Active Treatment System (ATS) Plan

Rocklin Crossing

Project: 12SDD1

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

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Active Treatment System (ATS) Plan

This specific ATS Plan document was developed for the Rocklin Crossings

Latitude: 38.47 Longitude: -121.12

This project is granted coverage under the guidance of the Construction General Permit (CGP) Order: 2009-0009-DWQ created and managed by the California State Water Resources Control Board, Division of Water Quality. This document is a compliance requirement under the CGP.

[The following is from the CGP pages 36 and 37 and the GCP Fact Sheet]

The effective design of an ATS requires a detailed survey and analysis of site conditions. With proper planning, ATS performance can provide exceptional water quality discharge and prevent significant impacts to surface water quality, even under extreme environmental conditions.

The primary treatment process in an ATS is coagulation/flocculation. ATS's operate on the principle that the added coagulant is bound to suspended sediment, forming floc, which is gravitationally settled in tanks or a basin, or removed by sand filters. A typical installation utilizes an injection pump upstream from the clarifier tank, basin, or sand filters, which is electronically metered to both flow rate and suspended solids level of the influent, assuring a constant dose. The coagulant mixes and reacts with the influent, forming a dense floc. The floc may be removed by gravitational setting in a clarifier tank or basin, and by filtration. Water from the clarifier tank, basin, or sand filters may be routed through cartridge(s) and/or bag filters for final polishing. Vendor-specific systems use various methods of dose control, sediment/floc removal, filtration, etc., that are detailed in project-specific documentation. The particular coagulant/flocculant to be used for a given project is determined based on the water chemistry of the site because the coagulants are specific in their reactions with various types of sediments. Appropriate selection of dosage must be carefully matched to the characteristics of each site.

ATS's are operated in two differing modes, either Batch or Flow-Through. Batch treatment can be defined as Pump-Treat-Hold-Test-Release. In Batch treatment, water is held in a basin or tank, and is not discharged until treatment is complete. Batch treatment involves holding or recirculating the treated water in a holding basin or tank(s) until treatment is complete or the basin or storage tank(s) is full. In Flow-Through treatment, water is pumped into the ATS directly from the runoff collection system or storm water holding pond, where it is treated and filtered as it flows through the system, and is then directly discharged. "Flow-Through Treatment" is also referred to as "Continuous Treatment."

[End GCP/Fact Sheet Information]

A copy of this document with all of the subordinate documents was submitted to the California State Water Resources Control Board, Division of Water Quality as part of the approval process to obtain a discharge permit. **A copy of the approved project ATS Plan must be kept on this construction site.**

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Appendices

A. **Initial Jar Test Report with ASTM 2035-08 Protocol**

B. **Residual Testing: Methodology, Laboratory Validation, and Aquatic Toxicity**

C. **ATS Operations and Maintenance Manual**

D. **ATS Monitoring Sampling & Reporting Plan**

E. **ATS Health and Safety Plan**

F. **ATS Spill Prevention Plan**

G. **ATS Operator Training and Certification**

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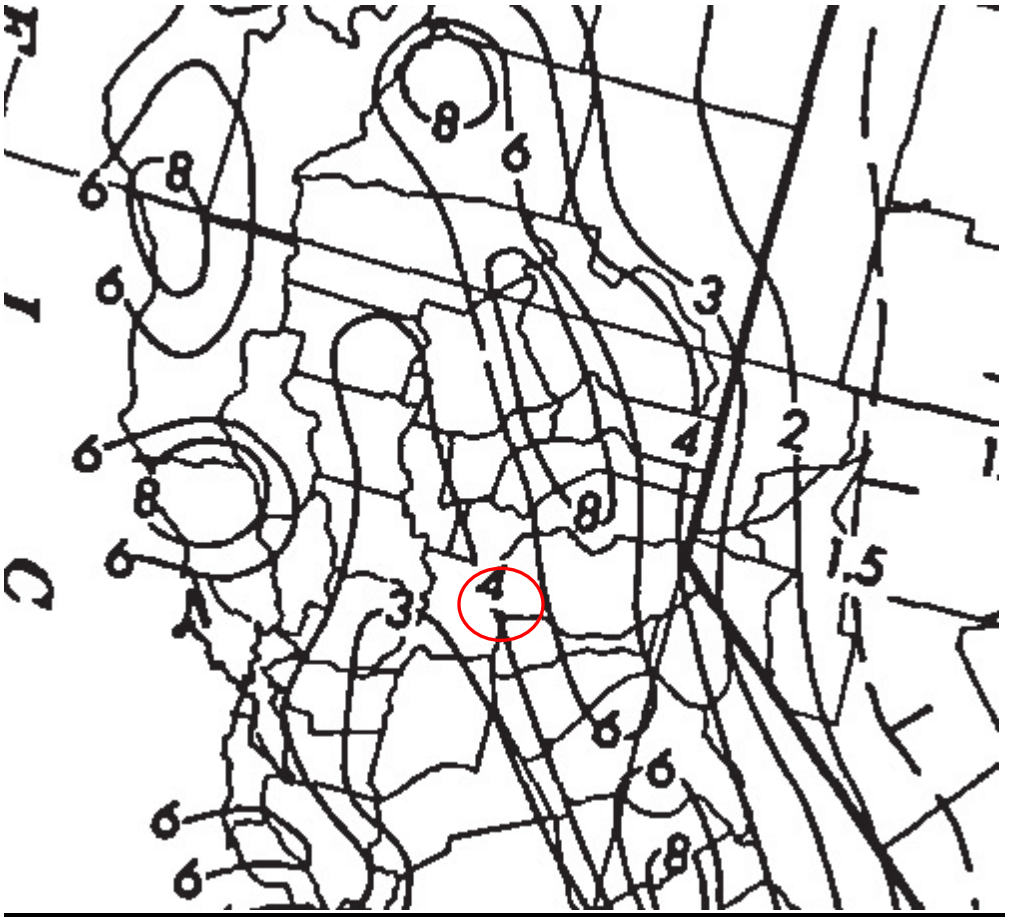
1.0 System Sizing

1.1 10YR/24HR: ATS Pumps, Filters, Basins and Interconnecting Plumbing.

Storm Event Data:	**Western Regional Climate Center**
10 Year/24 Hour Storm Event:	**4”**
Disturbed Site Acreage:	**50 AC**
System Type:	**Flow Through Treatment**
Nearest Governmental Rain Gauge:	**Onsite NOAA**
Onsite Storage (in Gallons):	**6,382,296.54**
Proposed System Flow Rate:	**1500 GPM**

ATS Calculation: (note - *see discussion in section 4 of this document)*
10YR/24HR Rain Event Model: 4” X 50 AC = **5,430,480 Gallons**
ATS Sizing Justification (72 HR Max: 5,430,480 ⁄ 60 ⁄ 1500=60.3 Hours (less than 72)

Historical Rainfall Map



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2.0 Online Monitoring

Online Monitoring: Instruments and Locations

Parameter	Influent	Pre Treat	Effluent
Turbidity:	YES	NO	YES
pH:	YES	YES	YES
Flow:	YES	YES	YES

Online Monitoring Data collection: **Programmable Logic Controller (PLC)**
Online Data Collection Frequency: **Once every 15 Minutes**

3.0 Chemical Additive Selection

The discharger shall conduct, at minimum, six site-specific jar tests (per polymer with one test serving as a control) for each project to determine the proper polymer and dosage levels for their ATS. These water samples and jar tests shall be conducted using water samples selected to represent typical site conditions and in accordance with ASTM D2035-08 (2003).

Results:
Chemical Additive: **Chitosan**
Trade Name: **ChitoVan™**
Best Dose (refer to **Appendix A**): **500 mg/L**

4.0 Filtration

The ATS includes a filtration step between the coagulant treatment train and the effluent discharge. This function is provided by high-rate, pressurized sand filtration. When sand filters are used for construction site dewatering they are typically de-rated from manufactures peak flow rates (15 GPM/FT² Media) to (8 GPM/FT² Media) to compensate for the resistance (pressure drop) from #20 silica sand and frequent back-flushing caused by high sediment loading. Differential pressure measurements are taken 'real time' to monitor filter loading and confirm that the final filter stage is functioning properly.

Calculation:

Calculation:

GPM/FT² Media Surface Area = **8 GPM**
Number of Filter Pods = **4**
Diameter of Sand Filter Pod =**54"**
Number of 54-4 Sand Filters: **3 (EA)**

54 ⁄ 12 ⁄ 2 = **2.25 Ft Radius**
2.25 X 2.25 X 3.14 = **15.9 Ft²**
15.99 X 4 X11= **508 GPM**
508 X 3 Filter =**1,524 GPM**

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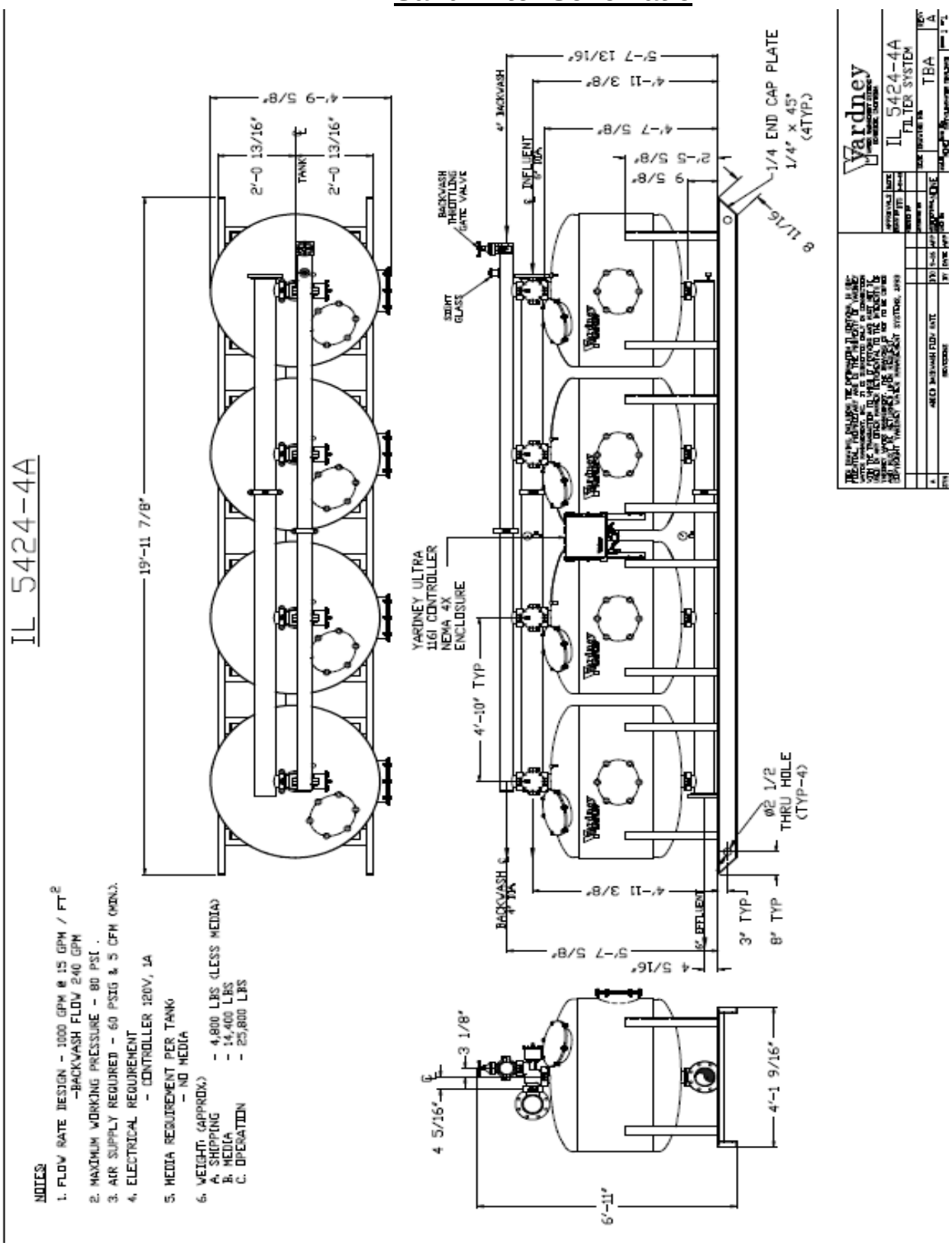
Sand Filter Schematic



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Onsite Water Storage

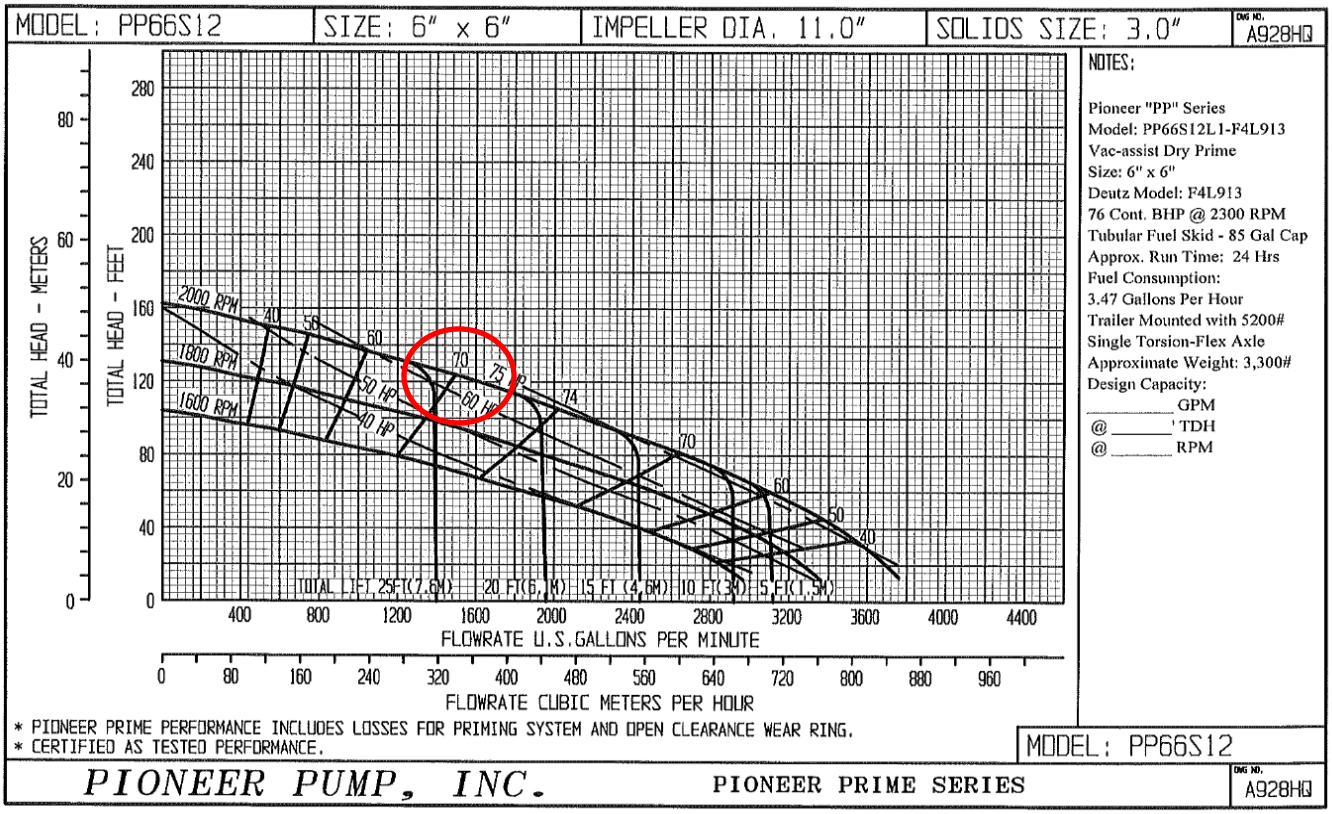
A total of 6,382,296.54 Gallons of additional storage will be provided to facilitate ATS treatment operations. This additional storage is in the form of 2 Basins which total 6,222,296.54 gallons and eight (8) 20,000 gallon storage tanks. Basin #2 will be used to collect runoff and basin #1 will be used as a pretreat and settling

5.0 Pump Requirements

Pumps are used to transfer water from the Collection Basin to the Pretreat Basin and through the treatment train while maintaining enough hydraulic capacity to perform proper backwashing of the sand filters. Proper sand filter backwashing pressure is a fundamental requirement used to “regenerate” the media and remove floc on a regular basis. The following metrics (expressed in (TDH) Total Dynamic Head) are minimum criteria to meet this condition based on a combination of manufacture recommendations and empirical data. Pump curves for the proposed pumps can be found below each TDH requirement.

