STOP push button when working with electrical equipment.
- Lockout and tag at the branch circuit breakers, and at all remote and local control stations.

2.8 HAZARDOUS MATERIALS

Hazardous materials such as chlorine solution are used during vessel disinfection and may be used during other operations at the facility. The following procedures are to be followed by managers and workers when around hazardous materials:

- Complete a task hazard analysis prior to the work to identify all potential hazards and safety procedures.
- Ensure that all workers are aware of the hazardous conditions and are trained to perform the work.
- Ensure that all necessary personal protective equipment (PPE) is available and that all personnel doing the work are properly fitted with all the necessary PPE.
- Clearly delineate the area where the work will be performed with signs and/or caution tape to warn other persons present of the hazardous work being performed and exclude all non-necessary personnel from the immediate work area.

Ensure that all Material Safety Data Sheets (MSDS) are available on-site during the work and that everyone doing the work is familiar with established emergency procedures.

3. FACILITY AND REGULATORY REQUIREMENTS

3.1 FACILITY OPERATING PARAMETERS

During normal operation, water quality and process-related parameters should be maintained as close as possible to values required to ensure safe and efficient operation of the WBA system. A list of operating parameters for the WBA Facility is provided in Table 3-1. The final operating parameters will be specified in the drinking water permit issued by CDPH.

Table 3-1: WBA Facility Operating Parameters

Parameter	Value
Facility effluent Cr(VI) target concentration	<5 µg/L
Operating pH	5.7 to 6.3
Design Flow Rate	425 gpm

Notes:
µg/L = micrograms per liter
Cr(VI) = hexavalent chromium
gpm = gallon per minute

3.2 DRINKING WATER STANDARDS

The CDPH sets the drinking water standards for the State while the United States Environmental Protection Agency (USEPA) sets Federal standards. In cases where the standards are different, the most stringent standard applies. The City also sets its own internal requirements for wellhead treatment systems, though these are not enforceable by either the Federal or State governments. The treatment requirements and effluent contaminant concentrations are specified in the CDPH Permit No. 04-15-00PA-000 (provided in Appendix B). Table 3-2 compares standards from the USEPA, the CDPH, and the City and also provides a historical range of concentrations measured in water samples collected from the GS-3 well.

Table 3-2: Comparison of Drinking Water Standards

Constituent	Units	Historical Concentrations in GS-3 Well	USEPA[1]	CDPH	GWP[2]
Total Chromium	µg/L	1.3 - 69	100	50	5
Cr(VI)	µg/L	1.1 - 75	–	–[3]	5

Notes:
µg/L micrograms per liter
CDPH California Department of Public Health
GWP Glendale Water and Power
USEPA United States Environmental Protection Agency
[1] USEPA. 2003. National Primary and Secondary Drinking Water Standards. EPA 816-F-03-016. June.
[2] City of Glendale treatment system design criterion and treatment target.
[3] CDPH is in the process of establishing a public health goal (PHG) for chromium (VI) of 0.06 µg/L.

3.3 SEWER DISCHARGE LIMITS

Untreated well water, treated water, and backwash wastewater will, from time to time, be discharged to the sanitary sewer. The City of Glendale holds a permit to discharge to the City of Los Angeles' sanitary sewer and a copy is included in Appendix C. The relevant sewer discharge limits are

provided in Table 3-3. The average raw water contaminant concentrations are also included in the table and are below the sewer discharge limits.

Table 3-3: Sewer Discharge Limits and Influent Contaminant Concentrations for WBA Facility

Constituent	Units	Limit	Raw Well Water
Total Chromium	mg/L	10	0.040[1]
Chromium(VI)	mg/L	-	0.040 – 0.060[2]
VOCs	mg/L	1	0.027[3]

Notes:
mg/L milligram per liter
VOC volatile organic compound
[1] Average concentration in Well GS-3 from February 2000 to May 2009.
[2] Range of chromium(VI) concentration.
[3] Total maximum concentrations of TCE, PCE, and 1,2,3-TCP in Well GS-3.

3.4 PERSONNEL AND STAFFING REQUIREMENTS

The WBA Facility normally operates on a continuous basis (24 hours per day) when the City-operated, well is in operation. The WBA Facility is operated and maintained by operators who have been listed and certified with the CDPH. The facility must be operated in a safe manner and in compliance with all treatment requirements and discharge limitations.

The WBA Facility will be operated and maintained by the City. Shift operators for the treatment system will be determined by the City. The City has previously filed a list of operators and their certifications with the CDPH. Normal operation will require daily site visits by a shift operator to monitor and adjust operating parameters. Certain operating parameters are integrated into the Supervisory Control and Data Acquisition (SCADA) system for remote monitoring and control in the GWTP control room. Additional personnel may be required to assist in other tasks such as media replacements or performing media backwash.

4. TREATMENT FACILITY DESCRIPTION

4.1 GENERAL DESCRIPTION OF WBA FACILITY

The Glendale WBA Facility was constructed at the site of a former granular activated carbon treatment plant that was retrofitted for use of WBA resin. The modifications are based on the Preliminary Design Report (Malcolm Pirnie 2007a). Additional components were installed to complete the system. The facility consists of the following major components:

- Carbon dioxide (CO_2) pH control system,
- Bag filters for particulate removal,
- Existing vessels retrofitted to use WBA resin, and
- Backwash system.

The WBA treatment process flow diagram is shown on Table 4-1 and the facility layout is shown on Figure 4-2. The WBA Facility treats water produced from Well GS-3. Influent water is pH-adjusted by the addition of CO_2 from the initial pH of approximately 6.8 to a pH of approximately 6.0. The water is then filtered prior to flowing through the treatment vessels where chromium is removed by ion-exchange by the WBA resin. The design flow for the treatment system is 425 gpm.

4.2 CARBON DIOXIDE pH CONTROL SYSTEM

CO_2 is used to control the pH of the water fed to the WBA vessels from a pH of approximately 6.8 to 6.0. CO_2 reacts with water to form carbonic acid and reduces the pH. The CO_2 pH Control System consists of the following components:

- 14-ton liquid CO_2 storage tank including; refrigeration unit, CO_2 vaporizer, CO_2 vapor heater, pressure regulator.
- CO_2 Control System including; carbonic acid feed control panel with a human-machine interface (HMI) and programmable logic controller (PLC), carrier water pumps, control panels, skids, and valves, carbonic acid diffuser assembly.

The design criteria for the CO_2 feed system are provided in Table 4-1.

The CO_2 system consists of the following major equipment components:

4.2.1 CO_2 Storage Tank and Refrigeration System

Liquid CO_2 is stored in an insulated steel storage tank that has a storage capacity of 14 tons (28,000 pounds) of CO_2. A refrigeration unit is used to cool the tank to maintain the pressure in the tank by keeping the CO_2 in the liquid phase. An electric vaporizer is used to feed CO_2 gas to the solution feeder and the vapor heater is used to maintain the supplied gas near ambient temperatures. The refrigeration compressor is operated with 480-volt 3-phase 60 Hertz (Hz) electric power.

4.2.2 CO_2 Carrier Water Pump

The carrier water pumps are required to boost the pressure of the carrier water through the static mixers in the CO_2 feed panel. Carrier water is provided as a side stream injection system to improve dissolution of CO_2. A portion of the well flow is diverted for the side stream injection system through the carbonic acid feed panel using a carrier water pump. The system uses two pumps; one on duty and one on standby. The carrier water pumps are horizontal centrifugal pumps operated on 480-volt, 3-phase 60-Hz power. Each has a 10-horsepower (HP) electric motor and operates on 480-volt 3-phase 60 Hz electric power.

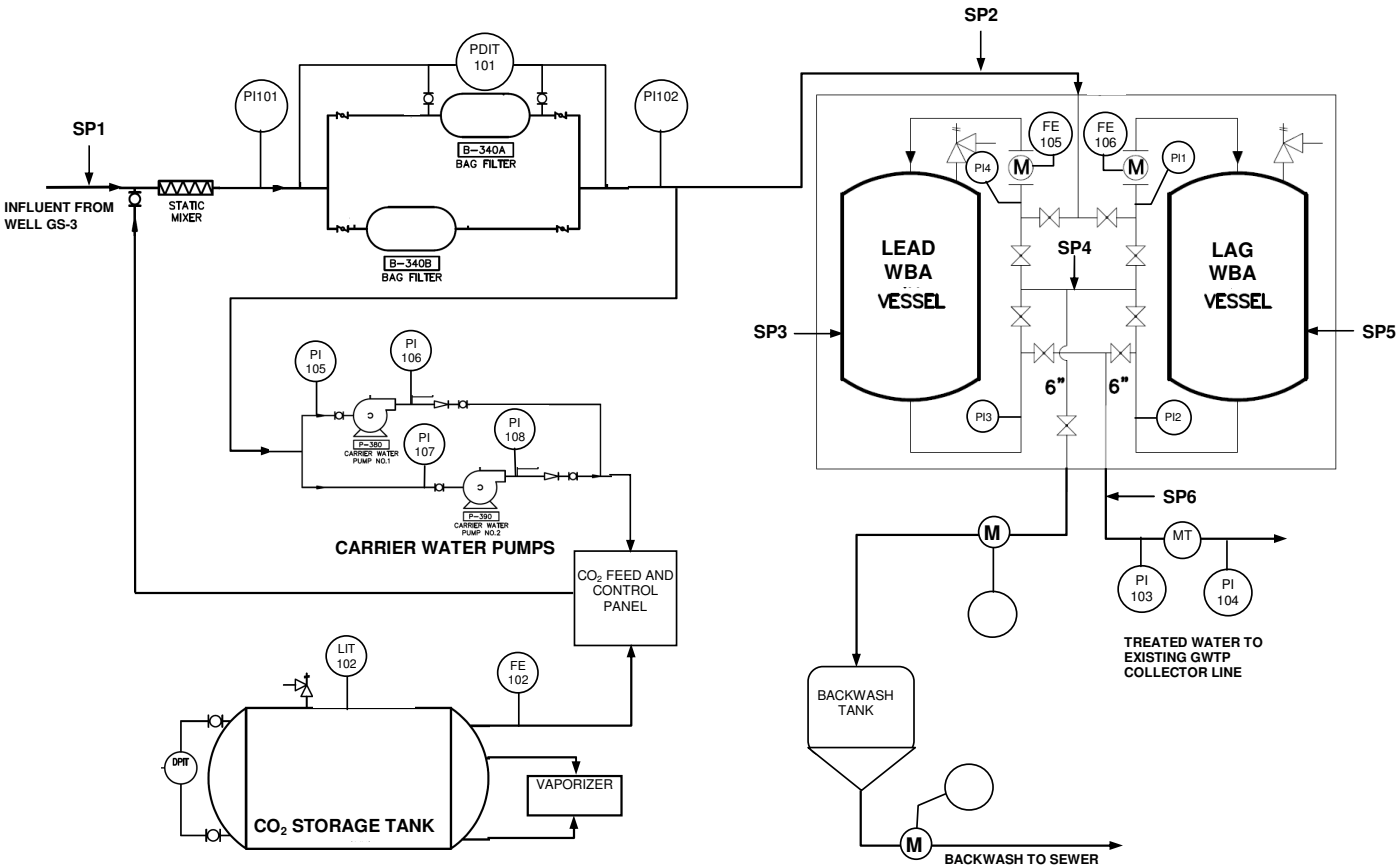
Table 4-1: CO_2 System Design Criteria

Parameter Design	Criteria
Design Flow	425 gpm
Design Dose	288 mg/L
Maximum Usage at Maximum Design Flow	2075 ppd
Average Usage at Design Flow	1470 ppd
Total Storage Amount	28,000 lb
Days of Storage at Design Flow	19 days
Days of Storage at Maximum Design Flow	13.5 days
Carrier Water Requirements	65 gpm at 110 psig
Type of Storage Tank	ASME Pressure Vessel
Material	Steel
Pipe and Valve Materials CO_2 Gas	Steel
Pipe and Valve Materials for Dissolved CO_2	CPVC
Carrier Water Pipe and Valve Materials	Steel or Copper
Gaskets and Elastomeric Materials	Buna-N (Nitrile)

Notes:
ASME = American Society of Mechanical Engineers
CPVC = chlorinated polyvinyl chloride
gpm = gallon per minute
cf = cubic foot
ft = foot
lb = pound
mg/L = milligram per liter
ppd = pounds per day
psig = pounds per square inch, guage

4.2.3 CO_2 Feed Panel

The feed panel includes a flow control valve, flow meter and static mixer to control the feed rate of CO_2 gas into the carrier water. In the mixing panel liquid CO_2 is vaporized and combined with carrier water prior to being injected into the plant influent. The CO_2 mixing panel includes a pneumatic control valve controlled by the plant PLC for regulating the amount of CO_2 being added. The control valve is actuated by the pressure of the process CO_2.



Notes:
CO_2 = carbon dioxide
GWTP = Glendale Water Treatment Plant
WBA = weak-base anion

Figure 4-1: WBA Treatment System Process Flow Diagram

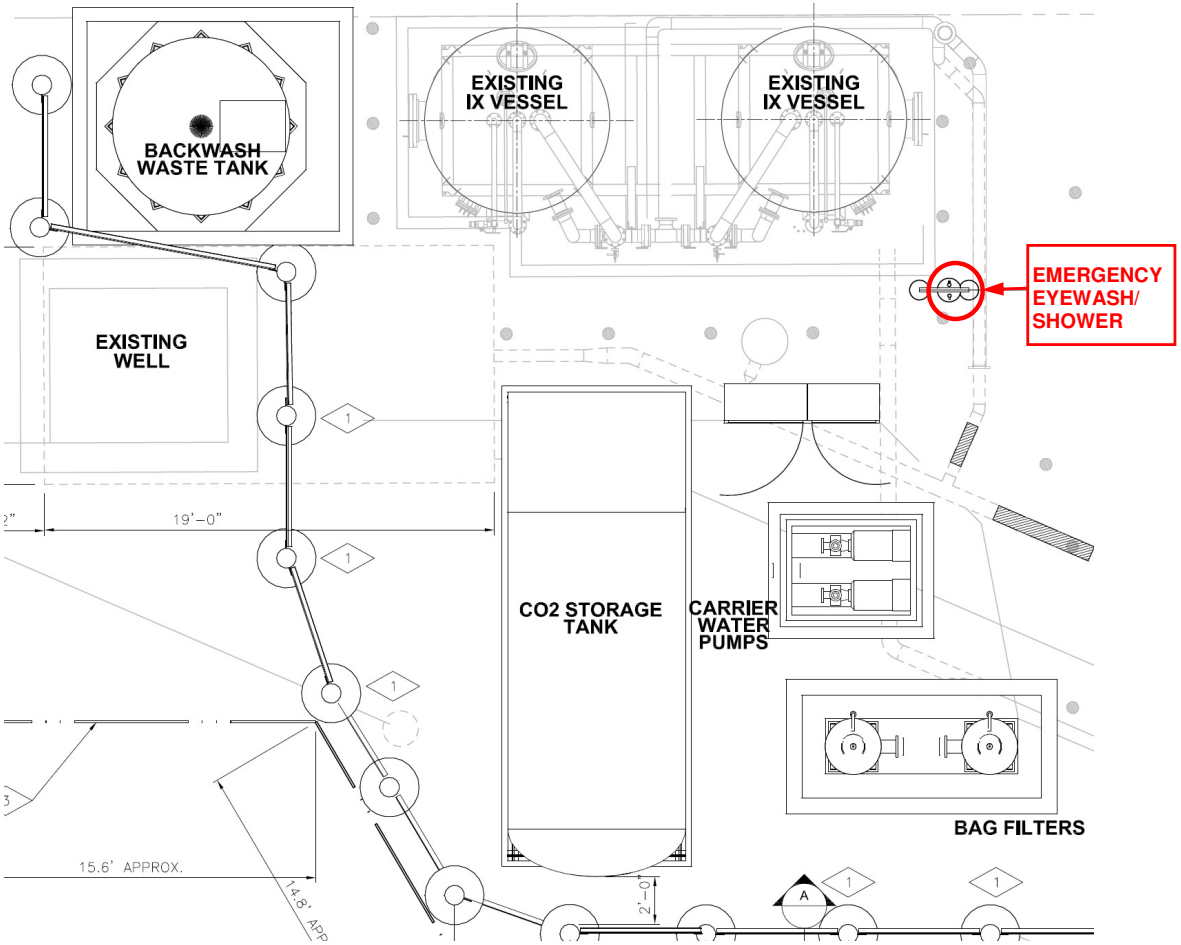


Figure 4-2: Facility Layout

4.3 ION EXCHANGE VESSELS

Two existing GAC vessels will be operated in series in a lead and lag configuration. The system was designed as a demonstration scale facility that will have a limited operating period. It is not expected that the facility will need to be in operation for 30 or more years, so the construction material choices are based on a limited life cycle demonstration facility. The design criteria for the WBA vessels are listed in Table 4-2.

Table 4-2: Design Criteria for Retrofitted WBA Vessels

Parameter	WBA Vessel (each)
Design Flow	425 gpm
Maximum Capacity of Vessel Underdrain	600 gpm
WBA Loading Rate	2.5 gpm/cf
Required Usable WBA Volume at Design Flow	170 cf
Vessel Diameter	8 ft
Vessel Total Straight Shell Height	7 ft
Vessel Rounded Bottom Height	2 ft
Total volume of Vessel	553 ft^3 (4136 gallons)
Unusable Volume from Bottom of Vessel to Top of Nozzle	1 ft
Unusable Resin Below Nozzle	15 cf
Total WBA Resin Required at Design Flow	185 cf
Available Bed Expansion at Maximum Design Flow	42%
Straight Shell Depth of Resin at Design Flow	2.68 ft
Available Bed Expansion at Design Flow	62%
Minimum Required Backwash Rate for 60% Bed Expansion	3.5 gpm/sf (176 gpm)
Backwash Supply	Existing 8-inch Water Main
WBA Resin	Rohm & Haas Amberlite PWA7
WBA Resin Particle Size Range	0.3 – 1.2 mm
Underdrain Lateral Screen Size	0.25 mm (60 mesh)

Notes:
% = percent
gpm = gallons per minute
cf = cubic foot
ft = foot
ft^3 = cubic foot
sf = square foot
mm = millimeter
WBA = ion exchange

4.4 BACKWASH TANK

The backwash tank is a 3,000-gallon, cross-linked high-density polyethelene (HDPE), cone-bottom tank mounted on a steel stand. The tank was supplied by Snyder Industries, Inc.

4.5 PARTICULATE FILTERS

Upstream of the WBA vessels are two bag filter vessels in parallel for particulate matter removal. The filters are sized so that filter bag changes can be completed without shutting down the treatment system. The design criteria for the bag filters are provided in Table 4-3. Product cut sheets are included in

Table 4-3: Bag Filter Design Criteria

Parameter	Design Criteria
Manufacturer	Fil-Trek Corporation
Model	LPADV24-1212-6F-150-BTFV
Number of Bag Filter Assemblies	2 in parallel
Design Flow per Vessel	600 gpm
Design Pressure and Temperature	15 psig, 250 ˚F
Maximum Clean Headloss at Design Flow	2 psid
Bag Filter Housing Material	Painted Carbon Steel
Filter Elements per Assembly	6
Filter Elements	20 micron cloth bag filters, NSF-approvved
Filer Element Support	316 Stainless Steel Perforated Baskets

Notes:
ºF = degrees Fahrenheit
gpm = gallon per minute
psig = pounds per square inch, gauge
psid = pounds per square inch, differential
NSF = National Sanitation Foundation
[1] Currently, SIR-700 is not approved by the National Sanitation Foundation (NSF). Use of this resin would require that certification. PWA7 is already NSF-certified.

4.6 CONTAINMENT PADS AND ANCILLARY EQUIPMENT

The backwash tank, filters, and carrier water pumps are mounted on concrete pads with elevated sidewalls to serve as containment areas for nuisance spills or leaks. The containment pads are for identifying minor pipe leaks and minimizing discharges of the well water to the storm sewer. Level switches located inside sumps in each pad alert operators at the control panel and the remote monitoring location that it is filling with liquid.

The site piping materials are epoxy-lined and coated steel for above grade piping and cement-lined and coated steel pipe and ductile iron pipe for below grade piping. Exposed valves are cast iron butterfly valves. Buried valves are ductile-iron, body-resilient, wedge, gate valves installed in traffic-rated valve cans with the valve operators below grade. The piping materials for the carbonic acid system are Schedule 40 galvanized steel for the CO_2 gas and stainless steel for the dissolved carbonic acid solution after the feed panel.

5. PROCESS MONITORING AND CONTROL

5.1 INTRODUCTION

The following section describes the operation of major facility process elements. Brief operational descriptions are provided for each of the main process systems and basic instrumentation design is also discussed.

Most functions of the WBA Facility are designed for automatic operation and include a SCADA system for remote monitoring and control of many of the treatment system parameters from the GWTP control room. Local control of the plant is possible through the HMI located on the control panel at the facility.

Well GS-3 is normally controlled via the existing SCADA system in an automatic-remote manner with manual-remote operation possible from the GWTP control room and local control at the well. The well pump is equipped with a variable-frequency drive that is automatically controlled to match the plant flow rate setpoint.

Critical equipment is interlocked by hardwiring directly to control devices. Operating conditions that exceed setpoints either trigger an alarm or equipment shutdown. The specific alarm conditions must be returned to normal operation before the individual alarm light can be reset. Table 5-1 summarizes the instrumentation equipment and control setpoints (listed by tag number, as shown on the Process and Instrumentation Diagram (P&ID) found in Appendix A, and actions triggered by those setpoints.

5.2 PH CONTROL SYSTEM

The pH of the water is controlled by measuring the pH upstream of the influent to the WBA vessels and adjusting the amount of CO_2 injected into the plant influent. Carrier water is taken from the influent to the WBA vessels, mixed with CO_2, and injected ahead of the static mixer on the plant influent. The volume of carrier water injected is constant. The pH control system is set to maintain a pH of 6.0.

Should the pH of the influent water remain outside the setpoint for an extended period, alarms are activated and actions are taken by the system, as follows:

- If the pH remains over 6.3 for more than 60 seconds, an alarm is triggered on the control panel. An alarm is also indicated on the Human Machine Interface (HMI) and a signal is sent to the SCADA system in the GWTP control room.
- If the pH remains over 6.3 for more than 3 minutes, the well in operation is shut down along with the pH control system. A signal is also sent to the SCADA system in the GWTP control room.
- If the pH remains under 5.7 for more than 60 seconds, an alarm is triggered on the control panel. An alarm is also indicated on the HMI and a signal is sent to the SCADA system in the GWTP control room.
- If the pH remains under 5.7 for more than 3 minutes, the well is shut down along with the pH control system. An alarm is indicated on the HMI and a signal is sent to the SCADA system in the GWTP control room.

NOTE: Shutdown of the well requires manual restart by operations personnel.

5.3 WBA VESSELS

The two WBA vessels will be operated in series in a lead/lag configuration with the effluent from one vessel feeding the inlet of the other. Effluent from the second vessel will be discharged to the existing 8-inch GWTP collector line (transmission main).

5.3.1 Monitoring and Control

The majority of the operational changes for the WBA vessels will be manually initiated. Flow through the WBA vessels is controlled by the well pump speed and losses through the system. The well pump is powered by a variable-frequency drive motor and will be automatically controlled to maintain the flow rate through the plant at a given setpoint.

Each vessel is equipped with a flow meter on the inlet to the vessel for local display of flow rate.

Valves on WBA vessels are not throttled to control flow during normal operation. During backwash cycles, media changeouts, and switching lead and lag vessel are performed manually by an operator.

5.3.2 Responses and Interlocks

There are no interlocks associated with the WBA vessels. An alarm is activated on the HMI and SCADA system if liquid accumulates in the containment pad and triggers the high level sensor.

5.4 BACKWASH SYSTEM

The WBA vessels may be backwashed from time to time to reduce the pressure drop across the media. Backwash supply is provided from the transmission main and by manually opening check valve CV01 to allow backflow of water.

5.4.1 Monitoring and Control

Backwashing of the WBA vessels is manually initiated. The backwash rate is controlled by manually throttling the valves on the WBA vessels and monitoring the flow on the backwash flow meter.

Field instruments used for controlling backwash cycles include:

- Backwash flow meter, FE/FIT103, on the backwash discharge line
- Backwash discharge flow meter/totalizer, FE104, is used to control the discharge from the backwash tank to the City sewer, which is limited to 7 gpm.

5.4.2 Responses and Interlocks

There are no interlocks. An alarm is activated on the HMI and SCADA system if liquid accumulates in containment pad and triggers the high level sensor.

Table 5-1: Instrumentation and Control Functions

Instrument Tag Number	Description	Operating Range	Setpoint	Responses and Interlocks
PARTICULATE FILTERS				
LSH101	High Level Sensor for Particulate Filter Containment Pad	NA	mid-height of containment berm	An alarm is activated with output to the control panel and SCADA system for local and remote monitoring, respectively.
PDIT101	Pressure Differential Indicator/Transmitter for Particulate Filters	0 – 10 psid	10 psid	An alarm is activated with output to the control panel and SCADA system for local and remote monitoring, respectively.
PI101	Pressure Indicator for Inlet to Particulate Filters	100 – 115 psig	NA	NA Provides local readouts only.
PI102	Pressure Indicator for Outlet of Particulate Filters	95-110 psig	NA	NA Provides local readouts only.
WBA TREATMENT SYSTEM				
FE105	Flow Meter for Vessel A	0 – 1,000 gpm	NA	NA Provides local readouts only.
FE106	Flow Meter for Vessel B	0 – 1,000 gpm	NA	NA Provides local readouts only.
LSH104	High Level Sensor for WBA Vessel Containment Pad	NA	mid-height of containment berm	An alarm is activated with output to the control panel and SCADA system for local and remote monitoring, respectively.
DPSH103	Differential Pressure Gauge/Switch for Media Trap	0 – 10 psid	10 psid	An alarm is activated with output to the control panel and SCADA system for local and remote monitoring, respectively.
PI103	Pressure Indicator for Media Trap Inlet	80 - 90 psig	NA	NA Provides local readouts only.
PI104	Pressure Indicator for Media Trap Outlet	75 – 85 psig	NA	NA Provides local readouts only.
BACKWASH SYSTEM				
LSH102	High Level Sensor for Backwash Tank Containment Pad		mid-height of containment berm	An alarm is activated with output to the control panel and SCADA system for local and remote monitoring, respectively.
FE103	Flow Meter/Transmitter for Backwash System	4 – 310 gpm	NA	NA Provides local readouts only.
FE104	Flow Indicator/Totalizer for Backwash Tank Discharge	0 – 1182 gpm	NA	NA Provides local readouts only.

Instrument Tag Number	Description	Operating Range	Setpoint	Responses and Interlocks
CARRIER PUMPS				
LSH103	High Level Sensor for Carrier Water Containment Pad	NA	mid-height of containment berm	An alarm is activated with output to the control panel and SCADA system for local and remote monitoring, respectively.
PI105	Pressure Indicator for Inlet to Carrier Pump No. 1	0 – 200 psig	NA	NA Provides local readouts only.
PI106	Pressure Indicator for Outlet from Carrier Pump No. 1	0 – 200 psig	NA	NA Provides local readouts only.
PI107	Pressure Indicator for Inlet to Carrier Pump No. 2	0 – 200 psig	NA	NA Provides local readouts only.
PI108	Pressure Indicator for Outlet from Carrier Pump No. 2	0 – 200 psig	NA	NA Provides local readouts only.
PSH102	High Pressure Switch for Outlet from Carrier Pump No. 1	8 – 200 psig	160 psig	Interlock: Duty pump is stopped. An alarm is activated with output to control panel and SCADA system. Standby pump is started automatically.
PSH103	High Pressure Switch for Outlet from Carrier Pump No. 2	8 – 200 psig	160 psig	Interlock: Duty pump is stopped. An alarm is activated with output to control panel and SCADA system. Standby pump is started automatically.
CO_2 STORAGE TANK				
LIT102	Level Indicator/Transmitter for CO_2 Storage Tank	0 – 72 inches water column	NA	Measures the differential pressure between headspace and liquid in CO_2 storage tank and transmits a signal to the PLC that is converted to CO_2 liquid level.
PI113	Pressure Indicator for CO_2 Tank Effluent.	0 – 400 psig	NA	NA Provides local readouts only.
PI114	Pressure Indicator for CO_2 Storage Tank	0 – 600 psig	NA	NA Provides local readouts only.
PSH105	High Pressure Switch for CO_2 Storage Tank	315 – 325 psig	325 psig	An alarm is activated with output to HMI and SCADA system.
PSL101	Low Pressure Switch for CO_2 Storage Tank	235 – 245 psig	235 psig	An alarm is activated with output to HMI and SCADA system.
CO_2 FEED PANEL				
AE/AIT/AIC101	Plant pH Meter/ Transmitter/ Controller	0 - 14	6.0	Controller measures pH at inlet to WBA vessels and adjusts CO_2 flow rate to meet pH setpoint.
			6.2	pH > 6.2 for 5 minutes: turns off well pump, carrier pump, and CO_2 feed panel. An alarm is activated with output to control panel and SCADA system.
			6.1	pH > 6.1 for 90 seconds: An alarm is activated with output to control panel and SCADA system.

Instrument Tag Number	Description	Operating Range	Setpoint	Responses and Interlocks
			5.8	pH < 5.8 for 90 seconds: An alarm is activated with output to control panel and SCADA system.
			5.6	pH < 5.6 for 5 minutes: turns off well pump, carrier pump, and CO_2 feed panel. An alarm is activated with output to control panel and SCADA system.
FI102	Flow Indicator for Inlet to Static Mixer	0 – 86 lbs/hr	NA	NA Provides local readouts only.
PI109	Pressure Indicator Upstream of Pressure Reducing Valve PR52	0 – 400 psig	NA	NA Provides local readouts only.
PI110	Pressure Indicator Downstream of Pressure Reducing Valve PR52	0 – 200 psig	NA	NA Provides local readouts only.
PI111	Pressure Indicator Upstream of Static Mixers	0 – 200 psig	NA	NA Provides local readouts only.
PI112	Pressure Indicator Downstream of Static Mixers	0 – 200 psig	NA	NA Provides local readouts only.
PI201	Pressure Indicator for Carbonic Acid Solution Feed	0 – 200 psig	NA	NA Provides local readouts only.
PSL104	Low Pressure Switch for Carrier Water	8 – 200 psig	135 psig	An alarm is activated with output to HMI and SCADA system for remote monitoring. Shutdown of carrier water pumps and CO_2 feed panel.

Notes:
< = less than
> = greater than
CO_2 = carbon dioxide
gpm = gallon per minute
HMI = Human Machine Interface
lbs/hr = pound per hour
NA = not applicable
pH = negative log of the hydrogen ion concentration
PLC = programmable logic controller
psid = pound per square inch, differential
psig = pound per square inch, gauge
SCADA = supervisory control and data acquisition
WBA = ion exchange

5.5 PARTICULATE FILTERS

Bag filters will be used to remove particulates from well water prior to ion exchange treatment. The control description below is typical for Bag Filter 1 and Bag Filter 2.

5.5.1 Monitoring and Control

Pressure drops across the bag filters are monitored by a differential pressure transmitter. Inlet and outlet pressure gauges are also mounted on the piping for field observation. An alarm will be annunciated remotely on SCADA and displayed on the control panel based on a high differential pressure setpoint. The setpoint is initially set at 5 psig and may be adjusted based on an evaluation of the rate of particle accumulation and associated impacts on the well pump output during operation.

The local display will include a differential pressure reading between bag filters' inlet and outlet at the instrument.

5.5.2 Responses and Interlocks

If the differential pressure exceeds the maximum setpoint, an alarm is activated with output to the control panel and SCADA system.

5.6 CO_2 STORAGE TANK

5.6.1 Monitoring and Control

The refrigeration unit is equipped with a NEMA 4X control panel for automatic control of the compressor. A differential pressure transmitter (PDIT102) is installed on the storage tank to measure the tank level which will be shown locally on the refrigeration control panel and will be sent to the PLC for remote monitoring by SCADA. High and Low level alarms will be set via SCADA using software switches. High and low pressure switches (PSH105 and PSL101) installed on the tank will trigger local alarms on the refrigeration control panel and associated signals will be sent to the PLC and SCADA for remote alarms.

Display: Continuous level signal with output to control panel and SCADA system for local and remote monitoring.

5.6.1.1 AUTOMATIC OPERATION OF REFRIGERATION REPEAT PUMP DOWN CYCLE

Pressure Increase:

When the pressure in the storage unit reaches 305 psig, the CO_2 pressure switch closes, this opens the liquid solenoid valve, which increases the evaporator pressure and causes the pressure control switch to close and starts the compressor.

Pressure Decrease:

When the pressure in the storage unit decreases to 295 psig, the CO_2 pressure switch opens breaking the circuit to the motor starter and the compressor stops. The system will continue to cycle on and off as refrigerant pressure rises above 18 psig.

5.6.2 Responses and Interlocks

Interlocks:

- Low-low level software switch will be used to shutdown the carrier water pumps and CO_2 Feed Panel with alarms activated on the control panel and SCADA system.

The following situations will trigger alarms with outputs to the control panel and SCADA system for local and remote monitoring, respectively.

- Storage Tank Level
- Storage Tank Level High
- Storage Tank Level Low
- Storage Tank Level Low Low
- Storage Tank Press High
- Storage Tank Press High High

5.7 CARRIER WATER PUMPS

The control panel for the carrier pumps is adjacent to the pump skid. Duty/standby pumps are started locally from the Motor Control Center MCC or remotely from the PLC.

5.7.1 Monitoring and Control

Local control:

- HOA switch: When the HAND/OFF/AUTOMATIC (HOA) switch is in Hand mode, the operator can start/stop the pump locally. However, the hardwired high pressure switch will shut down the pump regardless of selected operating mode (HAND or AUTO).

Local display:

- On status
- Overload status
- Pump outlet pressure high status.

Remote Control at SCADA:

When HOA switch in AUTO, the operator can perform the following tasks remotely:

- Select Duty/standby pump,
- Start/stop of the duty pump.

In this mode, if the duty pump has stopped due to any failure, the standby pump will start automatically.

5.7.2 Responses and Interlocks

The following signals trigger shutdown of the carrier pumps:

- Well GS-3 pump shut down
- Low-low level in storage tank
- High pump outlet pressure

5.8 CO_2 FEED PANEL

The CO_2 Feed Panel controls the CO_2 to the static mixer. The feed panel includes a CO_2 flow meter (FI102), a single proportional-integral-differential (PID) controller, and a gas actuated flow control valve to control the CO_2 feed rate before injecting into the carrier water. The carbonic acid solution is then sent to the inlet line of the static mixers.

In Hand mode the system will operate based on an operator set local CO_2 feed rate. When Auto mode is selected at the feed panel, the system feed rate is controlled by the PLC.

In Auto mode, the CO_2 feed rate is controlled by the PLC through a feedback loop with pH as the control variable.

The CO_2 feed rate is controlled by the PLC to maintain the pH setpoint of the influent water to the IX vessels.

5.8.1 Monitoring and Control:

Field instruments used for controlling the CO_2 feed rate will include:

- Existing flow meter on well pump outlet
- CO_2 flow meter inside the feed panel
- pH analyzer on bag filters' outlet
- Low Pressure switch on the carrier water pump's outlet

When Auto mode is selected, the CO_2 feed setpoint shall be used by the PID controller to control the CO_2 feed rate by modulating the CO_2 flow control valve.

The pH analyzer will have four separate software switches (Low-Low, Low, High and High-High). The Low and High switches will initiate an alarm at SCADA. The Low setpoint will initially be set at 5.8 and the High will initially be set at 6.1 to ensure the target pH of 6.0 is maintained within a narrow range. The Low-Low and High-High setpoints will stop the well pump, carrier water pumps and the CO_2 feed panel. The Low-Low setpoint will be set at 5.6 and the High-High setpoint will be set at 6.2 to protect the materials of the piping and vessel and to prevent any breakthrough of Cr(VI) through the resin. There will be an adjustable delay on the shutdown from the High-High and Low-Low setpoints to allow for start-up of the carbonic acid feed system.