Basin and Holding Tanks to Pre Treat Tanks

6” Diesel Pump



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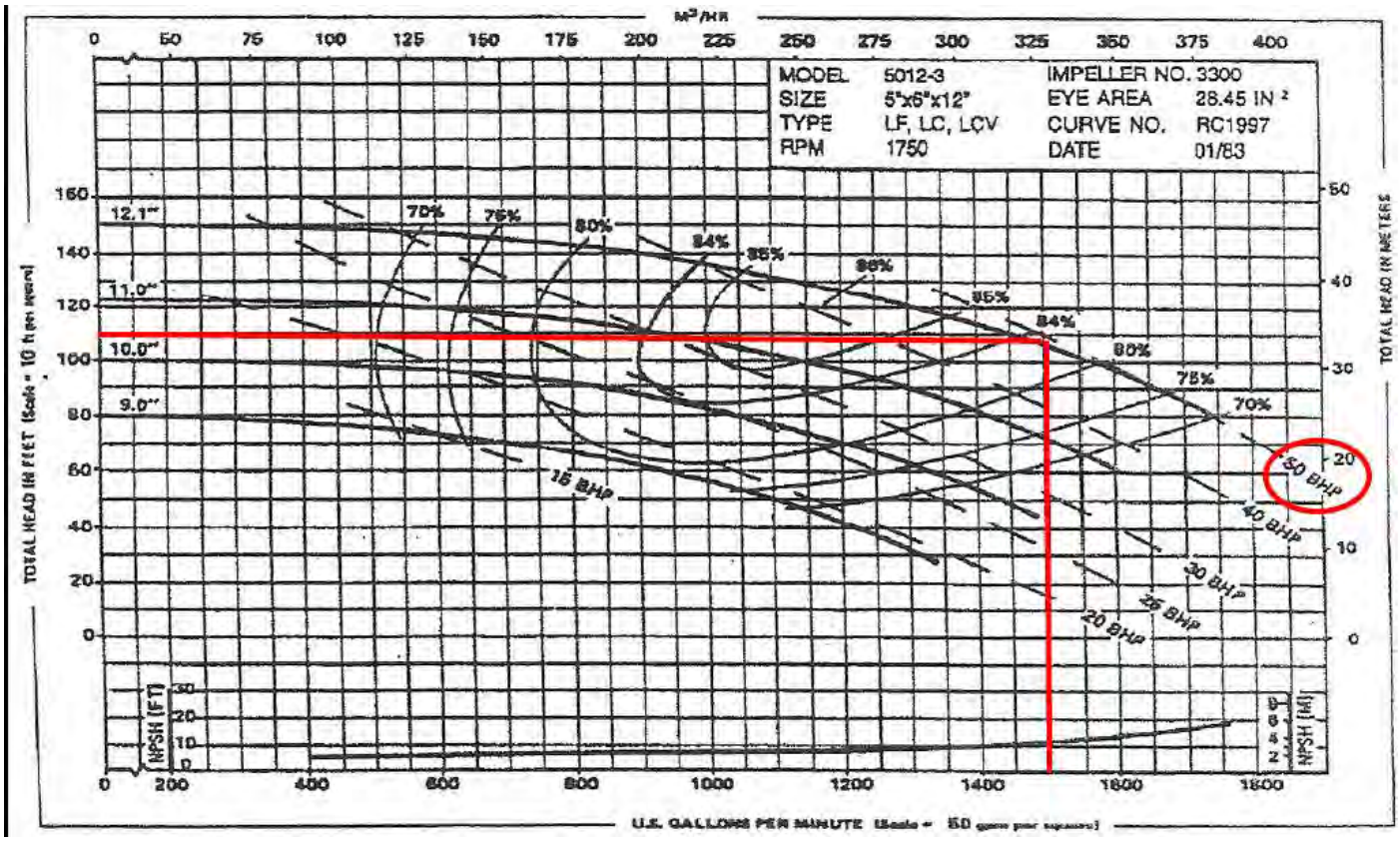
50 hp Centrifugal



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6.0 Residual Chemical Additive Testing and Laboratory Verification

The discharger will utilize the residual chemical test developed for Chitosan which produces a result within one hour of sampling and has a detection limit of 10% of the MATC for the most sensitive species.

Most Sensitive Species = **Oncorhynchus mykiss (Rainbow Trout)**
MATC = **177 mg/L (as neat product)**
177 X 10% = **17.7 mg/L (as neat product)**
Residual Test Detection Limit (certified by a California Laboratory) = **10 mg/L**

The proposed test protocol has been validated by a California State certified laboratory. A certification is included with this ATS Plan. Specifically the lab reviewed the test protocol, test parameters, and the detection limit of the coagulant and certified the test.

Refer to (**Attachment B**) for Test Methodology, Laboratory Validation, and Aquatic Toxicity.

7.0 Residual Management

Sediment will be removed from the storage or treatment cells to ensure that they maintain at least 70% of their initial water storage at all times (i.e., at no point will sludge buildup reduce available storage by more than 30%). Handling and disposal of all solids generated during ATS operations will be done in accordance with all local, state, and federal laws and regulations.

8.0 Instrumentation and Control

The ATS is equipped with instrumentation that automatically measures and records influent and effluent water quality data and flow rate. In addition to monitoring and recording water quality this information is used to control discharge and bypass valve on effluent discharge. The following will be used as project set-points:

1. Influent Turbidity = **No Limit**
2. Influent pH = **No Limit**
3. Effluent Turbidity = **10 NTU**
4. Effluent pH = **6.5 – 8.5**

The system is equipped with a microprocessor system which provides data logging and recording every 15 minutes.

Cumulative flow volume is captured electronically and is also to be recorded daily in a manual operations log.

The instruments are all interfaced with the microprocessor system which in turn controls valves which re-circulate the effluent in the event that effluent measurements exceed pre-set turbidity or pH values. The system will also force recirculation upon system upset, power failure, or other catastrophic event, so that no water is discharged. All instrumentation (flow meters, probes, valves, controlling computers, etc.) are installed and will be maintained per the manufacturer's recommendations. (Refer to **Attachment C**: QA/QC plan and **Attachment D**: O&M Manual)

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The QA/QC plan covers calibration procedures and frequencies, instrument method detection limit or sensitivity verification, laboratory duplicate procedures, and other pertinent procedures. The O&M Manual covers startup and shutdown procedures.

To prevent potential overdosing, the ATS provides a method for controlling coagulant dose. This is performed through the use of periodic jar testing and metering pump adjustment. Adjustments consist of changes to the chemical pump frequency and stroke settings (i.e. injection rates) in conjunction with the use of calibration cylinders. Thus, the proper set point for the metering/injection pump is based on the polymer requirement determined from the jar tests.

9.0 ATS Operation and Maintenance Manual

A site-specific Operation and Maintenance (O&M) Manual covering the procedures required to install, operate and maintain this ATS is included with this ATS Plan. This O&M Manual is to be used in conjunction with this project specific design based on the previously defined specifications for this system configuration and operating parameters.

The O&M Manual includes operating manuals for specific pumps, generators, control systems, and other equipment included in the overall ATS system (refer to **Attachment C**).

10.0 ATS Monitoring, Sampling and Reporting Plan Including Quality Assurance

10.1 Visual Monitoring

The Discharger/LRP shall designate a person responsible for system operation and monitoring. This person shall be on site daily at all times during treatment operations. On-site visual monitoring of the system for proper performance shall be conducted and recorded in the project data log. Copies of these forms are included in the Monitoring Plan document binder.

The log shall include the name and phone number of the person responsible for system operation and monitoring. The log shall also include documentation of the responsible person's training.

10.2 Operational and Compliance Monitoring

Flow shall be continuously monitored and recorded at not greater than 15-minute intervals for total volume treated and discharged. Influent and effluent pH must be continuously monitored and recorded at not greater than 15-minute intervals. Influent and effluent turbidity (expressed in NTU) must be continuously monitored and recorded at not greater than 15-minute intervals. The type and amount of chemical used for pH adjustment, if any, shall be monitored and recorded. Dose rate of chemical used in the ATS system (expressed in mg/L) shall be monitored and reported 15-minutes after startup and every 8 hours of operation. Copies of the forms for this data logging are included in the Monitoring Plan document binder.

Duplicates of any Laboratory Test Reports shall be maintained onsite.

Effluent shall be monitored and recorded for residual chemical/additive levels. This test shall be documented and the records maintained on site. Copies of these test forms are included in the Monitoring Plan document binder under Toxicity Monitoring.

10.3 Reporting and Record Keeping

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At a minimum, every 30 days a Legally Responsible Person (LRP) representing the discharger shall access the State Water Board Storm Water Multi-Application and Report Tracking system (SMARTS) and electronically upload field data from the ATS. Records must be kept for three years after the project is completed.

NAME _____
ADDRESS _____
_____
_____
FACILITY _____
LOCATION

ACTIVE TREATMENT SYSTEM
DISCHARGE MONITORING REPORT (*DMR*)

PERMIT NUMBER	DISCHARGE NUMBER

Discharge Location:

	MONITORING PERIOD						
	YEAR	MO	DAY		YEAR	MO	DAY
FROM				TO			

Parameter		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				No. of Exceed-ances	Frequency of Analysis	Sample Type
		Average	Maximum	Units	Minimum	Average	Maximum	Units			
FLOW (VOLUME DISCHARGED)	Sample Measurement			Gallons per Day				Gallons			
	Permit Requirement										
RATE OF DISCHARGE	Sample Measurement			Gallons per minute				Gallons			
	Permit Requirement										
TURBIDITY	Sample Requirement							NTU			
	Permit Requirement										
pH	Sample Requirement							STD UNITS			
	Permit Requirement										
RESIDUAL CHITOSAN	Sample Measurement							mg/L			
	Permit Requirement										
OTHER	Sample Measurement							µgm/L			
	Permit Requirement										
OTHER	Sample Measurement							mg/L			
	Permit Requirement										

COMMENT AND EXPLANATION OF ANY VIOLATIONS:

TYPED OR PRINTED NAME OF INDIVIDUAL PREPARING REPORT	SIGNATURE	TITLE	DATE

10.4 Toxicity Monitoring

This ATS operates in flow through mode and no acute toxicity tests are required.

10.5 Non-Compliance Reporting

Any indications of toxicity or other violations of water quality objectives will be reported to the appropriate regulatory agency as required by the General Permit, by the designated person responsible for monitoring. Upon any measurements that exceed water quality standards, the system operator shall immediately notify their supervisor or other responsible parties, who shall notify the Regional Water Quality Board. If any monitoring data exceeds any applicable NEL in General Permit, the discharger shall electronically submit a NEL Violation Report to the State Water Board <u>within 24 hours</u> after the NEL exceedance has been identified. ATS dischargers shall certify each NEL Violation Report in accordance with the Special Provisions for Construction Activity in this General Permit.

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The ATS operators will retain an electronic or paper copy of each NEL Violation Report for a minimum of three years after the date the annual report is filed. The NEL Violation Report will include: (1) The analytical method(s), method reporting unit(s), and method detection limit(s) of each analytical parameter (analytical results that are less than the method detection limit shall be reported as “less than the method detection limit”); (2) The date, place, time of sampling, visual observation (inspections), and/or measurements, including precipitation; and (3) A description of the current onsite BMPs, and the proposed corrective actions taken to manage the NEL exceedance.

Compliance Storm Exemption - In the event that an applicable NEL has been exceeded during a storm event equal to or larger than the Compliance Storm Event, ATS dischargers shall report the on-site rain gauge reading and nearby governmental rain gauge readings for verification.

10.6 Quality Assurance/Quality Control (QA/QC) Plan

A project-specific QA/QC Plan, developed for this project is included as a part of the Operation and Maintenance Manual (refer to **Attachment C**). This QA/QC content includes the following (at a minimum):

Calibration – Calibration methods and frequencies for all system and field instruments shall be specified.

Method Detection Limits (MDLs) – The methods for determining MDLs shall be specified for each residual coagulant measurement method. Acceptable minimum MDLs for each method, specific to individual coagulants, shall be specified.

Laboratory Duplicates – Requirements for monthly laboratory duplicates for residual coagulant analysis shall be specified.

11.0 ATS Health and Safety Plan

A site specific ATS HASP is required to identify specific hazards (refer to **Attachment E**).

12.0 ATS Spill Prevention Plan

A Site specific ATS Spill Prevention Plan is required to identify what spill provisions are in place (Refer to **Attachment F**).

13.0 ATS Operator Training and Certification

To become ATS Certified an individual must complete a minimum of 8 hours of classroom training and 32 hours of supervised field training. This training will be conducted by ATS professionals with at least five years of related water treatment experience using Active Treatment Systems. Once all training requirements have been satisfied, a certificate will be presented, certifying that the individual has completed ATS training.

14.0 ATS Training Plan

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The Certified ATS Operators will have completed training specific to using an ATS and coagulants for stormwater discharges in California. The training will be conducted as a formal class. Upon successful completion of the training program and examination the individual will be presented with a certificate, valid for one year. A refresher class and test will qualify the individual for certificate renewal. (Refer to **Attachment G**).
Training includes at a minimum the following topics:

1. Coagulation Basics – Chemistry and physical processes
2. ATS System Design and Operating Principles
3. ATS Control Systems
4. Coagulant Selection – Jar testing, dose determination, etc.
5. Aquatic Safety/Toxicity of Coagulants, proper handling and safety
6. Monitoring, Sampling, and Analysis
7. Reporting and Recordkeeping
8. Emergency Response

15.0 Certification

The ATS shall be designed and approved by a Certified Professional in Erosion and Sediment Control (CPESC), a Certified Professional in Storm Water Quality (CPSWQ); a California registered civil engineer; or any other California registered engineer.

Name: Jason Hills

CPESC Registration #: 7073

Exp Date: 8/24/2013

Signature:

Date: 12/11/2012

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Attachment A

Initial Jar Test Report
With ASTM 2035-80 Protocol

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Form # CWCABS01
Rev Date: March, 2012

Active Treatment Systems, Inc.
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JAR TEST DATA SHEET

Water Source:

Date:	12/10/2012
Project #	12SDD1
Water ID#	Raw Water Pond 1
Tech:	Vernon Slater

Raw Water Characteristics (aka: Control sample water quality)

Time	Temp ºC	Turbidity	ph	Color	Specific Conductivity
11:30	16.5 C	2430NTU	6.95	Brown	51uS/cm

Jar No.	Polymer Type	Dosage ppm	Flash Mix Seconds	Floc Characteristics: Description size, nature, etc.	Settling Time	Settling Rate
1	Chitosan	300ppm	**30 Sec**	medium size floc with settling	**5 minutes**	Medium
2	Chitosan	500ppm	**30 Sec**	Large heavy fast settling floc	**5 minutes**	Fast
3	Chitosan	700ppm	**30 Sec**	Large floc with fast settling	**5 minutes**	Fast
4	Chitosan	900ppm	**30 Sec**	Medium floc with medium rate settling	**5 minutes**	Medium
5	Chitosan	1100ppm	**30 Sec**	Small to medium floc with some settling	**5 minutes**	Slow
6	Chitosan	1300ppm	**30 Sec**	small floc with slow settling	**5 minutes**	Slow

Settled Characteristics

Jar No.	Temp ºC	Turbidity	ph	Color	Specific Conductivity
1	16.7 C	67.9NTU	6.75	Lt Brown	55uS/cm
2	16.7 C	10.5NTU	6.62	Clear	57uS/cm
3	16.7 C	19.9NTU	6.55	Clear	57uS/cm
4	16.7 C	62.4NTU	6.43	Lt Brown	58uS/cm
5	16.7 C	113NTU	6.30	Lt Brown	60uS/cm
6	16.7 C	162NTU	6.14	Lt Brown	62uS/cm

Notes, comments, other parameter notes

Jar No.	Best Dose Filtered Water Quality: Temp ºC	Turbidity NTU	pH	Color	Specific Conductivity
2	16.7 C	6.18 NTU	6.72	Clear	58uS/cm

Best dose other notes:

Control Sample w/no treatment

Control Type	Settling Time (Min)	Temp ºC	Turbidity	pH	Color	Specific Conductivity
Settled	**5 minutes**	16.5 C	2400NTU	6.95	Brown	51uS/cm
Filtered	**N/A**	N/A	N/A	N/A	N/A	N/A

Control sample other notes:
Control sample is not filterable due to suspended matter that is not settling

Signature: Vernon Slater **Date:** 12/10/2012

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Form # CWCABST02
REV DATE 6/4/2012

BENCH SCALE TREATABILITY

Project Title: Rocklin Crossing Walmart **Project No:** 12SDD1

Technician: Vernon Slater **Run Number:** 1

Project Location: Rocklin, California **Date:** 12/10/2012

Sample Identification: Raw Water Pond 1 Temperature: 12.7 C

Sample Time: 1015 Sample Volume: 1000mL Turbidity NTU: 2430 NTU

pH initial (Std. units) 6.95 pH (If Adjusted): N/A Conductivity (µS/cm): 51µS/cm

Polymer Type: Chitosan Acetate Concentration: 1.5% mg/mL or drop 50mg/drop

Bench Scale Treatability Results

Drops or mL of polymer	Estimated dose Rate ppm	Observed Results (Floc size, settling time, etc.)
2	100ppm	Instant floc formation, medium size, with settling.
2	200ppm	Instant large floc with good settling and fasteere settling rate than 100ppm dose.
2	300ppm	Instant large floc with fast settling; clarified water is nearly clear within a few seconds
2	400ppm	large to extra large flocr; most floc settled in first minute of settling; NTU = 36.6
4	600ppm	large floc with good settling; maybe passed best dose; NTU = 48.9
2	700ppm	Large floc with good settling NTU = 27.7
4	900ppm	large floc with good settling NTU = 64.5; Best dose has been passed

Other Observations:

This water treats well with Chitosan Acetate. Best dose covers a large rang of dosing that will allow easy treatment in actual field conditions,

Technician Signature Vernon Slater **Date:** 12/10/2012

1
2
3
4
5
6
Active Treatment Systems, Inc.
1000 mL
PYREX
CONT

1
2
3
4
5
6
Active Treatment Systems, Inc.
CONTROL
1000 mL
PYREX
PHIPPS & BIRD

1
2
3
4
5
6
Active Treatment Systems, Inc.
CONTROL

Designation: D 2035 – 08

Standard Practice for Coagulation-Flocculation Jar Test of Water[1]

This standard is issued under the fixed designation D 2035; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers a general procedure for the evaluation of a treatment to reduce dissolved, suspended, colloidal, and nonsettleable matter from water by chemical coagulation-flocculation, followed by gravity settling. The procedure may be used to evaluate color, turbidity, and hardness reduction.

1.2 The practice provides a systematic evaluation of the variables normally encountered in the coagulation-flocculation process.

1.3 *This standard does not purport to address the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 1129 Terminology Relating to Water
D 1193 Specification for Reagent Water
D 1293 Test Methods for pH of Water
D 3370 Practices for Sampling Water from Closed Conduits
D 6855 Test Method for Determination of Turbidity Below 5 NTU in Static Mode
D 7315 Test Method for Determination of Turbidity Above 1 Turbidity Unit (TU) in Static Mode

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology D 1129.

4. Summary of Practice

4.1 The coagulation-flocculation test is carried out to determine the chemicals, dosages, and conditions required to achieve optimum results. The primary variables to be investigated using the recommended practice include, but are not limited to:

4.1.1 Chemical additives,
4.1.2 pH,
4.1.3 Temperature, and
4.1.4 Order of addition and mixing conditions.

5. Significance and Use

5.1 This practice permits the evaluation of various coagulants and coagulant aids used in the treatment of water and waste water for the same water and the same experimental conditions.

5.2 The effects of concentration of the coagulants and coagulant aids and their order of addition can also be evaluated by this practice.

6. Interferences

6.1 There are some possible interferences that may make the determination of optimum jar test conditions difficult. These include the following:

6.1.1 *Temperature Change (During Test)*—Thermal or convection currents may occur, interfering with the settling of coagulated particles. This can be prevented by temperature control.

6.1.2 *Gas Release (During Test)*—Flotation of coagulated floc may occur due to gas bubble formation caused by mechanical agitator, temperature increase or chemical reaction.

[1] This practice is under the jurisdiction of ASTM Committee D19 on Water and is the direct responsibility of Subcommittee D19.03 on Sampling Water and Water-Formed Deposits, Analysis of Water for Power Generation and Process Use, On-Line Water Analysis, and Surveillance of Water.

Current edition approved May 1, 2008. Published May 2008. Originally approved in 1964. Last previous edition approved in 2003 as D 2035 – 80 (2003).

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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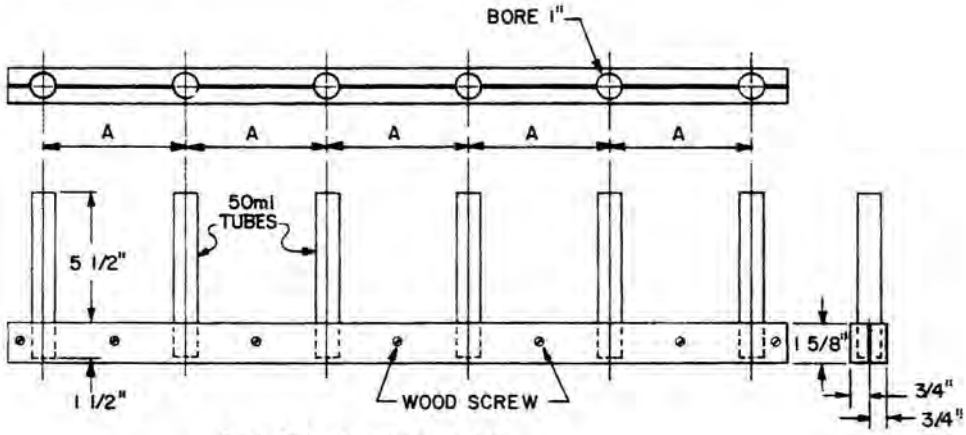

A = ℄ Distance between jars in multiple stirrer apparatus (6" for a Phipps-Bird)

TUBES - 1" x 7" 50ml Color Comparator Type

RACK - Oak 3/4" x 1-5/8"

FIG. 1 Reagent Rack for Multiple Stirrer Jar Test Apparatus

6.1.3 *Testing-Period*—Biological activity or other factors may alter the coagulation characteristics of water upon prolonged standing. For this reason the period between sampling and testing should be kept to a minimum, with the time being recorded.

7. Apparatus

7.1 *Multiple Stirrer*—A multiposition stirrer with continuous speed variation from about 20 to 150 rpm should be used. The stirring paddles should be of light gage corrosion-resistant material all of the same configuration and size. An illuminated base is useful to observe the floc formation. Precautionary measures should be taken to avoid heat being imparted by the illumination system which may counteract normal settling.

7.2 *Jars (or Beakers)*, all of the same size and shape; 1500-mL Griffin beakers may be used (1000-mL recommended minimum size).

7.3 *Reagent Racks*—A means of introducing each test solution to all jars simultaneously. There should be at least one rack for each test solution or suspension. The racks should be similar to that shown in Fig. 1.

8. Reagents

8.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[3] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

8.2 *Purity of Water*—Unless otherwise indicated, reference to water for reagent preparation shall be understood to mean water that meets the quantitative quality specifications for Type IV reagent water conforming to Specification D 1193, Section 1.1.

8.3 The following chemicals and additives are typical of those used for test solutions and suspensions. The latter, with the exception of coagulant aids, may be prepared daily by mixing chemicals with water to a concentration of 10 (±0.1) g/L (1.0 mL of test solution or suspension when added to 1 L of sample is equivalent to 10 mg/L):

Prime Coagulants
- Alum[$Al_2(SO_4)_3 \cdot 18H_2O$]
- Ferric sulfate [$Fe_2(SO_4)_3 \cdot xH_2O$]
- Ferric chloride ($FeCl_3 \cdot 6H_2O$)
- Ferrous sulfate ($FeSO_4 \cdot 7H_2O$)
- Magnesium carbonate ($MgCO_3 \cdot 3H_2O$)
- Sodium aluminate ($NaAlO_2$)

Coagulant Aids
- Activated silica
- Anionic (polyelectrolyte)
- Cationic (polyelectrolyte)
- Nonionic Polymer

Oxidizing Agents
- Chlorine (Cl_2)
- Chlorine dioxide (ClO_2)
- Potassium permanganate ($KMnO_4$)
- Calcium hypochlorite [$CaCl(ClO) \cdot 4H_2O$]
- Sodium hypochlorite ($NaClO$)

Alkalis
- Calcium carbonate ($CaCO_3$)
- Dolomitic lime
- (58 % CaO, 40 % MgO)
- Lime, hydrated [$Ca(OH)_2$]
- Magnesium oxide (MgO)
- Sodium carbonate (Na_2CO_3)
- Sodium hydroxide ($NaOH$)

Weighting Agents
- Bentonite
- Kaolin
- Other clays and minerals

[3] *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

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Miscellaneous
Activated carbon (powdered)

8.4 *Coagulant Aids*—There are numerous commercially available coagulant aids or polyelectrolytes. All polyelectrolytes are classified anionic, cationic or nonionic, depending upon their composition. These aids may have the ability to produce large, tough, easily-settled floc when used alone or in conjunction with inorganic coagulants. A small dosage (under 1 mg/L) may permit a reduction in the dosage of, or complete elimination of, the coagulant. In the latter case, the polyelectrolyte would be considered the prime coagulant rather than a coagulant aid. Aids come in powdered and liquid form. Powdered aids should be prepared as 0.1 % solutions with appropriate aliquots to provide proper dosage. Always add powdered aids to the dissolving water rather than the reverse, and add slowly to the shoulder of a vortex created by stirring. If a vortex is not formed, the dry powder will merely collect on the surface of the water in gummy masses and become very difficult to dissolve. Dissolving time may vary from several minutes to several hours. Suggested manufacturers' procedures for wetting, dissolving, and storing should be followed when available. Liquid forms can be readily prepared to the above strength without difficulty.[4]

9. Sampling

9.1 Collect the water sample under test in accordance with the applicable Practices D 3370.

10. Procedure

10.1 Measure equal volumes (1000 mL) of sample into each of the jars or 1500-mL Griffin beakers. As many sample portions may be used as there are positions on the multiple stirrer. Locate beakers so that the paddles are off-center, but clear the beaker wall by about 6.4 mm (¼ in.). Record the sample temperature at the start of the test.

10.2 Load the test chemicals in the reagent racks. Use one rack for each series of chemical additions. Make up each tube in the rack to a final volume of 10 mL, with water, before using. There may be a situation where a larger volume of reagent will be required. Should this condition prevail, fill all tubes with water to a volume equal to the largest volume of reagent in the reagent rack. When adding slurries, it may be necessary to shake the rack to produce a swirling motion just prior to transfer.

10.3 Start the multiple stirrer operating at the "flash mix" speed of approximately 120 rpm. Add the test solution or suspensions, at predetermined dosage levels and sequence. Flash mix for approximately 1 min after the additions of chemicals. Record the flash mix time and speed (rpm).

10.4 Reduce the speed as necessary to the minimum required to keep floc particles uniformly suspended throughout the "slow mix" period. Slow mix for 20 min. Record the time for the first visible floc formation. Every 5 min (during the slow mix period), record relative floc size and mixer speed (rpm). If coagulant aids are used, mixing speed is critical because excessive stirring tends to break up early floc formation and may redisperse the aid.

10.5 After the slow mix period, withdraw the paddles and observe settling of floc particles. Record the time required for the bulk of the particles to settle. In most cases this time will be that required for the particles to settle to the bottom of the beaker; however, in some cases there may be interfering convection currents. If so, the recorded settling time should be that at which the unsettled or residual particles appear to be moving equally upward and downward.

10.6 After 15 min of settling, record the appearance of floc on the beaker bottom. Record the sample temperature. By means of a pipet or siphon, withdraw an adequate sample volume of supernatant liquor from the jar at a point one half of the depth of the sample, to conduct color,[5] turbidity, pH and other required analyses, (Note 1) determined in accordance with Test Methods D 6855 or D 7315 (for turbidity) and D 1293 (for pH). A suggested form for recording results is appended (see Fig. 2).

NOTE 1—Tests for residual chemicals should be included, for example, alum; residual Al_2O_3; copperas; residual Fe_2O_3; etc.

10.7 Repeat steps 10.1-10.6 until all pertinent variables have been evaluated.

10.8 The times given in 10.3, 10.4, and 10.6 are only suggestions.

11. Reproducibility

11.1 It is recognized that reproducibility of results is important. To demonstrate reproducibility, the so-called 3 and 3 procedure is suggested. In this procedure, duplicate sets of 3 jars each are treated simultaneously with the same chemical dosages in jars 1 and 4, 2 and 5, and 3 and 6.

12. Keywords

12.1 coagulation; flocculation; jar tests

[4] A periodically updated "Report on Coagulant Aids for Water Treatment" is published by the Environmental Protection Agency Office of Water Supply, Cincinnati, Ohio 45268, listing coagulant aids that may be used in water treatment without adverse physiological effects on those using the water, based on information submitted by the manufacturers or distributors, or both.

[5] For the color determination, reference is made to *Standard Methods for the Examination of Water and Waste Water*, Fourteenth edition, American Public Health Association, Inc., New York, NY, 1975, pp. 64–71.

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Sample _____ pH _____ Turbidity _____ Date _____

Location _____ Color _____ Temperature _____ Sample Size _____ ml

	JAR NUMBER					
	1	2	3	4	5	6
Chemicals, mg/litre *(a)*						
Flash Mix Speed, rpm						
Flash Mix Time, min						
Slow Mix Speed, rpm						
Slow Mix Time, min						
Temperature, °F						
Time First Floc, min						
Size Floc						
Settling rate						
Turbidity						
Color						
pH						

(a) Indicate order of addition of chemicals.

FIG. 2 Jar Test Data

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PB-700™ Series Six-Paddle Standard JarTester

It is widely accepted that accurate jar testing is one way to help produce the highest quality water possible, as economically as possible. The consistently reproducible results obtained by Phipps & Bird JarTesters assist water and wastewater treatment plants around the globe in achieving their goals by helping to determine the optimal dosing for their specific conditions.

Today, there are four world-class Phipps & Bird JarTesters from which to choose. Each is designed to meet specific, yet different, needs. Each is constructed with the same quality and craftsmanship that have gone into all our jar testers for more than 70 years.

The PB-700™ Series Six-Paddle Standard JarTester, the "classic" gang stirrer, incorporates all the most-asked-for features. Constructed on a powder-coated steel uniframe chassis, six stainless steel 1" x 3" paddles are spaced six inches apart and are adjustable to a maximum depth of nine inches. An electronic motor control system offers regulated variable speeds of all paddles simultaneously, from 1-300 rpm, with the exact speed clearly displayed on a digital readout. A fluorescent lamp floc illuminator is built into the jar tester base to provide soft, diffused lighting of samples being tested. Each unit comes complete with your choice of either six standard, round, glass, 1-liter laboratory beakers or six B-KER2® square, acrylic, 2-liter testing jars, and is covered by a one-year manufacturer's warranty. All Phipps & Bird JarTesters are available in 120V, 60Hz or 220V, 50/60Hz. Catalog Series #7790-7XX.

And now you can make your jar test results even more meaningful by adding a Phipps & Bird Column Filtration System™ to your jartesting system. The Column Filtration System accurately simulates the process of a direct filtration water treatment plant, right in your lab!
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Rev: 03/02
LC-WT-002c

Standard Features

	PB-700	PB-750	PB-900	PB-950
Powder-coated steel uniframe chassis	✓	✓	✓	✓
Fluorescent-lamp floc illuminator	✓	✓	✓	✓
Stainless steel 1” x 3” paddles	✓	✓	✓	✓
Round, 1L glass beakers or 2L B-KER$^{2®}$ Square lab jars	**6**	**4**	**6**	**4**
CE Certification (220V only)	✓	✓		
Electronic motor control, 5-300 rpm; digital readout	✓	✓		
1 – year warranty	✓	✓	✓	✓
Four operator-programmable memory banks			✓	✓
Choice of 120V,60 Hz or 220V, 50/60 Hz	✓	✓	✓	✓

Optional Feature

Carrying case, meets Air Transport Assn. Specification 300, Category 1.		✓		✓

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LC-WT-004c

Attachment B

Residual Testing

Methodology, Laboratory Validation, and Aquatic Toxicity

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

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1. Test Methodology

2. Laboratory Validation

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1. Test Methodology

Residual Chitosan Acetate Field Test Instructions

Sample Collection

A one liter (1000mL) beaker is provided for sample collection. Collect 1L of sample into this clean container.

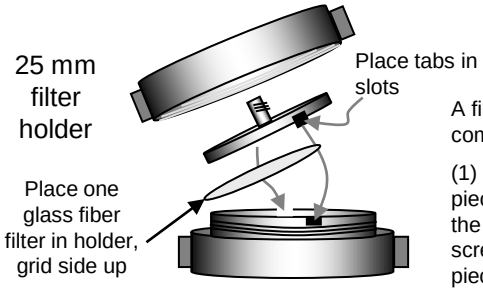
The sample should be fairly clear and of low turbidity, less than 10 Nephelometric Turbidity Units (NTU.)

Collect the sample from the outflow area of the treatment system. For active CESF treatment, collect the sample in the effluent at the end of the treatment system.

Place 5 drops of color enhancement solution into the sample, then mix by stirring or gently swirling with the lid on.

You do not need to pH adjust the sample. This test can be run at any pH, usually pH 5-9.

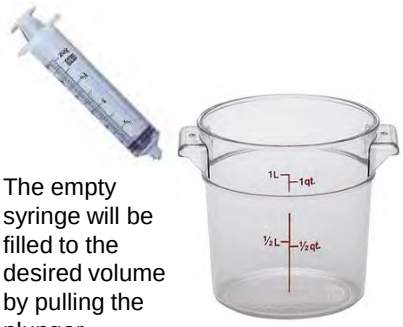
Swinnex Filter Housing Assembly



A filter housing known as a Swinnex holder is included. Note that the assembly comes in three pieces:

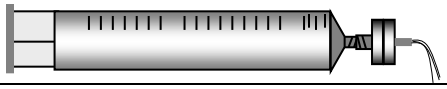
(1) The bottom piece , which holds the filter. The filter should be placed onto this piece such that the grid side faces up. (2) The middle piece. This piece has tabs at the sides which are aligned with the bottom piece when fitted together. It also has a screw top known as a luer-lok fitting. This will screw onto the syringe. (3) The top piece. When all three pieces are fitted together, the assembly can be attached to your syringe containing the necessary volume of sample.

Filtration of the Sample

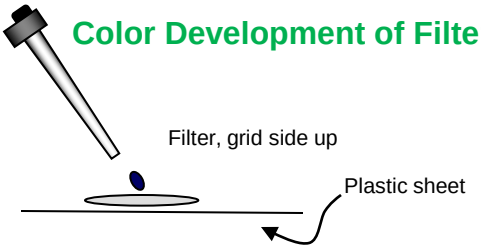


The empty syringe will be filled to the desired volume by pulling the plunger.

This is a qualitative test. A positive result indicates the presence of greater than or equal to 17 ppm of ChitoVan Chitosan Acetate. A total of 100mLs should be filtered. Pull the syringe while the tip of the syringe is submersed in your sample. After filling to the 100mL mark, place the filter housing onto the end of the syringe. Push the plunger to filter the liquid. You do not need to keep the filtered liquid; only the filter itself.



Color Development of Filter



Remove the filter pad from the housing using the tweezers provided. Place it on a plastic surface with the side up that was facing the syringe. Add 1-2 drops of iodine to the center of the filter. Immediately compare your filter to the color comparison chart. A positive result will appear dark brown or purplish. Very light brown may be seen on the blanks. Use the photographs and the numerical chart on page two to help you interpret the results. A positive result indicates the presence of Chitosan Acetate at 17 ppm or more. A negative result indicates you are below the level of detection.

Notes: (1) Filter sample slowly – rapid filtration may rupture filter. (2) Always place the filter pad on the plastic sheet included. Placing the filter pad on paper will result in a positive reaction as iodine reacts with the starch in paper products. (3) Put the iodine drop(s) on the side of the filter pad that was facing the syringe (the side that would collect any Chitosan present). (4) There is no need to dry the filter prior to the iodine addition.

Quality Control – Quality Assurance

The following QA/QC steps are used to qualify the test procedure and typically need not be performed with every sample.

Blank – Filter the appropriate amount of distilled water (no Chitosan added.)

Filter the same amount of water as you did for your sample (100mLs.)

17 ppm Matrix Spike

A true matrix spike can be run by putting 1 drops of the Chitosan Acetate Standard Spike Solution into 1L of the filtrate (effluent) water. Be sure to mix the sample for about 5 minutes prior to filtration, then process it as directed on page 1.

17 ppm Blank Spike

A blank spike can be run by putting 1 drops of the Chitosan Acetate standard solution into 1L of distilled water. Be sure to mix the sample for about 5 minutes prior to filtration, then process it as directed on page 1. A blank spike confirms that the reagents are working as they should, and gives the user an idea of the color to look for.

Color Comparative Chart

Immediately after addition of iodine

100 mLs filtered

Blank

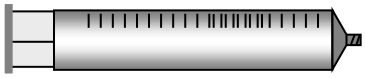
(no ChitoVan Chitosan Acetate)

17 ppm

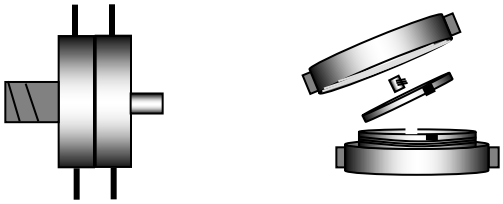
ChitoVan Chitosan acetate

This is a qualitative test. A positive result indicates the presence of greater than or equal to 17 ppm of Chitosan Acetate.

Parts List:



140 mL plastic syringe



25 mm filter holder

25 mm glass fiber filter

1-liter (1-quart) plastic pitcher or one liter tri flow beaker

Glass Stir Rod.

Color Enhancement Solution

Chitosan Acetate Standard Spike Solution

Iodine Solution

Tweezers (for handling filter pads)

2. Laboratory Validation

cel analytical, inc.
ELAP# 2647

Residual Chitosan Acetate Test Dilution Study & Method Detection Limit
Dungeness Environmental

Analysis Dates: 06-13 to 06-19-10
Project: CelA 1804

Reporting date: 07-08-10

Blank-Filter 100mls of distilled water (no chitosan added.)

2 ppm Matrix Spike-Filter 100mls of 2 ppm chitosan acetate sample. 1 drops of the chitosan acetate standard solution into 1L of the filtrate water. 1 to 5 dilutions to make 2ppm sample.

Blank-Filter 100mls of distilled water (no chitosan added.)

4 ppm Matrix Spike-Filter 100mls of 4 ppm chitosan acetate sample. 1 drops of the chitosan acetate standard solution into 1L of the filtrate water. 1 to 2.5 dilutions to make 4ppm.