Local Display/Control at CO_2 Feed panel:

- Hand/Off/Auto selector switch
- pH Display
- pH High Alarm
- pH Low Alarm
- Carrier Water Low pressure
- CO_2 Flow rate
- CO_2 Feed setpoint entry (via PID controller keypad)

Remote Control:

When the CO_2 Feed Panel is in Auto mode, the PID controller will modulate the flow control valve based on CO_2 flow rate (feedback signal from CO_2 flow meter) and remote feed rate setpoint:

In Remote mode, feed rate setpoint will be a flow paced signal based on main water flow rate.

The following signals will be sent from the CO_2 Feed Panel to the PLC:

- System ON
- System in Auto
- CO_2 Flow Rate
- pH signal
- Loss of Carrier Water

The following commands will be sent from the PLC to the CO_2 Feed Panel:

- Run/Stop command
- CO2 Feed Setpoint

5.8.2 Responses and Interlocks

- Shutdown on Low-Low or High-High pH
- Low-Low level from the storage tank.

5.8.3 HMI Generated Alarms and Indications

- Feed Panel in Auto
- System ON
- CO_2 Flow Rate
- CO_2 tank liquid level
- pH value
- pH High-High alarm and light indicator
- pH High alarm and light indicator
- pH Low alarm and light indicator
- pH Low-Low alarm and light indicator
- Loss of Carrier Water Pressure

6. PLANT OPERATIONS

This section provides information on standard plant operations including:

- Start-up Processes
- Continuous Operation
- Media Changeout Procedure
- Backwash System Operation
- Carrier Feed Pump Operation
- CO_2 pH Control System Operation

NOTE: Operating procedures for the WBA vessels make reference to Figure 6-1, Figure 6-2 and Figure 6-3 with Vessel A as the lead vessel and Vessel B as the lag vessel. Valves V11A, V11B, V12A, V12B, V13A, V13B are normally CLOSED unless specified otherwise.

6.1 FACILITY SHUTDOWN AND START-UP

6.1.1 Initial Facility Start-up

Initial start-up of the facility after construction requires special procedures that include testing for nitrosamines and effluent treatment performance to satisfy the CDPH requirements. The initial start-up plan is provided in Appendix D.

6.1.2 Short-term Shutdown and Start-up

Short-term shutdowns apply to shut downs in which no water flows through the WBA vessels containing resin lasting less than 24 hours and are typical of minor system equipment maintenance and repairs. During short-term shutdowns the vessels are not drained or emptied of media and there is no need to perform bacteriological testing upon start-up.

1. Pre-Start-up Checks.

   These tasks must be performed by the operator prior to placing any portion of the system, or equipment in operation. The tasks must be performed at least 48 hours prior to beginning start-up operations in order to allow time for troubleshooting in the event of problems.

   a. Fill CO_2 storage tank and verify that all associated systems are functioning properly.
   b. Calibrate pH probe if necessary.
   c. Check all valve positions to ensure they are in the proper orientation (e.g., WBA vessels are in lead-lag) for the specific mode of operation as described in this manual and the respective equipment supplier/manufacturer's operating manuals.
   d. Verify that all isolation valves to process instrumentation are open.
   e. Check flow meters for accuracy. These include the flow meters on the WBA vessels (**FE105and FE106**) and the flow meters/totalizer for the backwash system (**FE103 and FE104**).
   f. Check and clean or replace filters and strainers.
2. Start Well GS-3 at the lowest possible flow rate.
3. Start the carrier pump.
4. Start the CO_2 pH control system and monitor pH.

6.1.3 Long-term Shutdown and Start-up

If the facility must be shut down for long periods, the media must be removed and the vessels drained and vented to prevent bacterial, mold and other growth in the vessels.

When the facility is put back on line the following steps are followed. This start-up procedure assumes that all equipment is ready for operation (e.g., pumps are in working order, etc.).

1. Pre-Start-up Checks.

   These tasks must be performed by the operator prior to placing any portion of the system, or equipment in operation. The tasks must be performed at least 48 hours prior to beginning start-up operations in order to allow time for troubleshooting in the event of problems.

   a. Disinfect the entire facility in accordance with Section 6.3.2.
   b. Collect two water samples from the vessel effluent at 30-minute intervals and test for the presence or absence of total coliform bacteria and *E. coli* bacteria. If any of the samples show the presence of coliform, one of the following procedures shall be followed before placing the unit or facility in service:

      i) Take repeat samples at least 24 hours apart until consecutive samples do not show the presence of coliform.

      ii) Repeat vessel and media disinfection in accordance with Section 6.3.2.

   c. Load media into vessels
   d. Fill CO_2 storage tank and verify that all associated systems are functioning properly.
   e. Calibrate pH probe if necessary.
   f. Check all valve positions to ensure they are in the proper orientation (e.g., WBA vessels are in lead-lag) for the specific mode of operation as described in this manual and the respective equipment supplier/manufacturer's operating manuals.
   g. Verify that all isolation valves to process instrumentation are open.
   h. Check flow meters for accuracy. These include the flow meters on the WBA vessels (**FE105and FE106**) and the flow meters/totalizer for the backwash system (**FE103 and FE104**).
   i. Check and clean or replace filters and strainers.
2. Start Well GS-3 at the lowest possible flow rate,
3. Start the carrier pump,
4. Start the CO_2 pH control system and monitor pH.

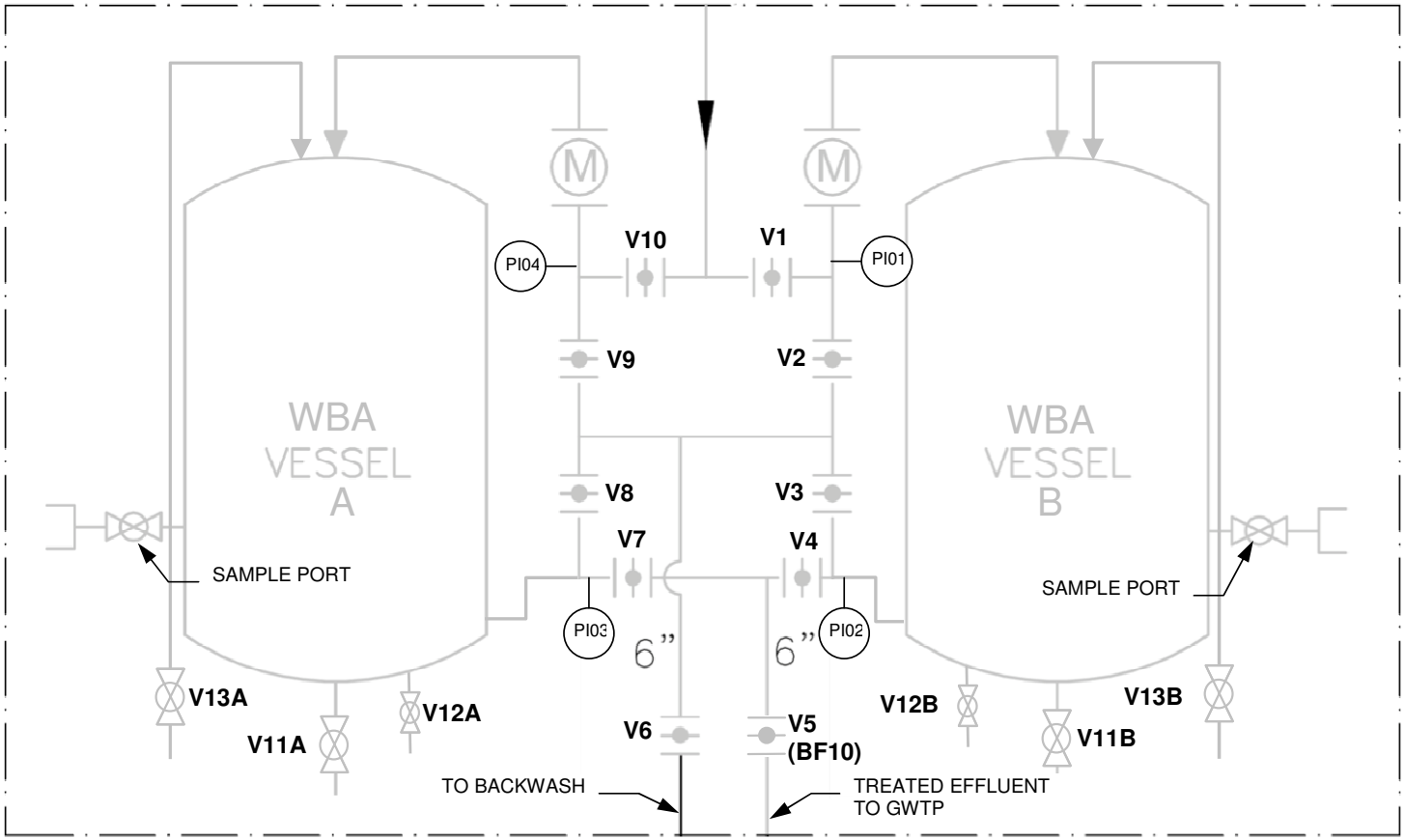


Figure 6-1: Valve Configuration for WBA Vessels

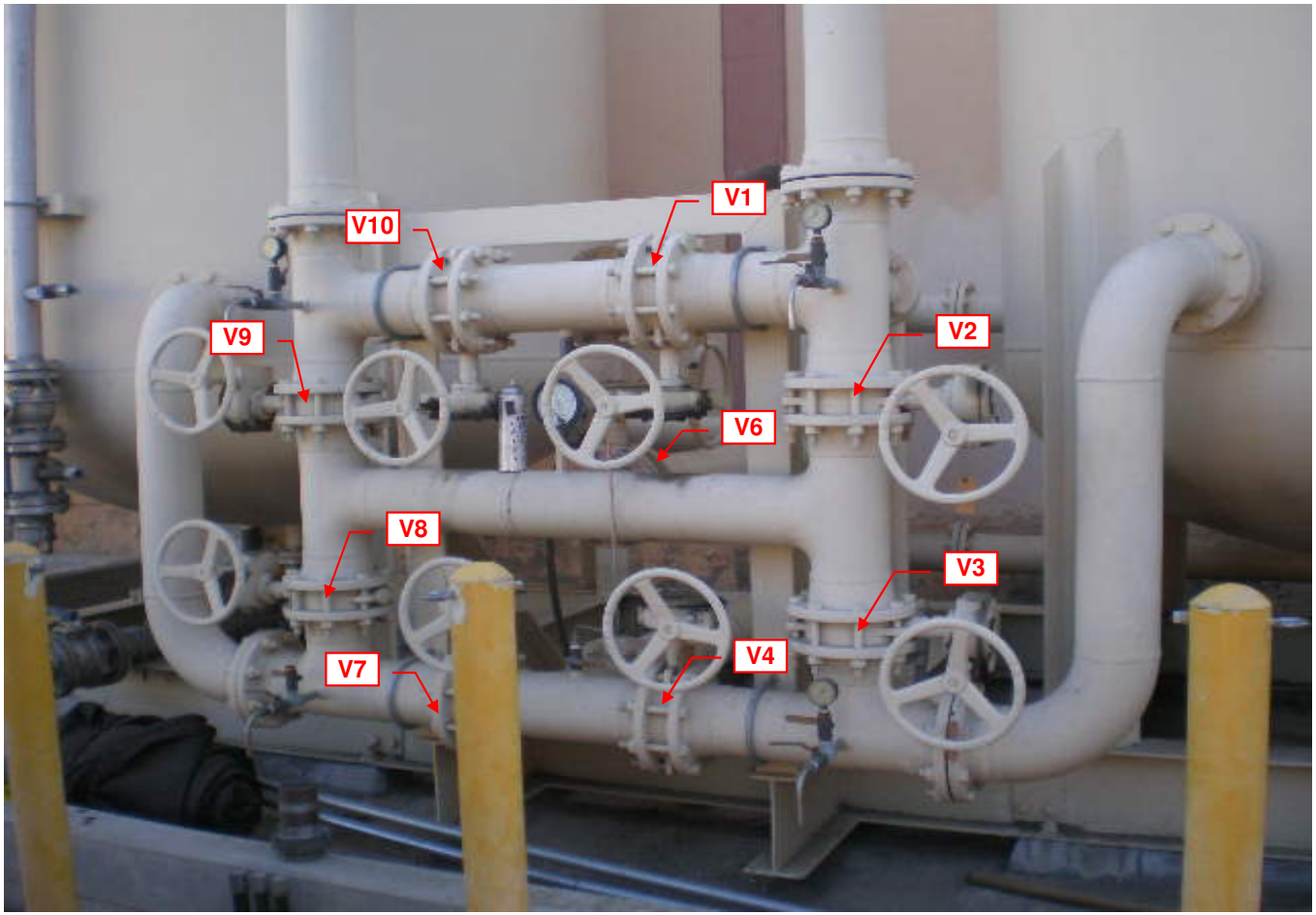


Figure 6-2: Photograph of WBA Vessel Valve Tree with Valve Identification Tags

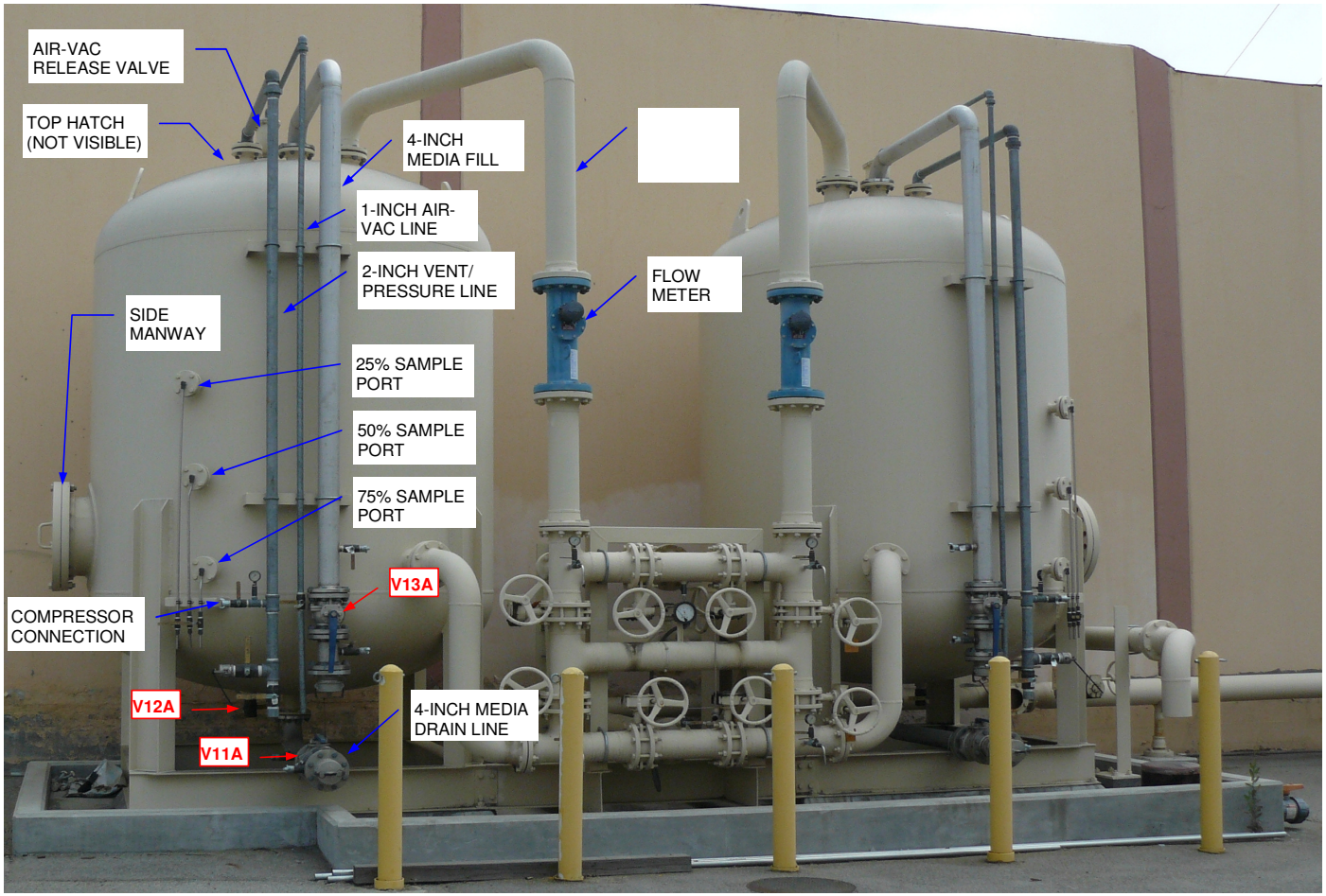


Figure 6-3: Vessel Appurtenances

6.2 CONTINUOUS OPERATION

The two WBA vessels will be operated in series in a lead/lag configuration with the effluent from one vessel feeding the inlet of the other. Effluent from the second vessel will be discharged to the existing 8-inch water transmission main. Table 6-1 indicates the valve positions for the two operating configurations possible. The valve locations are shown on Figure 6-1 and on Figure 6-2.

Table 6-1: Valve Configuration – Normal Operation

Valve	Vessel A Lead Vessel B Lag	Vessel B Lead Vessel A Lag
V1	CLOSED	OPEN
V2	OPEN	CLOSED
V3	CLOSED	OPEN
V4	OPEN	CLOSED
V5 (BF10)	OPEN	OPEN
V6	CLOSED	CLOSED
V7	CLOSED	OPEN
V8	OPEN	CLOSED
V9	CLOSED	OPEN
V10	OPEN	CLOSED

6.3 MEDIA CHANGEOUT PROCEDURE

Media changeout is initiated when Cr(VI) breakthrough on the lead vessel occurs., i.e., Cr(VI) is detected in the lead bed effluent or treatment midpoint at a concentration greater than 15 µg/L. Virgin media must be preconditioned by the supplier prior to delivery to the site. Preconditioning includes washing the media with a minimum of 30 bed volumes of non-chlorinated water to rinse the media of possible nitrosamines and to remove fines. The media is drained prior to transport to the site. After loading, the media is then backwashed with 3 bed volumes (Section 6.4.2), and forward flushed with 30 bed volumes, as described in Section 6.4.3.

When breakthrough occurs, weekly sampling begins at the lag vessel's 50% bed depth and sampling from the lead vessel's 50% bed depth ceases until the resin is changed and the lead and lag vessel order is reversed.

The following are the steps performed for media changeout:

1. Shutdown treatment train:
   a. Shut down CO_2 pH control system
   b. Shutdown carrier pump
   c. Shutdown Well GS-3
   d. Close Valve V5/BF10 to prevent backflow or siphoning of the water in the vessels.
2. Isolate lead vessel,
3. Remove spent resin (see Section 6.3.1),
4. Disinfect vessel (ONLY IF ENTERED FOR INSPECTION OR MAINTENANCE) (see Section 6.3.2),
5. Load virgin resin (see Section 6.3.4),
6. Reconfigure WBA vessel valves switching the lead/lag order of the vessels and change signage on vessels,

7. Start-up Well GS-3,
8. Start-up the carrier pump,
9. Startup the CO_2 pH control system.
10. Collect two water samples from the vessel effluent at 30-minute intervals and tested for the presence or absence of total coliform bacteria and *E. coli* bacteria. If any of the samples show the presence of coliform, one of the following procedures shall be followed before placing the unit or facility in service.
    a. Take repeat samples at least 24 hours apart until consecutive samples do not show the presence of coliform.
    b. Contact the resin supplier for instructions to disinfect the media.

6.3.1 Media Removal

Media removal is performed by slurrying the resin under pressure from the vessel directly into a tanker trailer. The equipment necessary for performing the transfer includes:

- Tanker truck
- Compressor and hoses
- Media transfer hoses equipped with a sight glass to observe resin transfer
- Chlorine solution to disinfect hoses and connections
- Media sampling equipment if sampling is required
- Documentation (i.e., work order, bill of lading or manifest)

NOTE: Refer to Section 9 regarding waste management requirements.

Procedure:

1. Isolate the vessel according to Table 6-2.

Table 6-2: Valve Configuration – Media Removal

Valve	Position
V1	CLOSED
V2	CLOSED
V3	CLOSED
V4	CLOSED
V5 (BF10)	CLOSED
V6	CLOSED
V7	CLOSED
V8	CLOSED
V9	CLOSED
V10	CLOSED

2. Connect the compressed air hose to the vessel's 2-inch vent/pressure line. Pressurize vessel to a maximum of **15 psig**.
3. Connect the spent media collection hose to the vessel's media drain line and open Valve **V-11A** once the vessel has been pressurized.
4. Transfer some water from Vessel B to rinse the walls of Vessel A by opening valves **V-1, V-3, and V-9**. The well pump may have to be started if there is not enough water pressure in the system.

5. Alternate between pressurizing the vessel, rinsing, and draining the media by closing and opening valve **V-11A** until no more resin is transferred to the tanker truck as seen through the sight glass.

6.3.2 Disinfection

6.3.2.1 EMPTY VESSEL

The vessels, along with the water mains and appurtenances must be disinfected in accordance with the following standards:

- American Water Works Association (AWWA) Standard C653, Disinfection of Water Treatment Plants,
- AWWA Standard C651, Standard for Disinfecting Water Mains, and
- National Sanitation Foundation (NSF) Standard 60 for Drinking Water Treatment Chemicals or equivalent standard.

Disinfection is accomplished by filling the vessel with water and adding sufficient chlorine solution to maintain the free chlorine residual in the vessel above **10 parts per million (ppm) after 24 hours**. The chlorine solution may be added directly into the vessel through the access hatch prior to filling the vessel with water or other suitable method. The chlorine solution must be certified as meeting or exceeding NSF Standard 60.

For the 4,000-gallon WBA vessel, 1.5 gallons of 12.5% sodium hypochlorite solution or 4 gallons of 5.25% sodium hypochlorite solution will provide an initial concentration of chlorine of approximately 50 ppm.

Vessel disinfection is performed prior to start-up, prior to loading the vessels with media, when maintenance is performed inside the vessel, or when the water tests positive for Bac-t indicating previous disinfection did not work.

1. Shutdown the well.
2. Remove media from Vessel A following the procedure in Section 6.3.1.
3. Introduce the chlorine solution into the vessel via the side manway and close the manway.
4. Fill the vessel with groundwater by placing the valves in the configuration shown in Table 6-3. **NOTE: To fill the Vessel A from Vessel B close valve V10 and open valves V3 and V9.**

Table 6-3: Vessel Disinfection Valve Configuration

Valve	Position
V1	CLOSED
V2	CLOSED
V3	CLOSED
V4	CLOSED
V5 (BF10)	CLOSED
V6	CLOSED
V7	CLOSED
V8	CLOSED
V9	CLOSED
V10	OPEN

5. After the treatment period, the vessel and piping are drained directly to the sanitary sewer. NOTE: it is not necessary to dechlorinate the water before discharging. The vessel is

drained by connecting a hose from the 4-inch vessel media discharge line (**V11A**) or the 2-inch connection (**V12A**) to the backwash discharge line via the 2-inch connection (**BV12**) upstream of flowmeter **FE104** that is connected to the sewer.

6. After the vessel has been refilled with water, collect two water samples from the vessel effluent at 30-minute intervals and test for the presence or absence of total coliform bacteria and *E. coli* bacteria. If any of the samples show the presence of coliform, one of the following procedures shall be followed before placing the unit or facility in service.
   a. Take repeat samples at least *24* hours apart until consecutive samples do not show the presence of coliform.
   b. Chlorinate the vessel once again following the above procedure and resample.

NOTE: Untreated or partially treated water shall not be discharged to the storm drain. It is not necessary to dechlorinate disinfection water for discharge to the sanitary sewer.

6.3.2.2 MEDIA IN VESSEL

Follow the procedures to be provided at a later date.

6.3.3 Vessel Draining

6.3.3.1 EMPTY VESSEL:

Start with isolated vessel following valve configuration in Table 6-2.

The vessel is drained by connecting a hose from the 4-inch vessel media discharge line (**V11A**) or the 2-inch connection (**V12A**) to the backwash discharge line via the 2-inch connection (**BV12**) upstream of flowmeter **FE104** that is connected to the sewer.

CAUTION: Media discharge line will almost always have media inside. Drain valve shall be opened slowly and residual media collected in a container for disposal.

6.3.3.2 MEDIA IN VESSEL:

If Vessel A is full of media, the vessel can be drained partially by connecting a hose from a tanker truck or vacuum truck to the 4-inch connection on the backwash drain line (opening valve **BF13** and closing valve **BF12**), closing valves **V7, V9 and V10,** and opening valves **V8 and V6** on the WBA vessel valve tree. This will redirect the water from the treatment effluent to the backwash system. The vessel will drain to the height of the backwash line only.

6.3.4 `Media Loading

Once the vessels have been disinfected successfully (i.e., Bac-t results are negative) the individual vessels can be loaded with media using the following procedure:

1. Isolate the vessel to be loaded according to Table 6-4.

Table 6-4: Valve Configuration – Media Loading into Lead Vessel A

Valve	Position
V1	OPEN
V2	CLOSED
V3	OPEN
V4	CLOSED
V5 (BF10)	CLOSED
V6	CLOSED

Valve	Position
V7	CLOSED
V8	CLOSED
V9	CLOSED
V10	CLOSED

2. Fill the vessel to about one quarter full to provide a water cushion for the media by opening valve **V9** and starting the well pump if necessary. The correct volume of water is obtained when water flows out of the 75% Sample Port.
3. Shut off flow and close the sample port when the correct volume is reached.
4. Connect the media loading hose from the tanker truck to the vessel's media fill line and open valve **V13A**. Make sure the vessel vent/pressure valve is open.
5. When the vessel is loaded, **close V13A and the vent/pressure valve**, place the vessels in series operation with the vessel with the fresh media in the **LAG** position according to Table 6-5.

Table 6-5: Valve Configuration – Vessel A in Lag

Valve	Position
V1	OPEN
V2	CLOSED
V3	OPEN
V4	CLOSED
V5 (BF10)	OPEN
V6	CLOSED
V7	OPEN
V8	CLOSED
V9	OPEN
V10	CLOSED

6. Restart the plant (i.e., well pump and CO_2 system) with discharge to the GWTP collector line and test effluent for Bac-t. After the vessel has been refilled with water, collect two water samples from the vessel effluent at 30-minute intervals and tested for the presence or absence of total coliform bacteria and *E. coli* bacteria. If any of the samples show the presence of coliform, one of the following procedures shall be followed before placing the unit or facility in service.
    c. Take repeat samples at least 24 hours apart until consecutive samples do not show the presence of coliform.
    d. Contact the resin supplier for instructions to disinfect the media.

6.3.5 Media Trap Maintenance

The pressure drop across the media trap is monitored and recorded on a daily basis. The trap is checked and cleaned during every media change out.

When the pressure drop reaches 10 psi and the alarm is triggered on the control panel and SCADA system the plant must be shut down and the trap checked. This may be an indication of a problem with the treatment system.

The trap is cleaned by removing the lid and emptying and rinsing the basket strainer and replacing after cleaning.

6.4 BACKWASH/FORWARD FLUSH SYSTEM OPERATION

6.4.1 Background

The size of the vessels will allow for 62% bed expansion at the design flow. The minimum required backwash rate for 60% bed expansion is 3.5 gpm/square foot (sf) (176 gpm). The backwash water supply is provided from Well GS-3 via the WBA Vessel bypass line. The backwash rate must be carefully controlled to limit resin entrainment (losses) during backwashing. It is not anticipated to have to backwash the WBA resin often due to particulate accumulation because of the bag filters upstream of the vessels. The use of CO_2 at concentrations above atmospheric saturation may result in off-gassing within the resin bed when the well is shut down and the vessels are de-pressurized.

Off-gassing of CO_2 carbon dioxide in the resin bed could lead to reduced flows in the contactors necessitating an increased backwash frequency. The backwash frequency will be developed based on operational experience. The rate of pressure loss through the WBA vessels determines the backwash frequency. The backwash duration is determined by the pressure loss through the vessel following backwash.

The backwash water is discharged directly to the backwash tank located on-site and then discharged at a lower rate from the tank to the existing 8-inch sewer line.

The use of carbonic acid is anticipated to increase the backwash frequency due to off-gassing of CO_2 when the well is shutdown and the potential for air binding the WBA media. The partial pressure of CO_2 at atmospheric pressures is approximately $10^{-3.5}$ atm After CO_2 addition the partial pressure will increase by 0.2-atmosphere resulting in a 1.2 atm (18 psig) pressure requirement to keep the CO_2 in solution. When the well is shutdown and the pipeline and vessel depressurize back to atmospheric pressure there will be the tendency for the CO_2 to off-gas and equalize to the atmospheric partial pressure. This may require backwashing after each shutdown of the system. The size of the backwash tank is 3,000 gallons. This will accommodate a 17-minute backwash at 176 gpm under design flow operation.

6.4.2 Backwash Procedure

NOTE: Media backwash is performed on each vessel individually. A minimum of 3 bed volumes of backwashing is required to condition fresh media.

1. Shutdown the well pump and place the valves in the configuration shown in Table 6-6 the particular vessel to backwash.

Table 6-6: Valve Configuration – Media Backwash

Valve	Valve Position to Backwash Vessel A	Valve Position to Backwash Vessel B
V1	CLOSED	CLOSED
V2	CLOSED	OPEN
V3	CLOSED	CLOSED
V4[1]	**CLOSED**	**CLOSED TO START**
V5 (BF10)	OPEN	OPEN
V6	OPEN	OPEN
V7[2]	**CLOSED TO START**	**CLOSED**
V8	CLOSED	CLOSED
V9	OPEN	CLOSED
V10	CLOSED	CLOSED

Notes:
[1] Flow control valve for backwashing Vessel B.
[2] Flow control valve for backwashing Vessel A.

2. Close valve **BF14** (Drawing N-1, Appendix A) to shut off flow to the GWTP collector line.
3. Open valve **BF15** and close valve **BF16** to divert the groundwater to the WBA bypass line.
4. Open check valve **CV01** to allow water from the bypass line to flow backward into the treatment system. This is the backwash supply. **CV01** has a manual-open feature consisting of a manual screw that keeps the valve in the open position when turned clockwise.
5. When ready for backwash, slowly open the control valves **V7 and V4** while watching the Backwash Flowmeter (**FE103**) being careful to avoid entraining media with the backwash. Increase the flow steadily to the maximum flow rate of **176 gpm** per bed to obtain minimum 60% bed expansion.
6. Backwash media for approximately 8 minutes at the backwash rate.
7. After completing the backwash, the vessels may be placed back into operation by reconfiguring the valves for lead-lag operation (see Table 6-1).
8. Backwash residuals (water and solids [consisting mainly of entrained resin]) are discharged to the sanitary sewer at a maximum flow rate of 7 gpm (or as allowed by the discharge permit) via the discharge line by opening valve **BV10**.

6.4.3 Forward Flush Procedure

Forward flushing is to be conducted at the completion of backwashing and prior to pumping water to distribution and is done on each vessel individually. A minimum of 30 bed volumes of forward flushing is required to condition fresh media. Forward flush water is collected in temporary storage tanks and drained to the sewer via hose.

1. Mobilize two, 21,000-gallon water storage tanks to store forward flush water from the facility. Tanks are needed to store facility effluent while testing of treated water is being conducted.

2. Adjust valve positions according to Table 6-7:

Table 6-7: Valve Configuration – Media Forward Flush

Valve	Valve Position to Forward Flush Vessel A	Valve Position to Forward Flush Vessel B
V1	CLOSED	OPEN
V2	CLOSED	CLOSED
V3[1]	CLOSED	OPEN
V4	CLOSED	CLOSED
V5 (BF10)	CLOSED	CLOSED
V6	OPEN	OPEN
V7	CLOSED	CLOSED
V8[2]	OPEN	CLOSED
V9	CLOSED	CLOSED
V10	OPEN	CLOSED

Notes:
[1] Flow control valve for forward flushing Vessel B.
[2] Flow control valve for forward flushing Vessel A.

3. Connect the system effluent water via temporary hoses to BF-13 (Drawing N-1, Appendix A) to discharge into the storage tanks. Close Valve BF-12.

4. The tanks will be plumbed to the sanitary sewer by hose connection from the tanks to BV-12 (Drawing N-1, Appendix A). Valve BV-13 will be used to restrict the discharge to the sewer to 7 gallons per minute (gpm) or at the flow rate specified by the discharge permit.

6.5 CARRIER PUMP OPERATION

6.5.1 Start-up in Auto Mode:

1. Ensure Well GS-3 pump is running and water is flowing through the plant.
2. Ensure upstream and downstream valves on the duty pump are open.
3. Ensure there are no alarm conditions. If an alarm condition exists as indicated by the amber light labeled PUMP FAILURE, on the control panel, clear the situation and press the red, RESET button. Refer to Section 5.7 Carrier Water Pumps for possible reasons.
4. Place HOA switch on control panel for duty pump on HAND or AUTO. The green light labeled PUMP RUNNING will turn on.

6.5.2 Operation

6.5.2.1 MANUAL OPERATION

The carrier pumps may be operated manually by placing the HOA switch to HAND after following Steps 1 through 3 above.

NOTE: When the pump is under manual control, the interlocks are bypassed except for the pumps downstream high pressure switch.

6.5.2.2 AUTOMATIC OPERATION

When HOA switch in AUTO, the operator can perform the following tasks remotely:

- Select duty/standby pump
- Start and stop the duty pump.

All interlocks are active and the PLC will stop the pump for the following situations:

- Pump's outlet pressure high (pressure switch high [PSH] is hardwired to new MCC and duplicated for PLC for alarm)
- Existing well pump shut down.

In this mode, if the duty pump has stopped due to any failure, the standby pump will be started.

6.5.3 Shutdown

1. Turn the HOA switch to OFF.
2. Close the pump's upstream valve.

6.6 CO_2 pH CONTROL SYSTEM OPERATION

CAUTION: CO_2 equipment is not complex; however, it is highly specialized and since it is under relatively high pressure, it can be dangerous to the untrained. For this reason, no one other than a CO_2 equipment specialist should attempt any maintenance or repair until he/she has familiarized himself/herself with the material contained in this manual, and then proceed with extreme caution.

NOTE: OPERATIONS OR MODIFICATIONS TO THE CO_2 SYSTEM SHOULD BE PERFORMED BY A QUALIFIED CO_2 EQUIPMENT TECHNICIAN ONLY.

Consult the TOMCO Operation Manual for detailed start-up and operating instructions.

6.6.1 CO_2 Storage Tank

Once the storage unit is installed and checked out for proper operation, it requires very little attention. However, it is suggested that the CO_2 supply valve at the unit be cut off when not in use. At the beginning of each workday, the operator should check the pressure and liquid level gauges. If the pressure is not within the normal pressure range, if should be reported at once, and if the liquid level is at or below the re-order quantity, the CO_2 supplier should be notified.

The operator should make it a practice to inspect the visible portions of the entire unit each day for audible leaks, frost spots or any signs of physical damage that may create an unsafe condition, and report any such findings immediately.

6.6.2 Vaporizer

Once this equipment is properly installed, the operation is automatic. However, since this unit takes liquid CO_2 from the bottom of storage unit, vaporizes it, and returns the evolved gas back to the storage unit, it acts very much like a still in that impurities will tend to collect within the vaporizer vessel. It is therefore essential that a purging procedure be established. Generally speaking, a weekly purging procedure will be sufficient. The suggested procedure is based on the assumption that the CO_2 meets the NSF Standard 60.

6.6.3 Vapor Heater

The series CVH-4 CARBON DIOXIDE VAPOR HEATER is designed to super heat CO_2 vapor to a warmer gas by means of electricity. The unit consists of a heat exchange platen, cabinet and controls. CO_2 vapor is indirectly heated by heating elements embedded in an aluminum block. The unit adds the energy to superheat CO_2 vapor at or above ambient temperatures.

6.6.4 CO_2 Feed Panel

IT IS RECOMMENDED THAT THE OPERATOR STUDY THE INDIVIDUAL COMPONENT INSTRUCTION MANUALS LOCATED IN THE CO_2 CONTROL PANEL SECTION OF THE TOMCO OPERATION AND MAINTENANCE MANUAL BEFORE ANY ATTEMPT TO OPERATE THE CO_2 FEED PANEL.