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cel analytical, inc.
ELAP# 2647

Residual Chitosan Acetate Test Dilution Study & Method Detection Limit
Dungeness Environmental

Analysis Dates: 06-13 to 06-19-10
Project: CelA 1804

Reporting date: 07-08-10

Blank-Filter 100mls of distilled water
(no chitosan added.)

8 ppm Matrix Spike-Filter 100mls of 8 ppm chitosan acetate sample.(Putting 1 drops of the chitosan acetate standard solution into 1L of the filtrate water. 1 to 1.25 dilution to make 8ppm .

Blank-Filter 100mls of distilled water
(no chitosan added.)

10ppm Matrix Spike-Filter 100mls of 10ppm chitosan acetate sample. (1 drops of the chitosan acetate standard solution into 1L of the filtrate water).

Results: The test method can detect 8ppm to 10ppm matrix spike of Chitosan Acetate with reproducible visual color change when compared to control blank filter. MDL is set at 10 ppm.

Reviewed by: **Yeggie Dearborn, PhD**
Laboratory Director

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3. Aquatic Toxicity

(425) 481-0600

Dungeness Environmental
A Division of Dungeness Development Assoc.

1%, 1 ½% AND CHITOSAN LACTATE FLAKE EC_{50}, EC_{25} AND GMATC

Test	Endpoint	EC_{50} (mg/L as 1% product)	EC_{25} (mg/L as 1% product)	GMATC (mg/L as 1% product)	EC_{50} (mg/l as 1.5% product)	EC_{25} (mg/l as 1.5% product)	GMATC (mg/l as 1.5% product)	EC_{50} (mg/l as 100% chitosan lactate)	EC_{25} (mg/l as 100% chitosan lactate)	GMATC (mg/l as 100% chitosan lactate)
Rainbow trout 96-hr chronic	Survival	177	nc	177	296	186	118			
Fathead minnow 96-hr acute	Survival	909	723	---			---			
Daphnia pulex 48-hr acute	Survival	>10,000	>10,000	---			---	353	138	246
Rainbow trout 7-day survival & growth	Survival	287	228	---			---	>30	24.2	22.5
	Biomass	291	184	---			---			
	Weight	>250	249	---			---			
Fathead minnow 7-day survival & growth	Survival	798	597	---			---	23.4	17.4	11.6
	Biomass	752	513	---			---			
	Weight	>1000	>1000	---			---			
Rainbow trout embryo viability	Viability	>1,000	>1000	---			---			
Fathead minnow embryo-larval survival & teratogenicity	Survival	633	519	---			---			
	Development	639	526	---			---			
Topsmelt 7-day survival & growth	Survival	>1000	>1000	---			---			
	Biomass	>1000	>1000	---			---			
	Weight	>1000	>1000	---			---			
Bivalve 48-hr larval development	Survival	>1000	>1000	---			---			
	Development	>1000	>1000	---			---			

Notes:
1) The GMATC (geometric mean of the NOEC and LOEC) is provided when the EC25 cannot be calculated because the data do not meet statistical assumption for linear regression analyses.
2) 1% ChitoVan is 1% chitosan acetate, 1 ½% ChitoVan is 1 ½% chitosan acetate.

NOEC & LOEC ENDPOINTS FOR 1%, 1 ½% AND CHITOSAN LACTATE FLAKE

Test	Endpoint	NOEC (mg/L as 1% product)	LOEC (mg/L as 1% product)	GMATC (mg/L as 1% product)	NOEC (mg/l as 1.5% product)	LOEC (mg/l as 1.5% product)	GMATC (mg/l as 1.5% product)	NOEC (mg/l as 100% chitosan lactate)	LOEC (mg/l as 100% chitosan lactate)	GMATC (mg/l as 100% chitosan lactate)
Rainbow trout 96-hr chronic	Survival									
Fathead minnow 96-hr acute	Survival									
Daphnia pulex 48-hr acute	Survival							353	138	246
Rainbow trout 7-day survival & growth	Survival	500	250	353				15	30	22.5
	Biomass	291	184							
	Weight	125	250	177	83.3	167	118			
Fathead minnow 7-day survival & growth	Survival							7.5	15	11.6
	Biomass									
	Weight									

Most sensitive species and most sensitive test endpoint.

Attachment C

ATS O&M Manual

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

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Active Treatment System

Operation & Maintenance Manual

For

Active Treatment Systems, Inc.

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

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INTRODUCTION

1.1 ACTIVE TREATMENT SYSTEM

This Operation and Maintenance Manual (O&M Manual) has been written to describe the elements involved in the deployment, operation and maintenance of chitosan-enhanced sand filtration systems for treating water on construction sites.

An Active Treatment System is a safe and effective method for removing sediment from runoff. Proper water management protects our natural waterways and enables site development. Flow-through ATS systems can treat far greater quantities of stormwater runoff than traditional settling processes. ATS is not a substitute for traditional stormwater management techniques such as BMPs. This technology is to be used in conjunction with standard erosion and sediment control measures.

1.2 INTRODUCTION TO THE POLYMER CHITOSAN

Chitosan is extracted from chitin and is nature's second most abundant natural biopolymer next to cellulose. Chitin is the structural material found in crustacean shells such as shrimp, crabs, and lobsters. Chitin is also found in fungi cell walls and the exoskeletons of insects. Chitin and chitosan are natural components of biochemical degradation processes occurring naturally in the earth's soil and water. Like chitin, chitosan is found to exist naturally in the environment (water and soil) because it is a biodegradation product of chitin.

Chitosan has been used in water treatment for more then three decades. It has the unique ability to absorb dissolved oil and grease from water, chelate (bond with) heavy metals, and flocculate suspended sediment. Chitosan-based water treatment has been used for decades in various industrial and municipal applications and commercial aquarium clarification. The U.S. Environmental Protection Agency has approved chitosan for use in drinking water treatment and in the agriculture industry.

Stormwater treatment with Chitosan, at proper dose rates, is highly effective in reducing turbidity levels by greater than 95% when used with sand filtration systems. Chitosan's effectiveness lies in its ability to make small suspended soil particles larger and denser. The larger and denser floc particles can be easily removed through forced settling or sand filtration. The cationic nature of chitosan molecules interact with the predominately anionic sediment particles in stormwater. As these opposite charges attract, the chitosan molecules can bind with numerous soil particles. This process of flocculation creates larger, denser particles in solution, allowing them to settle via gravity or be removed by filtration systems. Over dosing can cause the opposite of the intended effect. An excess of cationic material can cause the floc that initially formed at a lower dose to break apart.

1.3 ATS TREATMENT OVERVIEW

Chitosan-enhanced sand filtration is a flow-through stormwater treatment technology that utilizes chitosan in conjunction with pressurized sand filtration to remove suspended sediment from stormwater runoff. These systems are designed to be deployed on construction sites for the duration of a particular development project and then removed after the successful stabilization of all disturbed areas. Construction companies are compelled by law to prevent the discharge of polluted stormwater runoff from active construction sites. Active Treatment Systems, Inc. works in conjunction with its clients to develop and implement a comprehensive Stormwater Pollution Prevention Plan (SWPPP).

After a careful study of site hydrology and local precipitation patterns, the contractor will install appropriate erosion and sediment control measures called Best Management Practices (BMPs). The BMPs will help reduce the turbidity of the site runoff conveyed to a retention pond or tank for treatment. Each treatment system is designed and installed to be operated on an as need basis, pumping water from the retention basin or tank through the ATS system on demand.

Upon arrival at a treatment site, operators will complete a list of required tasks before operating the treatment system. A site inspection, meter calibrations, water quality tests, manual valve operation and paperwork initiation all must be completed before system start up can commence. The purpose of these tasks is to assure operator safety and proper system operation. After all preliminary procedures are completed the operator will start up the system by turning on the system pump(s). Operations will proceed by calibrating the chitosan delivery system, performing residual chitosan tests, manually logging water quality data, and monitoring the system for pressure and flow optimization.

When stormwater is transferred through the ATS system, Chitosan is introduced to the water to coagulate suspended solids, which then will settle out via gravity or be removed within the sand filter. The sand filters are equipped with automatic backflush systems, which will backflush the filtered sediment from the individual filter pods as necessary to maintain the hydraulic capacity of the filtration media. This feature allows the treatment system to operate on a continuous flow-through basis. The treatment systems are also equipped with in line pH and turbidity sensors capable of monitoring and recording the effectiveness of the treatment. Automated valves direct treated stormwater to recirculate or discharge based on the water quality readings of the in line sensors.

After the operation period is complete the treatment technician will exercise standard and site specific shut down procedures. Familiarization with current site and weather conditions, pond water level, project manager (PM) and contractor concerns, and operation schedules are the responsibility of the technician. Good team work will ensure operational success and personal safety.

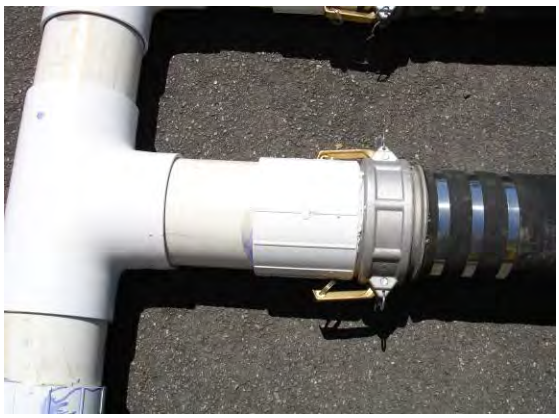
1.4 TREATMENT SYSTEM COMPONENTS

Although there are variations between individual ATS systems, many of the basic components are similar. The following is a list of the individual segments that one would expect to see associated with an ATS system.

1) Stormwater retention structure[s] — Stormwater retention structures include ponds, tanks or vaults. Ponds can either be lined or unlined; permanent or temporary. Tanks are rental units and frequently have weirs inside to facilitate settling. Vaults are permanent underground structures built for long term stormwater management.

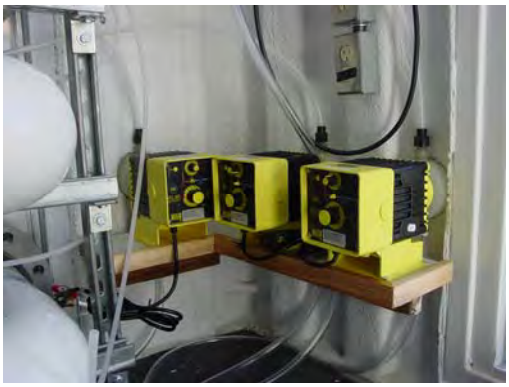
2) Interconnecting piping — Water may be conveyed via swales, ditches or pipes to the retention structure. Interconnecting piping integrates all the components in the treatment system and conveys the water to the discharge point. Pipe types may include PVC, Bauer, flex hose and polyethylene tubes for sampling.

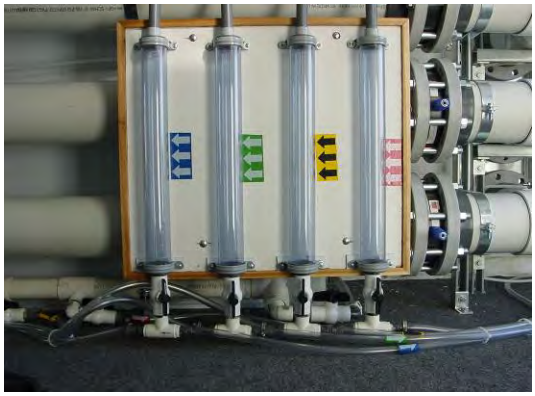
3) Pipe fittings – PVC pipes are typically connected with couplers and glue. Flanges are bolted together with a rubber sealing gasket. Bauer and cam lock connectors are quick disconnect fittings.



4) Primary influent and pre-treat pump — The pre-treatment pump is typically submersible and is attached to a float. The main pump, which pushes water through the sand filter, is shore based. Pumps are typically electric.

5) Chitosan injection system — The chitosan injection system consists of a storage tank, peristaltic delivery pump, graduated cylinders for calibration, a static mixer, and assorted tubing and control valves.

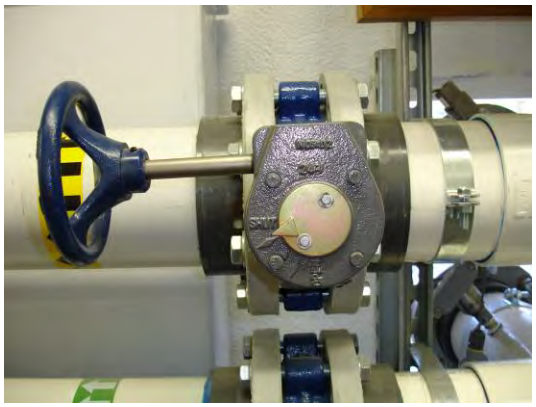


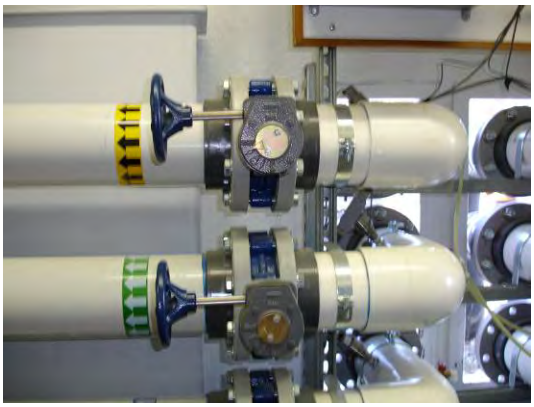


6) Sand Filtration Unit — The 36X4 (or larger, e.g. 48X4 or 54X4) sand pod unit with back flush capabilities is commonly used. A minimum of 'three pod' units should be used. Sand pods are the primary cleaning mechanism of the ATS system.

7) Effluent water quality monitoring equipment — This equipment continuously samples the effluent water for pH and turbidity. The system includes pH meters, turbidimeters, flow meters, an instrument display panel, and sample lines. Data collected here is recorded by the PLC.

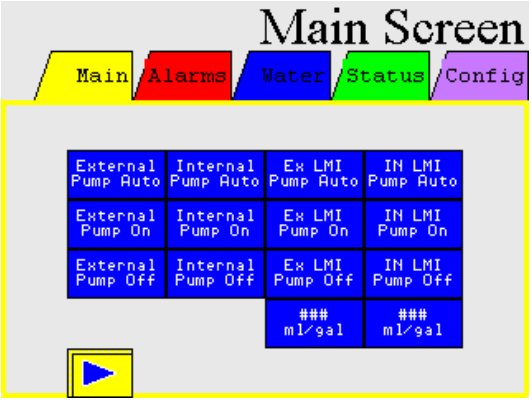
8) Manual valves — Manual valves are used by the operator to control flow rates and internal system pressures. There are manual valves located on the influent and effluent side of the sand filter, as well as on the backflush line. Additionally, a manual throttle valve may be located on the system pump.





9) Automatic valves — Automated pneumatic valves are located on the effluent line in the system container. These valves divert flow between the discharge and recirculation lines based on the water quality readings of the in-line sensors.

10) Programmable Logic Controller (PLC) — Primary control panel used to operate the treatment system. All automated controls, alarm settings, and recent system data are stored in the PLC.



11) Power Generator— These are rented units needed when permanent power is not available which provide electric power for ATS equipment and operations.

12) Laboratory Equipment — Components for bench scale testing and monitoring include handheld meters, beakers, droppers, filters, standard solutions, chemicals, monitoring forms and other miscellaneous items.

13) Air Compressor — Provides pressurized air to operate pneumatic control valves on the ATS effluent line and backflush valves on the sand filter

14) Backflush Control Box — Sets parameters for sand filter back flush cycles. Activates automatically based on differential pressure in the filter.

TREATMENT CONCEPTS AND SYSTEM DESIGN

2.1 CONSTRUCTION SITE OPERATIONS

The majority of Active Treatment Systems, Inc. treatment operations take place on active construction sites. Construction sites are particularly dangerous locations and Active Treatment Systems, Inc. employees should remain vigilant about health and safety issues. Constantly changing conditions, unstable surfaces, heavy equipment operations, as well as other issues all contribute to site hazards.

Health and safety precautions are extensive and beyond the scope of this manual. Technicians should refer to the site specific Health and Safety Plan (HASP) for safety issues pertaining to each job site. The weekly checklist included in the HASP needs to be read and signed by every Active Treatment Systems, Inc. employee that visits a site for that particular week.

2.2 STORMWATER REGULATIONS

Construction stormwater runoff has been identified as a major source of pollution in our nation's natural waters. The physical, biological and chemical integrity of a natural water body receiving discharge from a construction site can be greatly impacted.

The two major laws that most stormwater regulations emanate from are the Federal Clean Water Act and Endangered Species Act. The Environmental Protection Agency is ultimately responsible for enforcement of these laws, but may delegate enforcement to a state agency. Always consult local regulations before operating ATS systems.

There are many other stormwater regulations that are beyond the scope of this text. Increased knowledge of stormwater regulations will improve an operator's effectiveness.

2.3 WATER CHEMISTRY

Effective implementation of a treatment system requires a thorough understanding of site stormwater characteristics and the potential impact on chitosan flocculation. Potential contaminants such as VOCs, PCBs, heavy metals, etc., must be identified and remediated prior to discharge. Other compounds such as naturally occurring lignin and tannins can impact the ATS treatment process but do not pose a concern for discharge.

ATS systems are designed to treat turbid stormwater impacted with suspended sediments. Many environmental contaminants can be adsorbed to soil particles and become suspended in stormwater runoff. Many of these contaminants can be removed from solution by removing the sediment. Although this can be a beneficial side reaction in ATS treatment, Active Treatment Systems, Inc. makes no treatment claims for stormwater runoff other than turbidity.

Prior to full-scale deployment, it is essential to conduct a series of bench scale treatability tests to ensure the stormwater sediment is conducive to treatment with chitosan. These tests should be focused on determining stormwater turbidity and pH, treatability, proper chitosan dose rate, and potential settling times if required.

Aside from harmful contaminates, the water chemistry variables of primary concern are pH, turbidity and conductivity. pH must be in the range of 6.5 - 8.5. Values outside this range will require pH adjustment prior to flocculent addition. Typical pH adjustment involves either adding an acid or a base discussed further in this document.

Although ATS systems are capable of continuous operation when turbidity approaches 600 NTUs, experience has shown that optimal system function is typically limited to influent turbidities less than 200 NTU. Generally, typical pre-treatment activity will bring NTU levels well within range of sand filter use. High turbidity (in excess of 600 NTU for an extended period of time) may require reevaluation of existing site Best Management Practices (BMPs).

2.4 SCREENING AND TREATABILITY TESTS

It is essential to confirm early on that site stormwater is conducive to treatment with chitosan. A simple bench scale treatability test enables Active Treatment Systems, Inc. technicians to assess the treatability of site stormwater quickly in the field.

Bench scale treatability testing allows PMs and system operators to determine a likely chitosan dose range. On large sites, it is strongly recommended that technicians perform treatability tests using samples from several different areas of the site.

Several factors can influence treatability, including pH (typically from concrete work onsite or natural limestone), detergents, the presence of soil tackifiers such as polyacrylamides (PAMs) and guar (starch) in the runoff.

Bench scale treatability tests should be done multiple times prior to system deployment to identify and address treatability issues early on. Treatability tests are also to be preformed daily before system start-up and whenever conditions on the site warrant reevaluation.

The procedure for this test is described in section 3.6 of this manual

2.5 RETENTION STRUCTURES AND SEDIMENT MANAGEMENT

Stormwater retention ponds and traditional erosion control devices are the first line of defense in sediment management. ATS systems are more effective when properly integrated into a SWPPP that uses traditional erosion and sediment control techniques. Actual sizing and placement of retention structures and BMPs is beyond the scope of this document. Regardless of the type and size of structure, the following components are necessary for implementation:

1. **Traditional BMPs** — Traditional BMPs are essential to proper stormwater management. These surface stabilization measures help prevent significant erosion and sediment movement. ATS is intended to aid, not to substitute, standard stormwater management techniques.

2. **Primary retention structure** — The water reservoir in which all untreated stormwater is directed and stored. This is typically an excavated pond prepared by the contractor to store site runoff. The storage capacity of these structures varies depending on the size of the disturbed area and site limitations.

3. **Pre-treat retention structure** — Secondary retention structure in which pre-treated, unfiltered stormwater is allowed to settle prior to sand filtration. These structures can be ponds or above ground tanks. Ideally these structures will contain weirs to reduce and dissipate energy in the flowing water and aid in sediment settling.

4. **Backflush (from the sand filtration system)** — Backflush water will contain floc particles accumulated on the surface of the sand filter beds. These floc particles will settle rapidly in the retention structure due to their large size and density. The rate of settlement will depend on sediment load, water chemistry and flow rate. Backflush water should never be directly released into the receiving water body.

Every effort should be made to avoid routing backflush water to the primary retention structure. Ideally, the backflush outflow should be directed to a dedicated backflush tank which overflows into the pre-treat cells. At minimum, the backflush outflow should be directed to the opposite end of the retention structure from the intake pump.

- If there is any possibility that the coagulated/flocculated sediment (sludge) contains hazardous materials, then the retention structure should be lined to facilitate proper handling and disposal of contaminated sediments. Lining the retention structure will also prevent unwanted infiltration of untreated water.

- Disposal — Sludge may be dewatered and disposed of onsite. Contaminated sediment should be handled in accordance with applicable regulations and permit stipulations.

2.6 INTERCONNECTING TREATMENT SYSTEM PIPING

The filtration system requires interconnecting piping capable of transferring desired flow rates without significant friction head losses. Typically, schedule 40 polyvinylchloride (PVC) pipe and flexible hose is used to interconnect the system components. Sizing should be in accordance with system requirements, and will generally be as follows:

PIPING SIZES AND FLOW RATES

FLOW RATE	*PIPE SIZE*
Up to 400 gpm	**4”**
400-750 gpm	**6”**
+750 gpm	**8”**

The headers on the sand filter and the internal piping of the treatment system container are 6 inches in diameter. The ideal diameter of the external system piping is 6 inches which will maintain consistent pressures and flow rates. Reducing the diameter of a conveyance line (pipe) will increase the pressure the water exerts within that line. Conversely, increasing the diameter down a conveyance line will relieve the pressure in that line.

The treatment system container has hand operated flow control valves located on the influent and effluent lines for the sand filter. These valves control pressure and flow rates in and through the sand filter. In addition, the sand filter has a flow control valve located on the back flush line. Flow control throttle valves may also be located on the system pumps.

2.7 PLUMBING

As the treatment system container and sand filter is equipped with 6” pipe, it is recommended that 6” pipe be used to connect the system components. There are many factors that influence the type and size of pipe used for an ATS system which are beyond the scope of this manual. PVC or Bauer pipe are most commonly used for field mobilization but different types of flexible hose may also prove necessary in certain configurations.

Most ATS systems are equipped with pre-treatment and backflush capabilities. The backflush line from the sand filter is a 4” header and will require 4” pipe. The pre-treat line will require a pump separate from the main system pump and will typically be assembled using 6” pipe and fittings.

Before plumbing the system, make sure all required system components are in place and as level as possible. This includes the system operation container, water pumps, electrical generator, sand filter and any tanks.

CAUTION: BE SURE TO LEAVE ACCESS TO THE TREATMENT CONTAINER AND GENERATOR FOR ANY VEHICLES NEEDED TO RESUPPLY CHITOSAN AND DIESEL!

If the pump being used is submersible it should be connected to a flotation device prior to placement in a pond. Many types of flotation devices are used, and the decision on which type to use needs to be made based on the size of the pump. If the pump being used is not a submersible pump, the intake line should be connected to a suction float with a debris screen. Flotation devices and screens prevent the introduction of rocks, sticks, mud and other debris to the pump. This can prevent costly maintenance, repairs, replacements and operational time loss.

The order in which the system is plumbed will depend on the physical configuration of the site. For the purpose of this manual the mobilization procedure will be described in the chronological order of the system water flow. The following list is generalized and site specific adjustments may apply.

- **Connect the pre-treat pump.** Any flotation devices should be connected to influent before placement in the water. Run the line from the water to the pump, then from the pump to the bottom header at the front of the treatment container. Tape on the headers in the system container indicates direction of flow.

- **Connect pre-treat line between system container and pre-treat retention structure.** A distance of at least 50 feet is desired to maximize the mixing of the chitosan and the stormwater. Water should be released into the retention structure above the surface.

- **Connect line from pre-treat retention structure to sand filter pump.** The water intake line from the pre-treat retention structure should be as far as possible from the point where the pre-treated water is introduced to the structure. This placement will take advantage of the maximum possible settling time of the sediment.

- **Connect line from system pump to treatment container.** This line will go from the pump discharge to the middle header at the front of the treatment container. Tape on the header in the container indicates flow direction.

- **Connect line from middle header effluent to the sand filter.** A distance of at least 50 feet is desired to maximize the mixing of the chitosan and the stormwater. This line will run to the top 6” header of the sand filter.

- **Connect line from bottom header of sand filter to treatment container.** This line will go to the top header at the front of the treatment container. Tape on the header in the container indicates direction of flow. This line will branch in to two effluent lines, each with an automated valve. The lower of these lines is the discharge effluent line. The top line is the recirculation line.

- **Connect discharge line.** This line will run from the container to the discharge location.

- **Connect recirculation line.** This line will run from the top effluent pipe and typically run into the primary retention structure consultant the PM for site specific modifications.

- **Connect backflush line.** This line will run from the 4" header on the top of the sand filter to the primary retention structure or separate backflush cell. This line should introduce water to the retention structure as far as possible from the pre-treatment influent line to minimize uptake of suspended solids.

2.8 CHITOSAN POLYMER DELIVERY SYSTEM

The Chitosan polymer delivery system consists of a chitosan storage container, secondary spill containment structure, metering pump, graduated cylinder(s) for calibration, static mixer, interconnecting tubing and valves. A secondary spill contaminant structure is required by regulatory agencies to provide containment in case of accidental spills. Consideration should be given to regular chitosan supplying procedures when installing the treatment system on site.

The metering pumps for the sand filtration systems are LMI Model C77 variable speed chemical metering pumps with high viscosity head assemblies. This pump is a variable-output, positive displacement metering pump with a flow rate range of 0-10 gallons per hour at 80 psi. Individual pumps are typically installed for the pre-treatment and filter influent dosing.

PISTON SPEED AND DISPLACEMENT RATE SHOULD ONLY BE ADJUSTED WHILE PUMP IS IN OPERATION!

The capacity of a chitosan storage container can range from 150 to 275 gallons. The operational time frame of a storage container can last from several days to several months, depending on dose rate and the volume of water treated. Ball valves are installed on the chitosan delivery lines for meter calibration purposes. The static mixers installed on the pre-treat and sand filter influent lines increases the mixing rate within the pipes. Incorporation of static mixers into Clear Water's ATS systems have reduced the required chitosan contact time, the overall system footprint, and decreased chitosan utilization by 25 to 50%.

Follow the bench scale treatability protocol to determine the likely dosage range.

2.9 WATER QUALITY MONITORING

Local, Regional, State and Federal regulations will determine the scope of water quality testing that must be performed on the site. Construction permit and SWPPP approvals from applicable environmental jurisdictions will typically state what testing must be performed, how often, and who should receive the results. These regulations will often effect system discharge location and volume.

The treatment system is designed to monitor effluent turbidity and pH, and to automatically divert flow from discharge to recirculation should these values exceed permit limits. Influent water quality parameters are also monitored by the system PLC but do not trigger any flow diversions.

Treatment technicians must calibrate system sensors on a daily basis to ensure reliability of the automated process. Additionally, technicians must perform multiple manual water quality tests to verify online instrumentation. Hand held meters must be checked and compared to the in-line meters on a daily basis. This procedure is referred to as a Confidence Check.

Other water quality parameters governed by local regulatory agencies must be monitored and addressed by the system operator. Sample ports are provided in the system to take water samples for bench scale monitoring. The filter influent and effluent headers each have one sample port feeding into the system's flow-through water quality sensors. The influent port samples pure runoff or pre-treat water before it gets dosed for the sand filter. The effluent port samples water after if has been filtered but before it is discharged. Water sampled for residual chitosan tests should be drawn from the effluent port to prove the absence of residual Chitosan.

TREATMENT SYSTEM OPERATIONS

3.1 SYSTEM OPERATOR

The stormwater filtration system shall be operated, monitored and maintained by experienced water filtration personnel. The system operator should have previous training or should be trained during the first several days of operation under the guidance of an individual experienced in chitosan-enhanced water treatment systems.

3.1.1 Required Operator Qualifications

1. Minimum 1 year experience with, and sound working knowledge of, pressurized sand filtration systems.
2. Experience deploying and troubleshooting pressurized water pumping and piping systems.
3. Fundamental knowledge of stormwater discharge regulations for applicable region/locale.
4. Fundamental knowledge of water quality testing procedures for parameters applicable to the region/locale.

3.1.2 Required Operator Training

Classroom training

1. Stormwater regulatory framework and requirements
2. Stormwater treatment chemistry (chitosan, pH, coagulation, filtration, etc.
3. Stormwater treatability (how to do jar testing)
4. Treatment system components and their operation
5. Troubleshooting

Field Training

1. Operating a treatment system
2. Entering data in the system operation log
3. Testing turbidity and pH

4. Optimizing chitosan dose rate

5. Water quality sampling and testing (turbidity and pH)

3.2 SYSTEM OPERATION SEQUENCE

The typical operational sequence for starting and stopping systems is given below. System, site, and regulatory variations must always be considered. The following sequence is intended to be a general outline for ATS operations, not a comprehensive protocol.

3.2.1 System Start Up

1. Perform site and system inspection procedures (section 3.3). Examine system for obvious damage or malfunction. Unlock container and power up the system. Orient all valves for operation in recirculation mode.

2. Turn on the sensors. Read and record system volume totalizers in the Daily System Operation and Maintenance log. Record any other relevant system information.

3. Calibrate hand held pH, turbidity and conductivity meters.

4. Take a grab sample from primary retention structure and perform bench scale treatability test to determine likely chitosan dosage.

5. Perform water quality background check. This includes taking grab samples from the receiving water body and recording pH, turbidity and conductivity in the appropriate field log.

6. Calibrate inline pH and turbidity meters.

7. Switch PLC to recirculation mode. Recheck manual valve orientation.

8. Start the filtration system pumps using system PLC screen and watch for proper system functioning.

9. Start LMI pumps

10. Calibrate LMI pumps to deliver proper chitosan dosage

11. Once LMI pumps are calibrated and all discharge conditions are met, switch system to automatic mode by touching the “valves auto” button on the main screen of the system PLC.

12. Collect samples of sand filter effluent and perform the residual chitosan test.

13. Treatment technicians will remain on site while the system is in operation to monitor overall system performance. System pressure and inline water quality results are to be recorded every fifteen minutes in the appropriate field log.

14. Residual chitosan tests are to be performed twice during the first two hours of system operation. LMI calibrations are to be performed every four hours after start up calibration, or when a significant change occurs in the dose rate or influent turbidity

3.2.2 System Shut Down

1. Begin system shut down by switching system back into recirculation mode.

2. Turn off main system pumps and LMI pumps.

3. Open sand filter bleeder and/or drain valves and let water drain from the recirculation line.

4. Record flow meter totalizer readings in the appropriate field log. Note any operational anomalies and certify operations.

5. Follow shut down procedures for inline pH and turbidity meters (Section 3.15).

6. Drain air compressor using manufacturer installed drain plug.

7. Clean and organize the treatment system container.

8. Close all applicable system valves (inline sample; chitosan storage tank; water storage tank; pneumatic valves).

9. Turn off all extraneous power in the system and lock the container.

3.2.3 Freeze Protection

During cold weather conditions, certain precautions need to be taken to protect against freeze events. A freeze event could result in system component damage and/or operations loss.

1. All conveyance lines should be drained. Frozen pipes could result in flow blockage and/or pipe fracture. Ball valves are likely installed on conveyance lines to drain water for freeze protection. Disconnect low end cam-locks or Bauer fittings for drainage if necessary.

2. Sand filters should be drained. Bleeder valves on the top of the sand pods should be open to aid in filter drainage. Drain valves may be installed on the bottom header for more direct filter evacuation.

3. System Container should be kept heated at all times. Generator, system, and heater should all be left in “auto”. Extreme cold conditions can cause instrument damage, plumbing damage and will affect the hydraulic performance of the chitosan. The properties of some of the chemicals may be compromised if they freeze.

3.3 SITE AND SYSTEM INSPECTION

A preliminary assessment should be made of the overall integrity of a job site upon arrival. Conditions may have changed at the site in such a way that affects treatment operations. In addition, standard operating procedures must be performed prior to system start up.

Overall site integrity: Construction sites are in a constant state of change. Be aware of major physical changes such as road additions or removal, vegetation removal, sanitary facility location, site access points, excavations and heavy equipment operation.

Pond Level: Check pond/tank levels upon arrival and report excessive levels immediately. Observe pond/tank level prior to system startup and monitor level frequently during operation. Note both increases and decreases in pond/tank level to assure efficient staffing and operation.

Pipe Integrity: Check to see if all the conveyance lines are in working order. Surface pipes on construction sites are vulnerable to vehicle impact, vandalism, and environmental damage. Small stress cracks can become significant safety or operational problems when operating under pressure

Freeze Protection: Close all drain valves that may be affixed to water conveyance lines or the sand filter. These valves are left open to drain excess water from the lines in cold weather. Water expands as it freezes and PVC pipe becomes more brittle in cold weather. This combination can render a system inoperable.

Manually Operated Valves: Switch any manual valves to the proper position for site specific operations. Some valves associated with system operation are automatically controlled by the PLC. However, some systems may incorporate manual valves for pre-treatment cells, multiple retention ponds, or multiple discharge locations. If you are unsure about proper valve positions, contact the project manager.

Hose/Pipe Connections: Shut down protocol on some sites require operators to disconnect specific conveyance lines to drain the system. Assure all necessary conveyance piping and hoses are attached to appropriate system equipment.

Generator Fluid Levels: Check the fluid levels (fuel, oil, water) on the system power generator to see if the equipment needs to be serviced. If any fluids are low or warning signals lit, contact the project manager.

Equipment Theft: Power cables, generators and hand tools are a frequent target of theft. Check to see if any operational equipment appears to be missing or tampered with.

Unlock Container: All Active Treatment Systems, Inc. treatment containers are kept locked when company personnel are not present. Keys for all treatment containers will be provided by the PM.

Power Up System: A treatment system will likely be in AUTO or OFF upon arrival. ATS system key switch and generator should be set to ON during system operation.

Chitosan Injection System Valves: The chitosan storage tank valve should be shut at the end of every shift to protect against chitosan leaks. Open any valves necessary for proper chitosan injection.

Sand Filter Bleeder and Drain Valves: Small bleeder valves at the top of the sand filter pods are typically left open at the end of system operations to aid in the drainage of the sand filter. Make sure these valves and drain valves are closed before introducing water to the filter.

Sample Port Valves: Water quality sampling lines should be closed at the end of system operations. Keep these valves closed until the inline water quality meters have been calibrated. Open the valves before system operations.

Air Compressor: Turn on air compressor if it is turned off. Make sure the compressor breaker switch is on. Check to make sure the previous operator drained the compressor of water and the drain valve is closed.

Chitosan Volume: Asses the quantity of chitosan in the storage tanks. Site PMs need to be kept aware of chitosan levels so they can schedule a timely resupply.

3.4 FIELD DOCUMENTATION

A series of triplicate forms are provided in all the system containers for technicians to log the results of operational activities. Completion of these forms is necessary for

compliance with Active Treatment Systems, Inc. and regulatory procedures. The complete set of forms is to be used during every operational period.

All the forms have a field to record the project title, project number, project location and date in the header block. System operators should print and sign their name at the bottom of the sheet. If multiple operators are working in a single system container, the forms should be signed by the most senior operator. All fields on each form are to be completed. Fields are never to be left blank. Fields which do not apply to a particular site or system should be completed with the letters NA (not applicable).

ATS – Daily System Operations and Maintenance: This is the primary form used by system operators. The pre and post treatment flow totalizer numbers as well as the total volume treated and the total volume discharged are recorded here. This form is intended to summarize system activities and productivity. Regulatory agencies require an evaluation of system performance and water quality monitoring for all discharge periods. Other relevant operational information should be recorded here for reference by onsite staff.

Bench Scale Treatability Form: This form is used to record water quality data and the observed results associated with the bench scale treatability test. The procedure for this test is described within this manual. Visual observations should be recorded in conjunction with each dose adjustment. Additionally, a general assessment of the entire test should be recorded upon completion of the test.

Receiving Water Quality Monitoring Form: The receiving water quality form is used to record the results of upstream and downstream conditions in the receiving water body. The observations recorded on this form are used to assess any impacts ATS discharges may impose on the receiving water. This form has limited usability on some sites because of the location of the discharge or type of receiving body.

Chemical Metering Pump Calibration Form: This form is used to record the LMI chemical delivery rate and calculate the treatment system dose rate. The chitosan calibration procedure is described within this manual. Chitosan injection pumps are to be calibrated upon system start up and every four hours thereafter.

Residual Chitosan Test Form: This form is used to record the results and sample data associated with residual chitosan tests. The procedure for this test is described within this manual. This residual chitosan is to be performed twice during the first two hours of ATS operation.