Consult the TOMCO operation manual, Section E, CO_2 Control Panel, for start up and shutdown procedures.

6.7 EMERGENCY PLANT SHUTDOWN

In case of emergency the plant can be shut down by switching off Well GS-3. This will stop the water flow to the treatment system.

The CO_2 pH control system is powered off by turning the POWER SWITCH on the CO_2 control panel to the OFF position.

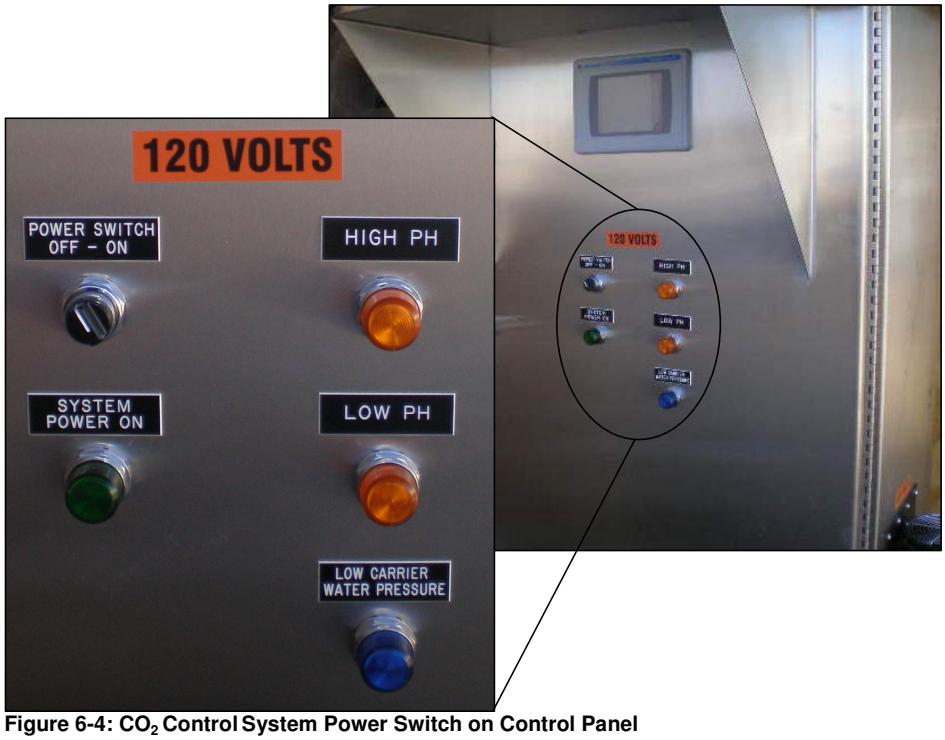


Figure 6-4: CO_2 Control System Power Switch on Control Panel

7. MONITORING AND SAMPLING PLAN

The draft monitoring and sampling plan was provided by Malcolm Pirnie (Malcolm Pirnie 2007b). Evaluation of WBA resin for Cr(VI) removal at the demonstration scale focuses on the measurement of key chemical and process parameters to fully test the utility of the treatment process. Of critical importance, Cr(VI) and total Cr concentrations in influent, 50% bed depth, lead vessel effluent, and lag vessel effluent water samples will be monitored. In addition, other process-related parameters and water quality constituents described below are measured to assess operational effectiveness of the WBA technology and its impact on water quality.

The sections below provide an overview of the data collection and study protocol for the operation of the WBA Facility, which includes monitoring parameters, locations, frequency, and analytical approach. The comprehensive data collection and management plan is contained within the Quality Assurance Project Plan (Malcolm Pirnie 2008). The Quality Assurance Project Plan (QAPP) is provided as Appendix D in this document.

Water samples are routinely collected on behalf of the City in accordance with the drinking water permit. All analyses are performed by State-certified, drinking-water analytical laboratories using approved quality control programs.

7.1 MONITORING PARAMETERS

7.1.1 Water Quality Parameters

Critical water quality parameters for the demonstration-scale WBA Facility include Cr(VI), total Cr, and pH. Pilot testing highlighted the importance of pH depression and constant pH control for the effective operation of WBA resin. Other chemical and physical parameters, including temperature, conductivity, turbidity, and alkalinity, will be routinely measured. Anions that may impact ion exchange, such as sulfate, nitrate, and silicate, are monitored. Nitrosamines, which have been found to leach from ion exchange resins, are monitored during WBA facility startup to determine the amount of time necessary to flush the resins. Table 7-1 summarizes the proposed sampling parameters for the Phase III WBA Demonstration Study.

7.1.2 Process Parameters

In addition to chemical and physical water quality analyses, process-related parameters are recorded to evaluate the operations of the WBA system. The process-related parameters are listed in Table 7-2 and include flow rate, system pressure, headloss through the bag filters and resin vessels (both lead and lag vessels), backwash frequency, empty-bed contact time (EBCT), numbers of bed volumes to breakthrough (more than [>] 5 micrograms per liter [µg/L]), numbers of bed volumes to 50% saturation of the lead vessel, and CO_2 feed rate and volume use rate.

7.1.3 Treatment Residuals

Treatment residuals, including exhausted ion exchange resin and sediments from the backwash tank, are also assessed to confirm disposal options using the Toxicity Characteristic Leaching Procedure (TCLP, USEPA Method 1311 as mandated by 40 Code of Federal Regulations [CFR] 261) and the California Waste Extraction Test (CWET). Pilot-scale testing indicated that the spent WBA resins would likely be classified a hazardous waste in the State of California based on total chromium concentrations leached during the CWET. Uranium accumulated on the spent WBA resin is also determined throughout the testing; PWA7 resin may need to be replaced prior to 50% resin breakthrough to avoid uranium concentrations exceeding 500 milligrams per kilogram (mg/kg) (i.e., the threshold above which the waste could be classified a low-level radioactive waste). Table 7-1 also lists the required measurements for the treatment residuals.

7.2 MONITORING LOCATIONS

All the samples collected for analysis are obtained from the WBA Facility. Figure 7-1 shows a schematic of the WBA system with sampling ports for water quality parameters highlighted. The monitoring locations and sampling frequencies for the water quality parameters are summarized in Table 7-1. Descriptions of analytical methods for each water quality parameter are provided in Table 7-3.

Sampling locations for the WBA treatment system include raw water (before CO_2 addition, designated as Sample Port 1, or SP1), WBA influent (after CO_2 addition, SP2), lead vessel 50% bed depth (SP3), lead vessel effluent (SP4), lag vessel 50% bed depth (SP5), and lag vessel effluent (SP6).

7.3 MONITORING FREQUENCY

7.3.1 Water Quality Parameters

The sampling frequency for chemical and physical parameters, shown in Table 4-2, is based on treatment process design and the expected duration of testing (approximately one year for the demonstration-scale study). Samples will be collected at a sufficient frequency to provide enough information to achieve the project's stated objectives. The chromium sampling frequency will capture a 29-point breakthrough curve for a predicted bed life of 207 days (based on maximum uranium accumulation).

The weekly Cr(VI) and total Cr sampling frequency are established for the following key sampling points:

- SP1: WBA influent
- SP3: Lead vessel 50% bed depth
- SP4: Lead vessel effluent
- SP6: Lag vessel effluent

Once breakthrough occurs such that the lead bed effluent Cr(VI) concentration exceeds 5 µg/L, the lag vessel 50% depth location is added to the list of sampling points monitored weekly and the lead vessel 50% depth curtailed (until the next bed is installed and the lead and lag vessel order is changed).

pH, which is a critical parameter due to its impact on WBA resin treatment, is measured continuously at a point near the influent to the WBA vessels. Note that sufficient mixing is necessary to enable capture of stable pH values representative of the influent to the WBA resin; thus, CO_2 will be added upstream of the bag filters and samples collected after the bag filters and before the lead vessel inlet. pH of lead and lag vessel effluent will be monitored on a weekly basis to evaluate the corrosion potential of the treated effluent on the transmission pipes.

Nitrosamines are measured during the first week of startup according to the CDPH permit requirements.

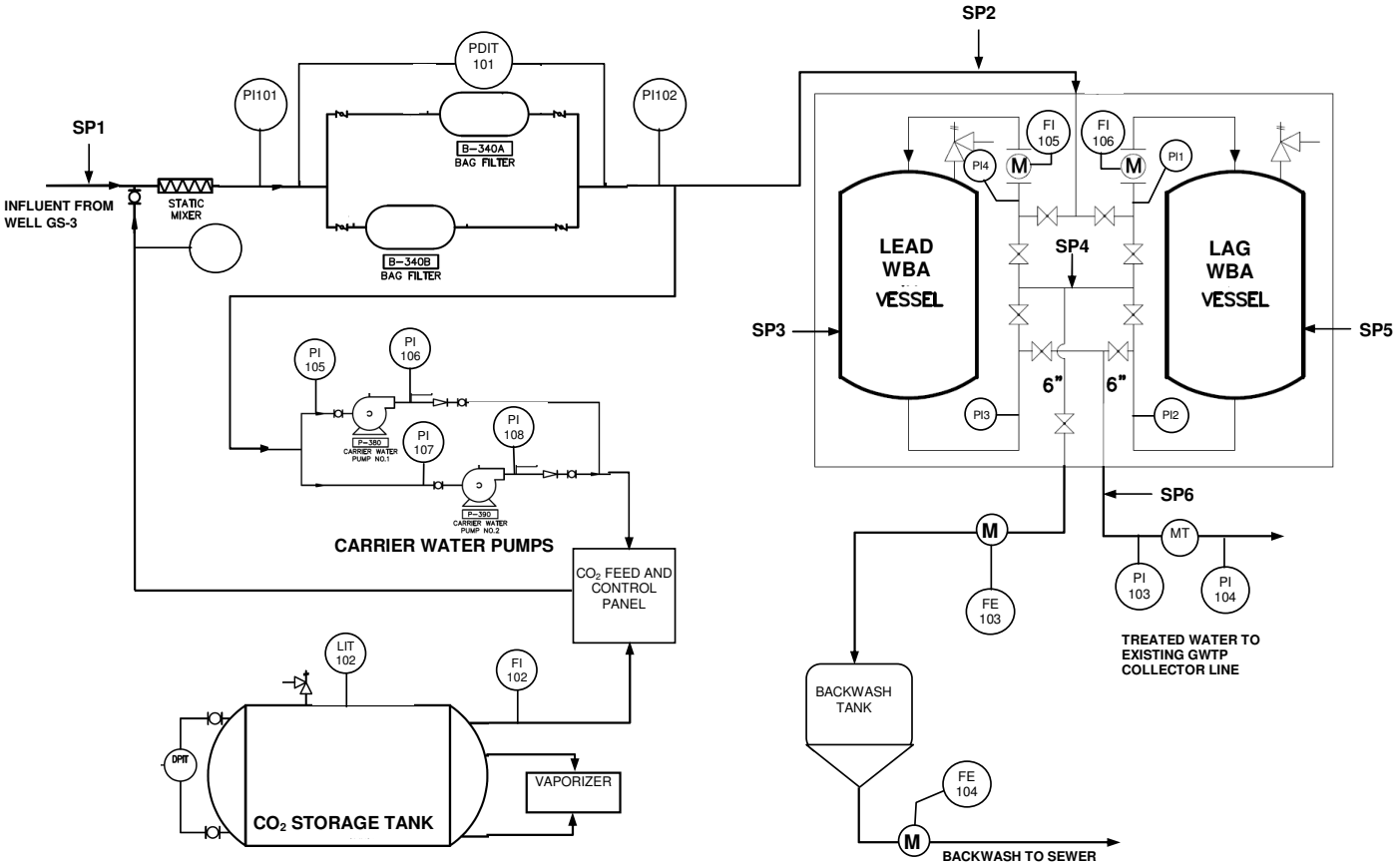
Non-critical parameters, including temperature, sulfate, nitrate, phosphate, silicate, alkalinity, conductivity, and turbidity, are measured monthly at the following sampling points:

- Influent
- Lag vessel effluent

Table 7-1: Monitoring Locations and Sampling Frequencies for Water Quality Parameters

Analytical Measurement	Monitoring Locations							
	SP1 **Raw Water (before CO_2 addition)**	**SP2** **WBA Influent (after CO_2 addition)**	**SP3** **Lead Vessel 50% Bed Depth**	**SP4** **Lead Vessel Effluent**	**SP5** **Lag Vessel 50% Bed Depth**	**SP6** **Lag Vessel (Plant) Effluent**	**Residuals** **Spent Resin**	**Residuals** **Backwash water**
Cr(VI)	Monthly	Weekly	Weekly	Weekly	Weekly[1]	Weekly	–	Annually
Total Cr	Monthly	Weekly	Weekly	Weekly	Weekly[1]	Weekly	–	–
pH	–	–	–	Weekly	–	Weekly	–	–
Bac-t	Monthly	Monthly		Weekly		Weekly		
Temperature	–	–	–	Weekly	–	Weekly	–	–
Sulfate (SO_4^{-2})	–	Monthly	–	–	–	Monthly	–	–
Nitrate (NO_3^-)	–	Monthly	–	–	–	Monthly	–	–
Phosphate (PO_4^{-3})	–	Monthly	–	–	–	Monthly	–	–
Silicon Dioxide (SiO_2)	–	Monthly	–	–	–	Monthly	–	–
Iron (Fe)	–	Monthly	–	–	–	Monthly	–	–
Alkalinity	–	Monthly	–	–	–	Monthly	–	–
Conductivity	–	Monthly	–	–	–	Monthly	–	–
Turbidity	–	Monthly	–	–	–	Monthly	–	–
Nitrosamines[2, 3]	–	Start of test	–	Start of test	–	Start of test and Monthly thereafter	–	–
BNA SVOC	–	Start of test	–	Start of test	–	Start of test and Monthly thereafter	–	–
Aldehydes/ketones	–	Start of test	–	Start of test	–	Start of test and Monthly thereafter	–	–
TCLP, CWET	–	–	–	–	–	–	Annually	–
Uranium	–	–	every 10,000 BV (approx. 21 days)	–	–	Annually	Annually	–

Notes:
% = percent
µg/L = micrograms per liter
approx. = approximately
BNA SVOC = base, neutral, acid semi-volatile organic compounds including phenol and tentatively identified compounds (TIC)
BV = bed volume (1,272 gallons)
CDPH = California Department of Health
CO_2 = carbon dioxide
Cr = chromium
CWET = California Waste Extraction Test
pH = negative log of the hydrogen ion concentration
TCLP = Toxicity Characteristic Leaching Procedure
[1] Samples collected only when the lead vessel effluent exceeds 5 µg/L.
[2] Nitrosamines will be analyzed at a frequency required by the CDPH permit.



Notes:
CO_2 = carbon dioxide
GWTP = Glendale Water Treatment Plant
MT = media trap
SP = sample port
WBA = weak base anion (resin)

Figure 7-1: Sampling Locations for Water Quality Parameters

7.3.2 Process Parameters

In addition to chemical and physical water quality analyses, process-related parameters are recorded to evaluate the operations of the WBA system. The process-related parameters include flow rate and pressure buildup through the WBA vessels.

Table 7-2 identifies the process parameters that will be monitored at each location and associated monitoring frequencies. It should be noted that the WBA Facility will be designed to operate automatically with minimal operators' supervision. As a result, some of the process-related parameters will be monitored and recorded continuously and the data will be transmitted to the GWTP via the SCADA system. However, system operators are still required to follow the monitoring plan as specified in Table 7-2 to ensure the completeness of the operational data.

Table 7-2: Monitoring and Sampling Schedule for Process-Related Parameters

Equipment Tag No.	Process-related parameters	Frequency
PI101, PI102, PDIT101	Filter influent, effluent, and differential pressures	Once Daily
FE105, FE106	Plant influent water flow rate and total volume from WBA vessel flow meters	Once Daily
NA	Position of each vessel (lead or lag)	Once Daily
V1, V10	Influent valve position on both vessels	Once Daily
	Pressure differential across each vessel	Once Daily
	Vessel influent pressure	Once Daily
	Vessel effluent pressure	Once Daily
PI103, PI104	Media trap influent, effluent, and differential pressures	Once Daily
PI201	CO_2 solution injection pressure	Once Daily
FI102, LIT102	CO_2 injection rate and liquid level	Once Daily
PI105,107 PI106, 108	Carrier Water Pump inlet and outlet pressures	Once Daily
FE/FIT103	Backwash water flow rate and total volume	Once every backwash cycle
FE104	Spent backwash water total volume	Once every backwash cycle

Notes:
NA = not applicable

7.3.3 Treatment Residuals

The analyses of resin residuals will be performed each time resin changeout is required. Backwash water will be analyzed periodically as specified in the discharge permit.

7.3.4 Analytical Approach

The analytical methods for the water quality parameters and treatment residuals will conform to USEPA guidelines and recommended test methods, including those in *Standard Methods for the Examination of Water and Wastewater* (APHA 1998) and the requirements of the Record of Decision (USEPA 1993). This section briefly describes the analytical approach used in the demonstration-scale study. More detailed information can be found in the QAPP mentioned previously.

Chemical and physical analytes will be measured in this demonstration-scale study either in the field or in a laboratory. Laboratory analytical measurements will be sent to Montgomery Watson Harza Laboratories. Analytical parameters are analyzed using the methods shown in Table 7-3.

Table 7-3: Analytical Methods and Locations of Analyses for the Demonstration-Scale Study

Analysis	Analytical Method	Analysis Location	Notes
Cr(VI)	USEPA 218.6 (IC)	ELAP-certified lab	Reporting limit: 0.10 µg/L
Total Cr (contract lab for compliance)	USEPA 200.8 (ICP-MS)	ELAP-certified lab	
pH	SM 4500H+ B (Electrometric)	Field	
Bac-t	SM9223B SM9215B	ELAP-certified lab	Total coliform + *E. coli* by presence/absence Total coliform + *E. coli* by enumeration Heterotrophic plate count
Temperature	SM 2550 (Thermometric)	Field	
Sulfate (SO_4^{-2})	Hach 8051 (Colorimetric)	Field	
Nitrate (NO_3)$^-$	USEPA 300.0 (IC)	ELAP-certified lab	
Phosphate (PO_4^{-3})	Hach 8048 (Colorimetric)	Field	
Silicon Dioxide (SiO_2)	Hach 8185 (Colorimetric)	Field	
Iron (Fe)			
Alkalinity	Hach 8203 (Titration)	Field	
Conductivity	SM 2510B (Conductance)	Field	
Turbidity	SM 2130 B	Field	
Nitrosamines	USEPA 521	ELAP-certified lab	Testing for nitrosamines includes the following compounds, N-Nitrosodimethylamine (NDMA), N-Nitrosomethylethylamine (NMEA), N-Nitrosodiethylamine (NDEA), N-Nitrosodi-n-propylamine (NDPA), N-Nitrosomorpholine, N-Nitrosopyrrolidine (NYPR), N-Nitrosopiperidine (NPIP), N- Nitrosodi-n-butylamine (NDBA)
BNA semi-volatiles and phenols[1]	USEPA 625	ELAP-certified lab	Including reporting tentatively identified compounds (TICs) and unknown gas chromatography/mass spectrometry (GC/MS) peaks
Aldehydes/ketones	USEPA 556	ELAP-certified lab	Including reporting tentatively identified compounds (TICs) and unknown gas chromatography/mass spectrometry (GC/MS) peaks
Residuals – TCLP	USEPA 1311	ELAP-certified lab	
Residuals – CWET	CWET (Title 22)	ELAP-certified lab	
Residuals - Uranium	ASTM5174-91 (KPA Method)	ELAP-certified lab	

Notes:
ASTM = America Society of Testing and Materials
BNA = base, neutral, and acid extractables
Cr = chromium
Cr(VI) = chromium VI
CWET = California Waste Extraction Test
ELAP = Environmental Laboratory Accreditation Program
pH = negative log of the hydrogen ion concentration
TCLP Toxicity Characteristic Leaching Procedure
USEPA = United States Environmental Protection Agency

8. MAINTENANCE PLAN

A complete and effective maintenance plan is necessary to attain and maintain safe, effective, and efficient facility operation and continuously acceptable facility performance.

The treatment facility must be monitored daily for proper operation. Operational activities and tasks that must be performed on a routine basis are part of the overall maintenance plan. The basic features of the plan include the following:

- A list of routine duties that provide the minimum requirements for operators of the plant.
- System maintenance programs that provide proper planning, scheduling and implementation information, as well as preventive, operational and corrective maintenance tasks.
- A record-keeping system that provides immediate access to necessary equipment data and information, manufacturers' instructions, and records of previous repairs.

The maintenance plan is kept as simple and logical as possible. It is not to be rigid, but is continually subject to review, updating, and improvement, based on past operating observations and experiences.

8.1 ROUTINE DUTIES

The following is a list of recommended duties to be performed on a routine basis. These are minimum requirements and are not intended to be a complete list of duties.

NOTE: The operator must follow the site safety plan, including wearing the proper personal PPE when performing tasks at the treatment facility and following confined space entry requirements. Where applicable, lockout/tagout of equipment to a zero energy state must be done to ensure equipment does not operate during maintenance.

- Monitor plant process for proper operation
- Fill out log sheets as required
- Maintain daily log book
- Maintain field notebook
- Maintain records in compliance with CDPH requirements
- Perform and document periodic maintenance as required by City standard procedures, and as recommended by the individual equipment manufacturer
- Document alarm conditions.

8.2 SYSTEM MAINTENANCE

Well-planned and scheduled system maintenance reduces unscheduled equipment breakdown, extends equipment life, and allows more efficient use of labor. Such a maintenance management system also provides information for solving maintenance problems. An overall management program should be developed by the maintenance supervisor contingent on available staffing and hours of facility operation.

Competent operations staff must be properly qualified, trained, and must be thoroughly aware of all safety hazards and appropriate emergency response procedures.

8.2.1 Preventive Maintenance Program

A successful preventive maintenance program requires that equipment be inspected and serviced regularly following the manufacturers' instructions in the manuals for each piece of equipment. The operator uses the information from the O&M manuals to prepare routine preventive maintenance schedules, which are compatible with the lubrication schedule, since these operations can normally be performed at the same time. A preventive maintenance plan for the major equipment that includes maintenance frequencies is provided in Table 8-1.

The following list summarizes the general equipment maintenance guidelines:

- Be continually alert for any unusual conditions, equipment malfunctions, and early warning signs of impending failures, such as noise, vibrations, hunting or surging, leaks, smoke, odor, heat, etc. These should be reported to the maintenance personnel as quickly as possible.
- Inspect all operating equipment at regular intervals to see that all bolts and nuts are kept tight and that correct adjustments and alignments of couplings are maintained. Equipment and surrounding areas must be kept clean and free of dirt. Machined surfaces must be cleaned, free of rust spots, and protected with paint or a heavy grease preservative.
- Do not attempt to work or make adjustments on moving equipment. Either the breaker at the MCC or the pushbutton at the machine must be locked out before work is begun on the equipment, and properly tagged at all locations by the maintenance personnel. Simple bearing lubrication, however, can often be performed while the machine is operating.
- Keep all electric motors free from dirt, dust and moisture. Check to be sure that operating spaces are free from articles which may obstruct air circulation. Check for excess grease and oil leakage from bearings.
- Most ball bearing failures are caused by over-greasing. In order to protect against this and to provide proper lubrication, the following is recommended:
    a. clean exterior of bearing housing and grease fitting;
    b. remove grease fitting and drain plug;
    c. use a rod or wire to break up any grease if grease has hardened at the drain plug. Note: **This is to be done only when equipment is not operating and has been locked out and tagged out.**
    d. replace grease fitting and, with equipment running and bearing at operating temperature, apply grease with a low pressure gun until all of the old grease is forced out of the equipment;
    e. operate equipment as required to allow excess grease to work out before replacing the drain plug.
- Plan and schedule all lubrication, maintenance, and work orders to minimize the required number of equipment outages.
- Lubrication of moving parts is one of the most important routine functions of a PMP. Each lubrication point on all equipment is marked or tagged to indicate correct lubricant and frequency of lubrication.

It is very important that plant operators and maintenance personnel routinely come in contact with every piece of equipment in the facility. Such routine maintenance provides a good "first line" for reporting equipment trouble and thus requires careful consideration.

Maintenance personnel should also become familiar with the format of equipment troubleshooting information presented in this manual, as well as in the manufacturer's service manuals, to keep equipment down time to a minimum.

Table 8-1: Preventive Maintenance Plan

Maintenance Task	Frequency	Justification and Reference Document	Responsible Party	Action By
CO_2 Storage System				
Exterior				
Follow the maintenance guide in the TOMCO Operation Manual, CO_2 Storage Tank, pp. B-14 to B-16	Semi-annually	TOMCO Operation Manual,	GWP	CO_2 Specialist
Inspect sheet metal enclosure and base assembly; repair, clean and repaint as needed.	Semi-annually	TOMCO Operation Manual,	GWP	CO_2 Specialist
Check manway insulation for water ice build-up and remove and signs of leak around manway.	Semi-annually	TOMCO Operation Manual,	GWP	CO_2 Specialist
Inspect visible portions of entire unit for frost spots, leaks, cracks in the insulation or any other indication of a possible unsafe condition, such as mechanical damage or corrosion.	Semi-annually	TOMCO Operation Manual,	GWP	CO_2 Specialist
CO_2 Refrigeration System				
Follow the maintenance guide in the TOMCO Operation Manual, CO_2 Storage Tank, pp. B-14 to B-16	Semi-annually	TOMCO Operation Manual	GWP	CO_2 Specialist
Check voltage, making sure actual voltage is within plus or minus 10% of name plate voltage.	Semi-annually	TOMCO Operation Manual	GWP	CO_2 Specialist
Vaporizer				
Purge vaporizer	Monthly	TOMCO Operation Manual, pp. C-3	GWP	Operator
Filters				
Inspect O-ring seals on filter vessels	Every Change-out	Standard Practice	GWP	Operator
Operate and inspect air relief valves on filter vessels	Per Changeout	Standard practice	GWP	Operator
Water Carrier Pumps				
Lubricate pump and motor bearings	4-6 months	Manufacturer's Recommendation	GWP	Operator
Replace pump bearings, seals, and wear rings	2 years	Standard Practice	GWP	Contractor
Replace pump-motor bearings, seals, and gaskets	2 years	Standard Practice	GWP	Contractor
Instrumentation & Control				
Calibrate WBA vessel flow meters	Annually	Standard Practice	GWP	Contractor
Calibrate backwash flow meters	Annually	Standard Practice	GWP	Contractor
Test pressure and differential pressure switches, level switches, controls, and interlocks	Annually	Standard Practice	GWP	Operator
Zero all pressure gauges	Annually	Standard Practice	GWP	Operator
Clean and calibrate pH meter	Monthly	Standard Practice	GWP	Operator

Maintenance Task	Frequency	Justification and Reference Document	Responsible Party	Action By
WBA Vessel Maintenance				
Exchange media (changeout)	As needed	Concentration or Pressure Driven	GWP	Resin supplier
Internal inspection of vessel without entry (check nozzles, screens, gaskets, and coatings)	Every Change-out	Standard Practice	GWP	Operator
Internal inspection of vessel with entry (check nozzles, screens, gaskets, and coatings)	Every Second Change-out	Standard Practice	GWP	Resin supplier
Inspect manway gaskets	Every Change-out	Standard Practice	GWP	Operator
Inspect entire vessels for leaks, corrosion, missing parts, and coating damage	Monthly	Standard Practice	GWP	Operator
Inspect and clean media trap	Every Change-out	Standard Practice	GWP	Operator
Service air-vacuum release valves	Annually	Standard Practice	GWP	Contractor
Valves				
Exercise manual valves and check for leaks for entire facility	Monthly	Standard practice	GWP	Operator
Exercise manual valves on WBA vessels and check for leaks	Per Changeout	Standard practice	GWP	Operator
Piping				
Inspect for leaks, corrosion, and damage to coating	Semi-annually	Visual Inspection	GWP	Operator
Electrical				
Tighten wire connections in electrical cabinets and vacuum cabinet interiors	Annually	Manufacturer's Recommendation	GWP	Operator
Check temperatures on electrical cabinets	Daily	Standard Practice	GWP	Operator
Miscellaneous				
Verify operation of lighting and lighting controls	Annually	Standard Practice	GWP	Operator
Inspect and clean sumps and drains	Semi-annually	Standard Practice	GWP	Operator
Perform housekeeping and plant cleanup	As needed	Standard Practice	GWP	Operator

Notes:
% = percent
CO_2 = carbon dioxide
GWP = Glendale Water and Power
MCC = Motor Control Center
VFD = variable frequency drive
WBA = ion exchange

8.3 TROUBLESHOOTING

8.3.1 CO_2 pH Control System

CAUTION: CO_2 equipment is not complex; however, it is highly specialized and since it is under relatively high pressure, it can be dangerous to the untrained. For this reason, no one other than a CO_2 equipment specialist should attempt any maintenance or repair until he/she has familiarized himself/herself with the material contained in this manual, and then proceed with extreme caution.

8.3.1.1 CO_2 STORAGE SYSTEM

A troubleshooting guide and repair and adjustment instructions are provided in the TOMCO Operation Manual, pp. B-17 to B-24.

8.3.1.2 VAPOR HEATER

A troubleshooting guide is provided in the TOMCO Operation Manual, p. D-2.

8.3.1.3 CO_2 FEED PANEL

A troubleshooting guide is provided in the TOMCO Operation Manual, p. E-9.

Other trouble shooting guidelines are provided in Table 8-2.

8.4 SPARE PARTS

Lists of spare parts for the CO_2 pH control system are provided in the TOMCO O&M Manual TOMCO 2009).

Other parts that should be kept on hand include:

- calibration buffers for the pH meter,
- spare filter elements (bags).

Equipment data sheets for the major pieces of equipment are provided in Appendix F.

8.5 RECORD KEEPING AND REPORTING

Data collection and reporting are an essential part of the operation of the facility. Accurate record keeping is required to comply with regulatory requirements and is used to assist in long-term planning.

Complete and accurate maintenance records must be kept on all equipment. These records are used for quick access to information needed regarding past maintenance practices, machinery adjustments and repairs, parts lists, and equipment service contacts. Periodic reviews of these records indicate improvements that can be made to the overall maintenance management program.

8.5.1 Records

At a minimum, a file of the following records must be kept at the City operations office:

- Daily operating log sheet, containing the following information:

- Facility operating conditions (flow rates [total and per module or vessel], pressure readings, alarm conditions, etc.)
- Material Safety Data Sheets (MSDS), where applicable
- Completed chain of custody forms
- Laboratory reports of analytical results from off-site laboratories
- Maintenance records of equipment, including calibration information
- All applicable and current permits and licenses
- All CDPH permits and other CDPH requirements
- Emergency response procedures and contact information
- Operator certifications
- Vendor records.

Important items to be recorded in the maintenance log include name of equipment, recommended lubricant, frequency of application, equipment inspection instructions, inspection intervals, and any additional special instructions. The operator uses this information to prepare schedules for weekly, monthly, quarterly, and semi-annual lubrication of equipment.

All records shall be kept on file for a minimum of five (5) years. Water quality records shall be kept on file for a minimum of ten (10) years.

8.5.2 Operating Logs

The WBA Facility is inspected on a daily basis, and operation records must be maintained. Daily records include operational parameters such as flow rates through each treatment vessel and total flow rates for the treatment facility.

The daily records include any scheduled or unscheduled shutdown of the treatment systems, the duration of the shutdown, the cause of the shutdown, and resolution of the situation that caused the shutdown.

8.5.3 Maintenance Logs

Each major piece of equipment has an equipment data sheet and a maintenance log. This log contains the equipment number and name and a complete history of all past maintenance and repair.

Whenever work is performed, the date of work, initials of the maintenance worker, type of repair(s), time out of operations, probable cause of breakdown (if known), comments of maintenance mechanic, and parts replaced are noted in the log.

8.5.4 Additional Records

Additional maintenance records include:

- Motor Service Record. Completed for every electrical motor and used to record data from motor testing.
- Tickler File. A reminder file prepared for items requiring monthly, quarterly, semi-annual or annual service.
- Service Report. A report completed by an operator or mechanic when equipment is taken out of service because of failure, malfunction, or obvious need for inspection.

Table 8-2: Troubleshooting Guide for WBA Facility

Fault Condition	Cause	Remedy
PARTICULATE FILTERS		
Pre-treatment filter high differential pressure (PDIT101)	Clogged filters	Clean/replace filter elements
Containment liquid level alarm (LSH101)	Liquid in containment pad from rainfall	Open pad drain to discharge to storm drain.
	Leak from filters or appurtenances	Shut down plant and repair leak. Liquid in containment pad must be pumped by vac-truck to backwash tank or for disposal elsewhere.
WBA VESSELS		
Media trap high differential pressure (PDSH103)	Clogged trap	Shut down plant and clean basket strainer in trap. If the trap contains a small amount of material (i.e., resin) this be due to accumulation over time of fines from the vessels. If a large amount of resin is observed, this is an indication of a problem with the WBA vessels such as a broken nozzle or a misplaced nozzle gasket. The plant must be shut down and the problem investigated.
Containment liquid level alarm (LSH104)	Liquid in containment pad from rainfall	Open pad drain to discharge to storm drain.
	Leak from filters or appurtenances	Shut down plant and repair leak. Liquid in containment pad must be pumped and
BACKWASH SYSTEM		
Containment liquid level alarm (LSH102)	Liquid in containment pad from rainfall	Open pad drain to discharge to storm drain.
	Leak from filters or appurtenances	Shut down plant and repair leak. Liquid in containment pad must be pumped and
CARRIER PUMPS		
Containment liquid level alarm (LSH102)	Liquid in containment pad from rainfall	Open pad drain to discharge to storm drain.
	Leak from filters or appurtenances	Shut down plant and repair leak. Liquid in containment pad must be pumped and
High discharge pressure for either pump (PSH102 or PSH103)	Downstream valves are set improperly	Check valve positions and ensure they are open
LEAKS		
Miscellaneous Leaks	Improperly tightened bolts	Tighten flange bolts
	Damaged or dirty seals	Replace/clean gaskets, seals, as appropriate
Air Release Valves	Valve failure	Replace valve

Fault Condition	Cause	Remedy
	Media in air release valve	Close shut-off valve and open to clear
		Disassemble and clean valve
FLOW METERS		
No Display	No power to flow meter	Check circuit breaker
		Check power at flow meter
		Check fuses at flow meter

8.6 MONTHLY REPORTING

The City is responsible for submitting a monthly report to the CDPH containing the operations records for the month, including the following information:

- Number of bed volumes treated per vessel since the last media change-out;
- Daily flow rate;
- Total volume of water treated and delivered to distribution during the month;
- Copies of water quality test results; and
- Any emergency and/or scheduled plant operation interruption, including the date, time, duration, location, cause of the interruption, and resolution of the interruption.

8.7 ANNUAL REPORT

After one year of the treatment plant operation, the City must prepare and submit a report to the CDPH, with an evaluation of the performance of the treatment plant. The report shall detail any proposed changes to the operations plans or to the monitoring plan.

9. WASTE MANAGEMENT

The purpose of this section is to ensure that all wastes are properly characterized prior to disposal. The demonstration facility is part of a Superfund site and falls under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Section 121(d)(3) of the CERCLA applies to any CERCLA response action involving the off-site transfer of any hazardous substance, pollutant or contaminant (CERCLA wastes). The transfer and disposal of CERCLA wastes must abide by the Off-Site Rule set forth in the National Contingency Plan (40 CFR 300.440). All CERCLA wastes must be transferred to a CERCLA-approved facility.

9.1 WASTE STREAMS

When there is Cr(VI) breakthrough of the lead vessel, it must be replaced with new media. Pilot-scale testing indicated that the spent WBA resins would likely be classified as hazardous waste in the State of California based on total chromium concentrations leached during the CWET test.

Additionally, backwash water, partially spent media, sand and silt that can accumulate in the backwash tank must be cleaned and disposed of according to this plan.

Filter media from the particulate filters (bag filters) will also have to be characterized at the first changeout to determine disposal criteria.

The steps required for disposing of waste are as follows:

1. Characterize the waste,
2. Submit a waste profile with the disposal company for approval,
3. Select waste transportation and disposal contractors,
4. Prepare waste disposal documents (Hazardous Waste Manifest or Bill of Lading),
5. Oversee waste loading and sign waste disposal documents,
6. Follow-up to receive copies of documentation (i.e., manifest, bill of lading, disposal/destruction certificates).

NOTE: Items 1 through 4 will be performed by the waste management vendor but must be overseen by the Project Manager or designated person. The current Waste Management Vendor is Siemens, Inc. Items 5 and 6 are performed by the Plant Operator and Project Manager, respectively.

9.2 WASTE CHARACTERIZATION

Treatment residuals, including exhausted ion exchange resin and sediments from the backwash tank, will also be assessed to confirm disposal options using the TCLP and the CWET. Pilot-scale testing indicated that the spent WBA resins would likely be classified a hazardous waste in the State of California based on total chromium concentrations leached during the CWET. Uranium accumulated on the spent WBA resin will also be determined. PWA7 resin may need to be replaced prior to lead bed breakthrough to avoid uranium concentrations exceeding 500 mg/kg (i.e., the threshold above which the waste could be classified a low level radioactive waste).

Wastes generated as a result of ongoing remediation or treatment operations must be profiled once every two years and whenever any of the following circumstances occurs:

- A change occurs in the process that produces the waste (e.g., – a new chemical constituent is discovered, the treatment process is changed),
- A change in the treatment media is made (e.g., – a new media vendor or type is used),
- A waste was tainted by inadvertent mixing of the waste with another waste,
- A change occurred in the hazardous waste regulations that apply to the waste.

Characterization involves collecting samples and having them analyzed by a certified laboratory. The types of samples and analyses required for the types of waste generated at this facility are listed in Table 9-1.

Table 9-1: Waste Sampling and Analysis

Waste	Sample type	Analysis[1]
Spent Resin	Composite Sample from a minimum of five grab samples	Title 22 metals and uranium (TCLP and CWET if necessary)
Backwash Water	Grab sample	Title 22 Metals, VOCs
Backwash Residue	Composite Sample from a minimum of five grab samples	Title 22 metals and uranium (TCLP and CWET if necessary)
Spent Filter Bags	Grab sample of filter residue	Title 22 metals and uranium (TCLP and CWET if necessary)

Notes:
ASTM = American Society of Testing and Materials
CWET = California Waste Extraction Test
TCLP = Toxicity Characteristic Leaching Procedure
USEPA = United States Environmental Protection Agency
VOC = volatile organic compound

Analytical Methods:
Uranium: ASTM5174-91 (KPA Method)
TCLP: USEPA Method 1311
Title 22 Metals: USEPA Methods 6010B and 7471A
VOCs: USEPA Method 8260B

Waste can be classified as follows:

- Non-hazardous: the waste has few restrictions for disposal and can go to a non-regulated disposal facility. A bill of lading is sufficient for transporting and disposing the waste.
- California-hazardous: The waste is considered hazardous in California and must go to a regulated facility. A hazardous waste manifest must accompany the waste to the disposal facility and a certificate of disposal or destruction is necessary.
- Federal Hazardous: The waste is a Resource Conservation and Recovery Act (RCRA) hazardous waste and must be disposed of at a RCRA-approved facility. A waste manifest must accompany the waste to the disposal facility and a certificate of disposal or destruction is necessary.

9.3 WASTE PROFILES

Waste profiles are obtained from the disposal contractor or accepting facility. The laboratory results from the characterization step are transferred onto the profile forms along with physical characteristics of the waste and information about the generator.

The profiles are submitted to the acceptance facility once completed and signed for review and approval. The accepting facility will determine whether they are permitted to receive the waste based on the information on the profile.

9.4 WASTE HANDLING, TRANSPORTATION, AND DISPOSAL

Based on the waste classification determination a waste disposal company (accepting facility) and waste management vendor (handler and transporter) are selected. Note that the same company may perform both roles.

The waste management contractor for the City's WBA Facility is responsible for the following:

- collecting samples,
- submitting the samples to the laboratory for analysis,
- preparing waste profiles and submitting them to the City for review,
- submitting waste profiles to disposal vendors for review and selecting a vendor,
- preparing the waste disposal documents and submitting to the City for approval, and
- transporting the waste to the appropriate facility meeting all Department of Transportation (DOT) requirements.

NOTE: Verify that the waste disposal and management companies are approved by the city of Glendale.

The spent media material is transported off-site by tanker truck. Supernatant water drained from the spent media is transferred to the backwash tank via hose connections and discharged to the sanitary sewer. Backwash wastewater is discharged to the sanitary sewer.

The Project Manager or designee must oversee waste handling on the day it is transported off-site and sign the bills of lading or manifests. Only City employees are permitted to sign waste manifests unless specifically authorized. Minimum requirements for signing manifests will include DOT Basic Hazmat Employee Training, HM-181, per 49 CFR, Part 172.704 (Subpart H).

9.5 DOCUMENTATION

Documentation requirements for transportation and disposal by waste type are as follows:

- Non-hazardous: A bill of lading is sufficient for transporting and disposing the waste.
- California-hazardous: A hazardous waste manifest must accompany the waste to the disposal facility and a certificate of disposal or destruction is necessary.
- Federal Hazardous: A waste manifest must accompany the waste to the disposal facility and a certificate of disposal or destruction is necessary.

One signed copy of shipping papers or bill of lading is required per truckload of super sacks.

Upon shipment off-site, a copy of the shipping papers is given to the plant operator. The operator will make additional copies, as needed, to: [a] provide one copy to the Project Manager; and [b] retain one in the facility's files.

A certificate of destruction from the disposal facility will be issued to the City within 30 days of waste destruction.

Waste characterization analytical results, the generator copy of the waste manifest, chain of custody forms, transportation, and destruction records (including certificates of destruction) shall be placed on file within 30 days of record finalization for any wastes transported and disposed. Waste disposal documents must be retained on record for a minimum of three (3) years, or as required by local codes.

10. REFERENCES

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Appendix A
Record Drawings

Appendix B
California Department of Health Services Amendment to the Domestic Water Supply Permit for System No. 04-15-00PA-000

Comment [DLP1]: Need official title

[To be included when completed.]

Appendix C
City of Los Angeles Sewer Discharge Permit for City of Glendale, Water and Power, Industrial User No. XXXXX

Comment [DLP2]: check wording

[To be included when completed.]

Appendix D
Initial Start-up Plan

Appendix E
Quality Assurance Project Plan

Appendix F
Equipment Data Sheets

Appendix F
Equipment Data Sheets

EQUIPMENT DATA SHEETS

WBA Treatment Facility
City of Glendale Water and Power
Glendale, CA

LIST OF EQUIPMENT

1. Liquid Level Switch
2. Static Mixer
3. Bag Filter
4. Flow Meter [Magnetic] – Backwash
5. Flow Meter – Backwash Tank Discharge
6. Backwash Tank
7. Media Trap
8. Check Valve
9. Air Release Valve
10. Differential Pressure Gauge

1. Liquid Level Switch

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- Units available to withstand pressures up to 500 PSI
- Electronic controllers, relays and converters can be provided

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MODEL NO.	With SLOSH SHIELD	DWG NO.	FLOAT MATL	STEM MATL	MAX TEMP (CELSIUS)	MAX PSIG	FLOAT SG	NOMINAL VA	LEAD WIRES	FITTING	** APPROVALS
M5600	MS5600	1	316SS	316SS	200˚	200	0.55	60	22 ga. Teflon 24"	1/4" NPT	A,B,C,D,E
M5600-SPDT	MS5600-SPDT	1	316SS	316SS	200˚	200	0.55	25*	22 ga. Teflon 24"	1/4" NPT	A,B,C,D
M5601	MS5601	1	316SS	316SS	200˚	200	0.55	100	22 ga. Teflon 24"	1/4" NPT	A,B,C,D
M5917	MS5917	1	316SS	316SS	250˚	200	0.55	60	18 ga. UL/CSA appr.	1/4" NPT	A,B,C,D
M4600	MS4600	2	Buna-N	316SS	105˚	150	0.45	60	22 ga. Teflon 24"	1/4" NPT	A,B,C
M4600-SPDT	MS4600-SPDT	2	Buna-N	316SS	105˚	150	0.45	25*	22 ga. Teflon 24"	1/4" NPT	A,B,C
M4601	MS4601	2	Buna-N	316SS	105˚	150	0.45	100	22 ga. Teflon 24"	1/4" NPT	A,B,C
M8600	MS8600	2	PP	316SS	105˚	100	0.75	60	22 ga. Teflon 24"	1/4" NPT	A,B,C,D
M8600-SPDT	MS8600-SPDT	2	PP	316SS	105˚	100	0.75	25*	22 ga. Teflon 24"	1/4" NPT	A,B,C,D
M8601	MS8601	2	PP	316SS	105˚	100	0.75	100	22 ga. Teflon 24"	1/4" NPT	A,B,C,D
M5600-PR	MS5600-PR	3	316SS	316SS	200˚	500	0.70	100	22 ga. Teflon 24"	1/4" NPT	C,D
MSB5600	–	4	316SS	316SS	110˚	85	0.55	60	Teflon Cable 6 ft.	–	–
M3842	–	4	316SS	316SS	100˚	30	0.64	25*	18 AWG Neoprene Cable 10 ft.	–	–

** SPDT switch operation* *PP= Polypropylene*

Miniature Switches

MODEL	With SLOSH SHIELD	DWG NO.	FLOAT MATL	STEM MATL	MAX TEMP (CELSIUS)	MAX PSIG	FLOAT SG	NOMINAL VA	LEAD WIRES	FITTING	** APPROVALS
M5000	MS5000	5	316SS	316SS	200˚	300	0.70	30	22 ga. Teflon 24"	1/8" NPT	A,B,C,D
M4400	MS4400	6	Buna-N	316SS	105˚	150	0.45	30	22 ga. Teflon 24"	1/8" NPT	A,B,C
M8020	MS8020	6	PP	316SS	105˚	100	0.80	30	22 ga. Teflon 24"	1/8" NPT	A,B,C,D

PP= Polypropylene

Side-Mounted Switches

MODEL	With SLOSH SHIELD	DWG NO.	FLOAT MATL	STEM MATL	MAX TEMP (CELSIUS)	MAX PSIG	FLOAT SG	NOMINAL VA	LEAD WIRES	** APPROVALS
M5900*	–	11	316SS	316SS	200˚	300	0.60	30	22 ga. Teflon 24"	A,B,C,D,E
M5910*	–	13	316SS	316SS	200˚	300	0.60	30	22 ga. Teflon 24"	A,B,C,D,E
M5920*	–	12	316SS	316SS	200˚	300	0.60	30	22 ga. Teflon 24"	A,B,C,D,E
M5970	–	14	316SS	316SS	200˚	100	0.70	30	22 ga. Teflon 24"	A,B,C,D
M5010	MS5010	15	316SS	316SS	200˚	300	0.70	30	22 ga. Teflon 24"	A,B,C,D

** Available with extended stem length, see drawing No. 19. Consult factory for appropriate model number.*

MODEL	SLOSH SHIELD	DWG NO.	FLOAT MATL	STEM MATL	MAX TEMP (CELSIUS)	MAX PSIG	FLOAT SG	NOMINAL VA	LEAD WIRES	OUTER THREAD
M3827-1	–	16	316SS	316SS	200˚	50	0.60	30	22 ga. Teflon 24"	1/2-13 Bulkhead
M3827-2	–	17	316SS	316SS	200˚	50	0.60	30	22 ga. Teflon 24"	1/2 NPT
M3827-3	–	18	316SS	316SS	200˚	50	0.60	30	22 ga. Teflon 24"	1/8 NPT
M3827-1NO	–	–	316SS	316SS	200˚	50	0.60	30	22 ga. Teflon 24"	1/2-13 Bulkhead
M3827-2NO	–	–	316SS	316SS	200˚	50	0.60	30	22 ga. Teflon 24"	1/2 NPT
M3827-3NO	–	–	316SS	316SS	200˚	50	0.60	30	22 ga. Teflon 24"	1/8 NPT

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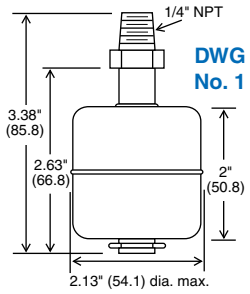
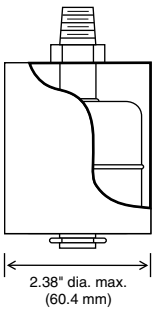
Madison® *M Series* Stainless Steel *Liquid Level Switches*

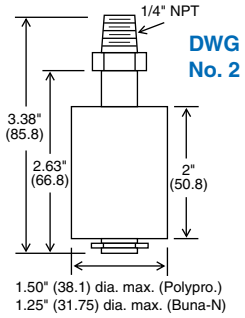
Vertical Switches



DWG No. 1



Cutaway Showing Slosh Shield Operation



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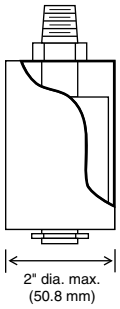

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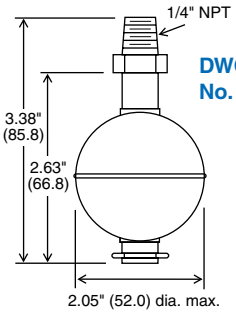

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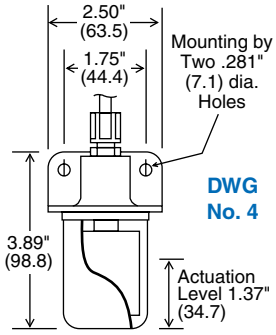

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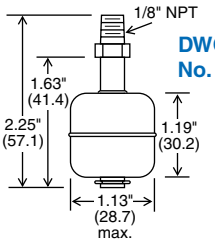

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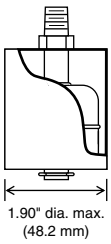

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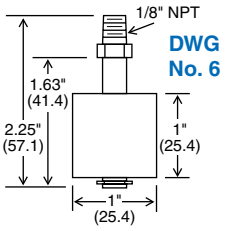

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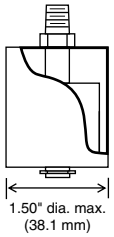
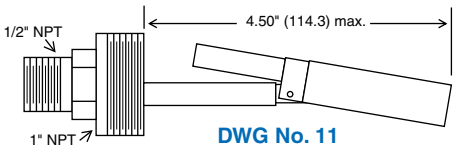


Cutaway Showing Slosh Shield Operation

Side-Mounted Switches



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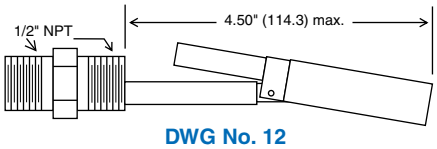

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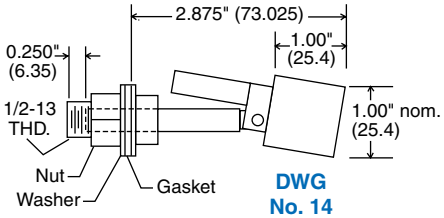

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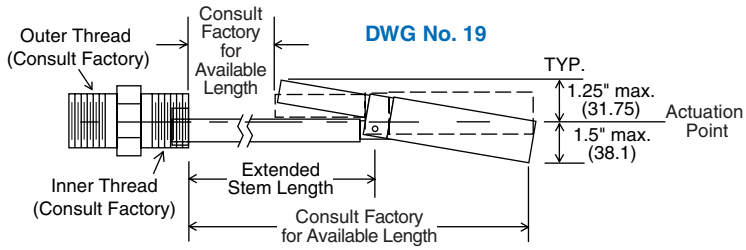

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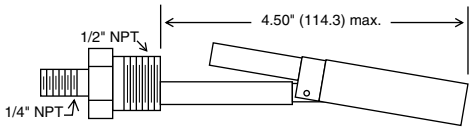

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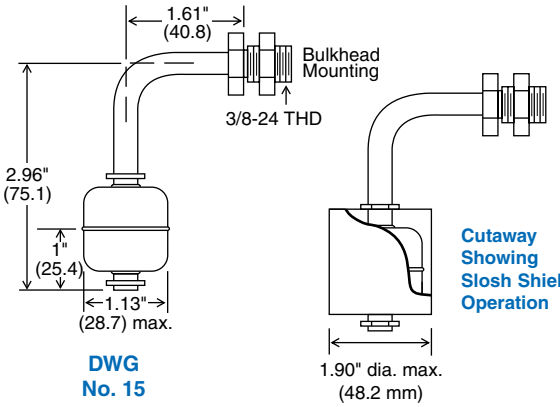

DWG No. 15

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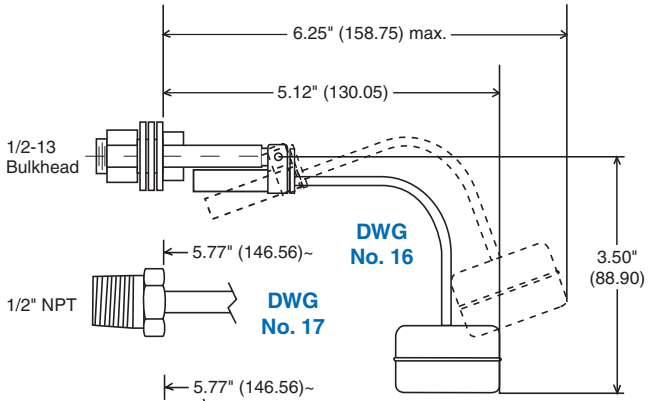
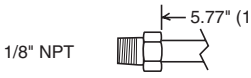


DWG No. 16

DWG No. 17



DWG No. 18

Madison Company • (203) 488-4477 • Fax (203) 481-5036 • E-mail: info@madisonco.com • www.madisonco.com

M Series

Single-Level Liquid Level Switches

A selection of engineered single-level switches

Madison Company offers a complete line of Standard and Configured (slightly modified Standard designs) models. These products continue to meet the needs of applications in many markets, at competitive prices. In addition, Madison Company offers the capability to design specific liquid level switches for OEM applications that require unique considerations in materials, configurations and system interfacing.

Engineered designs incorporate over 45 years of experience in liquid level switch applications in a variety of environments and installation configurations. High reliability of the magnetic reed switch technology assures repeatability at an economical price. Our design experience and flexible manufacturing techniques also offer customers many value-added design and assembly options to reduce their product cost.

Features

- Single-point
- Magnetic reed switch technology
- High reliability
- Wide selection of available materials
- Three basic sizes: full, miniature and subminiature
- Direct interface to controllers available

Madison Company • (203) 488-4477 • Fax (203) 481-5036 • E-mail: info@madisonco.com • www.madisonco.com

Product Selection Guide

The first consideration is the type of liquid, temperature and pressure to which the switch will be subjected. Madison manufactures liquid level switches in various styles, in a variety of materials, to cover a broad range of conditions. Following are some basic recommendations for selecting the proper liquid level switch material for your application.

► *See Approvals pages*

Material	Application
316 Stainless Steel	For high-temperature (to 200°C), high-pressure (to 300 PSIG) and corrosive conditions. Commonly used in food processing, medical, heating, and cooling equipment.
Polypropylene	For acidic conditions, such as found in electroplating and metal cleaning. Another choice for lower-temperature (to 105°C) food processing applications (Madison Company uses only polypropylene that is FDA-approved for food contact). Also a good choice for general-purpose applications in commercial or consumer appliances and equipment. Available in white and other colors.
Brass & Buna-N **PBT & Buna-N**	The selection for petroleum-based liquids, such as lubricating oils, gasoline and diesel fuels. Widely used in storage tanks of vehicles, generators, transmissions and hydraulic systems. Other uses are in lubrication, recovery, refining and fuel processing equipment. *Please note: PBT is not suitable for use in water above 65°C.*
Kynar	Chemical- and solvent-resistant properties make this material a problem solver for many applications. Its high-purity nature is ideal for food handling and sensitive laboratory or test equipment.

Once a suitable material has been selected, the type of switch and configuration are the next considerations. Madison Company stocks a full line of standard products that can meet the requirements of many applications. For specific designs, Madison can custom-build, to order, switches with an infinite number of variations and options. Please utilize our M & MT Series single-level specification sheet which, when completed, will allow our engineering department to better meet your needs.

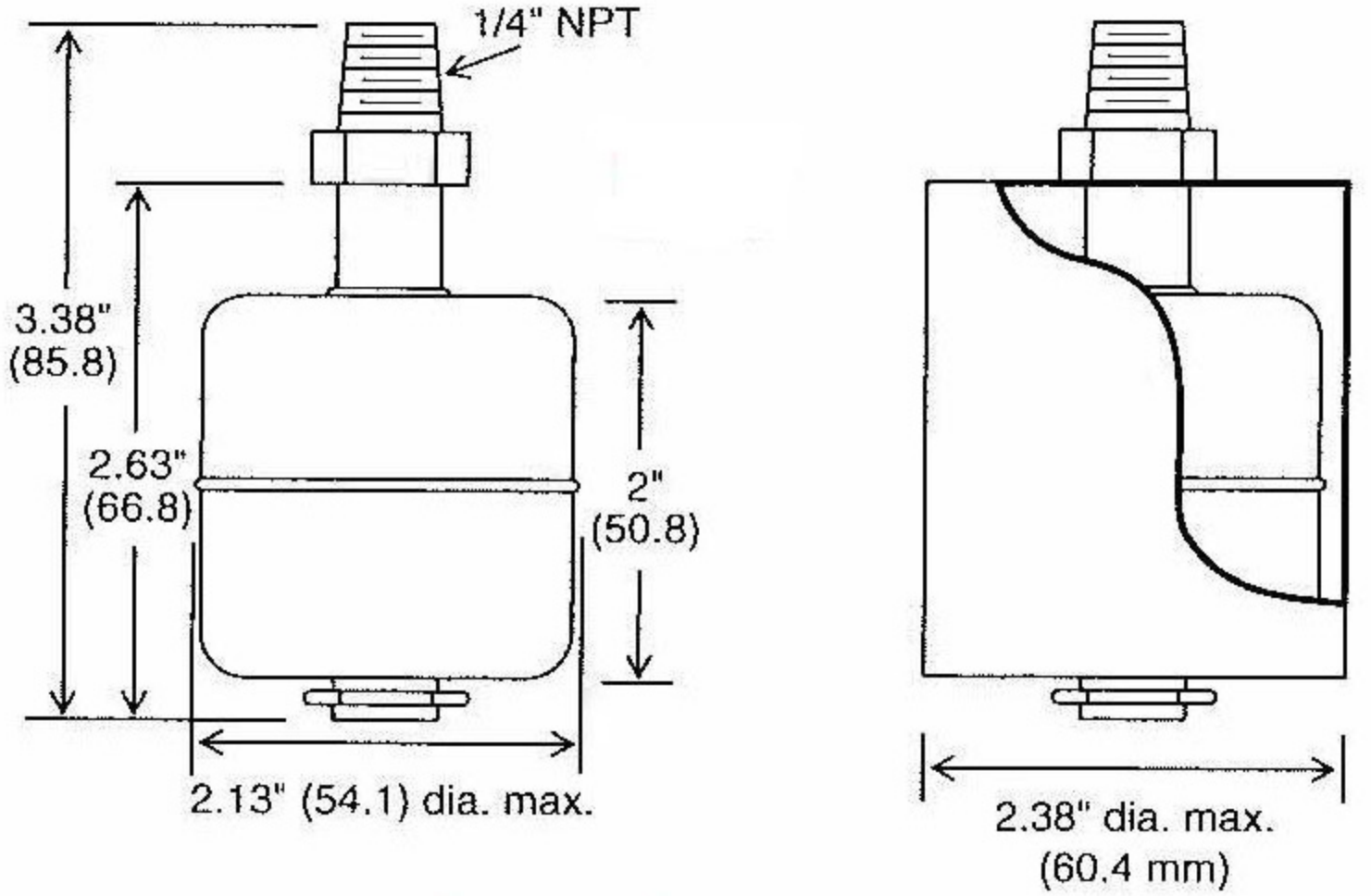
Madison®

Sensor solutions for today and the future™

CERTIFIED ISO 9001

Madison Company 800-466-5383

27 Business Park Drive, Branford, CT 06405 • 203-488-4477 • Fax: 203-481-5036
www.madisonco.com • E-mail: info@madisonco.com

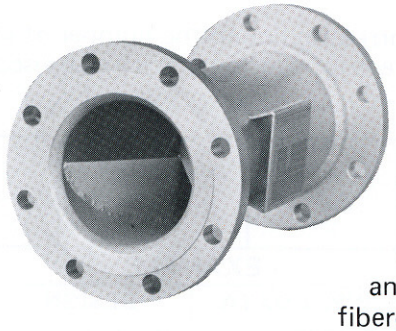


Cutaway Showing Slosh Shield Operation

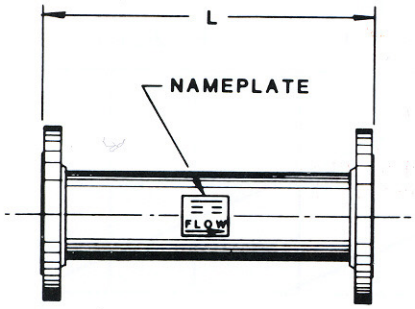
2. Static Mixer

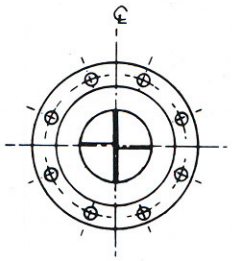
KOMAX "M" SERIES
INLINE STATIC/MOTIONLESS MIXERS

- GUARANTEED PERFORMANCE
- LOW COST



These "in Stock" mixers feature very high mixing efficiency with short mixing length. They are designed for use where additives to the main pipeline flow have already been introduced upstream of the mixer. The simple, three step design procedure shown on the next page allows the rapid choice of line size, number of mixing elements and pressure drop. Available from stock, mixers are supplied with two, three or four mixing elements. All have 150 lb. flanges, and materials of construction are carbon steel, 316 stainless steel, PVC and fiberglass. Dimensions and model numbers for the "M" series are listed below.





HOUSING: CARBON STEEL – A53 Grade B or equal Schedule 40
STAINLESS STEEL – Type 316 Schedule 40
P.V.C. – Schedule 80
F.R.P. – 150 psi rated filament wound

FLANGES: ANSI B16.5 – 150 lb. Drilling
CARBON STEEL &
STAINLESS STEEL – Raised Face
P.V.C. – For Sizes: 3" & Larger – Raised Face
Smaller than 3" – Flat Face
F.R.P. – Flat Face

LINE SIZE NPS	L_1 inches			SHIPPING WT. lb.		
	2 el.	3 el.	4 el.	2 el.	3 el.	4 el.
2	7	9	13	14	15	16
2½	8	11	14	21	23	25
3	9	13	16	27	29	33
4	11	16	21	43	49	55
6	16	24	31	78	93	110
8	21	31	41	132	163	195
10	26	39	52	213	267	326

NOTE

WEIGHTS LISTED ARE FOR CARBON STEEL & STAINLESS STEEL. TO OBTAIN SHIPPING WEIGHTS FOR PVC & FRP DIVIDE VALUES LISTED BY A FACTOR 3.
ALL DIMENSIONS ± 1/8

"M" SERIES NUMBERING SYSTEM

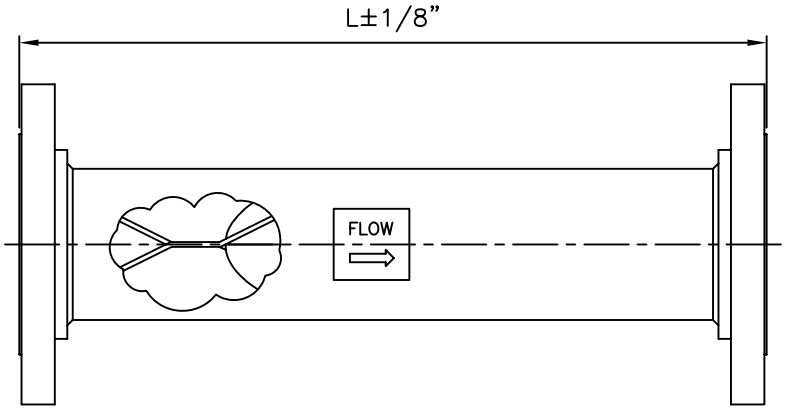
M C – 2½ – 3
- M: Series Identifier
- C: Material, refers to Carbon Steel
- 2½: Line Size, 2½" in example
- 3: Number of Elements, 3 in example

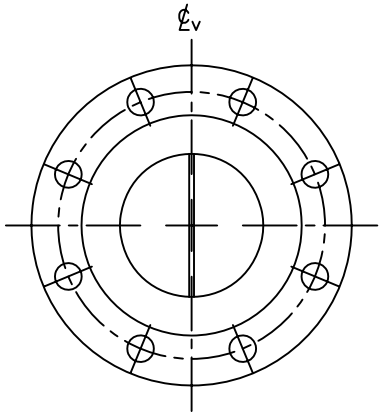
Symbol	Material
C	Carbon Steel
S	Stainless Steel
F	Fiberglass
P	P.V.C.

Larger Sizes, Materials & Configurations Available On Request

KOMAX SYSTEMS·INC
MIXING BY DESIGN

KOMAX SYSTEMS, INC.
P.O. BOX 1323, WILMINGTON, CA 90748-1323
TEL: (310) 830-4320 • (800) 826-0760 • FAX: (310) 830-9826
http://www.komax.com • E-mail: info@komax.com





DOWNSTREAM END VIEW

SYMBOL	MATERIAL	MIXER RATING
C	CARBON STEEL	260 PSIG/200°F
S	STAINLESS STEEL	240 PSIG/200°F
** F	FIBERGLASS	100 PSIG/165°F
P	PVC	150 PSIG/100°F
CP	CPVC	150 PSIG/100°F

** SIZE AVAILABLE FROM 2"DIA. TO 120" DIA.

CONTACT KOMAX FOR APPLICATION ASSISTANCE & SPECIFIC PART NUMBERS

HOUSING: CARBON STEEL – A53 GR B SCHEDULE 40
STAINLESS STEEL – TYPE 316 SCHEDULE 40
P.V.C. – SCHEDULE 80
CPVC – SCHEDULE 80
F.R.P. – 150 PSI RATED FILAMENT WOUND

FLANGES: ANSI B16.5 – 150 LB DRILLING – FLAT & RAISED FACE AVAILABLE
CARBON STEEL & STAINLESS STEEL
P.V.C. – VANSTONE
CPVC – VANSTONE
F.R.P. –

COATINGS: AVAILABLE WITH POTAPOX EPOXY INTERAL COATING TO PROVIDE RESISTANCE TO MOST CHEMICALS

TABULATION BLOCK

LINE SIZE NPS	'L' OVERALL LENGTH						SHIPPING WT. LB					
	2 ELEM	3 ELEM	4 ELEM	5 ELEM	6 ELEM	8 ELEM	2 ELEM	3 ELEM	4 ELEM	5 ELEM	6 ELEM	8 ELEM
3/4	3	4	5	6	7	9	5	6	7	8	9	11
1	4	5	6	8	9	12	6	7	8	10	11	14
1 1/2	5	7	9	12	14	18	8	9	10	14	16	20
2	7	9	13	15	18	24	14	15	16	18	20	24
2 1/2	8	11	14	18	21	28	21	23	25	27	29	33
3	9	13	16	22	27	35	27	29	33	39	43	51
4	11	16	21	28	35	46	43	49	55	62	70	86
6	16	24	31	44	52	70	78	93	110	130	150	186
8	21	31	41	58	69	92	132	163	195	245	280	355
10	26	39	52	74	88	115	213	267	326	410	476	592
12	32	47	62	89	106	137	330	405	519	633	729	906

LARGER SIZES AVAILABLE UP TO 144" IN CARBON & STAINLESS STEEL

ALL DIMENSIONS ARE IN INCHES

NOTES:

WEIGHTS LISTED ARE FOR CARBON STEEL AND STAINLESS STEEL

TO OBTAIN SHIPPING WEIGHT FOR PVC AND FRP UNITS, DIVIDE VALUES LISTED BY A FACTOR 3.

MANUFACTURED UNDER ONE OR MORE OF THE FOLLOWING U.S. PATENTS
3201813 3923288, 4034965, 4208136, 4614440, 4808007, 5066137, 5176448, 5484203, 5758967, 5947597, 6024842, 6027241, 6082713, 6102561, 6132079, 6276823
OTHER U.S. AND FOREIGN PATENTS PENDING

KOMAX® SYSTEMS, INC.
P.O. BOX 1323 WILMINGTON, CA 90748-1323 310-830-4320 FAX: 310-830-9826

OUTLINE & MOUNTING CONFIGURATION

TYPICAL KOMAX M SERIES MIXER (NO ADDITIVE PORT)

SCALE: 1/4" = 1"	APPROVED BY:	DRAWN BY: EA
DATE: 05-09-08		REV. DATE:
		CODE# 004 / DRAWING NUMBER: PROPOSAL

3. Bag Filter

Fil-Trek

LP Series

- Multi-purpose industrial ASME "U" code filter bag housings.
- Accepts multiple double or single length bags.
- 150psig (10.3bar) @ 250°F(121.1°C) design pressure.
- Vessels available in carbon or stainless steel 304 or 316.
- Also available in LDX2101, C276, AL6XN, RA2205 & Monel 400
- LP housings allow for easy filter bag removal and do not require ladders or platforms to change the filter bags.
- Swing bolt closure allows for quick bag change out.
- Side in/side out standard. Other options available.
- For drawings, flow charts, custom applications and filter cartridge information please visit www.fil-trek.com

LP SERIES

multi-bag housings
asme design

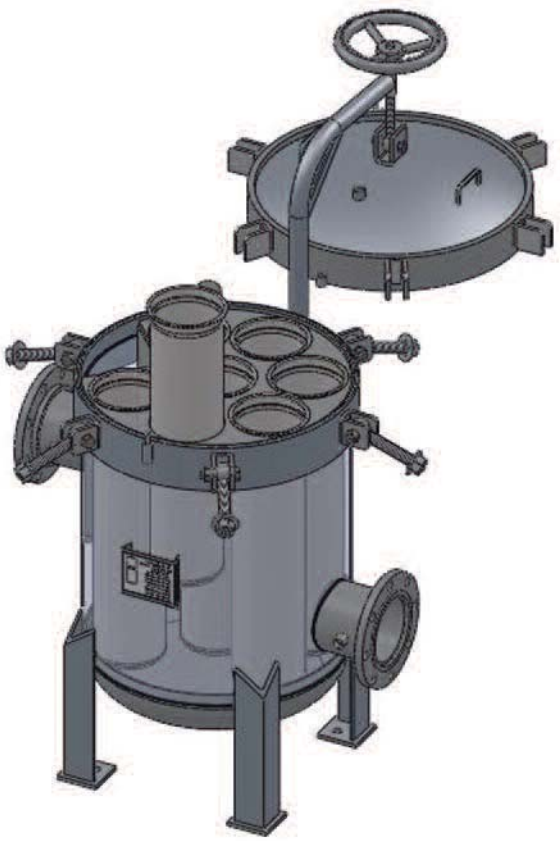
- Water
- Desalination
- Chemicals
- Electronics
- Food & Beverage
- Oil/Gas
- Air/Gas
- Inks/Paints/ Coatings
- Power
- Coolants
- Pult & Paper

Fil-Trek Corporation
70 Fleming Drive
Cambridge, ON N1T 2B1
(519) 623-7448
info@fil-trek.com
www.fil-trek.com

LP SERIES

multi-bag housings
asme design

LP Series



Model	No. of bags	Flow Rate (gpm)	Max. Inlet/outlet size
**LPA16	1	300	4”
LPA18	3	450	6”
LPA20	4	600	6”
LPA22	5	750	6”
LPA24	6	900	6”
LPA26	7	1050	8”
LPA28	8	1200	8”
LPA30	10	1500	8”
LPA32	11	1650	10”
LPA34	12	1800	10”
LPA36	14	2100	10”
LPA38	17	2550	10”
LPA40	18	2700	12”
LPA42	19	2850	12”
LPA44	22	3300	12”
LPA46	23	3450	12”
LPA48	25	3750	14”
LPA50	27	4050	14”
LPA52	29	4350	16”
LPA54	34	5100	16”
LPA56	35	5250	16”
LPA58	37	5550	18”
LPA60	40	6000	18”

** Domed top with hinge cover lift.
Mechanical davit available upon request.
Flow rates based on water at 150gpm/bag (10 micron). Actual flow rate is dependent on fluid viscosity, cartridge micron rating, contaminant and type of media.