Manual Data Collection Form: This form is used to record inline water quality data (pH, Turbidity) as well as system pressure. Influent and effluent data should be recorded for each of these three categories. This data should be recorded every 15 minutes and logged in military time. This data should be read from the

"water" page of the PLC. In addition, daily meter confidence checks should be recorded on this form.

Instrument Calibration Report Form: Clear Water's ATS systems have multiple water quality meters which need to be calibrated daily.
There are separate forms associated with inline pH meters, inline turbidity meters, and all the hand held meters. There are fields to record the strength of the calibration standard used, the initial meter reading, and the calibrated meter reading.

3.5 SENSOR CALIBRATION

The systems internal water quality sensors, as well as the hand held sensors, should be calibrated daily before operations begin. Log the calibration information for each instrument in the accompanying calibration form. Daily calibration of the sensors is directed in the use level designation and will help ensure accuracy of water quality monitoring.

Confidence Checks must be performed to confirm sensor accuracy. Hand held readings should be checked against inline readings during the residual chitosan tests. An additional Confidence Check is to be performed and recorded six hours after system start up (if applicable). Confidence Checks are to be recorded in the Manual Data Collection Form.

The manufacturer provided calibration procedures for each meter are included as an attachment in this manual. Additionally, the entire owner's manual for the hand held meters are included inside each treatment system. Calibration standards for the inline and hand held turbidimeters are included in the corresponding meter kits. Calibration standards for the inline and hand held pH meters are supplied within the treatment system containers. The calibration standard for the conductivity meter is supplied within the treatment system container.

3.5.1 Hand Held Meter Calibration

Hand held meters are to be calibrated at the beginning of each operational shift. A separate set of forms are included specifically for calibrating the hand held meters. These meters must be calibrated prior to the preliminary water quality tests. Follow the included manufacturer's instructions for proper calibration procedure.

3.5.1.1 Hand Held pH Meter

It is important to properly care for the pH meter probe. Irreparable damage to the probe commonly occurs due to simple neglect. pH probe storage solution and cleaning solution is included in the treatment system containers. Use the cleaning solution periodically or whenever its use appears necessary. Store the probe in probe storage solution whenever the meter is not in use. The tip of the probe should never be allowed

to dry out. The probe should be rinsed with water between insertions of different standards or samples to avoid contamination.

3.5.1.2 Hand Held Turbidimeter

The included cuvettes for calibration standards and sample measurements need to be handled carefully. The readability of the glass cuvettes will be compromised if they get scratched. Avoid touching the cuvettes with your bare fingers and carefully remove smudges with laboratory wipes. The cuvettes can become stained if dirty samples are allowed to sit inside for an extended period. Always promptly empty samples and rinse the cuvettes with distilled water after use. Clean stained cuvettes with a gentle solvent.

Make sure the outside of the cuvettes are dry before inserting them into the meters. Introducing moisture into the meters will compromise sample reading and damage the meter.

Record the Initial Reading before calibrating the meter. Record the Final Reading after calibrating the meter.

3.5.2 Inline Meter Calibration

Inline meters are to be calibrated at the beginning of each operational shift before water treatment begins. Record calibration data in the appropriate forms. Follow the included manufacturer's instructions for proper calibration procedure.

3.5.2.1 Inline pH Meter

Follow the probe care and usage instructions previously stated for the hand held meter.

Calibrate the pH meter using the EASYCAL method identified by the manufacturer. Choose a calibration slope appropriate to the water that will be treated for that shift (7 to 4 if water is under 7; 7 to 10 if water is over 7). Finish the calibration procedure by measuring the calibrated reading of the pH 7 buffer. This will ensure the meter is reading within the range of the stormwater being treated. Record the Initial Reading when the meter is in calibration mode and record the Final Reading when the meter is back in normal operation mode.

Carefully remove and replace probe from probe seat. Probe-amplifier lock points can be damaged if not removed gently. Cross threading is a common problem with the pH seats. Be aware of the O-ring gasket falling out when removing probe from pH seat.

3.5.2.2 Inline Turbidimeter

Follow the cuvette care and usage instructions previously stated for the hand held meter.

Be aware of condensation on the flow through cuvette when calibrating between 24 hour operational periods. Cold water in the cuvette and the warm air inside the treatment container will often promote condensation which would need to be wiped off before returning the cuvette to the measurement chamber.

Record the Initial Reading and Final Reading when in calibration mode.

3.6 PRELIMINARY WATER QUALITY TESTS

After the water quality sensors have been calibrated the system operator can perform the bench scale treatability and receiving water quality tests. These tests are used to assess the conditions of the water to be treated and the receiving waters. The technician may have to adjust treatment system operations based on the water chemistry test results.

3.6.1 Bench Scale Treatability Test

The bench scale treatability test lets the operator know of possible treatment problems prior to introducing water to the ATS system. Several factors can influence treatability, including pH (typically from concrete work onsite, or natural limestone), detergents, the presence of soil tackifiers such as polyacrylamides (PAMs) and guar in the runoff.

Conditions in the bench scale test are different than conditions inside the treatment system. For this reason different treatment outcomes may occur between bench scale tests and system operations.

The samples procured for this test should be representative samples from recent runoff, and should not contain sediment that would settle naturally (sand and rocks). On large sites it may be prudent to collect multiple samples from different points on the site and perform separate tests.

3.6.1.1 Required Equipment

In order to perform this testing sequence, the following items are required:

- Properly calibrated pH meter
- Properly calibrated turbidimeter
- Properly calibrated conductivity meter
- One 1-liter sample glass beaker
- One 1-liter sample plastic beaker
- Chitosan
- Pipette
- Stir rod

Perform the Screening Test

1. Retrieve a one liter grab sample of water from the site retention Pond/tank with a plastic beaker.

2. Transfer the sample into a one liter glass beaker

3. Measure and record initial pH, conductivity and turbidity of sample in the appropriate field log.

4. If the sample does not have a pH reading conducive to treatment (6.5 – 8.0), carefully adjust the pH of the sample by adding small amounts of base or acid until the sample reads a pH close to 7. Record the adjusted pH and note treatment method.

5. Add one drop of a known quantity chitosan to the sample.

6. Stir sample vigorously for one minute to assure dissolution.

7. Allow sufficient settling time and observe solution for the formation of small floc particles called pinfloc.

8. Grab a sample from the surface of the sample jar and record the turbidity.

9. Repeat steps 3 through 4, recording observations and dosage related to the appearance of floc and settling.

3.6.1.3 Interpreting the Screening Test

Visible sediment settling indicates that chitosan has coagulated the particles. The beaker may contain clear water on top, or be slightly cloudy, and there should be variation in coagulation amount between dose rates. The object of this test is not to produce completely clean, clear water in the beaker. Rather, it is to determine the most suitable dose rate for ATS treatment.

For planning purposes, the smallest effective dosage should be used as the initial dose rate.

If there is no change in sample appearance between does it is assumed that there are treatability problems. This is rare, and may occur for different reasons which need to be investigated.

3.6.2 RECEIVING WATER QUALITY TEST

Receiving water quality tests are designed to measure if discharge from ATS operations is negatively impacting the receiving water body. Site specific conditions may force the system operator to amend or even abandon this test all together. Certain discharge points, such as municipal storm sewers or overland infiltration, make it physically impossible to obtain a sample for this test.

This test is designed for a linear flow water body such as a river or stream. The procedure for this test will be described for such a water body. PMs and treatment technicians may need to improvise sample collection procedures if site conditions are inconsistent with this assumption.

1. Before system start-up, take two 1-liter beakers to the discharge point to obtain grab samples. Take one sample several yards upstream and one sample several yards downstream of the discharge (or per SWPPP requirements). Always wear nitrile laboratory gloves when taking grab samples. Operators must not place themselves in precarious situations to obtain a sample. NO JOB IS TOO IMPORTANT TO NEGLECT SAFETY CONCERNS!

2. Return samples to the system container to measure the water quality. Measure pH, turbidity and conductivity of each sample with hand held meters. Record the sample location, time and water quality data for the two samples in the top two columns of the Receiving Water Quality Form.

3. After several hours of operation, return to the system discharge point and take one sample from each of the previously identified locations. Return these samples to the system container to measure water quality. Record the water quality data along with the location(s) and time(s) on the bottom two columns of the form.

4. Compare the two data sets. Ideally there will be a negligible difference between the data sets. If there is a significant difference between the two data sets, it should be recognized as evidence that system operations are impacting the receiving water body. Operators should notify their project managers in such a case.

3.7 PUMP ACTIVATION

After meter calibration and preliminary water quality tests are completed, the operator is ready to introduce water to the ATS system. Operators should always verify all manual valve positions to ensure the pressurized water has a clear and proper path of entry and exit through the treatment system. Closed pathways will dead head the pump which can lead to equipment damage and/or safety concerns.

Attention should be paid to the water levels of the primary and (if applicable) secondary retention ponds/tanks. Pre-treatment should be momentarily delayed if the secondary cell is full. Filter treatment should be delayed if the secondary cell is empty.

Overflowing retention structures can result in stormwater runoff violations. Pumping of a dry retention structure can cause pump damage. Pre-treatment and primary pumps often do not deliver water at the same rate. Treatment technicians should continually check pond levels and pump flow rates and adjust pump operation accordingly.

3.7.1 Pump Activation Procedure

1. Open the automated recirculation valve by pressing the “Recirc Valve On” button on the Main Screen window of the PLC. Visually confirm that the valve has opened.
2. Toggle over to the secondary Main Screen window by pressing the yellow and blue arrow on the bottom of the screen. All the buttons on this screen supply power to individual pumps.
3. Switch on pre-treat and/or main pumps, based on retention structure(s) water level by pressing the “External Pump On”/”Internal Pump On” button(s) accordingly.
4. Switch on the corresponding pre-treat and/or main LMI pumps by pressing the “Ex LMI Pump On”/”In LMI Pump On” button(s).
5. Check associated components as water begins to run through the treatment system including, air compressor, backflush control box, flow meters, and flow through sample lines.
6. Observe pressure gauges to assure the ATS system reaches an acceptable operating pressure.

3.8 SYSTEM OPTIMIZATION

ATS systems usually take several minutes to reach full operating pressure after pump activation. Technicians should take this time to confirm proper system operation. Systems which have been operated recently and frequently will generally reach optimum operating conditions soon after pump activation. Systems which are starting up for the first time or have not been operated for a long time will require some adjustments to reach optimum operating conditions.

3.8.1 System Optimization Procedure

1. After pump activation, confirm that the air compressor is receiving power and delivering the proper pressures. Compression chamber pressure should be 100+ psi and line pressure should be 60+ psi
2. Visually confirm water discharge. Walk over to the discharge (recirculation) point to observe this. No water or decreased water flow indicates possible system breach.
3. Confirm that the flow sensors are working. There are different types of flow sensors and the reason for failure may differ. If the flow meter is not registering flow but system flow is evident, the sensor may need to be inspected. This process involves system shut down, water main evacuation and removing the meter for inspection.

4. Confirm backflush control box is powered. The backflush control box automates all backflush operations. Loss of backflush will result in filter sand bed impaction. Check main power, breaker switch and power cord if box is not powered.
5. Confirm sample line flow. Polyethylene tubes which convey the water quality samples should dispel water through one of the penetrations in the container. No outflow from these tubes indicates the water quality readings are not representative of the treated stormwater. Check for proper valve orientation and/or clogged lines.
6. Optimize flow rates. The maximum discharge flow rate for a specific site will be specified in the Stormwater Treatment Plan. Adjust manual valves to achieve desired flow rate.
7. Optimize system pressure. Optimal system pressure depends on the specific system and will vary from site to site. Variables such as pump capacity, plumbing configuration, filter size, discharge rate and water treatability will all affect system pressure. Typical system pressure should range between 30 and 50 psi. System pressures can be as low as 20 and as high as 50 with no operational impediments. Opening the influent valve will increase system pressure and increase system flow. Opening the effluent valve will decrease system pressure and increase system flow.

3.9 pH TREATMENT

Although pH treatment is not included in all ATS treatment regimens, it is not unusual. Many of the sites that require pH treatment require it on a consistent basis while other times it may be sporadic or short term.

pH treatment is required for regulatory and operational purposes. These two requirements are not necessarily unrelated.

Regulatory requirements dictate runoff from construction sites that discharge to non-marine surface waters must have a pH between 6.5 and 8.5. Most natural waters are well within that range. Many aquatic species are very sensitive to pH alterations and even a small alteration can have a significant effect on a natural system.

Stormwater pH must stay in the same range of 6.5 to 8.5 for ATS treatment. The chemical reaction which facilitates chitosan flocculation is optimized within this range. Outside of this range, the effectiveness of chitosan as a flocculent is compromised.

pH treatment for ATS systems is done with different chemicals. Beware of over correction. Adding too much chemistry for pH correction will render water untreatable.

3.10 LMI CALIBRATION

Technicians will operate and calibrate the chemical metering system consistent with any specific regulatory requirements. Technicians will calibrate the chemical metering system at system startup and every four hours thereafter. Additionally, the metering pump shall be recalibrated when a significant change occurs in either the flow or influent

turbidity or any system upset. Calibration results and flow rates will be recorded on the ATS system monitoring forms and the calibration records will be kept onsite.

OPERATIONAL NOTE: LMI pump dials should **ONLY** be adjusted when pumps are **OPERATIONAL.** Adjusting pump dials while pump is not running will likely result in pump damage and/or failure.

When adjusting the metering pump to obtain proper dose rate, there are two primary adjustments: stroke frequency and stroke length. Experience has shown that the stroke frequency should be set as high as possible for a consistent rate of delivery, and then the stroke length adjusted to deliver the desired dose rate.

Some ATS chemical injection systems have a dedicated delivery line for each pump, while other systems have multiple pumps connected to the same line. Operators should consider the design of the injection system being calibrated when executing this procedure. Systems that have multiple pumps plumbed to the same line will require the operator to isolate the unmeasured pump from the system during calibration.

Upon initiation of this procedure, the valve on the chitosan storage tank should be open and both system pumps and chitosan delivery pumps should be operating.

Calibration Procedure:

1. Fill the calibration cylinder by opening the valve on the bottom of the cylinder. Fill the cylinder as close to full as the static head pressure on the storage tank will allow without over filling.
2. Close the valve on the chitosan storage tank.
3. Allow the LMI pump to drain the cylinder to a desired volume and then begin timing the pump for one minute.
4. Close the cylinder valve at exactly one minute.
5. Immediately open the valve on the chitosan storage tank
6. Read and record the volume of chitosan consumed
7. Calculate the dose rate using the calculation table below. Pair the chitosan consumption rate with the corresponding stormwater flow rate.
8. Convert delivery rate from ml/min to mg/min (multiply result by 10 for 1% chitosan) and flow rate from gal/min to L/min (multiply by 3.78). Divide chitosan delivery rate by flow rate to get does rate (ppm). Refer to formulas presented below.
9. Adjust delivery rate toward desired dose rate* if necessary and repeat procedure until proper dosage is achieved.
10. Record the final results in the Chemical Metering Pump Calibration Form.
11. Repeat procedure for next LMI pump.

1. Chitosan delivery rate (ml/min) x 0.01 (chitosan concentration) x 1g/ml (weight of Liquid-Floc) = absolute weight of chitosan in g/min
2. Chitosan delivery (g/min) x 1000 (mg/g) = delivery rate (mg/min)
3. System influent flow (gpm) x 3.78 L/gal. = flow rate (L/min)
4. Delivery rate (mg/min) / flow rate (L/min) = dose rate in mg/L = ppm

When the LMI calibrations are complete, verify the valve on the chitosan storage tank is open and the valve on the calibration cylinder is closed. Verify that all LMI pumps are on.

Record the dose rate of the pre-treat pump and the sand filter pump separately. Add these two dose rates together to get the overall system dose rate.

***** The desired dose rate depends on many variables including site and system history, turbidity levels, use level designation limits, water chemistry, flow rate and pre-treatment activity. An operator should dose the minimum amount necessary to achieve the desired result.

3.11 RESIDUAL CHITOSAN TEST

High doses of chitosan in the aquatic environment have exhibited toxic effects on fish in laboratory tests. In the ATS process, the Chitosan introduced into stormwater is consumed during the coagulation/flocculation process. The residual chitosan test was developed to confirm the concentration of chitosan in the treated effluent is below the 0.2mg/L environmental threshold. The residual chitosan test is used as a precautionary measure to alert technicians of potential treatment problems before significant impacts can occur.

Purpose

This method is for use as a field test to determine if the residual Chitosan concentration in ATS discharge water is above or below .2 mg/L. If a positive result is obtained, inspection and maintenance of the storm water clarification system will be needed. Discharge shall not be reengaged until after a negative result from recirculation has been obtained.

Equipment / Reagents

2- 1000ml beaker
1 pkg. Glass fiber filters, 25mm grade GC50
2- Swinex filter holder assemblies
2- 140ml test syringe
Turbidimeter
pH meter
Chitosan matrix spiking solution .040µg/drop
Bleach solution .175µg/drop
Iodine solution .1N
2- Stirring rods
1 six-hole plastic filter holder

Scope

This test is a presence/absence test. A positive result indicates that Chitosan is present in concentrations greater than or equal to 0.2mg/L. The test is a qualitative; determination of the exact concentration of Chitosan is not possible with this method.

Procedure

1. Collect two 1000ml samples of discharge water
2. Check and record time, turbidity, pH, flow, Chitosan dose rate, and specific conductivity.
   Note: pH shall be between 6.5 and 8.5 (discharge limits) and turbidity should be less than 10NTU to proceed. A higher NTU value can give an initial false positive hit.
3. Mark one 1000ml sample “Spike” and the other sample “Analysis”
4. Add five drops of Chitosan matrix spike solution to the sample marked “Spike”.
5. After adding the five drops of Chitosan matrix spike solution, check the pH. Use enough Sodium Bicarbonate to restore the pH to near pH 7. This will take about 1/8 teaspoon of Sodium Bicarbonate.
6. Add one drop of Bleach solution to the “Spike” and “Analysis” sample.
7. Stir both samples vigorously for 30 seconds.
8. Disassemble both Swinex filter holders and place one filter (texture side up) on both filter housings.
9. Screw together the filter holders being sure to match up the plastic tab with the groove on the holder.
10. Withdraw 100ml of spike solution into one 140ml syringe.
11. Attach one filter housing to the end of the syringe, and slowly filter the 100ml sample. Repeat step 9 and 10 with an additional 100ml sample.
12. Remove the filter from the filter housing with tweezers and place onto the six-hole plastic filter holder.
13. Add one drop of 0.1N Iodine to the center of the filter.
14. Using the second 140ml test syringe and filter housing, repeat steps 9,10,11,12 with the sample marked “Analysis”.
15. Compare the two samples to determine presence/absence of Chitosan in the discharge water.
16. A positive hit will appear dark brown or purplish.