Housing Specifications

Inlet/Outlet: 2-18" Flanged

Dirty Drain: 1/2"NPT

Clean Drain: 2"NPT

Vent: 1/2”NPT

Gauges: 1/2” NPT

Fil-Trek Product Nomenclature

S4 LP A 28 8 12 8F

Material:
Carbon (blank), SS304 (S4), SS316 (S6)

Series:
LP (low profile design)

Style:
Side in side out (A)

Diameter of Bag Housing:
Refer to chart above

Number of Baskets (2 1/2”):
Refer to chart above

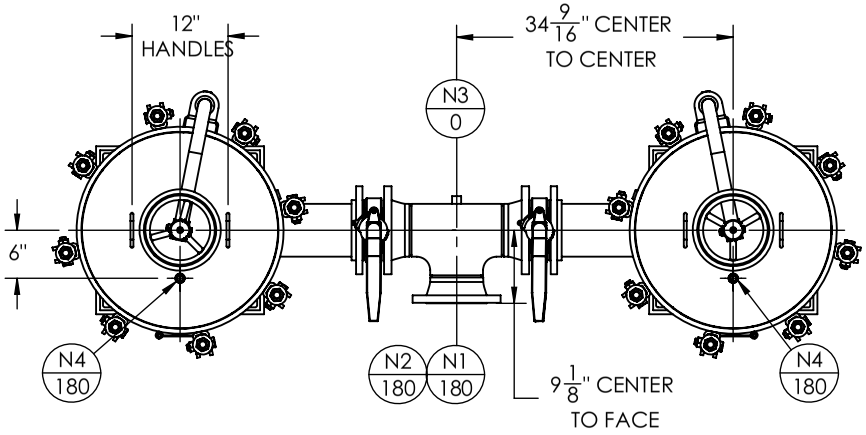
Length of Baskets:
Double Length (12)

Size of Inlet/Outlet:
Flange (F)

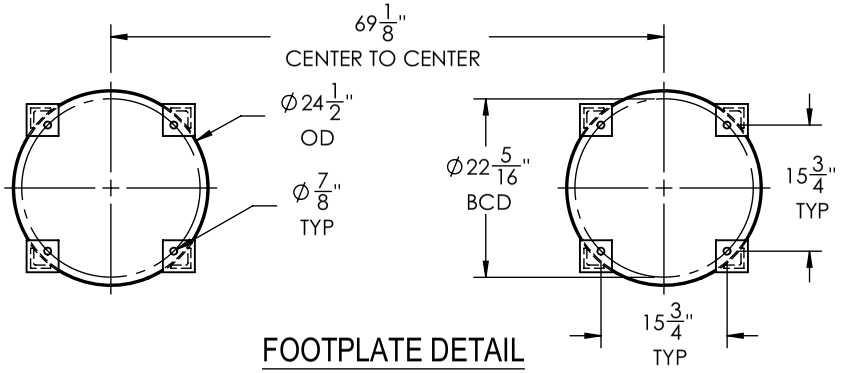
Fil-Trek Corporation
70 Fleming Drive
Cambridge, ON N1T 2B1
(519) 623-7448
info@fil-trek.com
www.fil-trek.com

Fil-Trek

NOZZLE SCHEDULE			
MARK	QTY	SIZE / RATING	DESCRIPTION
N1	2	6" 150# RFSO	INLET
N2	2	6" 150# RFSO	OUTLET
N3	2	1/2" 3000# NPT	PRESS GA
N4	2	1/2" 3000# NPT	VENT
N5	2	2" 3000# NPT	CLEAN DRAIN
N6	2	1/2" 3000# NPT	DIRTY DRAIN

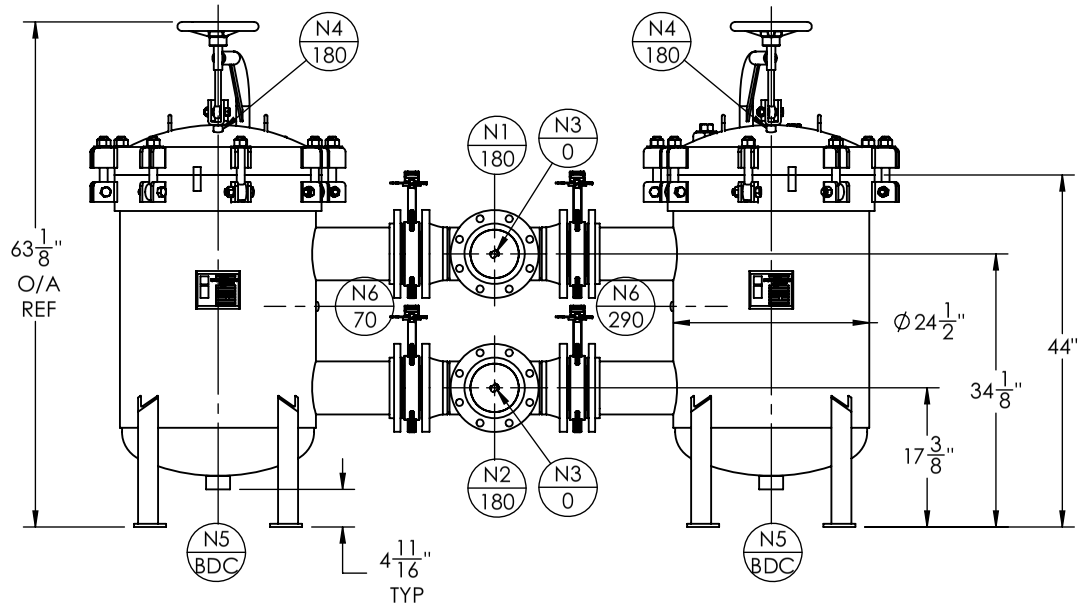


PLAN DETAIL



FOOTPLATE DETAIL

VESSEL DESIGN CONDITIONS			
CODE:	ASME SECTION VIII DIV. I 2007 EDITION, ADDENDA 2008		
M.A.W.P.:	150 PSI @ 250°F	M.D.M.T.:	-20° F @ 150 PSI
M.A.E.P.:	15 PSI @ 250°F		
CORROSION ALLOWANCE:	NONE	HYDROTEST PRESS:	195 PSI
STAMP:	'U' / NB	SERVICE:	NON LETHAL
PWHT:	N/A	RADIOGRAPHY:	N/A
MATERIAL:	SA516 70	GASKET:	BUNA-N



NOTES:
1. EACH VESSEL WILL HOUSE (QTY=6) SIZE 2 BAG FILTERS.
2. TAG NO.:

VESSEL DRY WEIGHT: 600 LBS./VESSEL
VESSEL FLOODED WEIGHT: 1300 LBS./VESSEL
VESSEL SHIPPING WEIGHT: 1500 LBS. TOTAL
VESSEL VOLUME: 9.0 CU. FT./VESSEL

THIRD ANGLE PROJECTION

TOLERANCES-UNLESS OTHERWISE NOTED
DECIMAL .X =±.1" .XX =±.02" .XXX =±.005"
FRACTIONAL ≤24" =±1/16" >24" =±1/8"
ANGULAR =± 1°
MAX. MACHINED SURFACE FINISH 125

PARENT:NEW DESIGN

PAGE: 1 OF 1

REV.	DATE	REVISION	DRAWN	APP'D

FIL-TREK CORPORATION
CAMBRIDGE ONTARIO - CANADA
www.fil-trek.com • Tel: 519.623.7448 • Fax: 519.623.8807

EQUIPMENT:	DUPLEX BAG FILTER HOUSING
MODEL NO:	LPADV24-1212-6F-150-BTFV
CUSTOMER:	VALIN CORPORATION

DRAWN: AMS	DATE: JAN. 27, 2009	JOB No.	DWG. No.	REV. No.
CHK'D: PT	SCALE: NTS	V-4164	R001538	0

4. Flow Meter [Magnetic] – Backwash

Product Data Sheet
PDS-656

TigermagEP
Technical Specifications

FM656 Obstructionless Electromagnetic Flowmeter

DESCRIPTION
The Model 656 is a microprocessor-based electromagnetic flowmeter designed to measure the flow of conductive liquids in full pipes. The sensor and the transmitter are integral and enclosed in a NEMA-7 explosion-proof housing. The sensor housing is made of steel.

A wide variety of liners and electrodes are available to allow you to tailor the meter to your process.

The Model 656's nonvolatile E^2PROM memory and circuitry eliminates the need for a microprocessor backup battery. It is not necessary to reprogram if the electronic module is replaced or exchanged with electronics from another size flowmeter.

APPLICATIONS
The Model 656's high signal frequency makes it ideally suited to applications with high levels of inherent noise including: Process Chemicals, Heavy Sludges, Pulp & Paper Stock, Mining Slurries, Polymers, Acids, Alkalies, Sewage, Cooling Water. Nearly any conductive liquid can be measured.

CERTIFIED ACCURACY
Each **TigermagEP™** is wet-flow calibrated in Sparling's Primary Flow Lab traceable to the National Institute of Standards and Technology. A certificate of accuracy is furnished with each meter.

PRINCIPLE OF OPERATION
The Model 656 magnetic flowmeter is based on Faraday's Law which states that the voltage induced in a conductor moving through a magnetic field is proportional to the velocity of that conductor. The magnetic flowmeter will measure liquids with conductivities greater than 5 micromhos.

STANDARD FEATURES
- Sampling frequency up to 100 Hz for accurate measurement of fluids with high levels of inherent noise
- Forward, reverse and net totalization
- Programmable high and low flow alarms
- Nonvolatile E^2PROM memory
- Universal electronics module compatibility
- 2-line, 16 character backlit display
- Programming made easy with Mag-Command™
- User-selectable damping & low flow cutoff
- NEMA-4X & NEMA-7 explosion proof enclosure
- Approvals include: FM, CSA (std.)
- Rotatable modular display
- Empty pipe detection
- PZR - Positive Zero Return
- Standard 0.5% accuracy
- Sizes available from 0.5" - 72"

FM APPROVED

SPARLING

EASY TO READ BACKLIT ROTATABLE DISPLAY

The 16 character, 2-line backlit transmitter display is rotatable 360° in 90° increments ensuring easy reading in any orientation.

INSTALLATION

The meter must be mounted at a point in the line in which the pipe is always full of the process liquid under flowing conditions.

The meter may be equipped with ANSI 150 or 300 lb., AWWA, DIN, PN10 or 16, JIS 10K or 20K, or British Standard flanges.

Only three diameters of straight pipe length are required from the center of the meter to normal obstructions to obtain specified accuracies. In the smaller sizes all of the necessary straight pipe is contained within the meter itself.

E²PROM NONVOLATILE MEMORY

A backup battery is not required and there is no need to reprogram if the electronics module is replaced or exchanged. Meter identification (tube ID, serial number, K, offset, etc.) is stored on an E²PROM chip independent of transmitter electronics. The E²PROM chip has lifetime data retention.

EMPTY PIPE DETECTION - Standard

The Sparling TigermagEP™ is designed to detect absence or inadequate volume of process fluid in the pipe and will hold the output signal to 4 mA or zero. This feature does not require any hard wiring as it is a software selection. One of the most important values of this feature is that it prevents false totalization possible with other meters under partially filled pipe conditions.

EASE OF COMMUNICATIONS

The TigermagEP™ is programmable with Mag-Command or Hart Protocol. 4-20 mA, RS-232 or RS-485 outputs give you flexibility when interfacing with your distributed control system.

REMOTE MOUNTED TRANSMITTER

Remote mounting of the transmitter is required when pipe vibration is excessive, when flooding is possible or where high temperature conditions exist (over 212°F / 100°C).

The TigermagEP™ remote transmitter is housed in a NEMA-4X enclosure and features a larger sized (8mm) 16 digit 2-line backlit display. All power, coil and electrode connections are made within the transmitter enclosure and junction box. The meter is programmed using Mag-Command. Hall-effect switches which are energized from outside the enclosure. The enclosure can be wall mounted. An optional bracket for pipe mounting is available.

HI-Z CIRCUITRY

The Sparling TigermagEP™ provides superior performance in liquids which tend to deposit nonconductive coatings. Hi-Z™ circuitry produces a high input impedance to the transmitter's preamplifier (10^{12} ohms). The impedance of the coating is negligible as compared to the impedance of the receiving instrument. The voltage drop across the electrode coating is also negligible eliminating the need for electrode cleaners.

TWO FLOW ALARMS

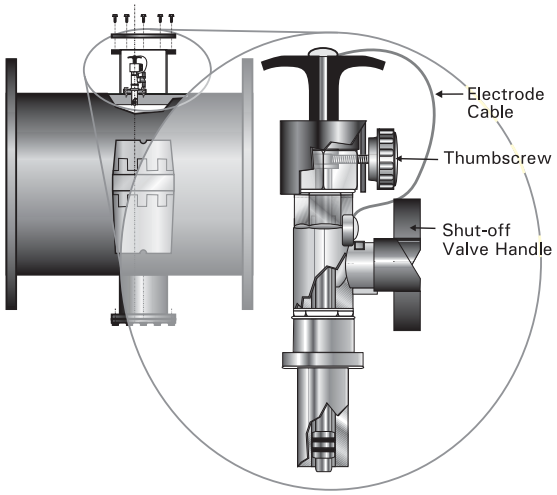
Fault alarms can be configured with alarm set points between 0-99% of flow for each alarm. Open collector output turns on above programmed set point.

PZR – Positive Zero Return

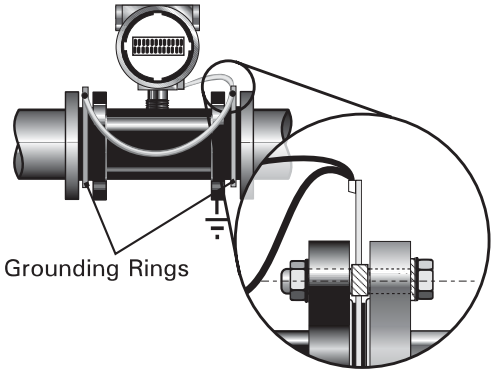
An electronic circuit is activated by an external contact closure when lines go empty or when a pump or valve is shut down, indicating to the meter that it should drive the output signal to 4 mA or zero.

REMOVABLE ELECTRODES *(option)*

Two configurations of removable electrodes are available in sizes 6" or greater for all FM656 meters. The first configuration allows removal of the electrode after the line has been depressurized and drained. Removal is performed with an 11/32" nut driver and a 3/4" socket wrench.



The second is the "hot-tap" electrode which allows electrode replacement while the system is still under pressure without disturbing the process flow. Removal can be easily performed with a phillips screwdriver and a crescent wrench. Special locking catches were designed to prevent high pressure accidents during electrode removal. The shut-off valve must be closed before the electrode may be removed.



GROUNDING

The use of grounding rings is recommended to ensure accuracy. Grounding rings are required if adjacent piping is lined or nonconductive. Pump noise or excessive RF should be minimized to achieve highest accuracy.

FLOW RATES & DIMENSIONS

Table 1 - Flow & Dimensions

Meter & mating flange size (inches)	Dimensions								Flowrates - GPM - Full Scale		
	A		B		C		D		1 fps.	3 fps.	33 fps.
	150 lb.	300 lb.	150 lb.	300 lb.	150 lb.	300 lb.	150 lb.	300 lb.			
0.5	4.00	4.00	3.50	3.75	9.50	9.62	9.25	9.37	0.6	1.7	18
1	4.00	4.00	4.25	4.88	10.19	10.50	9.94	10.25	2	6	66
1.5	4.00	4.00	5.00	5.12	10.88	11.44	10.63	11.19	5	15	174
2	4.00	4.00	6.00	6.50	11.69	11.89	11.44	11.64	9	27	303
3	6.00	6.00	7.50	8.25	13.00	13.40	12.75	13.15	20	60	664
4	6.00	6.00	9.00	10.00	14.38	14.88	14.13	14.63	35	107	1182
6	13.38	14.88	11.00	12.50	17.00	17.75	16.75	17.50	85	254	2800
8	13.38	15.40	13.50	14.25	19.40	19.78	19.15	19.53	145	436	4800
10	18.15	20.55	16.00	17.50	22.56	23.31	22.31	23.06	236	709	7800
12	19.40	21.78	19.00	20.50	25.00	25.75	24.75	25.50	333	1000	11000
14	21.38	23.75	21.00	23.00	26.67	27.67	26.42	27.42	409	1227	13500
16	23.38	25.88	23.50	25.50	28.97	29.97	28.72	29.72	545	1636	18000
18	27.25	29.88	25.00	28.00	31.14	32.64	30.89	32.39	667	2000	22000
20	27.63	30.40	27.50	30.50	33.39	34.89	33.14	34.64	879	2636	29000
24	32.75	35.75	32.00	36.00	37.44	39.44	37.19	39.19	1273	3818	42000
30	43.50	46.63	38.75	43.00	43.72	45.85	43.47	45.60	1909	5727	63000
36	47.75	50.85	46.00	50.00	50.20	52.20	49.95	51.95	2925	8775	96525
42	51.75	55.12	53.00	57.00	56.90	58.90	56.65	58.65	4040	12120	133320
48	51.75	55.38	59.50	65.00	63.05	65.80	62.80	65.55	5322	15966	175626
54	53.50	*	66.25	*	69.88	*	69.63	*	7144	21433	235800
60	65.50	*	73.00	*	76.75	*	76.50	*	8500	25500	280500
66	65.50	*	80.00	*	83.75	*	83.50	*	10300	31000	341000
72	72.75	*	86.50	*	90.00	*	89.75	*	12700	38100	419100

Dimensions for flanges. Allow 1/8" to 1/4" for lining thickness / Dimensions C & D ± .0125"

HOW TO ORDER A TIGERMAG EP MODEL 656

Base Model Number
FM-656 - TigermagEP

Size
OD = 0.50", OF = 1", OG = 1.5", 02 = 2", 03 = 3", 04 = 4", 06 = 6", 08 = 8", etc.

Table 3 - Liner Material

1	Hard Rubber (6" - 72")	3	Tefzel® (0.5" - 48")	6	Ceramic liner (0.5" - 2")
2	Soft Rubber (6" - 72")	5	Polyurethane (1" - 48")	9	Neoprene (6" - 72")

Table 4 - Electrode Material

1	316SS	4	Titanium	7	Platinum
2	Hastelloy C	5	Tantalum	8	Zirconium
3	316SS Bullet Nosed	6	Fused Platinum	9	Monel

Table 5 - Flange Rating

1	150 lb. flanges	4	PN 10 DIN	6	JIS 10K
3	300 lb. flanges	5	PN 16 DIN	7	JIS 20K

Table 6 - Transmitter and Mounting

0 Integral NEMA-4X/NEMA-7 enclosure
1 Remote NEMA-4X/NEMA-7 enclosure, 15' cable
3 Remote NEMA-4X/NEMA-7 enclosure, 15' cable, accidential submergence proof sensor
5 Remote NEMA-4X enclosure, 15' cable
6 Remote NEMA-4X encl., 15' cable, accidental submergence proof sensor
7 Remote NEMA-4X encl., 15' cable, permanent submergence proof sensor

Table 7 - Power Supply*

0 77-265 VAC Power 1 12-60 VDC Power

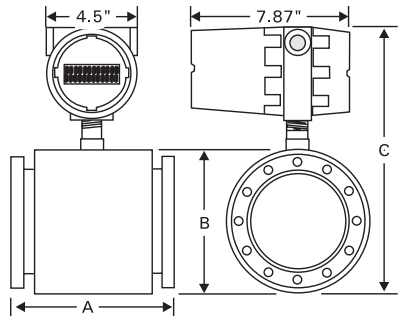
Special Notes for Construction

__ Hart® protocol (KP602 programmer available)
__ RS-485 Communications port
__ High temperature coils - required for temperatures over 266 °F
Requires remote mount option from Table 6
Ceramic max temp 420 °F / *Tefzel®* max temp 300 °F @ 100 psi
__ Hot Tap removable electrode design (6" & above only)
__ Removable electrode design (6" - 72")
__ Special cable length (over 15 feet - Max. 100 ft.)
__ Alarm with relay contacts (remote only)

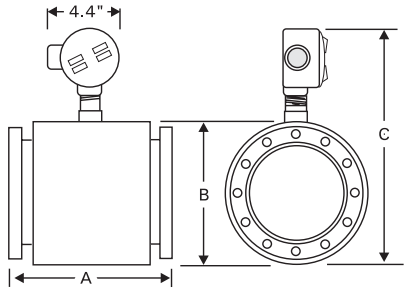
FM656 __ __ __ __ __ __

***FM approval is up to 120 volts**

Integral Mount Transmitter

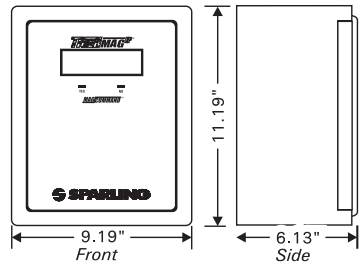


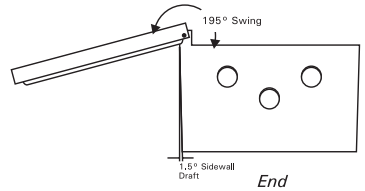
Remote Mount Transmitter

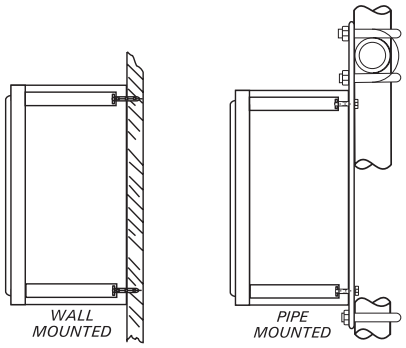


▲ Sensor

▼ Transmitter Enclosure (NEMA-4X)







STANDARD SPECIFICATIONS

Accuracy:
(Frequency Output)

1.0"-72"
0.5% of flow rate (1-33 fps)

0.5"
1% of flow rate (1-33 fps)

Temperature Effect: ±0.025 % FS/°C

Full Scale Ranges: From 0-3 to 0-33 ft/sec.

Repeatability: ±0.1% full scale

Electrodes: Stainless steel standard (others available)

Liner: Ceramic (aluminum oxide 99.5%), Hard Rubber, Soft Rubber, Neoprene, Polyurethane or *Tefzel* ®

Outputs: 1) Isolated analog 4-20 mAdc into 800 ohms (std); 2) scaled pulse 24 Vdc with selectable 12.5/25/50/100 ms on time, max. freq. 60 Hz; 3) 0-1000 Hz freq., for 0-100% flow rate. 15 Vdc; 4) two flow alarms; 5) fault, with open collector; 6) RS232 communication; 7) flow direction with open collector; 8) Positive Zero Return (PZR) for external relay contacts. Outputs 2 & 3 can be open collector if required.

Mag-Command™: Selection and change of meter parameters by magnetic probe without opening the enclosure.

Display: 2-Line, 16 Digit alphanumeric backlit display (rate and total) Modular, rotatable 360° in 90° increments.

Conductivity: Minimum 5 micromhos/cm

Minimum Velocity: 0.3 fps (0.1 mps)

Power Requirements: *77 - 265 Vac 50/60 Hz (12-60 Vdc optional)

Power Consumption: Less than 20 Watts

Enclosures: Transmitter: Cast aluminum epoxy coated. Integral (NEMA-7) or remote mounted (NEMA-4X).
Sensor Housing: Fabricated steel, epoxy coated.

Electrical Rating: FM – Class I, Div. 1 , Groups B, C, D; Class II, Div. 1, Groups E, F, G (150 psi integral mount), CSA Approved for Class 1, Division 2

Preamp Impedance: 10^{12} ohms minimum.

Ambient Temp: -20° to 140°F (-30° to 60° C) Display darkens over 158°F (70°C)

End Connections: 150 lb. or 300 lb.

Sensor Tube: 304 Stainless Steel

Process Temp:

Integral Mount:
Hard rubber, Soft rubber, Neoprene,
Polyurethane/Food Grade Polyurethane ..... -40 - 180°F
Tefzel®, Ceramic ..... - 40 - 212°F

Remote Mount (opt)
Tefzel® (to 300 psi), Ceramic ..... - 40 - 266 °F

High Temp Coils (opt)
Tefzel® (to 100 psi) ..... - 40 - 300 °F
Ceramic ..... - 40 - 420 °F

Selectable Damping: 0-99 sec.

Low Flow Cutoff: Selectable 0-9% of FS.

Options:

- Remote Mounted NEMA -4X Enclosure
- Remote Two-Stage Batching Transmitter
- Electrode Materials: Titanium, Hastelloy C, Monel, Zirconium, Tantalum, Platinum, Fused Platinum (ceramic only)
- Process Temperature to 420 °F (216 °C) (ceramic only)
- 12-60 Vdc operation
- Digital Communications (HART Protocol)
- Accidental/Permanent Submergence Proof Sensor (remote mount only)
- Removable Electrodes (6"-72" only)
- Hot-Tap Removable Electrodes (6" - 72" only)
- RS-485 Communication
- Alarm with relay contacts (remote mount only)

MODEL FM-656 SPECIFICATIONS

1.0 The magnetic flowmeter shall be microprocessor-based, and flanged. It shall indicate, totalize, and transmit flow in full pipes.

1.1 The magnetic flowmeter shall utilize DC bipolar pulsed coil excitation, operating at frequencies up to 100 Hz and automatically re-zeroing after every cycle.

1.2 The accuracy shall be at least 0.5% of flow rate over a 33:1 turndown at all flow rates above 1 fps. Accuracy shall be verified by calibration in a flow laboratory traceable to the U.S. National Institute of Standards and Technology.

1.3 The flow sensor liner shall be Ceramic, Hard Rubber, Soft Rubber, Neoprene, Polyurethane or *Tefzel*®. The housing shall be steel.

1.4 The integrally-mounted flow sensor and transmitter shall be FM approved for Class I, Division 1 & 2, Groups B, C, D and Class II, Division 1, Groups E, F, G environments without use of air purge. CSA Approved for Class 1, Division 2.

1.5 The electronics shall be integrally or remote mounted.

1.6 When remote mounted, the flowmeter transmitter shall be furnished in a NEMA-4X enclosure box, with a larger 3/8" character, 2-line 16 digit backlit display and 15 feet of cable (standard). Batch controller option available.

1.7 The flowmeter shall be suitable for operation at temperatures from -40°F to 266°F and at pressures from full vacuum to 740 psi. Temperatures to 420°F (optional).

1.8 The flowmeter electrodes on ceramic liners shall be fused platinum and shall not require O-rings.

1.9 The meter shall incorporate HI-Z circuitry. The preamplifier input impedance shall not be less than 10^{12} ohms. External ultrasonic electrode cleaners shall not be acceptable.

2.0 Available outputs shall be 1) Isolated analog 4-20 mAdc into 800 ohms (standard); 2) scaled pulse 24 Vdc with selectable 12.5/25/50/100 ms on time, max. freq. 60 Hz.; 3) 0-1000 Hz freq., for 0-100% flow rate. 15 Vdc; 4) two flow alarms; 5) fault, with open collector; 6) RS232 communication; 7) flow direction with open collector; 8) Positive Zero Return (PZR) for external relay contacts. Outputs 2 & 3 can be open collector if required.

2.1 Low flow cutoff shall be selectable from 0-9% of FS and there shall be two flow alarms settable from 0-99% of span.

2.2 A 2-line, 16 character backlit alphanumeric display shall indicate user-defined flow units and total flow. All menu advice and commands shall be visible on this display. The display shall be modular and rotatable 360°, in 90° increments. Characters shall be at least 0.125" high for ease of readability.

2.3 The flowmeter shall incorporate the MAG-COMMAND feature allowing menu selection and changes to be made from outside the housing via Hall-effect sensors. It shall not be necessary to remove covers, panels or fasteners to accomplish calibration or program changes.

2.4 The TigermagEP's unique diagnostic functions eliminate the need for a techican to carry test equipment or open the housing. Current ramp, complete coil check and true front-end input simulator may be activated in MAG-COMMAND without opening the enclosure.

2.5 The meter software shall incorporate a password feature preventing inadvertent program changes.

2.6 The meter shall feature nonvolatile E^2PROM memory and universal electronics module compatibility between all TigermagEP meters.

2.7 The flowmeter shall have a switching power supply having an operating range from 77 - 265 Vac 50/60 Hz (12-60 Vdc). Power consumption shall not exceed 20 Watts.

2.8 All printed circuit boards shall be contained in a plug-in module and be interchangeable for any size without requiring test equipment.

2.9 The flowmeter manufacturer shall have meters of the DC pulse type in similar flowing mediums for a minimum of five years.

3.0 The flowmeter shall be warranted against defective workmanship or materials for a period of two years from date of shipment.

4.0 Totalized flow and programmed configuration shall be maintained in memory for the meters lifetime.

5.0 The flowmeter shall be MODEL 656 TigermagEP™ as manufactured by Sparling Instruments, Inc.

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ISO-9001 DNV CERTIFICATED FIRM

04/02 Printed in U.S.A.(Dist. 05/04)

5. Flow Meter – Backwash Tank Discharge

Cold Water Recordall® Turbo 200 Meter	Size 2" (DN 50 mm)	Technical Brief

DESCRIPTION

Badger Meter offers the 2" Turbo Series meter in Cast Bronze and a Low Lead Alloy. The Low Lead Alloy (Trade Designation: Turbo Series LL-NS) version complies with NSF/ANSI Standard 61 and carries the NSF-61 Mark on the product.

APPLICATIONS: For use in measurement of potable cold water in commercial and industrial services where flow is in one direction only.

OPERATION: Water flows into the meter's measuring element contacting the multi-vaned rotor. Flow readings are obtained by rotor revolutions transmitted by magnetic drive coupling through the meter's cover plate to the sealed register. Magnetic drive is achieved by a right angle worm drive, coupling the rotor to a vertical transmission spindle, driving a gear set rotating the magnet carrier. A ceramic magnet in a carrier rotates around a vertical axis. Through the magnetic coupling, rotor rotation is transmitted to a follower magnet which transmits rotation to the register gearing.

The turbo measuring element is designed to greatly reduce wear by reducing friction potential between the moving parts of the rotor and bearing system. Less wear, in this critical area of the design, provides the utility manager with a lower life cycle cost for meter application. Throughout the normal operating range of the meter, the rotor floats between the thrust bearing system.

OPERATING PERFORMANCE: The Badger® Recordall Turbo 200 meter meets and exceeds registration accuracy for the low flow rate, normal operating flow rate, and maximum continuous operation flow rate as specifically stated in AWWA Standard C701.

CONSTRUCTION: The Badger Recordall 200 Turbo meter construction which complies with ANSI and AWWA C701 standards, consists of three basic components: meter housing, interchangeable measuring element and permanently sealed register. The housing is bronze, with round or elliptical flanges. The measuring element consists of the transmission coupling, measuring element insert, rotor, inlet and outlet straightening vanes with nose cones, and calibration ring assembly. The unique inlet and outlet straightening vanes minimize swirl from piping arrangements upstream as well as downstream.

To simplify maintenance, the register and measuring element can be removed without removing the meter housing from the installation. No change gears are required for accuracy calibration. Interchangeability of certain parts between 1 1/2" - 4" like-sized meters also minimizes spare parts inventory investment.

MAGNETIC DRIVE: Direct magnetic drive, through the use of high-strength magnets, provides positive, reliable and dependable register coupling for straight-reading, remote or automatic meter reading options.

SEALED REGISTER: The standard register consists of a straight-reading odometer-type totalization display, 360° test circle with center sweep hand and flow finder to detect leaks. Register gearing consists of self-lubricating thermoplastic gears to minimize friction and provide long life. Permanently sealed; dirt, moisture, tampering and lens fogging problems are eliminated. Multi-position register simplifies meter installation and reading. Automatic meter reading and close proximity systems are available for all Recordall Turbo meters. (See back of sheet for additional information.) All reading options are removable from the meter without disrupting water service.

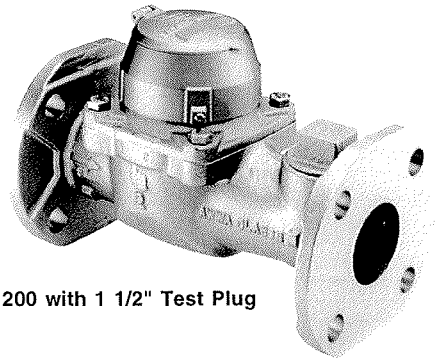
TAMPER-RESISTANT FEATURES: Customer removal of the register to obtain free water can be prevented if the tamper detection seal wire screw or TORX® tamper resistant seal screw is added to the meter. Either can be installed at the meter site or at the factory. A tamper resistant calibration plug seal provides protection from unauthorized personnel.

STRAINER: A separate strainer is recommended to protect the measuring element. See Technical Brief PS-T-1 for strainer dimensions.

MAINTENANCE: Badger Recordall Turbo meters are designed and manufactured to provide long-term service with minimal maintenance. When maintenance is required, it can be performed easily either at the meter installation or at any other convenient location. As an alternative to repair by the utility, Badger offers various maintenance and meter component exchange programs to fit the needs of the utility.

CONNECTIONS: Companion flanges for installation of meters on various pipe types and sizes are available in cast iron or bronze as an option.

TEST PLUG: An optional 1 1/2" NPT test plug puts an end to removing and reinstalling meters during field accuracy and pressure testing.



Turbo 200 with 1 1/2" Test Plug

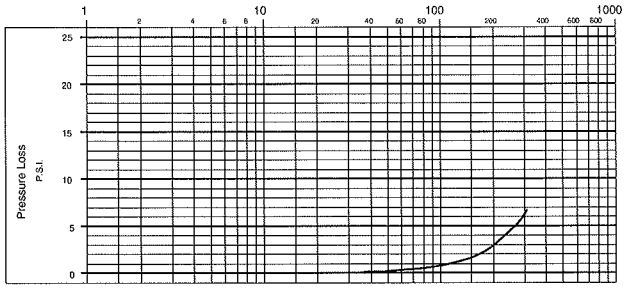
SPECIFICATIONS

Typical Operating Range (100% ± 1.5%)	4 - 310 GPM (0.9 to 70.4 m³/h)
Maximum Continuous Operation	200 GPM (45.4 m³/h)
Maximum Intermittent Flow	310 GPM (70.4 m³/h)
Typical Low Flow (Min. 95%)	2.5 GPM (0.6 m³/h)
Pressure Loss at Maximum Continuous Operation	3.1 PSI (.21 bar at 45.4 m³/h)
Maximum Operating Temperature	120°F (49°C)
Maximum Operating Pressure	150 PSI (10 bar)
Meter Flanges	2" Elliptical or Round Flanges, AWWA 125 pound class
Register	Straight reading, permanently sealed magnetic drive standard. Automatic Meter Reading and Close Proximity units optional.
Registration	100,000,000 Gallons 100 gallons/sweep hand revolution. 10,000,000 Cubic Feet 10 cubic ft./sweep hand revolution. 1,000,000 m³ 1 m³/sweep hand revolution. 100,000,000 Imperial Gallons 100 ImperialGallons/sweep hand revolution.

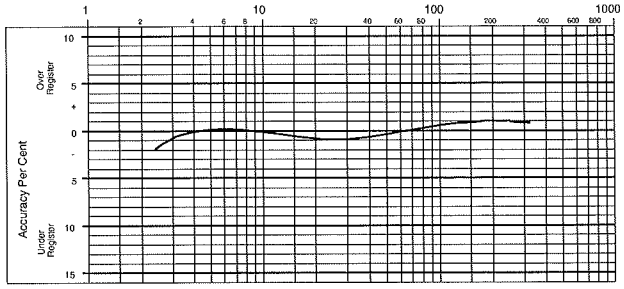
MATERIALS

Housing	Cast Bronze (B81), Low Lead Alloy
Turbo Head	Cast Bronze (B81), Low Lead Alloy
Nose Cone and Straightening Vanes	Thermoplastic
Rotor	Thermoplastic
Rotor Radial Bearings	Lubricated Thermoplastic
Rotor Thrust Bearings	Sapphire Jewels
Rotor Bearing Pivots	Passivated 316 Stainless Steel
Calibration Mechanism	Stainless Steel and Thermoplastic
Magnet	Ceramic
Register Lid and Shroud	Thermoplastic, Bronze
Trim	Stainless Steel

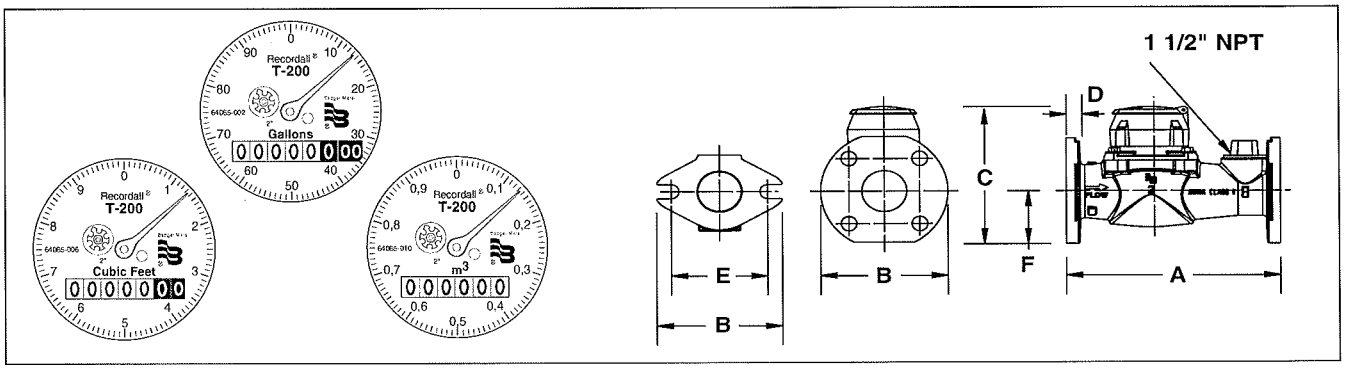
PRESSURE LOSS CHART
Rate of Flow, in Gallons per Minute



ACCURACY CHART
Rate of Flow, in Gallons per Minute

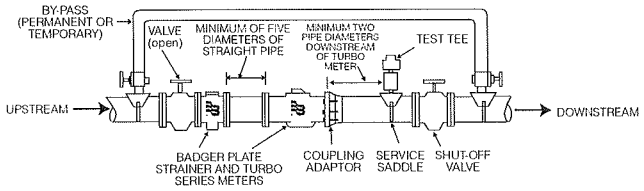


Meter & Pipe Size	DIMENSIONS								
	Length A	Width B	Height C	Flange D	Bolt Circle E	Centerline F	No. Bolts	Net Weight	Shipping Weight
2" EL (DN 50)	10" (254mm)	5 27/32" (148mm)	6 1/2" (165mm)	25/32" (20mm)	4 1/2" (114mm)	2 1/16" (52mm)	2	14.9 lb. (6.8 kg)	16.4 lb. (7.4 kg)
2" RD (DN 50)	10" (254mm)	6" (152mm)	7 3/32" (180mm)	5/8" (16mm)	4 3/4" (121mm)	2 5/8" (67mm)	4	17.4 lb. (7.9 kg)	18.9 lb. (8.6 kg)



PROPER INSTALLATION: The following installation guidelines will insure optimum field performance and reliability when installing a Badger Turbo meter.

1. A strainer is recommended to insure optimum flow conditioning and protection for the turbo meter measuring element.
2. When using a strainer, five (5) diameters of straight pipe separating the strainer upstream of the meter is recommended.
3. ONLY full-open gate valves should be used immediately upstream of the meter. Butterfly valves MUST be five (5) pipe diameters or more upstream of the meter. Full-open gate or butterfly valves can be used downstream.
4. DO NOT install pressure reducing devices or check valves upstream of the meter.
5. Unweighted check valves MUST be located at least three (3) pipe diameters downstream of the meter.
6. Pressure reducing devices and externally weighted check valves MUST be located at least five (5) pipe diameters downstream of the meter.



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.

BadgerMeter, Inc.
P.O. Box 245036, Milwaukee, WI 53224-9536
(800) 876-3837 / Fax: (888) 371-5982
www.badgermeter.com

6. Back Wash Tank

Snyder

Cone Bottom Tanks

Industrial Grade

Cone Bottom Tanks and Stands Features:

- HDLPE (high density linear polyethylene) or rugged XLPE (cross-linked polyethylene) construction.
- Available up to 11,500 gallons.
- Tanks 2,000-gallon capacity and larger available in two wall thicknesses, engineered for 1.5 and 1.9 specific gravity solutions.
- Smaller tanks have standard wall thickness for 1.9 specific gravity.
- Colors are natural (standard) or black.
- Accessory packages, engineering and seismic restraint systems available.
- Welded steel stands for 30° and 45° cone bottom tanks available.
- Stands are coated with black paint with rust inhibitor.

Cone Bottom Tanks

Tank Size (Gals.)	Angle	Dimensions (In.) Dia.	Tank Ht.	Cyl. Ht.	Manway Diameter (In.)	Tank Specific Gravity	XLPE Part Number	XLPE List Price Ea. ($)	HDLPE Part Number	HDLPE List Price Ea. ($)
15	45	16½	30¾	20¼	17	1.9	-	-	15245	127.00
17	60	18½	23½	5¾	8	1.9	-	-	18545	126.00
35	30	30¼	29½	8	10	1.9	-	-	15845	180.00
65	30	30¼	37	15½	10	1.9	-	-	15645	269.00
110	30	30¼	52	30½	10	1.9	-	-	60745	454.00
500	30	86	45¾	4	10	1.9	18842	1,411.00	18845	1,164.00
1,000	30	86	66	23	10	1.9	18942	1,981.00	18945	1,234.00
1,400	30	86	79¾	68	10	1.9	19042	2,231.00	19045	1,458.00
1,500	45	64	140¾	102	18	1.9	-	-	501045	2,187.00
1,650	30	86	95¾	54	10	1.9	19142	2,223.00	19145	1,441.00
2,000	30	90	101¾	63½	18	1.5	507040	2,592.00	507043	2,240.00
2,500	30	90	124⅔	86¾	18	1.5	511040	3,105.00	511043	2,313.00
2,600	45	90	139	85	18	1.5	510040	4,122.00	510043	3,244.00
3,000	30	90	144	102½	18	1.5	515040	4,056.00	515043	2,839.00
3,900	30	90	179¾	141½	18	1.5	544040	6,211.00	544043	5,165.00
4,100	45	90	197¼	143¼	18	1.5	-	-	518043	6,368.00
4,400	30	90	199½	160¾	18	1.5	-	-	520043	6,871.00
5,500	30	90	240½	195½	18	1.5	-	-	704043	10,109.00
6,000	30	142	136	78½	18	1.5	528040	11,278.00	528043	8,571.00
6,500	30	90	272¾	234½	18	1.5	718040	14,476.00	718043	12,911.00
7,400	30	142	156	98½	18	1.5	532040	11,755.00	532043	9,386.00
11,500	30	142	214½	157	18	1.5	534040	24,487.00	534043	22,327.00

Tank stands not included in price.

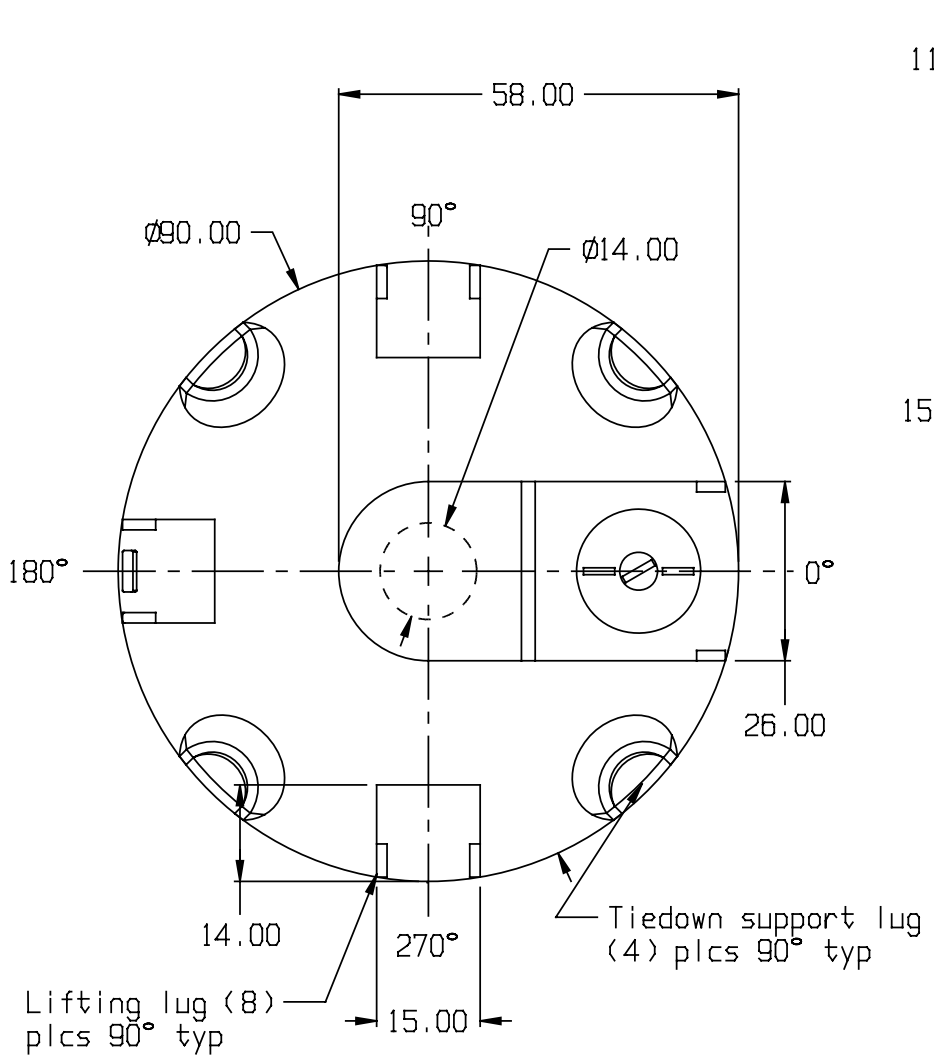
Cone Bottom Tank Stands

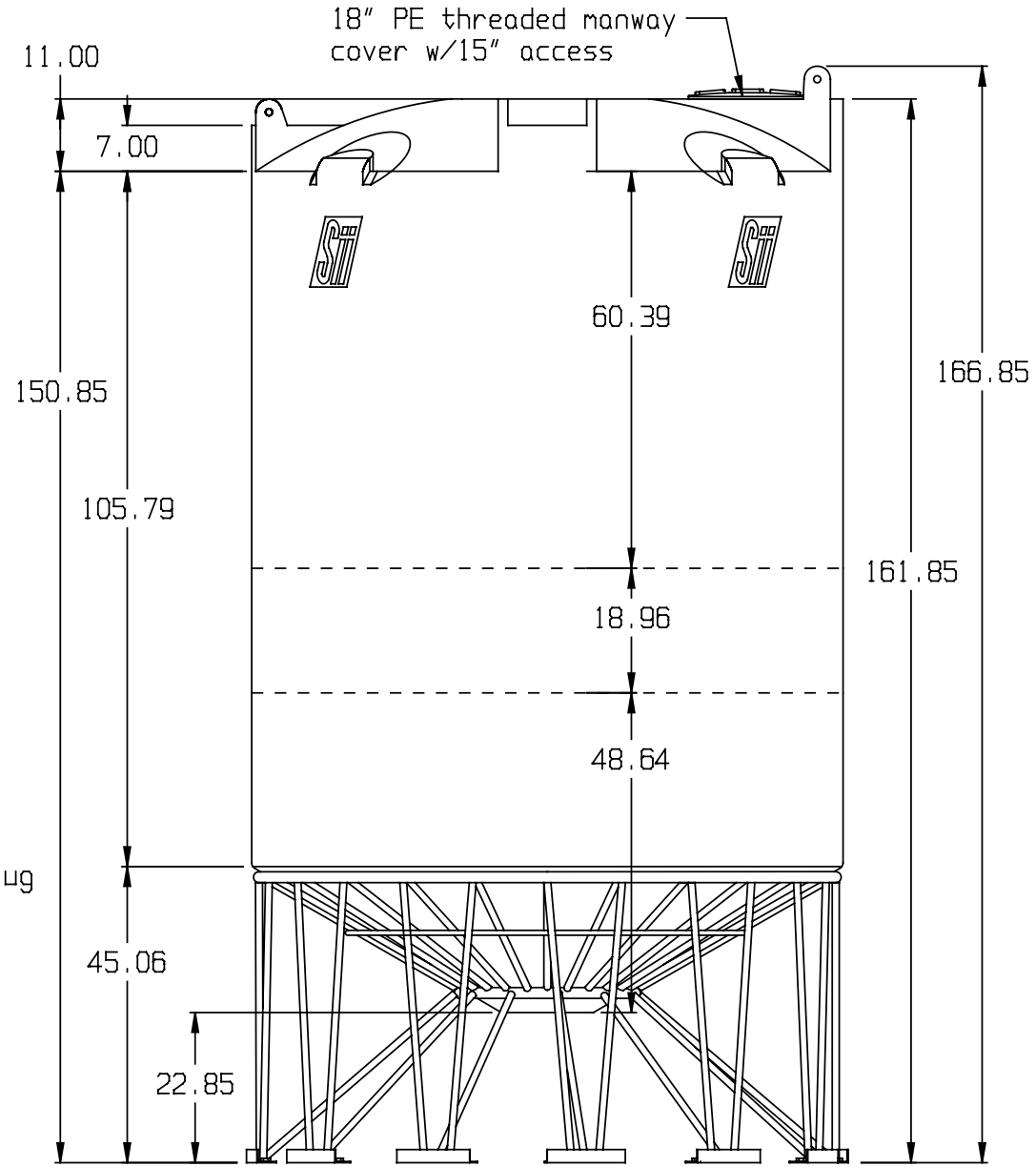
Part Number	Tank Diameter	Stand Capacity (Tons)	Number of Legs	List Price Ea. ($)
30° Cone Bottom Stands Welded				
79000	86	14	4	1,553.00
78900	86	Seismic	4	2,490.00
79300	90	65	12	2,490.00
79800	90	Seismic	12	3,353.00
79500	142	100	12	5,154.00
45° Cone Bottom Stands Welded				
78800	64	12	4	1,520.00
79900	90	Seismic	12	3,246.00
79400	90	60	12	2,683.00

All stands must comply with requirements for seismic restraints.

Small Cone Bottom Stand

Part Number	Tank Size (Gals.)	Cone Angle	List Price Ea. ($)
48900	15	45°	248.00
48400	17	60°	325.00
48600	35, 65 & 110	30°	341.00





SNYDER INDUSTRIES INC.

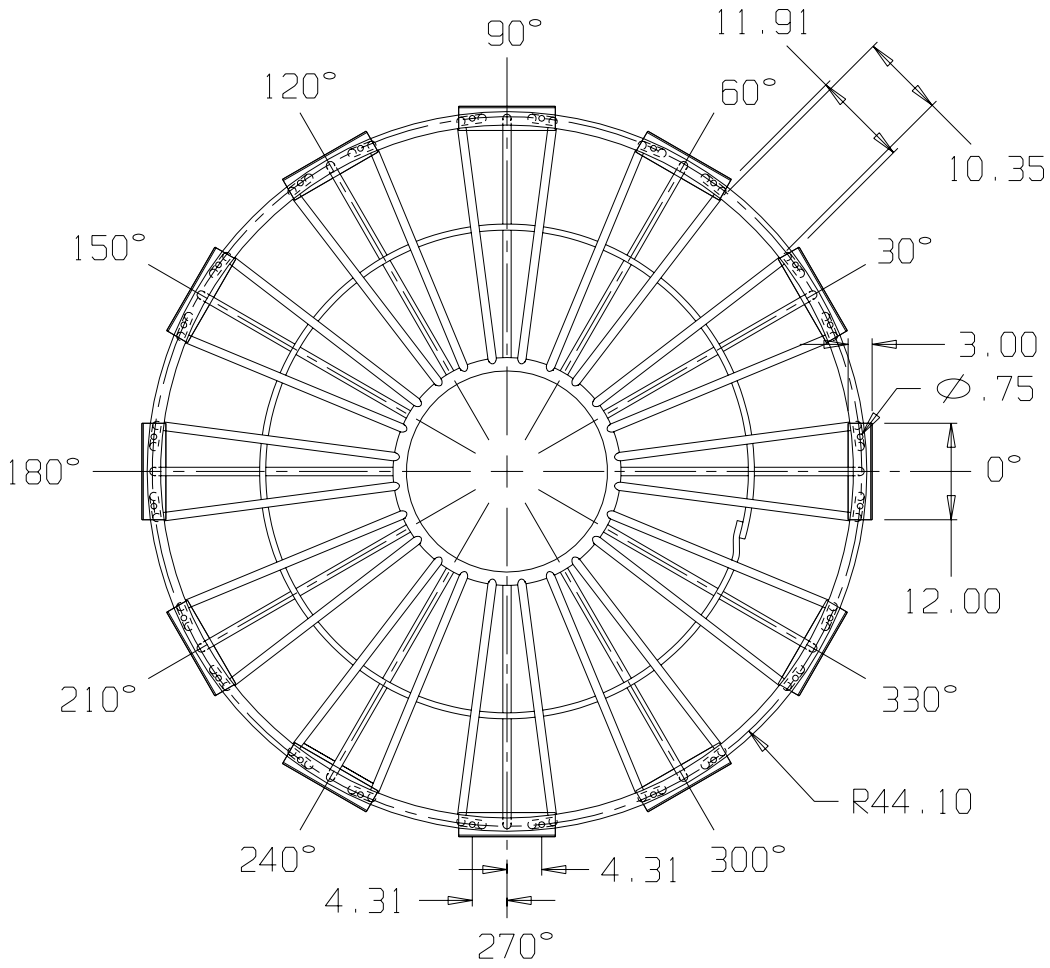
* BASE FITTINGS TO BE LEFT INSTALLED AT TIME OF SHIPMENT PER SII PROCEDURE
* Consult Snyder's Guidelines for Use and Installation prior to delivery. Available on-line at www.snydernet.com

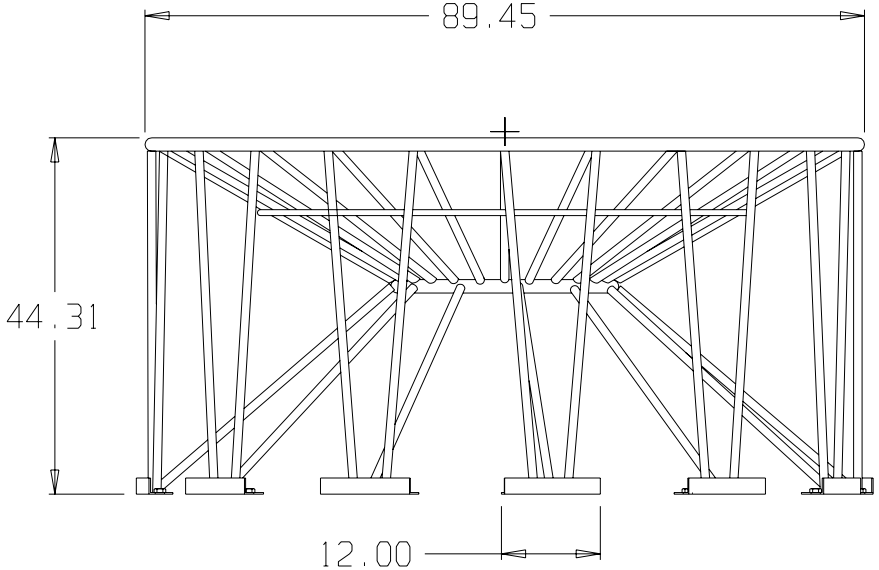
(all dimensions in inches)

3,000 GALLON 30° CONE BOTTOM TANK

PART #	TANK:	5150000N--L
	STAND:	79300000L
		79800000L (SEISMIC)
REF#:	0000	01/02/04

NOTE: CONSULT SII BEFORE MODIFYING ANY PART OF THIS STAND





SNYDER INDUSTRIES INC.

(all dimensions in inches)

PART # STAND: 79300
(SIESMIC): 79800

REF#: 0000

05/23/02

M-SERIES 12-LEG 30° CONE STAND

7. Media Trap

MODEL 72 SIMPLEX BASKET STRAINER

Sizes 3/8″ to 8″ • Iron, Bronze, Carbon Steel or Stainless Steel • Threaded or Flanged

The Industry Standard Simplex Strainer

Features

- Quick open cover – no tools needed
- Heavy wall construction
- Large capacity baskets
- Machined basket seat
- Threaded drain
- Perforated stainless basket

Options

- Basket perforations from 1/32″ to 1/2″
- Basket mesh from 20 to 400
- Monel baskets
- Viton, PTFE-encapsulated, or EPDM seals
- Vent valves
- 1/4″ NPT taps
- Magnetic basket inserts
- Pressure differential gauge and switch

The Eaton Model 72 Simplex Strainer has been the industry standard simplex basket strainer for over 75 years. It's perfect for industrial and commercial applications where the line can be temporarily shut down for strainer basket cleaning or changeout.

A reason for its popularity is the unusually large basket capacity. The free straining area is at least 6 times the cross sectional pipe area (even more in many sizes). No tools are needed to open the cover. The quick opening, swinging yoke can be disassembled and the basket removed in seconds. On sizes 4″ and larger, a special cover clamp is provided to distribute the seating pressure and to insure positive seating of the cover.

Another feature is a threaded drain on every size strainer (fitted with a plug). This can be used as a backwash connection, if desired. Sizes 2″ and larger are provided with legs for bolting to the floor for rock solid installation.

Wall thicknesses are exceptionally heavy. We have not stinted on weight to save material costs. The basket seats are precision machined to give a tight seal and prevent any material from by-passing the basket. The Eaton Model 72 Simplex Basket Strainer is a top quality, heavy duty unit designed to stand up to the most demanding of applications. There is simply no better simplex basket strainer made.

Model 72 Simplex

Size	Material	End Connection *	Seals	Pressure Rating
3/8″ to 3″	Iron and Bronze	Threaded	Buna N	200 psi @ 100F
1″ to 3″	Carbon Steel			
	Stainless Steel		Viton®	
1″ to 8″	Iron	Flanged 125#	Buna N	
	Bronze	Flanged 150#		
	Carbon Steel			
	Stainless Steel		Viton®	

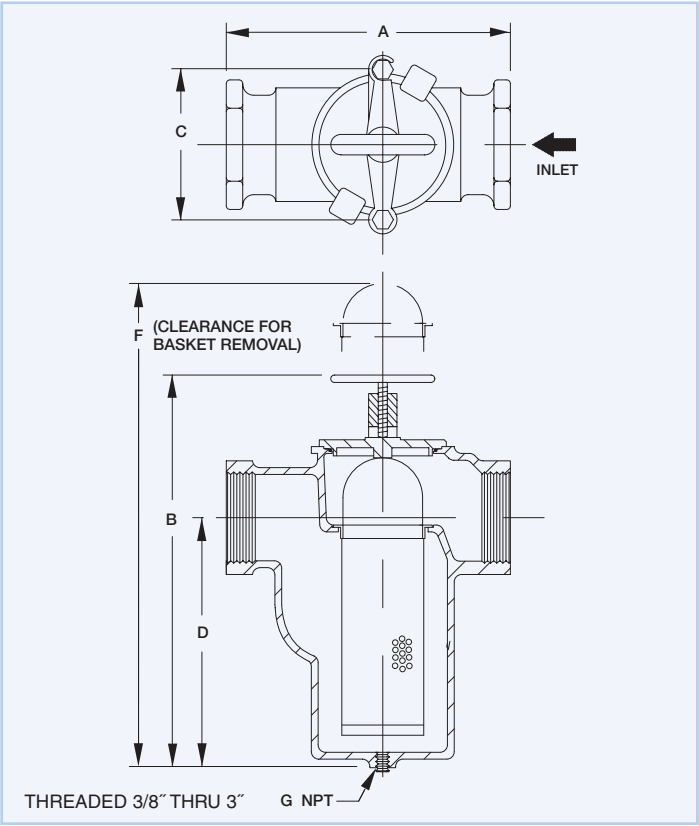
* DIN flanges and BSP threads available

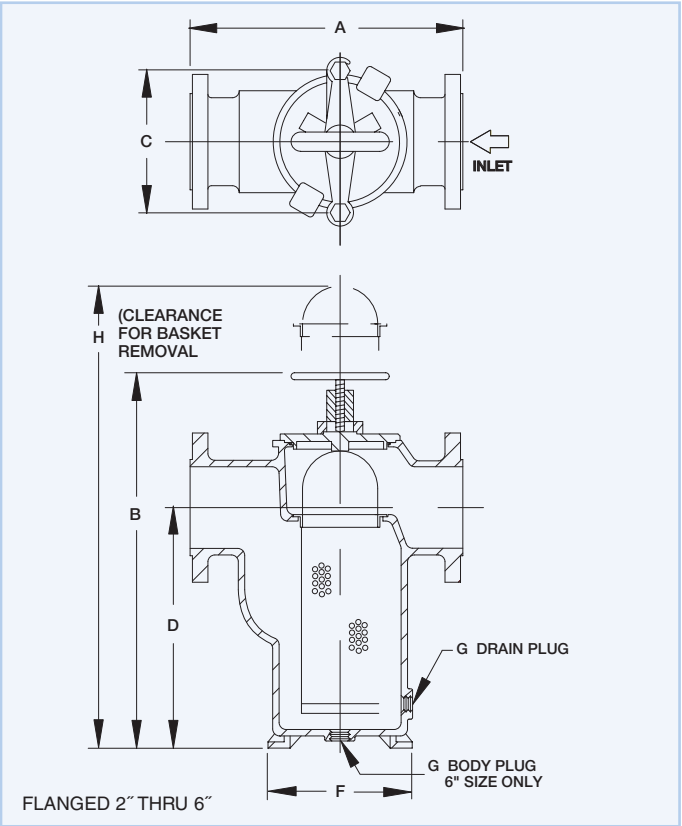
Mod. 72C_V Factors*

Size	Value	Size	Value
3/8″	15.0	2″	73
1/2″	15.0	2-1/2″	125
3/4″	15.0	3″	180
1″	22.5	4″	350
1-1/4″	31.5	6″	900
1-1/2″	46.0	8″	1400

* For water with clean, perforated basket

Technical Details





Dimensions and weights are for reference only. Contact us for certified drawings.

Threaded Model 72 Dimensions (in / mm)

Pipe Size	A	B	C	D	E	F	G	H	Net Wt. - lb / kg Bronze	Carbon Steel	Iron	Stainless Steel
3/8	4.00 / 102	6.63 / 168	2.88 / 73	4.00 / 102	2.38 / 60	11 / 279	3/8 / 10	–	4 / 1.8	—	4 / 1.8	–
1/2	4.00 / 102	6.63 / 168	2.88 / 73	4.00 / 102	2.38 / 60	11 / 279	3/8 / 10	–	4 / 1.8	—	4 / 1.8	–
3/4	5.38 / 137	8.38 / 213	4.00 / 102	5.00 / 127	3.06 / 78	13 / 330	1/2 / 15	–	8 / 3.6	—	7 / 3.2	–
1	5.38 / 137	8.38 / 213	4.00 / 102	5.00 / 127	3.06 / 78	13 / 330	1/2 / 15	–	8 / 3.6	7 / 3.2	7 / 3.2	7 / 3.2
1-1/4	6.75 / 172	9.88 / 251	4.88 / 124	5.88 / 149	3.88 / 99	14 /356	1/2 / 15	–	13 / 6	—	12 / 6	–
1-1/2	7.25 / 184	11.00 / 279	4.88 / 124	7.00 / 178	4.00 / 102	16 / 406	3/4 / 20	–	16 / 7	15 / 7	15 / 7	16 / 7.3
2	8.75 / 222	13.38 / 340	6.75 / 172	7.63 / 194	5.13 / 130	21 / 533	1-1/4 / 32	–	32 / 15	36 / 16	28 / 13	31 / 14
2-1/2	10.38 / 264	14.88 / 378	8.00 / 203	8.63 / 219	6.38 / 162	26 / 660	1-1/2 / 40	–	49 / 22	52 / 24	42 / 19	51 / 23
3	11.50 / 292	17.75 / 468	8.00 / 203	11.38 / 298	6.63 / 168	28 / 711	1-1/2 / 40	–	60 / 27	60 / 27	52 / 23	60 / 27

Flanged Model 72 Dimensions (in / mm)

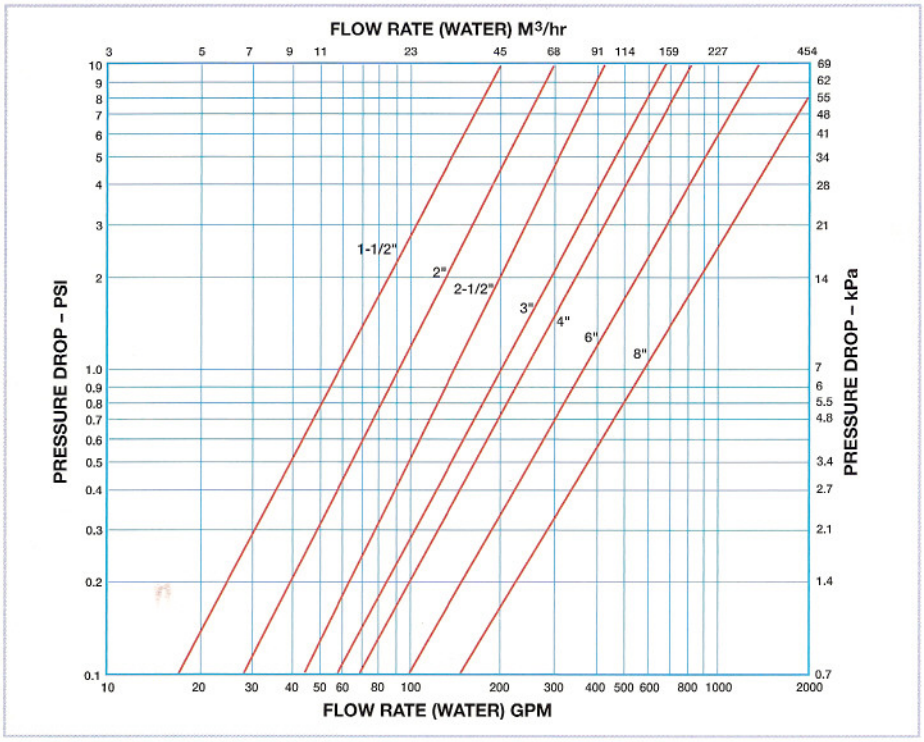
2	10.50 / 268	13.75 / 349	6.75 / 172	7.63 / 194	5.13 / 130	6.25 / 159	3/8 / 10	20.00 / 508	49 / 22.3	36 / 16	36.5 / 17	36 / 16
2-1/2	11.63 / 295	15.63 / 397	8.00 / 203	8.88 / 226	6.38 / 162	7.63 / 194	3/8 / 10	23.00 / 584	64 / 29.1	63 / 27	54 / 25	63 / 29
3	13.13 / 334	18.00 / 457	8.00 / 203	10.63 / 270	6.50 / 165	8.00 / 203	3/8 / 10	27.00 / 686	85 / 38.6	–	76 / 35	–
3	13.13 / 334	18.75 / 476	7.94 / 202	12.00 / 305	6.50 / 165	8.00 / 203	1/2 / 15	27.00 / 686	—	86 / 39	–	86 / 39
4	16.75 / 425	19.88 / 505	10.75 / 273	10.75 / 273	9.63 / 245	11.38 / 289	1/2 / 15	30.00 / 762	140 / 63.6	–	125 / 55	–
4	17.25 / 438	19.88 / 505	10.69 / 272	10.69 / 272	9.25 / 235	11.38 / 289	1/2 / 15	30.00 / 762	—	130 / 59	–	130 / 59
5	18.13 / 461	25.13 / 638	10.75 / 273	15.25 / 387	10.00 / 254	11.38 / 289	1/2 / 15	41.00 / 1041	182 / 82.7	–	170 / 775	–
6	19.63 / 499	28.50 / 724	10.69 / 272	18.38 / 467	10.00 / 254	11.38 / 289	1/2 / 15	46.00 / 1168	270 / 122.7	235 / 107	200 / 91	235 / 107
8	27.00 / 686	40.50 / 1029	–	27.00 / 686	13.75 / 349	17.50 / 445	1/2 / 15	60.00 / 1524	600 / 272.7	550 / 250	500 / 227	550 / 250

MODEL 30 & 72 PRESSURE DROP CURVES

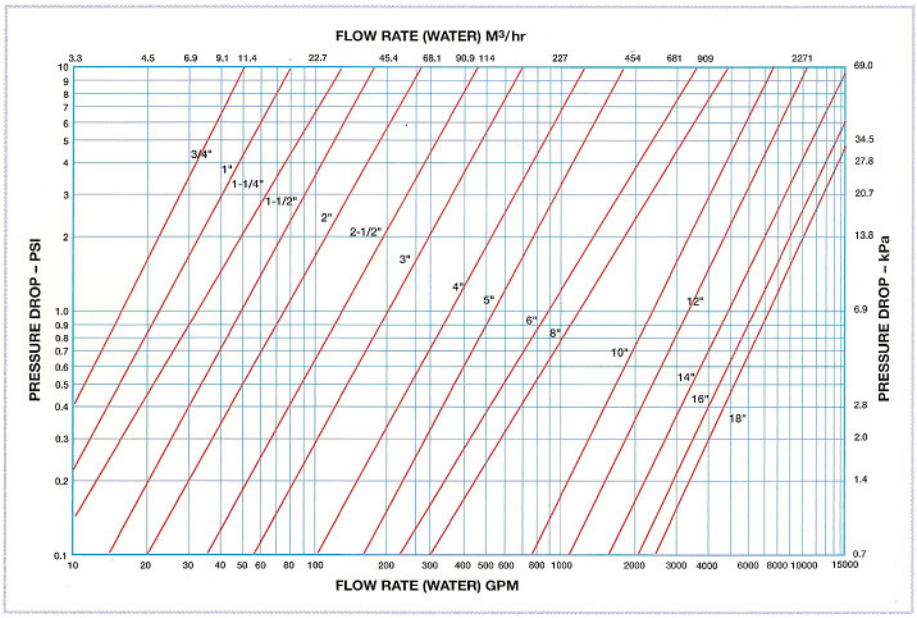
Pressure Drop vs Flow Rate

These curves are for clean baskets, without mesh liners – and with WATER flowing through the strainer.
For mesh-lined baskets and/or for other fluids, you must first compute a correction factor. See Page 47 for full details.