.2mg/L Spike Check
Put one drop (equal to 40µg) of the .040µg/drop Chitosan matrix spike solution on a clean filter, then add one drop of the chlorine bleach solution followed by one drop of Iodine. This will serve as a field spike check.

If an operator gets a positive test the system will immediately be shut down and investigated to determine if any of the operating parameters are out of specification. The system can then be corrected and the filtrate retested to confirm the absence of chitosan in the treated filtrate.

3.12 SYSTEM DISCHARGE

After the inline water quality readings are within discharge limits and initial LMI pump calibrations have been performed, the ATS system is ready for stormwater discharge. Access the Main Screen on the PLC and press the “Valves Auto” button. This will prompt the system to open the discharge valve and close the automated recirculation valve. The system will continue to direct all water through the discharge line as long as the pH and turbidity readings are within the programmed discharge limits.

The automated valves should be visually inspected periodically to confirm proper operation. Valves that do not fully actuate pose potential safety and/or equipment damage concerns. The discharge point should be visually inspected periodically for possible erosion, especially during the initial periods of operation.

3.13 MANUAL DATA COLLECTION

Water quality and system operational data are automatically logged through the PLC during periods of operation. In addition, operators should manually record system data every 15 minutes during operation. The Manual Data Collection Monitoring Forms are provided for this purpose.

These forms are designed to record influent and effluent data for pH, turbidity and sand filter pressures. Each sample recorded should be initialed by the operator logged in military time. An extra column is provided to make any relevant notes associated with each sample recorded.

As previously noted in section 3.5 Sensor Calibration, the Confidence Checks should be recorded in this form. This needs to be performed two times during every operational period. Immediately after a manual data record is taken, the system operator will obtain a grab sample from the sample influent and effluent lines. Turbidity and pH data is to be taken with the hand held meters and logged immediately below the inline meter data for comparison. Readings taken from the mechanical pressure gauges on the sand filter will be recorded and compared with the readings on the PLC. An asterisk should be placed in the “Notes” field to indicate Confidence Check as described on the form.

3.14 BACKFLUSH

Backflushing is the process by which water flow is reversed through the sand beds to expel the accumulated sediment on the top of the beds. Each sand pod is flushed one at a time while the rest of the pods in the filter continue to operate normally. The stormwater which was filtered from the active pods will fill the bottom header and a portion of it is forced upward through the pod that is being backflushed.

Although backflush cycles are automated, the process needs to be understood and controlled by the system operator. The backflush parameters are set from the control box which is fixed to the side of the sand filter. Flush duration, delay between switching

pods, manual start and stop as well as power and breaker switches are all on the control box. The cycle timer knob should be set to zero as backflush cycle initiation is typically controlled through the pressure differential switch on the bottom of the control box.

Typically, at a pre-set pressure differential, the controller will initiate a backflush cycle to remove the captured floc from the media bed. As the filter beds become clogged with floc particles the pressures between the top and bottom headers begin to deviate. The top header will gain pressure and the bottom header will lose pressure due to decreased water passage. When this pressure differential reaches a set level, the system will initiate the backflush cycle. The differential is generally set around 8 psi but will vary from system to system.

The system requires a minimum of 20 psi effluent pressure for adequate backflush. Pressures below this will generally not be high enough to fluidize the sand beds, which is necessary for proper backflush. System pressures and flow rates will differ between operation and backflush cycles. Operators must monitor flows and pressures during transition to backflush to assure they remain optimal. Valve adjustments may need to be made accordingly. In addition to the influent and effluent control valves there is a valve at the end of the backflush header. This valve is set during system start up to optimize backflush flow without discharging filter media. This backflush valve generally does not need adjusting and should only be adjusted by experienced operators who are familiar with that particular site.

A site glass is installed at the top of the backflush header to monitor backflush efficiency. The water in the site glass should appear turbid during the initial stage of each pod flush. Toward the end of the flush the water should appear clearer as all of the floc is expelled from the sand bed. Some systems are equipped with backflush sample lines which can also be used to monitor the effectiveness of the backflush. Flush duration should be set at two minutes. To increase backflush intensity, operators should increase the frequency instead of duration of the cycle.

The consequence of insufficient backflushing is impacted sand beds. Failure to backflush will cause excess floc accumulation in the filter. Excess floc under operating pressures will cause the beds to compact, limiting water movement through the beds. This is commonly called impaction. Impaction will force a system shut down. The water in the filter must be evacuated, the filters will need to be opened and the sand in the filter must be broken up with a shovel. In extreme cases the filter medium may be so compromised that it will need to be discarded and replaced.

3.15 SYSTEM SHUT DOWN

System operation is typically carried out during pre determined shifts. System operations may need to be abbreviated or extended based on retention pond levels or predicted rain events. Occasionally, shifts will be extended on an emergency basis if there is danger of potential site release.

The following checklist covers the range of typical tasks that need to be completed when shutting down an ATS system.

1) Switch pneumatic valve from “auto” to “recirc” by pressing “Recirc Valve On” on the PLC.

2) Switch LMI pumps off on the PLC.

3) Switch pre-treat and main pump off on the PLC.

4) Visually and audibly confirm pump shut down.

5) Record final totalizer readings on the daily operations form. Record any operational anomalies your PM may be concerned about. Record system operation assessment and certify acceptability of operation. Communicate significant system upsets or concerns directly to the PM.

6) Finish all paper work. Remove the pink slips from the operations form and place in the appropriate folder. Return remaining copies to the PM.

7) Drain air compressor.

8) Clean laboratory bench top and system container.

9) Close chitosan tank valve. Close sample port valves. Open sand filter bleeder valves to aid the drainage of the sand filter.

10) Empty, rinse and replace inline cuvettes. Remove and clean inline pH probes. Immerse probes in proper storage solution.

11) Perform any necessary freeze protection procedures. Leave heaters, container and generator switches in “Auto”

12) Switch sensors off on the PLC. Close automatic valves on the PLC.

13) Turn off all lights and any extraneous power from the container.

14) Secure the site and lock the system. Any valuable equipment should be locked up to discourage theft.

All staff should leave all PPE on until they have entered their vehicle to leave the site. All Active Treatment Systems, Inc. trucks are supplied with magnetic amber lights which should be attached to the top of the vehicle and activated until the vehicle has exited the construction site. Yield to all heavy equipment when driving on construction sites. Obey all traffic control instructions. Construction sites are inherently dangerous places and Active Treatment Systems, Inc. employees should exercise extreme caution when present.

CONTROL SYSTEM OPERATION

This section is designed to teach technicians how to use the control interface for the ATS systems. This is dedicated to the control system operations and does not include operating procedures for the mechanical parts of the system. The control system is commonly referred to as the programmable logic controller (PLC) or SCADA System. The system is designed to simplify technician procedures while ensuring compliance with regulatory requirements for ATS operations

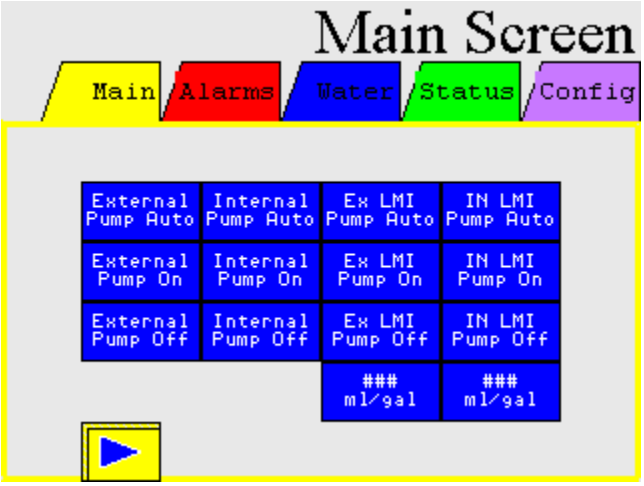
4.1 TOUCH SCREENS

When the touch screen first comes on it will display the alarm screen. Given that multiple alarms (of the same or different types) could have occurred since the last time the system was operational, a series of alarms may need to be acknowledged. Acknowledge alarms by pressing the “Ack All” button. Be sure to check the Alarm Screen before you begin operations.

Once all the alarms are acknowledged, the Logo (or Startup) screen will appear. This screen is for informational purposes only. Touch the “Main” button to access into the operational screens of the program.

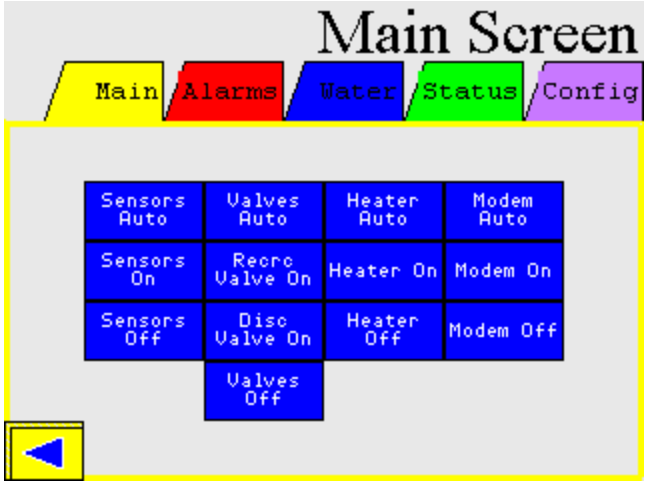
The screens are color coded and can be accessed by the file tabs at the top of the screen. The types of screen are; Main, Alarm, Water, Status, and Configuration.

"Main" screens are where system control takes place. There are two "Main" screens, for operations. The "Main" screens are laid out in a columnar fashion. The top button on each column puts that component into Automatic mode governed by the specific operational parameters that have been preset for it. The "On" button turns that component on with all safety and internal checks overridden for that particular component. The "Off" button disables that component.

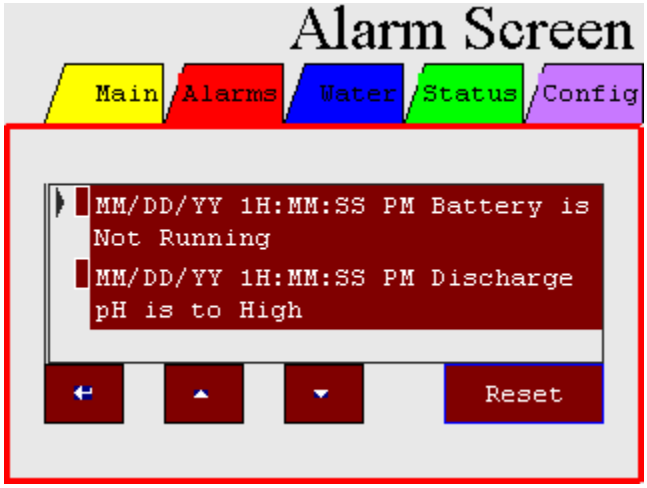


The yellow and blue arrow button at the bottom of the screen lets operators to toggle back and forth between the two main screens.

The secondary main screen controls system sensors, automated discharge valves, heaters and the system modem. In most situations the modem and heater controls should always be left in "Auto". These buttons will change state based on what the PLC is trying to do not necessarily what the system is actually doing. *Example: You push the button to open the Discharge Valve but there is no air pressure. The PLC is trying to open the valve so the display will blink "Disc Open" yet the valve is still closed.*

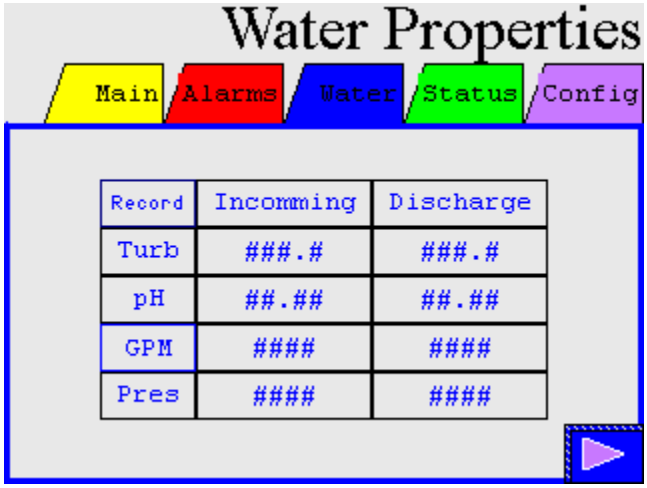


The "Alarm" screen displays emergency status information requiring immediate attention. All alarms on this screen that contain the word "Faulted" have to be cleared using the "Reset" button and are impeding operation of the system in some fashion. Alarms that do not contain "Faulted" warnings are for information only and do not require manual reset.

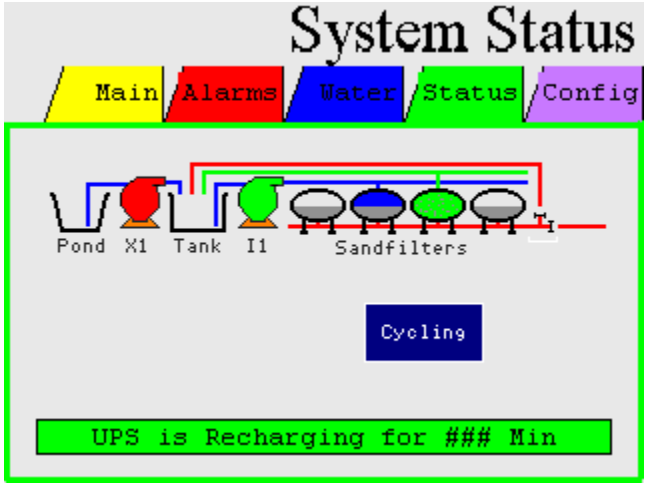


The “Water” screen is designed to display the water quality and system hydrology data. The data in the left hand column displays influent data and the column on the right displays effluent data. It alternates between current data and the running system recordable data. To know which you are looking at see the top left hand corner of the matrix.

The arrow button in the lower right hand corner will take you to the “Last Saved” screen.



The “Status” screen is a graphical display that is designed to give the operator a real-time flow diagram of system operations.
The water level in the “Pond” and “Tank” corresponds to the actual levels in those facilities. Pumps are green for on and red for off, with a large X indicating a fault. The sand filter modules change from gray, off; to blue, on; to green, back flush. The valves will change direction based on the current status of the system.

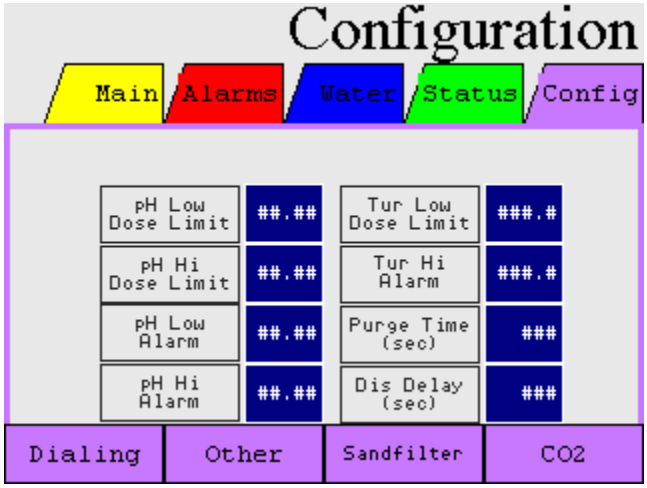


The main configuration screen sets the discharge limits for that particular site. These limits are preset and should not be changed by operators.

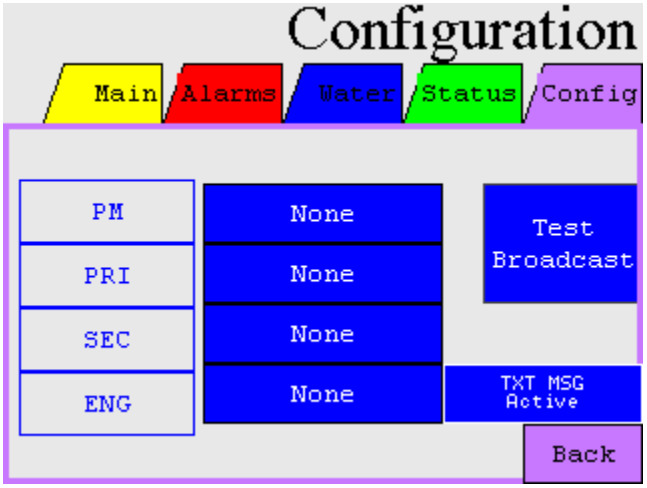
The pH and turbidity alarms identify the meter readings which will display visual alarms on the stop system discharge.

“Dis Delay” is the amount of time the treated water must be within spec before the PLC will allow discharge during automatic operation.

The second configuration screen is used



to select emergency text message recipients. Each one allows you to cycle through the list of possible recipients just by touching the name multiple times. Four individuals can be selected Project Manager, Primary Responder, Secondary Responder, and Engineer. This screen also contains a test broadcast button. This allows you to test the text message system. If “None” is selected in a given box the PLC will skip that individual to call.



4.2 ALARM GLOSSARY

Discharge pH is too High: The discharge pH reading the PLC is receiving from the pH meter on the discharge header is greater than the pH Hi Alarm value set in the configuration screen.

Discharge pH is too Low: The discharge pH reading the PLC is receiving from the pH meter on the discharge header is lower than the pH Low Alarm value set in the configuration screen.

Discharge Turbidity is too High: The discharge Turbidity reading the PLC is receiving from the Turbidity meter on the discharge header is greater than the Turbidity Hi Alarm value set in the configuration screen.

Tank Level is too High: PLC is receiving a signal from the Tank High Level float switch, or the value from the Tank Level transducer is reading higher than the preset high limit.

Pond Level is too High: PLC is receiving a signal from the Pond High Level float switch, or the value from the pond Level transducer is reading higher than the preset high limit.

System in Recirculation Mode: PLC has actuated the recirculation valve to Open.

UPS Power is Low: Generator is operational for the purpose of recharging the UPS.

Generator Faulted Out: PLC sent a signal for the Generator to auto start but has not received a power on signal in 30 seconds.

Pond Operate Switch Faulted: High Level Pond switch is triggered but the Operate switch is not.

Pond Low Level Switch Faulted: Operate Level Pond switch is triggered but the Low Level switch is not.

Tank Operate Switch Faulted: High Level Tank switch is triggered but the Operate switch is not.

Tank Low Level Switch Faulted: Operate Level Tank switch is triggered but the Low Level switch is not.

Internal Pump Faulted: PLC sent a start signal to the Soft Started and has not received an Up to Speed signal back for 30 seconds.