Model 30R Simplex – 1-1/2" through 8"



Model 72 Simplex – 3/4" through 18"



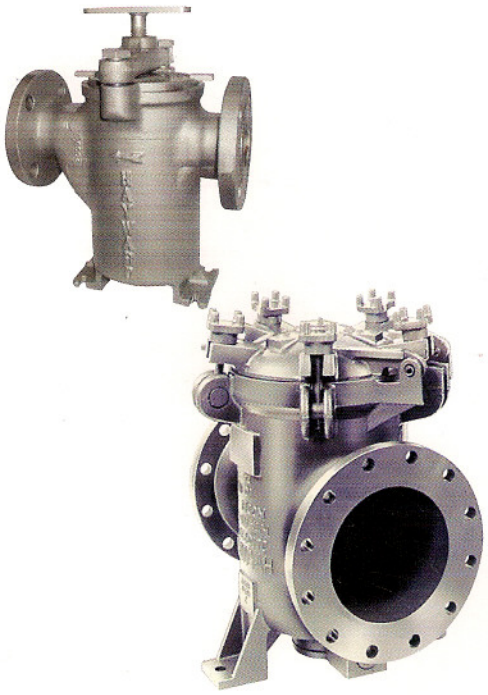


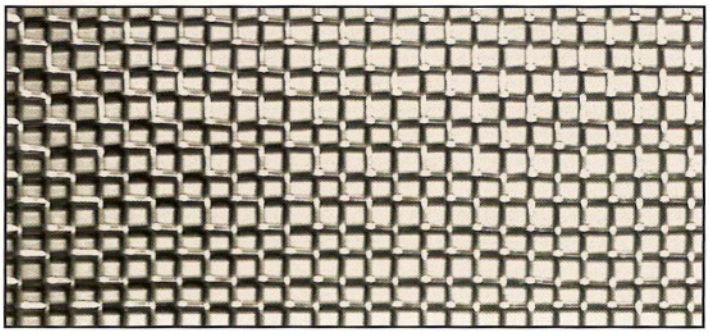
Table A. Perforated Basket Sheet Specifications

Perforation Size Inches	Sheet Thickness USS Gauge #	Hole Pattern	% Open Area
0.020	26	Straight	16.0
1/32	26	Straight	28.0
3/64	24	Straight	30.2
0.045	26	Staggered	36.0
1/16	26	Straight	31.0
1/8	26	Staggered	47.9
5/32	26	Staggered	63.0
3/16	26	Staggered	50.0
1/4	26	Staggered	42.0
3/8	26	Staggered	52.0
1/2	26	Staggered	47.9

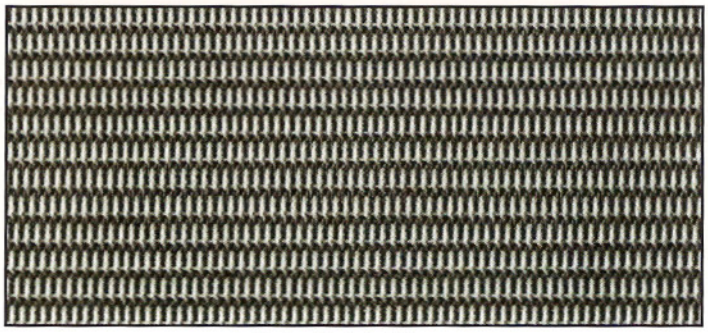
Table B. Mesh Basket Sheet Specifications

Mesh Size	Wire Diameter Inches	Mesh Opening Inches	Mesh Opening Microns	% Open Area
20	0.016	0.0340	864	46.2
40	0.010	0.0150	381	36.0
60	0.0075	0.0092	234	30.5
80	0.0060	0.0065	165	27.0
100	0.0045	0.0055	140	30.3
200	0.0021	0.0029	74	33.6
325	0.0014	0.0017	43	30.0
400	0.0015	0.0381	38	36.0

Wire Mesh Weaves

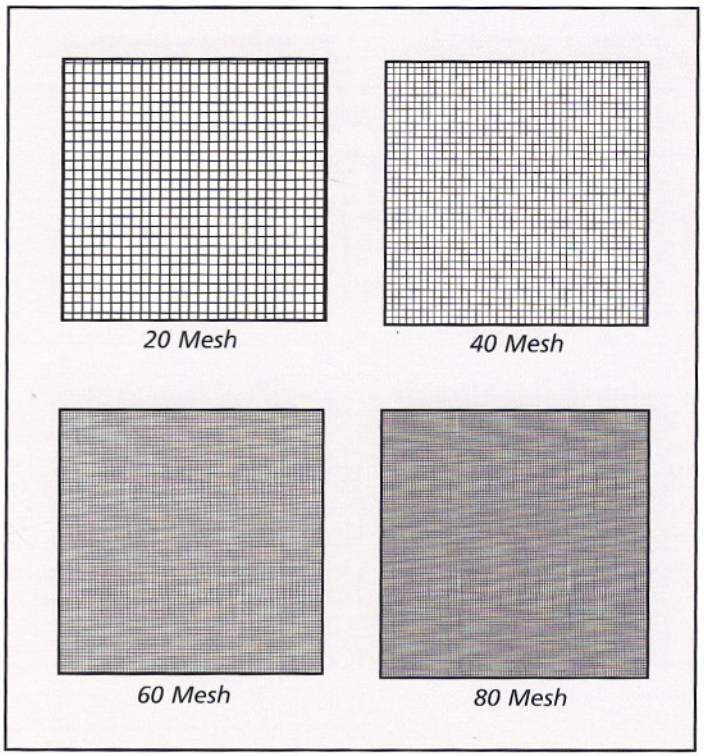


Plain Square Weave



Plain Dutch Weave

Mesh Liners



8. Check Valve

CLA-VAL®

— Model — 584
Flex-Check Valve

INTRODUCTION

The Model 584 Flex-Check Valve™ has been designed to give years of trouble-free operation. This manual will provide you with the information needed to properly install and maintain the valve and to ensure a long service life. The valve is opened by the fluid flow in one direction and closes automatically to prevent flow in the reverse direction. An optional return flow actuator may be mounted on the bottom of the valve to allow manual backflow through the valve in the reverse direction.

The valve is of the flex check type utilizing an angled seat and fully encapsulated, resilient disc. It is capable of handling a wide range of fluids including flows containing suspended solids. The size, flow direction, maximum working pressure, and Model No. are stamped on the nameplate for reference.

CAUTION: Do not use valve for line testing at pressures higher than nameplate rating or damage to valve may occur.

The "maximum working pressure" is the non-shock pressure rating of the valve at 150˚F. The valve is not intended as an isolation valve for line testing above the valve rating.

RECEIVING AND STORAGE

Inspect valves upon receipt for damage in shipment. Unload all valves carefully to the ground without dropping. Do not allow lifting slings or chains to come in contact with the seat area; use eyebolts or rods through the flange holes on large valves.

WARNING: Do not use threaded holes in cover for lifting the valve. Serious injury may result.

Valves should remain crated, clean and dry until installed to prevent weather related damage. For long term storage greater than six months, the rubber surfaces of the disc should be coated with a thin film of FDA approved grease such as Lubriko #CW-606. Do not expose disc to sunlight or ozone for any extended period.

INSTALLATION

Correct installation of the Model 584 Flex-Check Valve™ is important for proper operation. It may be installed in horizontal or vertical flow-up applications. When horizontal, however the valve must be installed with the nameplate facing up and the cover level. In all installations, the flow arrow cast in the valve cover must be pointed in the direction of flow during normal system operation.

WARNING: Do not use threaded holes in cover for lifting the valve. Serious injury may result.

FLANGED ENDS: Flanged valves should only be mated with flat-faced pipe flanges equipped with full-face resilient gaskets. The valve and adjacent piping must be supported and aligned to prevent cantilevered stress on the valve. Once the flange bolts or studs are lubricated and inserted around the flange, tighten them uniformly hand tight. The tightening of the bolts should then be done in graduated steps using the **crossover tightening** method. Recommended lubricated torque values for use with resilient gaskets (75 durometer) are given in Table 1. If leakage occurs, allow gaskets to absorb fluid and check torque and leakage after 24 hours. Do not exceed bolt rating or extrude gasket.

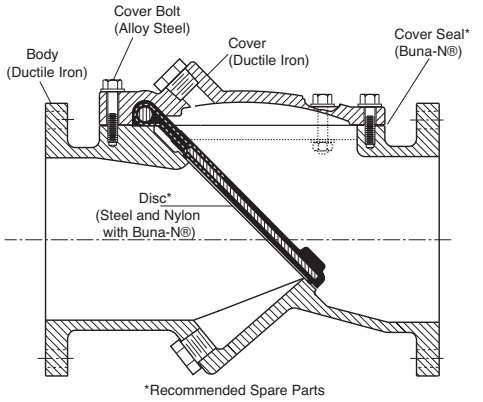
CAUTION: The use of ring gaskets or excessive bolt torque may damage valve flanges.

TABLE 1. FLANGE BOLT TORQUES

Valve Size (in)	Bolt Dia (in)	Recommended Torque (ft-lbs.)	Max. Torque (ft-lbs)
3	5/8	25	90
4	5/8	25	90
6	3/4	30	150
8	3/4	40	150
10	7/8	45	205
12	7/8	65	205
14	1	80	300
16	1	80	300
18	1 1/8	100	425
20	1 1/8	100	425
24	1 1/4	150	600

VALVE CONSTRUCTION

The standard Model 584 Flex-Check Valve™ is constructed of rugged Ductile iron with a rubber-encapsulated disc. The disc is the only moving part, assuring long life with minimal maintenance. The body is flanged for connection the pipeline with an open top sealed with a cast cover. The disc is retained by the cover.



*Recommended Spare Parts

MAINTENANCE

The Model 584 Flex-Check Valve™ requires no scheduled lubrication or maintenance. For service or inspection, the valve can be serviced without removal from line.

VALVE INSPECTION: If inspection of the valve is required, follow the Disassembly Instructions.

TROUBLESHOOTING

Several problems and solutions are presented below to assist you in troubleshooting the valve.

- Leakage at Bottom Actuator: Remove line pressure and exercise actuator. If leak persists, replace seals in actuator; see the Return Flow Actuator Seal Replacement Procedure
- Leakage at Cover or Flanges: Tighten bolts, replace cover seal.
- Valve Leaks when Closed: Inspect disc for damage and replace. Inspect body seating surface and clean if necessary.

• Valve Does not Open: Check for obstruction in valve or pipeline. Operating pressure may be less than cracking pressure. If less than 0.5 psig, review application with factory.

DISASSEMBLY

The valve can be disassembled without removing it from the pipeline. Alternately, for convenience, the valve can be removed from the line. All work on the valve should be performed by a skilled mechanic with proper tools and a power hoist for larger valves. Disassembly may be required to inspect the disc for wear or the valve for deposits.

WARNING: The line must be drained before removing the cover or pressure may be released causing bodily harm.

1 Relieve pressure and drain the pipeline.
Remove the cover bolts on the top cover.
2 Carefully pry cover loose and lift off valve body. 12" and larger valves
have tapped holes in cover for lifting eyebolts.
3 Remove disc and inspect for cracks, tears or damage in rubber sealing surface.
4 Clean and inspect parts. Replace worn parts as necessary and lubricate parts with thin film of FDA grease, such as Lubriko # CW-606.

RE-ASSEMBLY

All parts must be cleaned. Gasket surfaces should be cleaned with a stiff wire brush in the direction of the serrations or machine marks. Worn parts, gaskets and seals should be replaced during reassembly.
1 Lay disc over seat with beaded seating surface directed down.
2 Lay cover gasket and cover over bolt holes and disc hinge.
3 Insert lubricated bolts, noting that the bolts in the hinge area are longer than the other cover bolts.
4 Cover bolts should be tightened to the following specifications during assembly.

TABLE 2. VALVE COVER BOLT TORQUES

Valve Size (inches)	Cover Bolt Size	Torque (ft-lbs.)
2 - 2.5	1/2	75
3"	7/16	50
4	1/2	75
6	7/16	50
8	9/16	100
10	3/8	200
12 - 20	7/8	250
24	1	300

RETURN FLOW ACTUATOR OPERATION:

WARNING: Relieve line pressure before using backflow actuator or damage may occur.

An optional return flow actuator assembly is available which can be easily installed in the field. The actuator is not designed to operate at the valve's maximum working pressure rating, therefore, prior to using the actuator, close all isolation valves and bleed off line pressure. To operate, turn the handle clockwise. This will open the valve disc allowing backflow through the valve. The handle should turn easily. When resistance is felt, the disc has reached its body stop and is in the full open position. Upon completion of the back flushing operation, turn the handle counter-clockwise and the valve will automatically return to the closed position. Lock the actuator in the closed position with the jam nut provided. The system is again ready for normal operation.

RETURN FLOW ACTUATOR FIELD INSTALLATION:

WARNING: Removal of the bottom plug while under pressure may cause bodily harm.

1 Depressurize and drain the pipeline.
2 Remove the pipe plug in the bottom boss of the valve.
3 Inspect the return flow rod and place in the non-extended position. (The rod should extend about 1" past the end of the brass bushing.) Apply Teflon™ thread sealant to brass threads.
4 Insert the threaded end of the assembly into the valve boss. Slowly turn the assembly into the boss, taking care not to cross-thread the bushing. Continue turning the assembly into the valve for a tight fit.

RETURN FLOW ACTUATOR SEAL REPLACEMENT:

There are two parts (Rod Wiper and O-ring) on return flow actuator that are subject to wear. To replace seals, the valve and pipeline must first be depressurized and drained. Next, remove the return flow assembly from the valve by turning brass bushing counter-clockwise. Disassemble actuator as follows:
1 Remove one of the vinyl caps.
2 Remove the T-Handle and jam nut from the rod.
3 Remove the rod from the bushing by screwing in rod fully clockwise and pull rod through the valve end of the bushing.
4 Lubricate new seals with FDA approved grease such as Lubriko #CW-606 and install in bushing end grooves.
5 Clean, lubricate, and reinstall rod in bushing.
6 Re-install jam nut and T-Handle.
7 Place vinyl cap on handle.
8 Apply Teflon™ thread sealant to bushing and carefully thread into valve taking care not to cross-thread bushing.

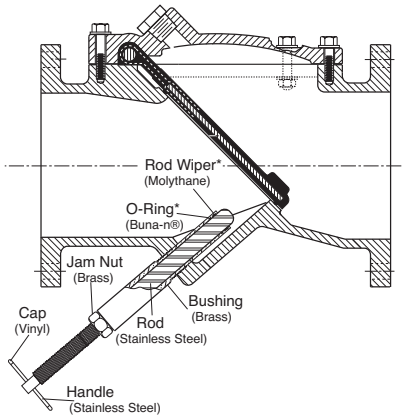
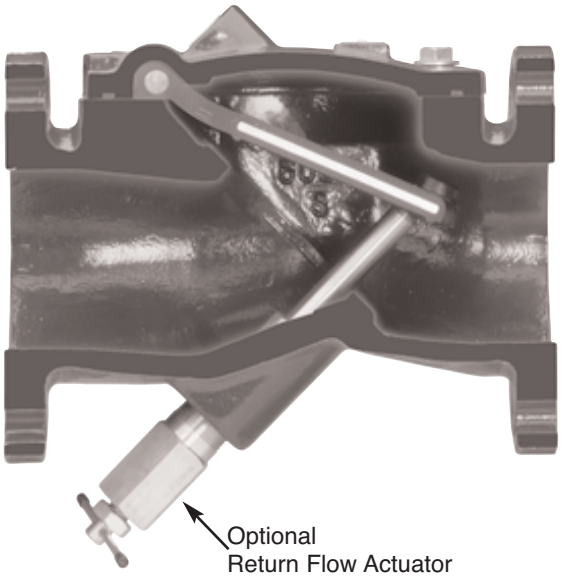


FIG. 3. BACKFLOW ACTUATOR ASSEMBLY

Model 584

Flex-Check Valve™



- **Full Pipe Size Flow Area**
- **Drop Tight Seating**
- **Non-Slam Closure**
- **Fusion Bonded Epoxy NSF-61**
- **Optional Return Flow Actuator**

The Cla-Val Model 584 Flex-Check Valve is designed for long service life and maintenance free check valve operation compared to traditional swing check valves. It has a full-flow area body with integral seat at 45° angle to reduce head loss. This minimizes disc travel to 35° degrees for improved no-slam check action and for reliable vertical up flow operation even on slurry applications. Body and Cover are fusion bonded NSF-61 epoxy coated for long service life on potable and non-potable systems. Unique one-piece steel and nylon reinforced Buna-N rubber disc assembly flexes to eliminate traditional metal hinge problems. During system flowing conditions the disc flexes up to the open position allowing unrestricted flow through the valve. When system reverse flow conditions occur the disc flexes down to the closed position for drop-tight seal preventing reverse flow. The flex-disc reliability is test-proven to over one million cycles. The optional Return Flow Actuator offers manual opening for pump priming, back flushing, draining lines, or system testing needs and is easy to field install.

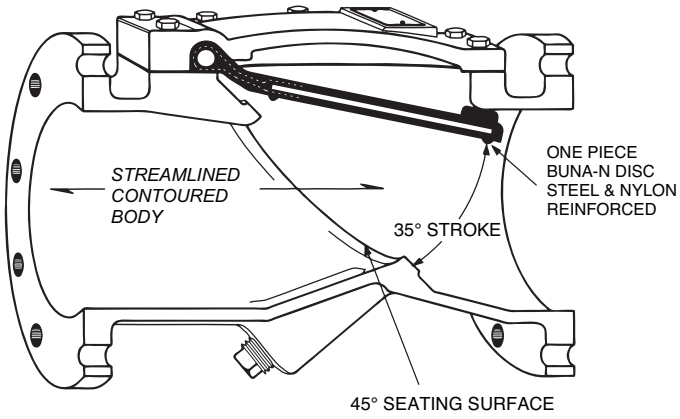
Cla-Val Flex-Check Valve™ Specifications

The check valve shall be of the Flex-Check Valve™ full body flanged type, with a domed access cover and only one moving part - the flexible valve disc.

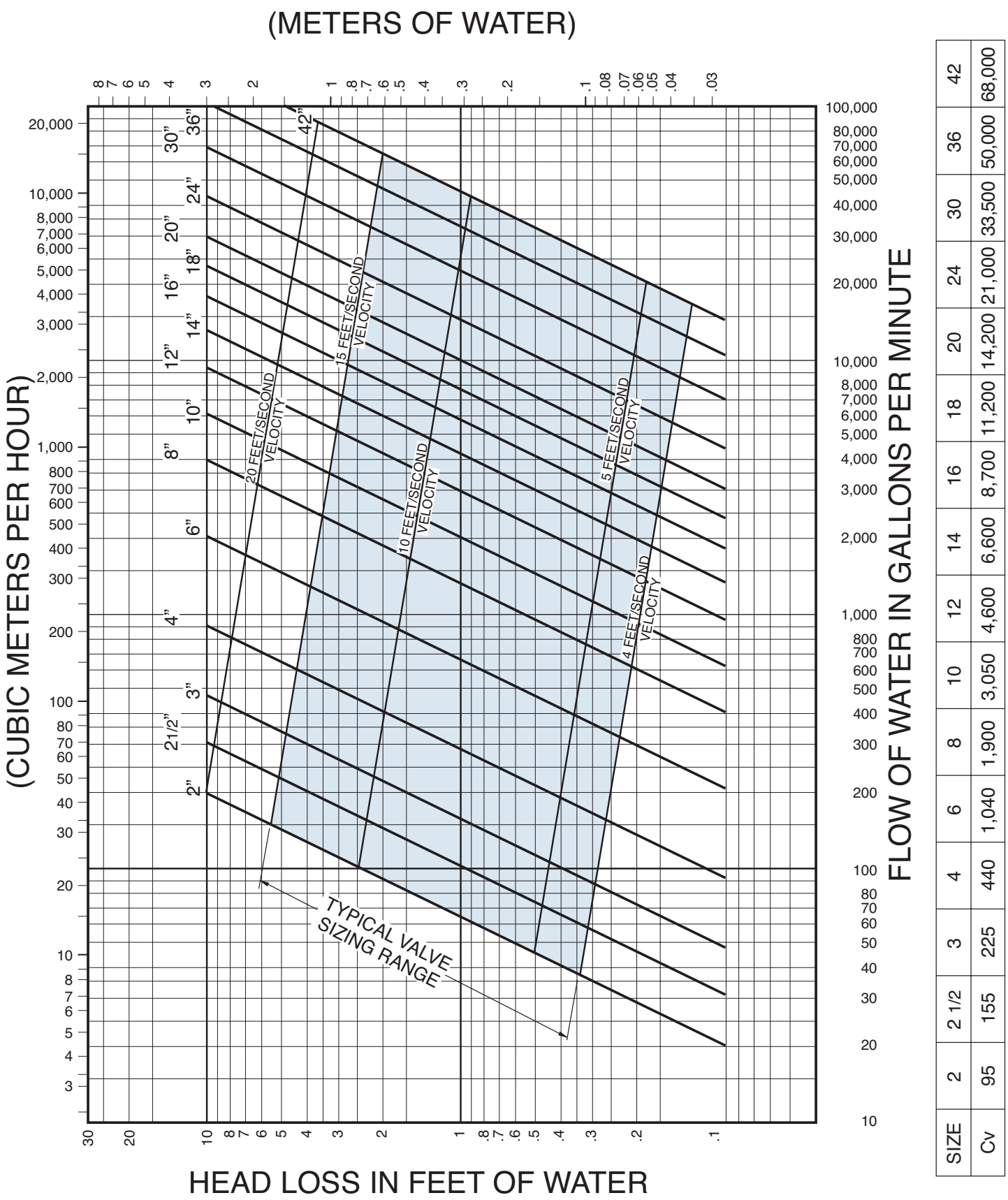
The valve body shall have full flow equal to nominal pipe diameter at any point through the valve. The seating surface shall be on a 45° angle to minimize disc travel and shall include a port for installation of a screw type return flow actuator for manually activated return flow capabilities. The top access port of the body shall be full size, allowing removal of the disc without removal of the valve from the pipeline. The cover shall be domed to create a flushing action around the disc when valve is open. The valve body and cover shall be ASTM A536 Grade 65-45-12, Class B Ductile Iron coated and lined with an ANSI/NSF61 approved fusion bonded epoxy coating. The Model 584 Flex-Check Valve™ shall be designed, manufactured, and tested ain accordance with ANSI/AWWA Standard C-508.

The disc shall be one-piece construction, precision molded with an integral O-ring type sealing surface and contain steel and nylon reinforcements in the central disc area and in the flex support area. The non-slam closing characteristic shall be provided through a short 35° disc stroke and disc return action. The disc shall be Buna-N® (NBR), ASTM D20000-BG.

This valve shall be a Cla-Val Model 584 Flex-Check Valve™ as manufactured by Cla-Val, Newport Beach, CA 92659-0325.



584 Flex-Check Valve Head Loss Chart



SIZE	2	2 1/2	3	4	6	8	10	12	14	16	18	20	24	30	36	42
Cv	95	155	225	440	1,040	1,900	3,050	4,600	6,600	8,700	11,200	14,200	21,000	33,500	50,000	68,000

9. Air Release Valve

AIR RELEASE VALVE

SERIES NO. 25

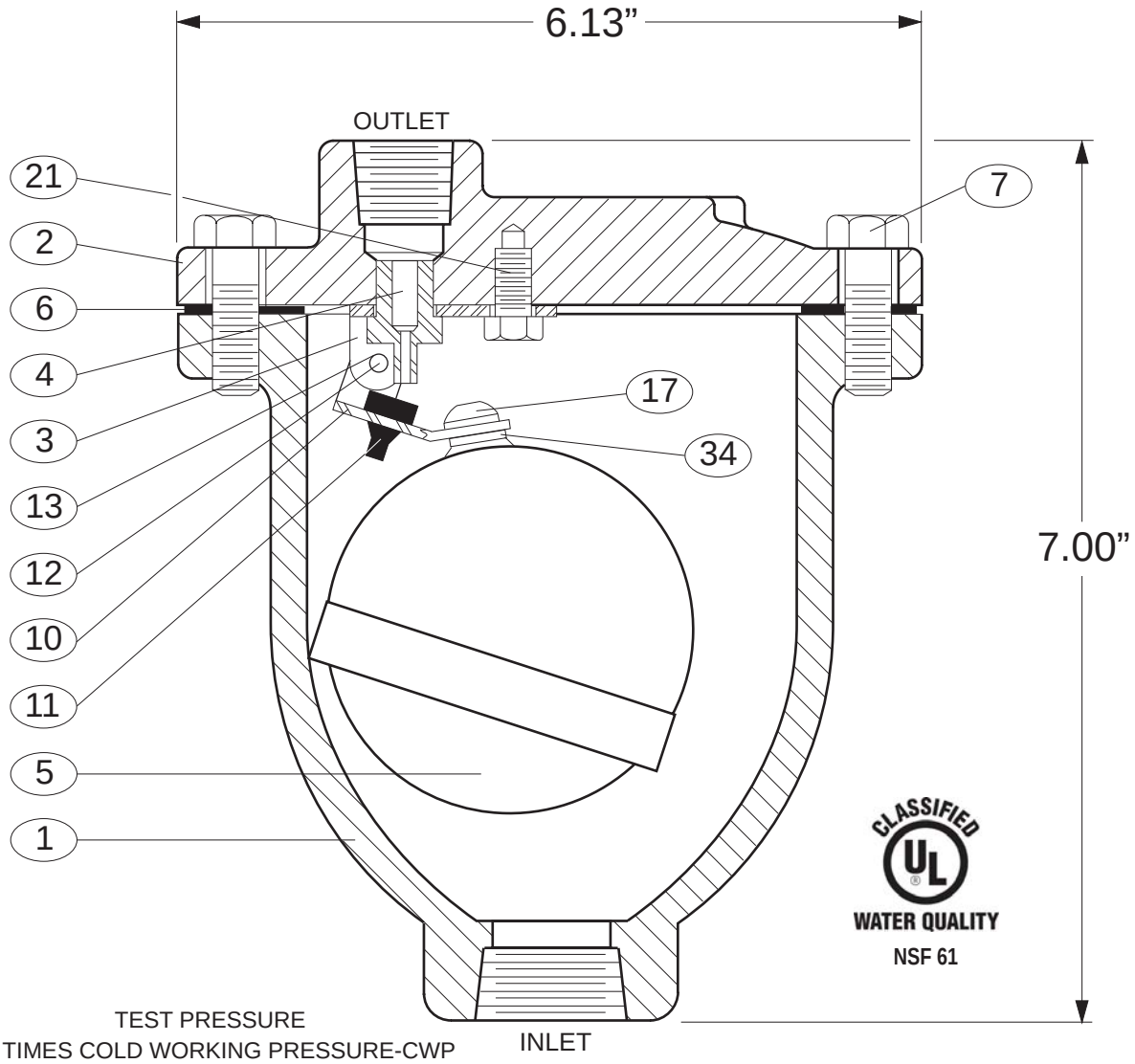
STANDARD MATERIALS OF CONSTRUCTION

PART NO.	PART NAME	MATERIAL
1	BODY	CAST IRON ASTM A126, CLASS B
2	COVER	CAST IRON ASTM A126, CLASS B
3	LEVER FRAME	STAINLESS STEEL T316, ASTM A240
4	SEAT	STAINLESS STEEL T316, ASTM A276
5	FLOAT	STAINLESS STEEL T316, ASTM A240
6	GASKET	COMPRESSED NON-ASBESTOS FIBER
7	COVER BOLT	ALLOY STEEL SAE, GRADE 5
10	FLOAT ARM	STAINLESS STEEL T316, ASTM A240
11	ORIFICE BUTTON	VITON
12	PIVOT PIN	STAINLESS STEEL T316, ASTM A479
13	PIN RETAINER	STAINLESS STEEL PH 15-7 MO
17	FLOAT RETAINER	STAINLESS STEEL T316, ASTM F879
21	LOCATOR	STAINLESS STEEL T316, ASTM F593
34	LOCK WASHER	STAINLESS STEEL T316, ASTM A240

NOTE: ALL SPECIFICATIONS AS LAST REVISED.

Revised 1-29-03

MATERIALS OF CONSTRUCTION	DATE 2/4/74
VAL-MATIC® VALVE AND MANUFACTURING CORP.	DRWG. NO. VM-25-M



SEE DRAWING NO. VM-25-M FOR STANDARD MATERIAL OF CONSTRUCTION.

VALVE SIZE *	MODEL NO.	INLET SIZE	OUTLET SIZE	CWP P.S.I.	ORIFICE SIZE
3/4"-1"	25.5	1" N.P.T.	1/2" N.P.T.	150	1/8"
3/4"-1"	25.6	1" N.P.T.	1/2" N.P.T.	300	3/32"

*When multiple size inlets are indicated for a specific model number, the valve is threaded for the largest size indicated and a reducer bushing is provided for the smaller sizes.

1	BODY	10	FLOAT ARM
2	COVER	11	ORIFICE BUTTON
3	LEVER FRAME	12	PIVOT PIN
4	SEAT	13	PIN RETAINER (NOT SHOWN)
5	FLOAT	17	FLOAT RETAINER
6	GASKET	21	LOCATOR
7	COVER BOLT	34	LOCK WASHER

Revision 2-24-09

AIR RELEASE VALVE

DATE 2-4-74

VAL-MATIC® VALVE AND MANUFACTURING CORP.

DRWG. NO. VM-25

AIR RELEASE VALVE

SERIES NO. 15A

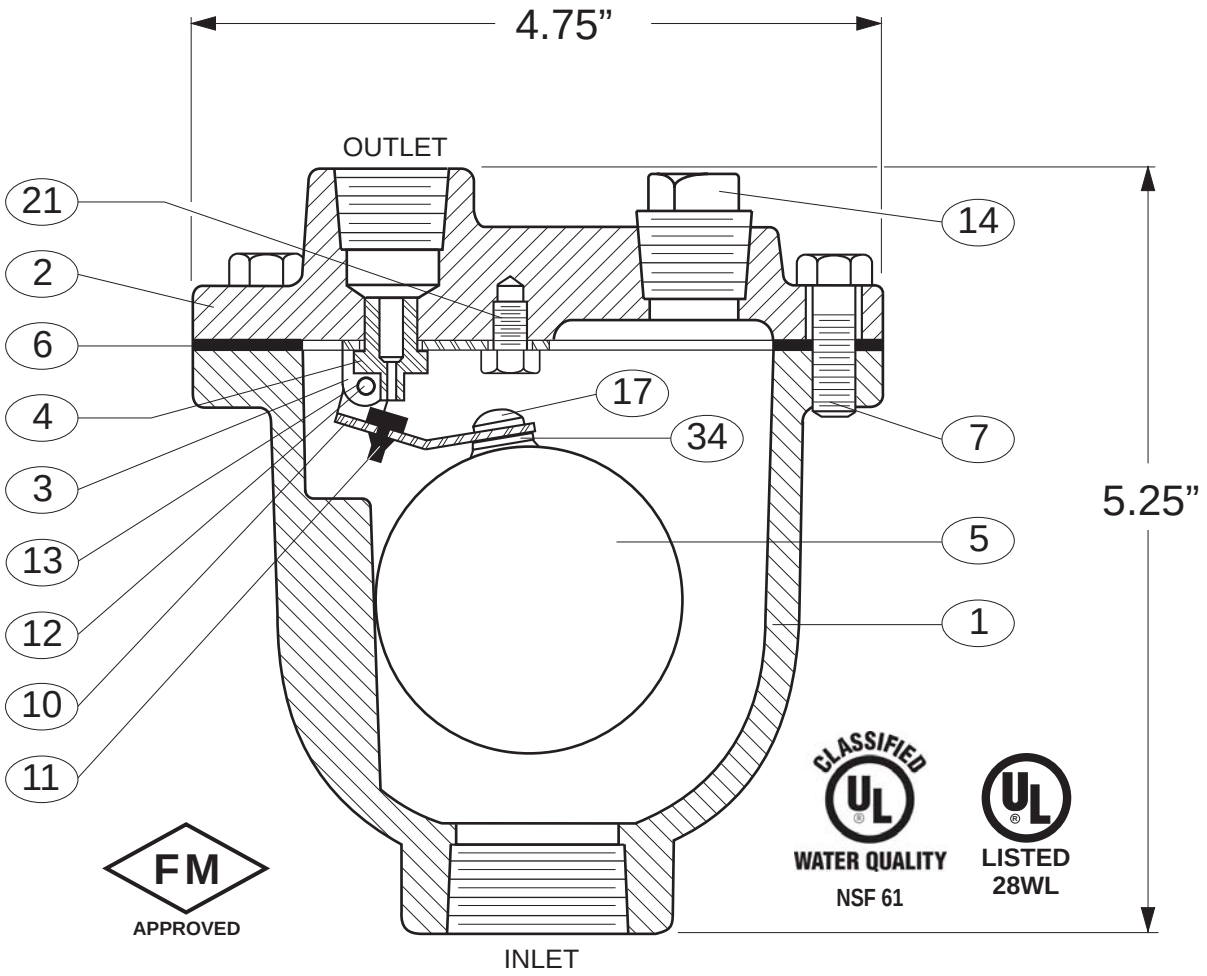
STANDARD MATERIALS OF CONSTRUCTION

PART NO.	PART NAME	MATERIAL
1	BODY	CAST IRON ASTM A126, CLASS B
2	COVER	CAST IRON ASTM A126, CLASS B
3	LEVER FRAME	STAINLESS STEEL T316, ASTM A240
4	SEAT	STAINLESS STEEL T316, ASTM A276
5	FLOAT	STAINLESS STEEL T316, ASTM A240
6	GASKET	COMPRESSED NON-ASBESTOS FIBER
7	COVER BOLT	ALLOY STEEL SAE, GRADE 5
10	FLOAT ARM	STAINLESS STEEL T316, ASTM A240
11	ORIFICE BUTTON	VITON
12	PIVOT PIN	STAINLESS STEEL T316, ASTM A479
13	PIN RETAINER	STAINLESS STEEL PH 15-7 MO
14	PIPE PLUG	STEEL
17	FLOAT RETAINER	STAINLESS STEEL T316, ASTM F879
21	LOCATOR	STAINLESS STEEL T316, ASTM F593
34	LOCK WASHER	STAINLESS STEEL T316, ASTM A240

NOTE: ALL SPECIFICATIONS AS LAST REVISED.

Revised 1-29-03

MATERIALS OF CONSTRUCTION	DATE 2/23/87
VAL-MATIC® VALVE AND MANUFACTURING CORP.	DRWG. NO. VM-15A-M



TEST PRESSURE
1.5 TIMES COLD WORKING PRESSURE-CWP

SEE DRAWING NO. VM-15A-M FOR STANDARD MATERIAL OF CONSTRUCTION.

VALVE SIZE	MODEL NO.	INLET SIZE	OUTLET SIZE	CWP P.S.I.	ORIFICE SIZE
1/2"	1/2"-15A	1/2" N.P.T.	1/2" N.P.T.	175	1/16"
3/4"	3/4"-15A.2	3/4" N.P.T.	1/2" N.P.T.	175	1/16"
1"	1" -15A.3	1" N.P.T.	1/2" N.P.T.	175	1/16"

1	BODY	11	ORIFICE BUTTON
2	COVER	12	PIVOT PIN
3	LEVER FRAME	13	PIN RETAINER (NOT SHOWN)
4	SEAT	14	PIPE PLUG
5	FLOAT	17	FLOAT RETAINER
6	GASKET	21	LOCATOR
7	COVER BOLT	34	LOCK WASHER
10	FLOAT ARM		

Revision 2-24-09

AIR RELEASE VALVE

DATE 2-23-87

VAL-MATIC® VALVE AND MANUFACTURING CORP.

DRWG. NO. VM-15A

10. Differential Pressure Gauge

0-5 to 0-1000 psid
Piston Sensor for Liquids

Features

- **Heavy duty — to 10,000 psi line pressure**
- **Weatherproof design and rugged construction**
- **Gauge, switch and transmitter versions**
- **Popular in filtration and flow measurements**

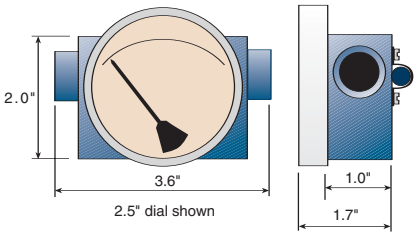
Our piston sensor models are for liquid applications where durability and long life are required. Their simple design has fewer parts to wear out and also keeps the price low.

A magnet attached to the dial pointer shaft follows a spring-loaded sensor magnet that moves as differential pressure changes. In this way the DP displacement of the sensor is translated to our easy-to-read 2.5 to 6-inch diameter dials.

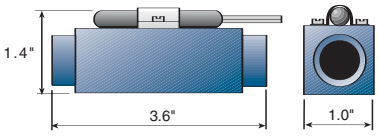
Select from a variety of options such as follower pointers, red arcs and mounting brackets along with switch, relay or transmitter outputs. See page 5 for a complete list of standard options.

Dimensions

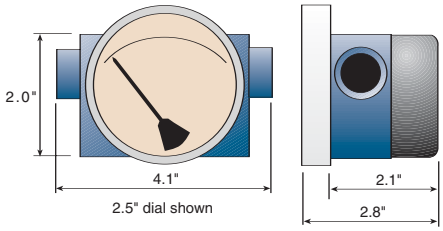
Detailed drawings on website.



1201PGS



1201PS



1203PGS

Specifications (Detailed Specification Sheets on Website)

Model	Differential pressure range	Maximum line pressure/ temperature	Accuracy (F.S.) (Ascending)	Porting (Many porting types available)	Electrical Available**
1201PG/PGS/PS	0-5 to 0-150 psid (0-0.33 to 0-10 bar)	3000 psig (200 bar) 200°F (93°C)	2%	¼" NPT	1 switch no enclosure
1203PG/PGS/PS/PGT/PT	0-5 to 0-150 psid (0-0.33 to 0-10 bar)	5000 psig (340 bar) 200°F (93°C)	2%	¼" NPT	1 or 2 switches 1 relay transmitter Class 1 Div. 2/NEMA 4X For Class 1 Div. 1, see pg. 26
1206PG*	0-5 to 0-150 psid (0-0.33 to 0-10 bar)	10,000 psig (680 bar) 200°F (93°C)	2%	¼" NPT	1 or 2 switches, 1 relay NEMA 4X
1306PG*	0-100 to 0-1000 psid (0-7 to 0-67 bar)	7500 psig (482 bar) 200°F (93°C)	2%	¼" NPT	1 or 2 switches, 1 relay NEMA 4X

P=Piston G=Gauge S=Switch T=Transmitter

*PS and PGS transmitter versions available
**NEMA 4X switch models have a 1/2 inch NPT conduit port as standard. A DIN 43650A-PG11 with mating connector is optional, rated IP65 & NEMA 4X

How to Order

Select from each of the applicable categories to construct a model number. Use the model number when ordering or obtaining additional information and pricing from Orange Research or your local distributor.
Reordering? You must supply the Part Number from your instrument label.

Sample Model Number

1201PGS – 1A – 2.5B – A 0-5 psid, 1, 3, E

1201PGS	–	1A	–	2.5B	–	A	0-5 psid	,	1, 3, E
Model		**Pressure Body**		**Dial Case**		**Electrical**	**Range**		**Options (more on pg. 5)**
1201PG 1201PGS 1201PS 1203PG 1203PS 1203PGS 1206PG 1306PG ***More models above***		***In-line ports:*** 1A = aluminum 1C = 316 stainless steel 1E = brass ***Change "1" above to "4" for back ports; to "5" for bottom ports*** ***Back/bottom ports N/A on 1203 or 1300 series; Brass N/A on 1300 series***		2.5B = 2.5" basic 3.5B = 3.5" basic 4.5B = 4.5" basic 6B = 6.0" basic ***Change "B" to "F" above for flanged dial case***		A = SPST, N.O. B = SPST, N.C. C = SPDT A-A = 2 ea. - A B-B = 2 ea. - B C-C = 2 ea. - C R2 = relay T2 = transmitter	0-5, 0-8, 0-10, 0-15, 0-20, 0-25, 0-30, 0-35, 0-40, 0-50, 0-60, 0-80, 0-100, 0-125, 0-150 psid ***1300 series ranges to 1000 psid***		1 = ½" NPT 2 = plastic lens 3 = liquid filled (glycerine) 4 = follower pointer 5 = Teflon coated magnet/spring 6 = red arc (specify range) 7 = dual scale (specify both) 8 = high temperature Special Seals (Buna-N standard): E = EPDM V = Viton F = Fluorosilicone T = Teflon

Orange Research Inc.
140 Cascade Boulevard, Milford, Connecticut 06460
203 877-5657 800 989-5657 Fax: 203 783-9546
www.orangeresearch.com

Product specifications for model 1203

Product Specifications, with reed switches or relays

sensor type	piston
functions	**gauge,gauge/switch, switch**
min. range	0-5 psid
max. range	0-150 psid
max. line pressure	5000 psig
min. burst pressure	15000 psig
standard maximum temperature	gauge: 200°F standard, 150°F (plastic lens) gauge/switch: 176°F standard, 150°F (plastic lens) switch: 176°F standard, 140°F relay
high temp. construction	gauge: 450°F(SS), 400°F(naval brass), 300°F.(alum) gauge/switch, switch: N/A
minimum temperature*	**Consult factory for low-temperature applications.*
calibration accuracy**	±2% of full scale ascending after rap at room temperature ***Calibration accuracy is affected by temperature, and also by liquid-filling and follower-pointer options.*
repeatability	±2% of full scale
switches/relay	1 or 2 hermetically sealed reed switches or 1 relay in weatherproof enclosure
switch adjustability	upper 80% of full scale ascending (70% for B & C form switches in SST)
switch dead band	5-20% full scale
certification	CSA Class I,DIV. 2,Groups A,B,C & D; Class II,DIV. 2,Groups F & G (File 152872) NEMA 4X,IP65 **Consult factory for CE equivalent.*

Standard configuration options, with reed switches or relays

configuration	unless otherwise specified	standard options available
porting size	1/4" NPT	1/8" NPT, 1/2" NPT, AND and MS
porting orientation	in-line	N/A
direction of pressure	left to right	right to left (reverse porting)
calibration medium	all units with EPDM seals: water all others: alum or SS: hydraulic oil brass or PVC: water	N/A
switches & relays	(must be specified)	**-A** SPST N/O **(120VAC,0.7A,70VA;200VDC,1.0A,50W)** **-B** SPST N/C **(120VAC,0.25A,5VA;175VDC,0.25A,5W)** **-C** SPDT **(120VAC,0.25A,5VA;175VDC,0.25A,5W)** **-R2** DPDT relay **(contacts:120VAC,28VDC,10A coil:6 to 240VAC,6 to 110VDC)**
switch/relay setting	set at top of range ascending	other set points within adjustability ascending or descending
primary wetted parts	(must be specified)	aluminum, 316SS, naval brass, PVC
secondary wetted parts	range spring: 302SS magnet: ceramic piston seal: Teflon	Teflon-coated spring and magnet
static seals	buna-N, except Viton for high temp.	Viton,Teflon,neoprene,EPDM,fluorosilicone
lens	glass	plastic
dial sizes	(must be specified)	2.5", 3.5", 4.5", 6"
dial case styles+	(must be specified)	"B" Basic Case (*C-clamp not available*) "F" Flanged Case (w/holes for panel mounting)
starting mark on dial	approximately 10% of full scale	N/A

Orange Research Inc.
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www.orangeresearch.com

Product specifications for model 1203

Product Specifications, with transmitter

sensor type	piston
functions	**gauge/transmitter, transmitter (Loop powered)**
min. range	0-5 psid
max. range	0-150 psid
max. line pressure	5000 psig
min. burst pressure	15000 psig
standard maximum temperature	gauge/transmitter: 200°F (glass lens), 150°F (plastic lens) transmitter: 200°F
high temp. construction	N/A
minimum temperature	-20°F
calibration accuracy∗∗	±2% of full scale ascending after rap at room temperature ∗∗*Calibration accuracy is compensated for temperature effects between -20°F - 200°F*
repeatability	±2% of full scale
transducer enclosure	weatherproof
certification	CSA Class I,DIV. 2,Groups A,B,C & D; Class II,DIV. 2,Groups F & G (File 152872) NEMA 4X,IP65 ∗*Consult factory for CE equivalent.*

Standard configuration options, with transmitter

configuration	unless otherwise specified	standard options available
porting size	1/4" NPT	1/8" NPT, 1/2" NPT, AND, MS
porting orientation	in-line	N/A
direction of pressure	left to right	N/A
calibration medium	all units with EPDM seals: water all others: alum or SS: hydraulic oil brass : water	N/A
electronic outputs	analog outputs: 4-20 mA (2 wire) 0-5 VDC (3 or 4 wire)	
supply voltage	9-35 VDC (reverse polarity protected)	
loop resistance	1300 ohms max. R=((Vs-9)*1000)/20 (ohms at Vs)	
board connection	**1:** + (EXC) **2:** - **3:** 0-5 V **4:** COM 20-26 AWG wire	
conduit connection	½" trade size	
primary wetted parts	(must be specified)	aluminum, 316SS, naval brass
secondary wetted parts	range spring: 302SS magnet: ceramic piston seal: Teflon	Teflon-coated spring and magnet
static seals	buna-N	Viton, Teflon, neoprene, EPDM, fluorosilicone
lens	glass	plastic
dial sizes	(must be specified)	2.5", 3.5", 4.5", 6"
dial case styles+	(must be specified)	"B" Basic Case (*C-clamp not available*) "F" Flanged Case (w/holes for panel mounting)
starting mark on dial	approximately 10% of full scale	N/A

---INSTRUCTIONS

Series 1203

DIFFERENTIAL PRESSURE INSTRUMENTS

Orange Research Inc.
140 Cascade Boulevard, Milford, Connecticut 06460
203 877-5657 800 989-5657 Fax: 203 783-9546
www.orangeresearch.com

Your new Orange Research Differential Pressure Instrument is a rugged instrument featuring simplicity of design to provide dependable and efficient service. Because it is an instrument it should be handled with care. Read all instructions carefully before attempting to install the instrument.

***CAUTION**: Do not exceed nameplate maximum operating pressure. Use only fluids compatible with wetted parts.*

HOW IT WORKS

The instrument operates on the difference between two pressures (delta-P). The sensing element is a spring biased piston which moves linearly in proportion to the difference between two basic pressures. A magnet on the **HI** pressure side of the piston assembly moves with the piston and rotates a follower magnet located adjacent to the pressure cavity. The gauge pointer is located at the end of the rotary magnet shaft and rotates with the magnet to provide gauge readings proportional to differential pressure variations. There are no mechanical seals between the pressure side of the instrument and the gauge mechanism side. This is accomplished by coupling the forces between two adjacent magnets through a solid wall.

SWITCH UNITS: On switch and indicating switch models, reed switches are located adjacent to the pressure chamber and are actuated when the piston magnet field interacts at a preset point with the reed switch armature. Reed switch set points are adjustable.

INSTALLATION

Check instrument and identify the **HI** and **LO** markings. **HI** identifies the high pressure port; **LO** the low pressure port. If instrument is installed backwards, it will neither operate nor be damaged. Reverse connections if installed backwards. The instrument can be line mounted, bracket mounted or panel mounted depending upon the model purchased.

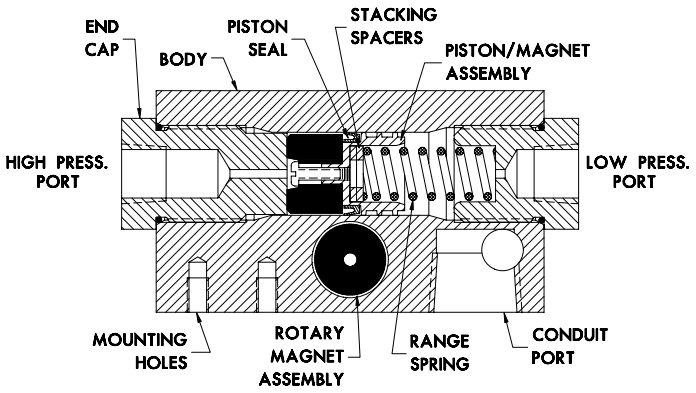
Under normal conditions Series 1203 Instruments are designed for line pressure to 5000 psig and can sustain a continuous 5000 psig forward or reverse overpressure.

It is recommended that the instrument be located above the pressure source to allow drainage of the unit.

IMPORTANT: Because of the magnetic movement, this instrument should never be mounted in direct contact with a steel surface. Otherwise a calibration shift will occur. Mount the instrument so that the pressure body is at least 1" away from metal surfaces with non-magnetic spacers or an aluminum-mounting bracket. Flush panel mounted instruments will not be affected by contact with aluminum panels. However, 2" and 2½" gauges flush mounted in a steel panel may require resetting of the pointer at zero.(this should be done at time of manufacture but can be reset in the field with a small loss of accuracy.)

MAINTENANCE

Other than replacing broken lens there is only one area where this instrument may need attention. Erratic pointer or switch action may indicate that cleaning is required. For cleaning:



1. Remove the unit from service.
2. Remove both end caps with a 1" spanner wrench.
3. Remove the range spring and the piston/magnet assembly. BE CAREFUL NOT TO LOSE STACKING SPACERS.
4. Clean parts in a solvent solution after removing O-Ring seals from the end caps since some solvents will attack the seal material.
5. It is good to practice to replace the O-Ring seals while the instrument is dismantled. DO NOT ATTEMPT TO MOVE THE TEFLON PISTON SEAL FROM THE PISTON. If piston seal is damaged order a new piston/magnet assembly.

To reassemble:

1. Lubricate the piston bore lightly with petroleum jelly, light oil or silicone grease.
2. Install the **HI** end cap first and tighten.
3. Install the piston/magnet assembly (magnet facing **HI** pressure port).
4. Insert stacking spacers in bottom of piston spring pocket and insert range spring.
5. Reassemble **LO** end cap making certain that spring is seated in the end cap spring pocket.
6. Tighten **LO** end cap and the instrument is now ready for service.

IMPORTANT: Magnet end of piston/magnet assembly MUST be facing the **HI** pressure port of the instrument, otherwise, the instrument will not operate.

LENS REPLACEMENT: To replace a broken lens, check to see if the lens is held on by a bezel or a snap-ring. To remove a bezel, which is a pressed on cover, either twist off by hand(watch out for the broken glass) or pry off with a screwdriver. To remove a snap-ring, pry out the ring with a small screwdriver. Remove all glass chips, insert new lens and re-insert the bezel or snap. With snap-rings, locate the ring joint at the bottom of the gauge.

POINTER REPLACEMENT: (Probably damaged when lens was broken). Remove bezel or snap-ring as previously described and clean out glass chips. Remove old pointer with pointer puller or two small screwdrivers opposite each other under pointer hub. Pry off evenly being careful not to bend the pointer shaft. Install new pointer dead on zero. Re-install lens, as described under lens replacement.

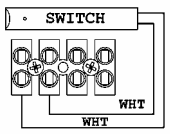
SWITCH ADJUSTMENT

Reed switch set points are field adjustable. On Indicating Switches, the reed switches can be adjusted over the top 80% of the gauge range. On Switch models the reed switches can be adjusted over the range shown on the nameplates.

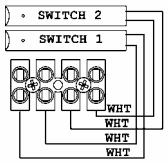
To change the reed switch setting, a source of pressure will be needed with the instrument. Remove the switch enclosure and loosen the set screw on the switch bracket. To increase the set point, slide the switch tube toward the **LO** port. To decrease the set point, slide the switch tube toward the **HI** port. Repeat as required until new setting is reached. Recheck the new actuation point. Re-tighten set screw.

SWITCH WIRE COLOR
-A SPST white and white
-B SPST green(N/C); blue(common)
-C SPDT green(N/C); red(N/O); blue(common)

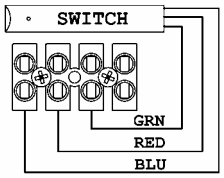
1 SWITCH
-A or –B



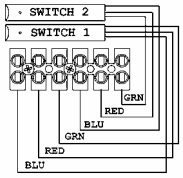
2 SWITCHES
-A or –B



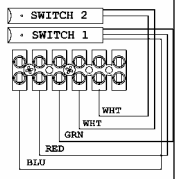
1 SWITCH
-C



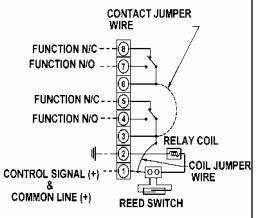
2 SWITCHES
-C & -C



1 -C SW. & 1
-A or –B SW.



RELAY DPDT -R2



REPLACEMENT PARTS

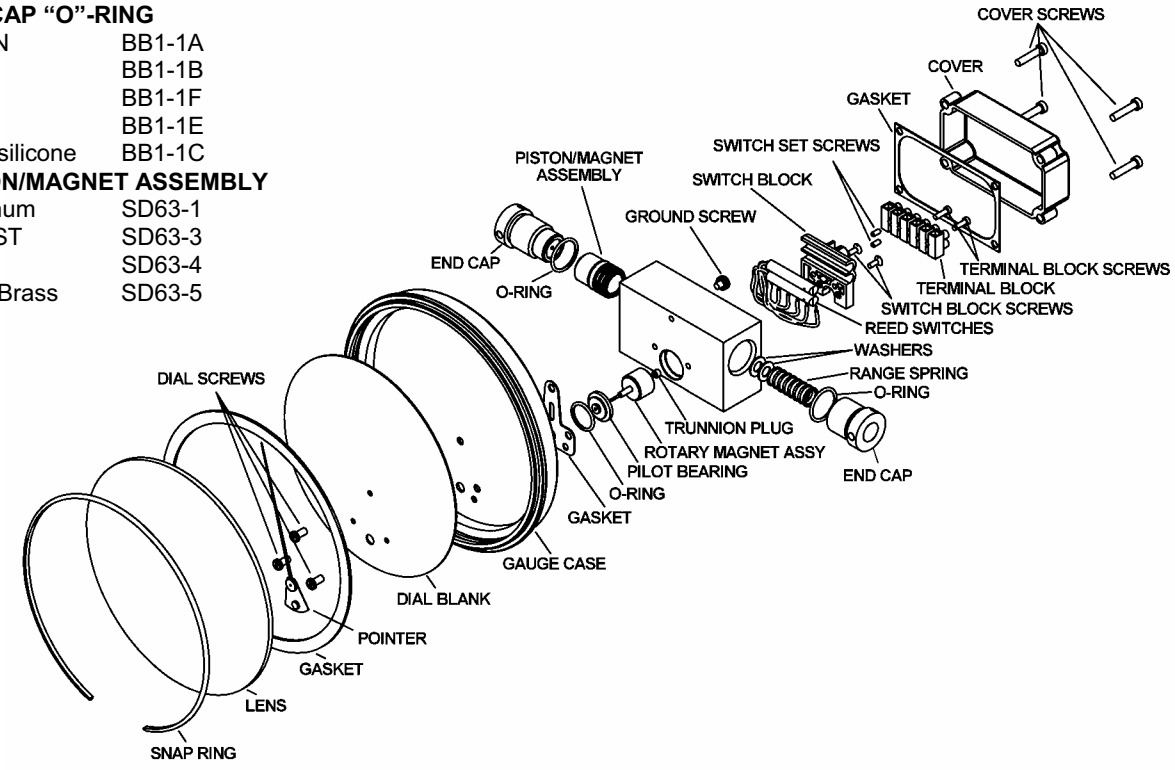
GAUGE DIA.	GLASS LENS	PLASTIC LENS	POINTER	SST BEZEL (press-fit)
2”	GG1-1	GG2-1	AF15-1	M1-5
2 ½”	GG1-2	GG2-2	AF15-2	M2-5
3 ½”	GG1-3	GG2-3	AF15-3	M4-5
4 ½”	GG1-4	GG2-4	AF15-4	M5-5
6”	GG1-5	GG2-5	AF15-5	---

END CAP “O”-RING

Buna N	BB1-1A
Viton	BB1-1B
Teflon	BB1-1F
EPDM	BB1-1E
Fluorosilicone	BB1-1C

PISTON/MAGNET ASSEMBLY

Aluminum	SD63-1
316 SST	SD63-3
PVC	SD63-4
Naval Brass	SD63-5



RECALIBRATION
Recalibration of this instrument is not required. However, if the range spring is damaged or a new dial is required, the instrument must be returned to the factory for the parts and recalibration.

NOTE: When ordering replacement parts, identify instrument SO# or WO# from the nameplate. Identify parts required and quantity.

Orange Research Inc.
140 Cascade Boulevard, Milford, Connecticut 06460
203 877-5657 800 989-5657 Fax: 203 783-9546
www.orangeresearch.com

Nov. '04

Replacement Parts*- Model 1201, 1202, 1203

Gauge Models:

Gauge Dia.	Glass Lens	Plastic Lens	Pointer **	S.Steel Bezel	Threaded Retaining Ring (standard)	Threaded Retaining Ring (liquid filled case)	Lens Gasket (standard)	Lens Gasket (liquid filled case)	Follower Pointer
2.0"****	GG1-1	GG2-1	AF15-1	M1-5	N/A	N/A	N/A	N/A	N/A
2.5"**** (press fit)	GG1-2	GG2-2	AF15-2	M2-5	N/A	N/A	N/A	N/A	SC4-2
2.5" (bayonet)	GG29-2	GG30-2	AF15-2	M19-2	N/A	N/A	W54	W54	SC34-2
3.5"	GG1-3	GG2-3	AF15-3	M4-5 ****	AD7-1	AD4-1	W32	W32A	SC4-3
4.5"	GG1-4	GG2-4	AF15-4	M5-5 ****	AD7-2	AD4-3	W31	W31A	SC4-4
6.0"	GG1-5	GG2-5	AF15-5	N/A	AD3-3 ***	AD4-5	W33	W33A	SC4-5

* Two year recommended replacement parts
** Factory replacement of pointer is recommended
*** Snap Ring
**** Obsoleted in 2004 but replacement parts available

Reed Switches:	**Uncovered (1201)**	**Covered (1203)**
A- SPST norm. open	AC1-12	AC25-3
B- SPST norm. closed	AC106-12	AC101-3
C- SPDT	AC5-12	AC26-3

End Cap O-Rings (qty of one):

Buna	BB1-1A
Viton	BB1-1B
EPDM	BB1-1E
Teflon	BB1-1F
Fluorosilicone	BB1-1C

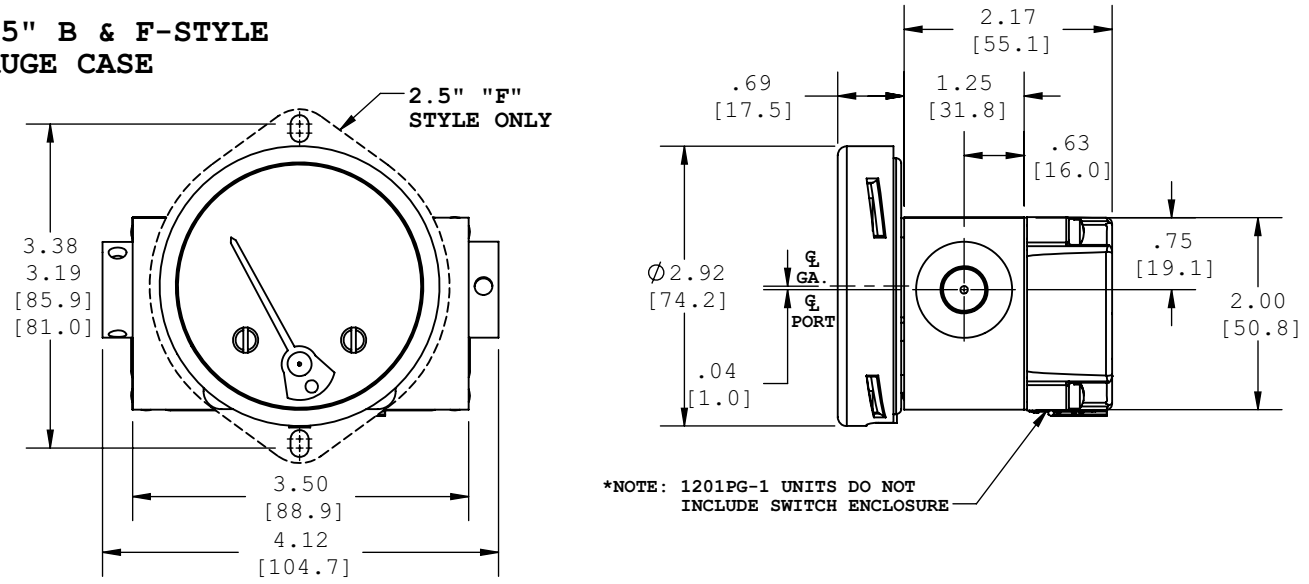
Piston/ Magnet Assembly:

Aluminum	SD12-1
Stainless Steel	SD12-3
Brass	SD12-5
PVC	SD12-4

1203PG-1,PGS-1,PS-1,PGT-T2 & PT-T2 MODELS

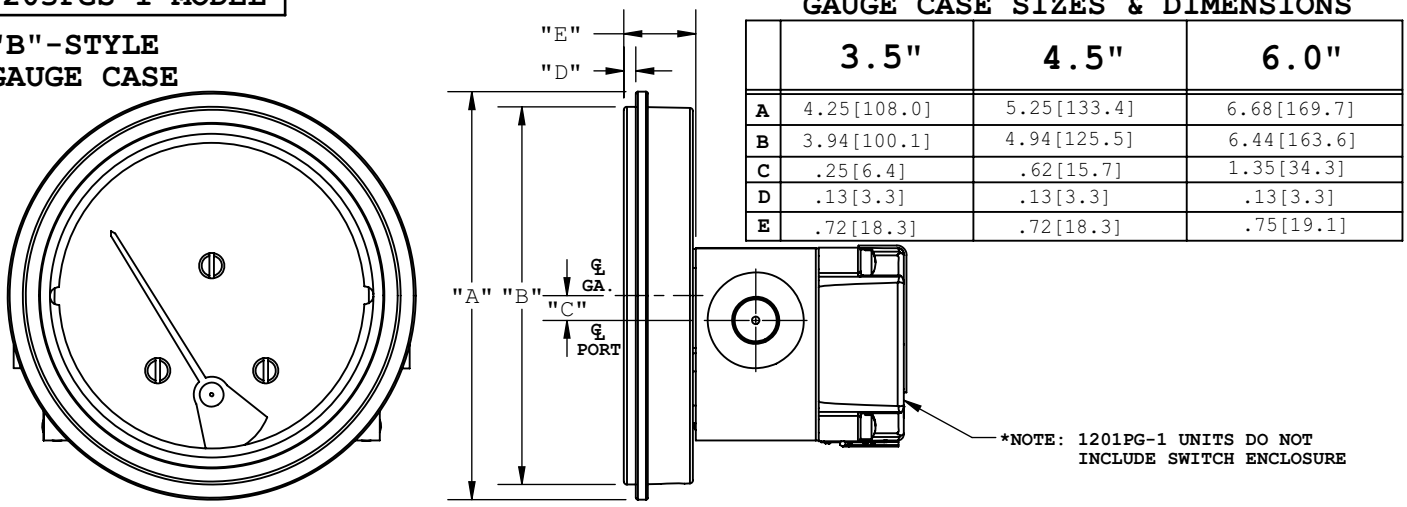
1203PGS-1 MODEL

2.5" B & F-STYLE GAUGE CASE



1203PGS-1 MODEL

"B"-STYLE GAUGE CASE

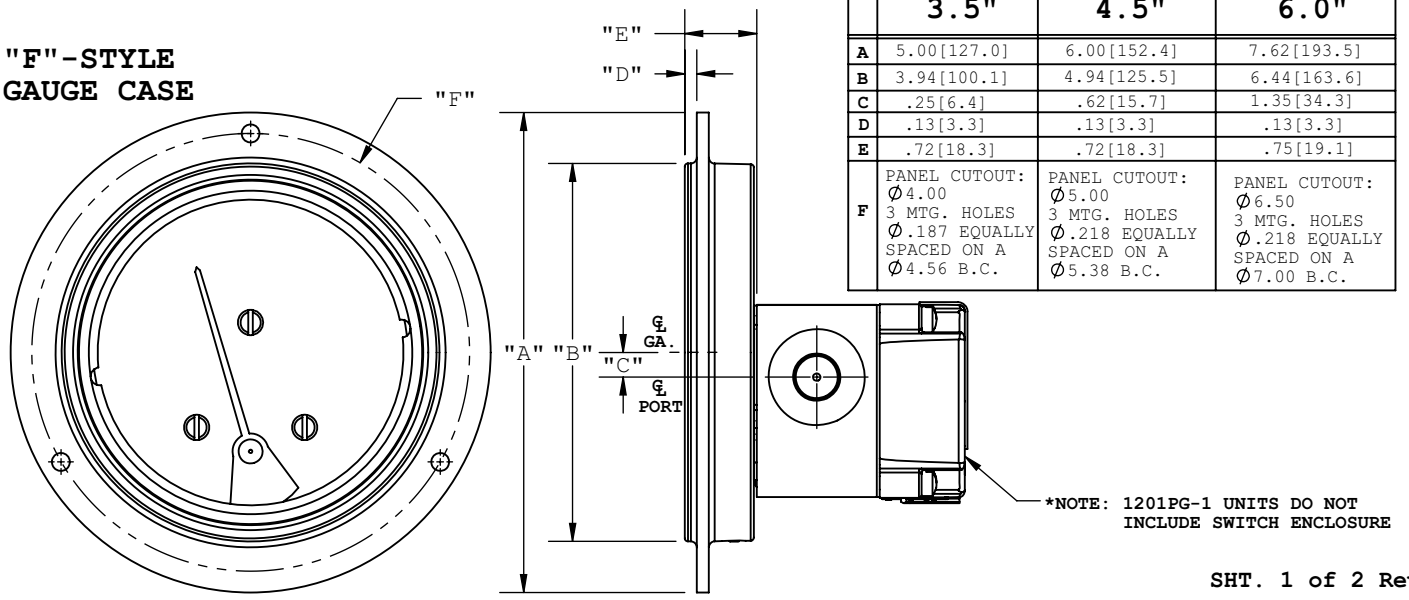


GAUGE CASE SIZES & DIMENSIONS

	3.5"	4.5"	6.0"
A	4.25[108.0]	5.25[133.4]	6.68[169.7]
B	3.94[100.1]	4.94[125.5]	6.44[163.6]
C	.25[6.4]	.62[15.7]	1.35[34.3]
D	.13[3.3]	.13[3.3]	.13[3.3]
E	.72[18.3]	.72[18.3]	.75[19.1]

1203PGS-1 MODEL

"F"-STYLE GAUGE CASE

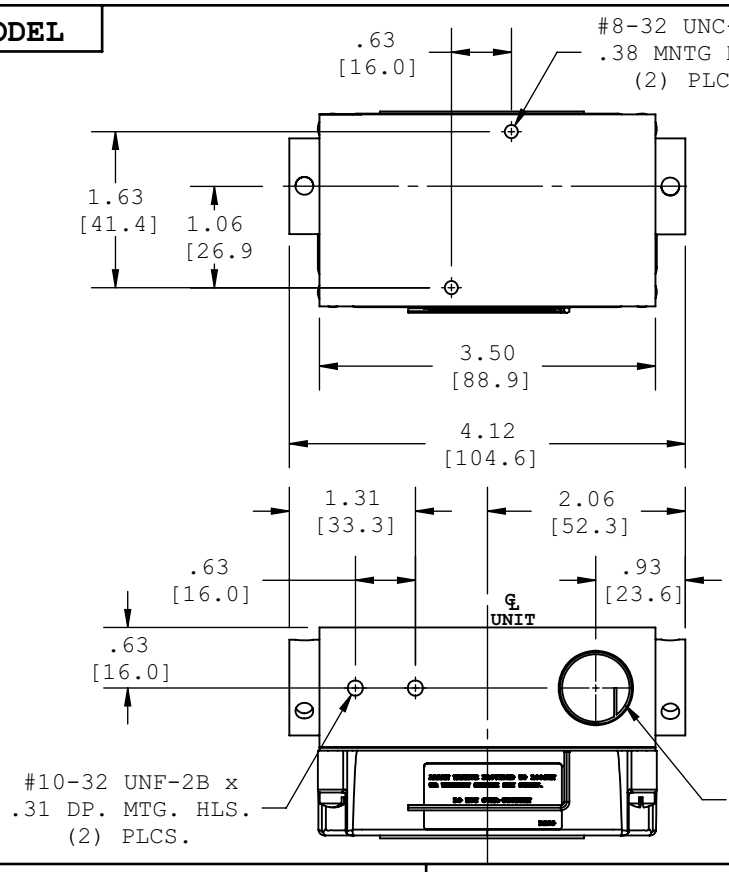


GAUGE CASE SIZES & DIMENSIONS

	3.5"	4.5"	6.0"
A	5.00[127.0]	6.00[152.4]	7.62[193.5]
B	3.94[100.1]	4.94[125.5]	6.44[163.6]
C	.25[6.4]	.62[15.7]	1.35[34.3]
D	.13[3.3]	.13[3.3]	.13[3.3]
E	.72[18.3]	.72[18.3]	.75[19.1]
F	PANEL CUTOUT: Ø4.00 3 MTG. HOLES Ø.187 EQUALLY SPACED ON A Ø4.56 B.C.	PANEL CUTOUT: Ø5.00 3 MTG. HOLES Ø.218 EQUALLY SPACED ON A Ø5.38 B.C.	PANEL CUTOUT: Ø6.50 3 MTG. HOLES Ø.218 EQUALLY SPACED ON A Ø7.00 B.C.

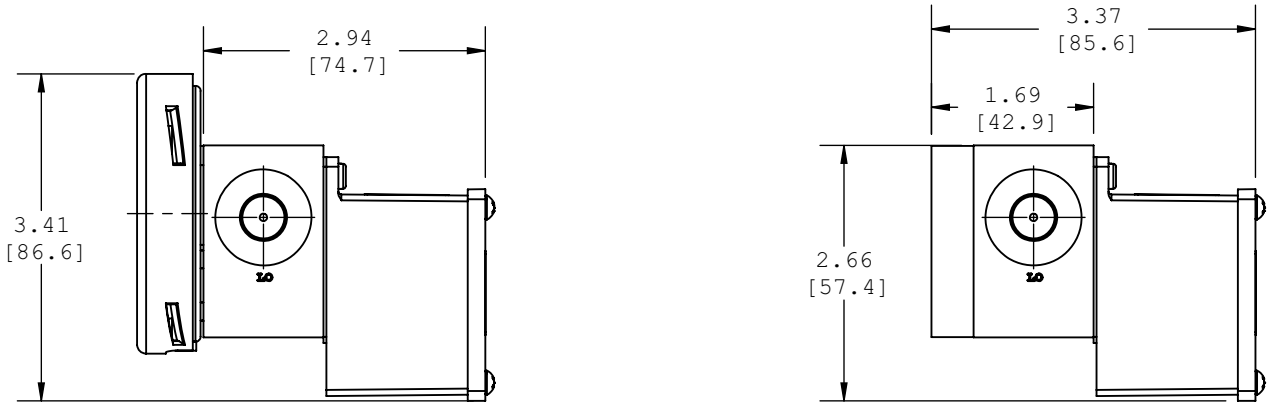
1203PG-1,PGS-1,PS-1,PGT-T2 & PT-T2 MODELS

1203PS-1 MODEL



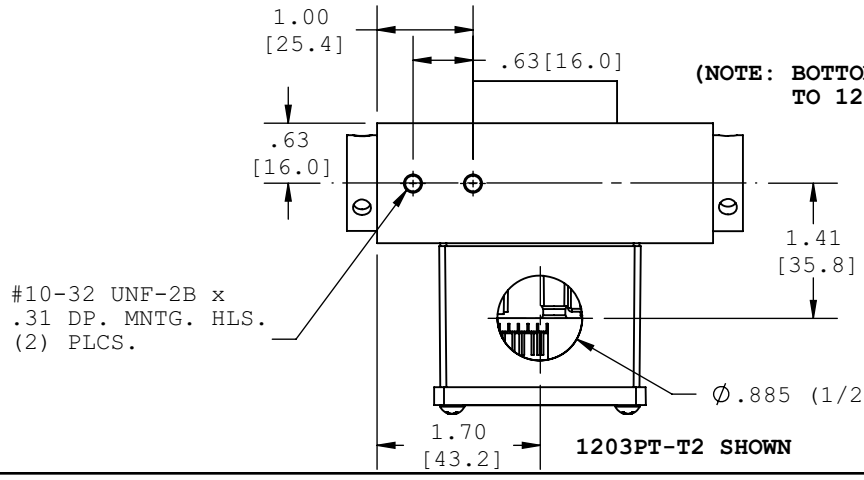
(NOTE: LOCATION OF BOTTOM MNTG. HOLES & CONDUIT PORT APPLIES TO 1203PG & PGS-1 UNITS ALSO)

1203PGT-T2 & 1203PT-T2 SIDE VIEWS



2.5" B-STYLE GA. CASE SHOWN

1203PGT-T2 & 1203PT-T2 BOTTOM MOUNTING



(NOTE: BOTTOM MNTG. HOLES APPLY TO 1203PGT-T2 UNITS ALSO)

1203PT-T2 SHOWN