External Pump Faulted: PLC sent a start signal to the Motor Contactor and has not received an operational signal back for 30 seconds.

Max Pressure Exceeded: One of the Pressure Transducers sent a signal to the PLC that exceeded the 60 PSI Maximum Pressure Setting and shut down the Pumps.

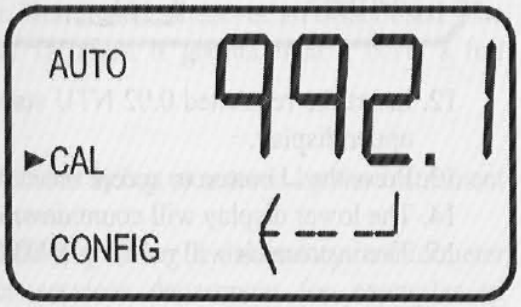
CALIBRATION and RESIDUAL TESTING

1. Inline Turbidimeter Calibration
2. Inline pH Meter Calibration

1. Inline Turbidimeter Calibration

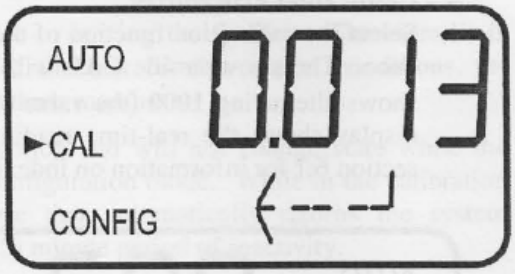
5.2 Calibration Procedures

1. Select the calibration function of the instrument by pressing the **MODE/EXIT** button once. The arrow beside **CAL** will be illuminated on the display. The lower display shows alternating **1000** (the value of the standard that is requested) and ↵. The upper display shows the real-time reading to allow the standard to be indexed. Refer to section 6.1 for information on indexing cuvettes.



2. Remove the flow through unit.
3. Insert the requested 1000 NTU standard. Index the standard to the lowest value on the upper display.
4. Press the ↵ button to accept the calibration.
5. The lower display will count down the progress of the calibration step.
6. The lower display will now change to show alternating **10** and ↵, requesting the 10.0 NTU standard.

7. If the alternating **10** and ↵ is not displayed, push the ▲ or ▼ until this display is shown.
8. Insert the requested 10.0 NTU standard. Index the standard to the lowest value on the upper display.
9. Press the ↵ button to accept the calibration.
10. The lower display will count down the progress of the calibration step.
11. The lower display will now change to show **02** and ↵, requesting the 0.02 NTU standard.

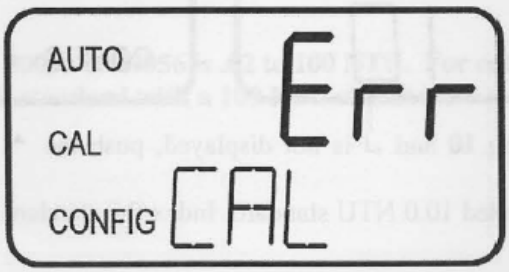


12. Insert the requested 0.02 NTU standard. Index the standard to the lowest value on the upper display.
13. Press the ↵ button to accept the calibration.
14. The lower display will count down the progress of the calibration step.
15. The instrument will return to **AUTO** mode at the end the calibration.

Note: During calibration, the fan inside the instrument is turned off to extend the life of the desiccant. The fan will be turned on during calibration countdowns and after returning to the AUTO mode or after five minutes, which ever comes first. It is recommended that the measurement chamber be kept covered during the calibration period and that the flow through cuvette be replaced immediately after the calibration to prevent premature saturation of the desiccant.

5.3 Calibration Error

If the screen shown below, is displayed after calibration, the internal diagnostics have determined that the calibration standards were either bad or that they were inserted in the wrong order. Either check the standards and recalibrate or restore the factory calibration see 6.2 *Restoring Factory Settings*. The instrument cannot be used without performing one of these operations.



To recalibrate press the MODE key and start the calibration sequence again. To restore the factory calibration, push and hold the ▲ button. Now push and release the ↵ then release the ▲ button.

2. Inline pH Meter Calibration

EASY CAL Procedure - pH

- This procedure simplifies system calibration using standard 4.0, 7.0, 10.0 pH buffers only. If these pH buffers are not available, calibrate the system via the CALIBRATE menu, using the STANDARD and SLOPE settings.
- Access the CALIBRATE menu and set sensor temperature before performing EASY CAL for new electrode installations.
- Access EASY CAL menu from the view menu.

EASY CAL: ---- Enter Key Code	Press UP, UP, UP, DOWN buttons in sequence to enter menu, XXXX will appear during code entry.

To Calibrate:	Response:	To Accept:
Place Sensor in pH Buffer #1 Place electrode tip in first pH buffer pH 7.0 = 0 mV pH 4.0 = 177 pH 10 = -177 Limit ± 50 mV	6.90 pH -005 mV Allow for stabilization 30 seconds*	6.90 pH -005 mV ENTER to accept 7.00 pH -005 mV
Place Sensor in pH Buffer #2 Place electrode tip in second pH buffer.	3.93 pH +179 mV Allow for stabilization 30 seconds*	3.93 pH +179 mV Press ENTER to accept second buffer calibration. 4.00 pH +179 mV
To exit menus and return to VIEW press UP and DOWN button at the same time	Display returns to VIEW Menu in 10 minutes or when ENTER is pressed	Good Easy Cal Press <ENTER>

Theoretical mV values

pH @ 25°C	mV
2	+296
3	+237
4	+177
5	+118
6	+59
7	+0
8	-59
9	-118
10	-177
11	-237
12	-296

APPENDICIES

APPENDIX A: IN-LINE pH METER MANUAL

APPENDIX B: HANDHELD pH METER MANUAL

APPENDIX C: IN-LINE TURBIDIMETER MANUAL

APPENDIX D: HANDHELD TURBIDIMETER MANUAL

APPENDIX E: PADDLE WHEEL FLOW METER MANUAL

APPENDIX F: MAGMETER FLOW METER MANUAL

APPENDIX G: CHEMICAL METERING PUMP MANUAL

APPENDIX H: PNEUMATIC VALVE MANUAL

APPENDIX I: AIR COMPRESSOR MANUAL

APPENDIX J: CENTRIFIGAL PUMP MANUAL

APPENDIX K: SAND FILTER AND CONTROLS

APPENDIX A: IN-LINE pH METER MANUAL

Signet 2750 DryLoc™ pH/ORP Sensor Electronics

English

3-2750.090 Rev. G 11/05 English

WARNING!

SAFETY INSTRUCTIONS

1. Depressurize and vent system prior to installation or removal.
2. Confirm chemical compatibility before use.
3. Do not exceed maximum temperature/pressure specifications.
4. Wear safety goggles or faceshield during installation/service.
5. Do not alter product construction.
6. When using chemicals or solvents care should be taken and appropriate eye, face, hand, body, and/or respiratory protection should be used.

1. Description
2. Specifications
3. In-line Installation
4. 2750 In-line Assembly
5. Submersible Installation
6. Digital (S^3L) wiring
7. 4-20 mA Loop wiring
8. Calibration
9. Troubleshooting
10. Ordering Information

1. Description

Signet 2750 pH/ORP Sensor Electronics provide two-wire 4 to 20mA loop output for pH and ORP measurements, without the expense of local display and other luxuries available in full-featured transmitters. Preamplification is built-in, reducing system costs while ensuring absolute signal integrity up to 304.8m/1,000 feet.

These sophisticated field-mount devices also provide the digital (S^3L™: Signet Sensor Serial Link) output, the latest development in leading-edge technology from Signet. The 2750 Sensor Electronics self-configure for pH or ORP operation via automatic recognition of electrode type, and the DryLoc™ electrode connector quickly forms a robust assembly for submersible and in-line installations.

NEMA 4X Junction Boxes are integral parts of the in-line version and are available as accessories for the submersible version. The optional Easy-Cal feature allows simple push-button calibration and includes an LED for visual feedback.

2. Specifications

General

- Compatible Electrodes: Signet DryLoc Electrodes
- Operational Range: 0.00 to 14.00 pH, ±2000 mV ORP
  0°C to 85°C (32ºF to 185ºF)
- Response Time (includes electrode response):
  pH: <6 s for 95% of change
  ORP: application dependent
  pH Temp τ: 140 s (2754)
  196 s (2756)
  438 s (2756-WT)

Materials:

2750-1, -2 (in-line): PBT (thermal plastic polyester)
2750-3, -4 (submersible): CPVC

Cable for -3, -4 submersible versions:
5 m (15 ft.) 3-conductor shielded, 22 AWG.

- May be extended up to 183 m (600 ft) with current output.
- May be extended up to 305 m (1000 ft) with S^3L output.

Weight:
2750-1, -2 (in-line): 0.75 kg (1.75 lb.)
2750-3, -4 (submersible): 0.64 kg (1.4 lb.)

Environmental

- Ambient Temp.: -10°C to 85°C
- Storage Temp.: -20°C to 85°C
- Relative Humidity: 95% max, non-condensing
- Immunity: EN50082-2
- Emissions: EN50081-1
- Enclosure Rating:
  2750-1, -2 (in-line): NEMA 4X/IP65 (with electrode connected)
  2750-3, -4 (submersible): NEMA 6P/IP68 (with electrode and watertight extension pipe connected)

Electrical

- Input Impedance: $>10^{11}\Omega$
- Input response time: 500 ms
- Temperature drift: ±0.002 pH per ºC
  ±0.1 mV ORP per ºC
- Input resolution: 0.02 pH, 1 mV ORP, 0.3ºC

Current output:

- Description: pH: Fixed 4 to 20 mA, isolated, 0 to 14 pH (custom scaling available)
  ORP: Fixed 4 to 20 mA, isolated, -1000 to 2000 mV (custom scaling available, -2000 to 2000 mV)
- Power: Regulated 12-24 VDC ± 10%, 20 mA max.
- Max Loop Resistance: 50Ω max. @ 12V
  325Ω max. @ 18V
  600Ω max. @ 24V
- Accuracy: ±32µA @ 25ºC
- Temperature drift: ±1µA per ºC
- Output resolution: ± 5 µA
- Error indication: 3.6 mA

Digital (S^3L) output:

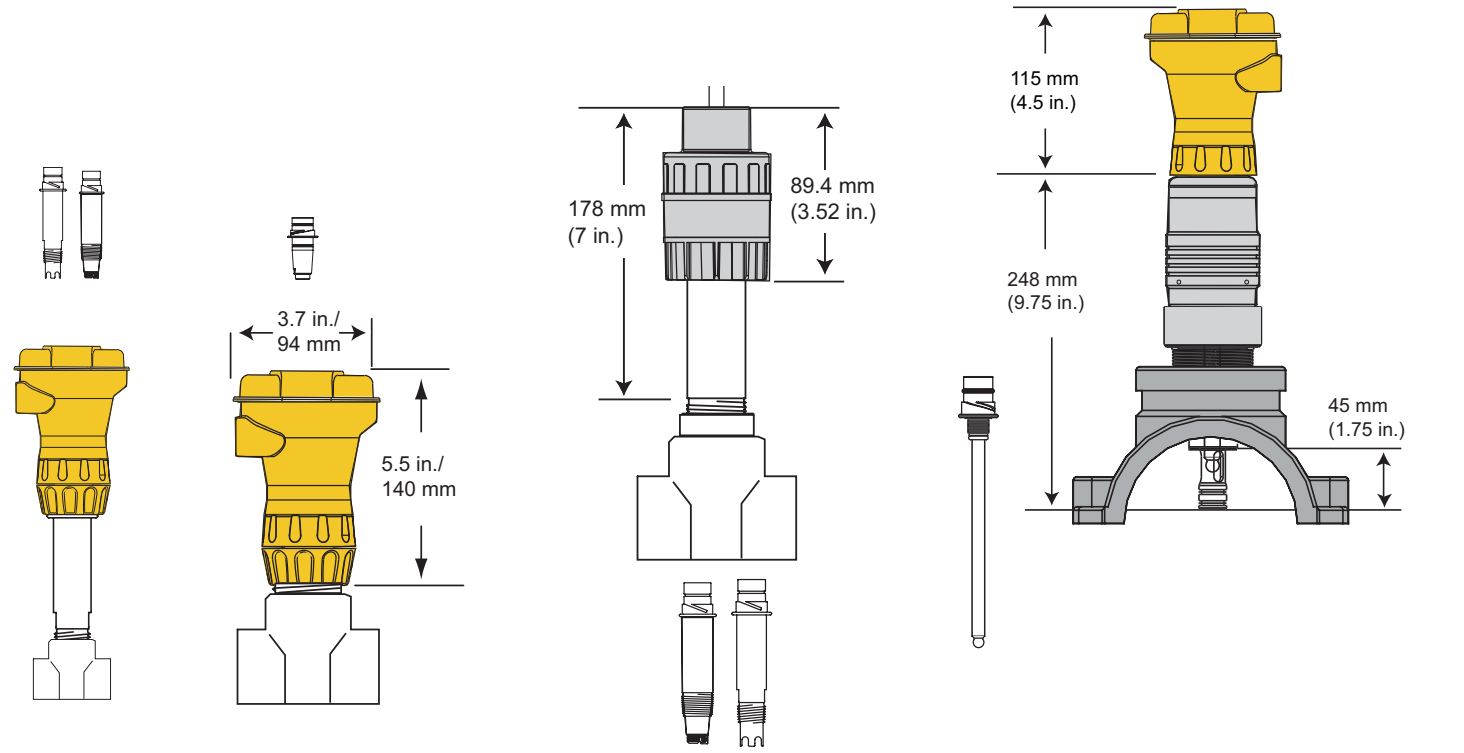
- Description: Serial ASCII, TTL level 9600 bps
- Power: 5VDC ± 10% regulated, 3 mA max
- Accuracy: pH: ± 0.03 pH @ 25°C
  ORP: ± 2 mV @ 25°C
- Resolution: pH: 0.02 pH
  ORP: 1 mV
  Temp. 0.2°C
- Error indication: Temp output "+999.9"

Standards and Approvals

- CE
- Manufactured under ISO 9001 & ISO 14001

3. In-line Dimensions

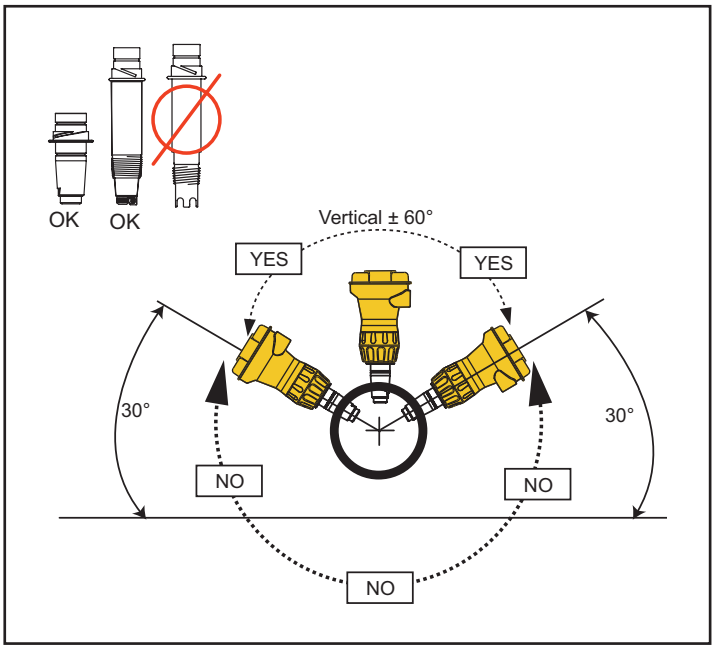
- The 2750-1 in-line sensor (without Easy-Cal) is designed for applications where electrode calibration is facilitated by remote equipment.
- The 2750-2 In-Line sensor includes Easy-Cal.
- A Signet installation fitting (1/2 in. to 4 in.) or a Signet pipe adapter is required to secure the electrode in the pipe.
- The Signet Measurement and Instrumentation catalog offers a complete selection of fittings.
- The 2750-3 and 2750-4 submersible sensor electronics are recommended for in-line applications using the 2764 series differential electrodes and the 2774 series Threaded DryLoc electrodes.
- 2764 and 2774 series electrodes thread directly into standard 1 in. or 3/4 in. NPT fittings.

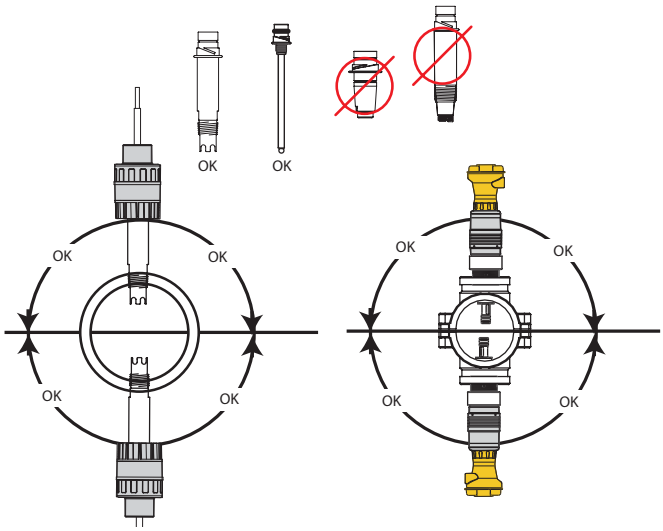


Mounting position

2754 and 2764 series electrodes must be mounted upright.

- Vertical (0°) position optimum
- Do not install within 30º of horizontal (Contact factory for horizontal or inverted installation requirements.)
- Recommended maximum flow rate 10 ft/s.
- Wet-tap electrodes and 2774 series electrodes have pressurized electrolyte chambers, enabling them to be mounted at any angle.

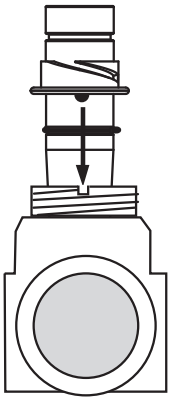




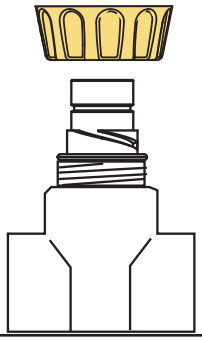
4. 2750 In-line pH Sensor Assembly

Note: This procedure applies to systems using standard 2754-2757 electrodes.
If the 3719 pH/ORP Wet-Tap is used, refer to the 3719 manual for instructions.

1. Insert electrode into Signet installation fitting. Seat the electrode tabs into the alignment notches in the fitting.

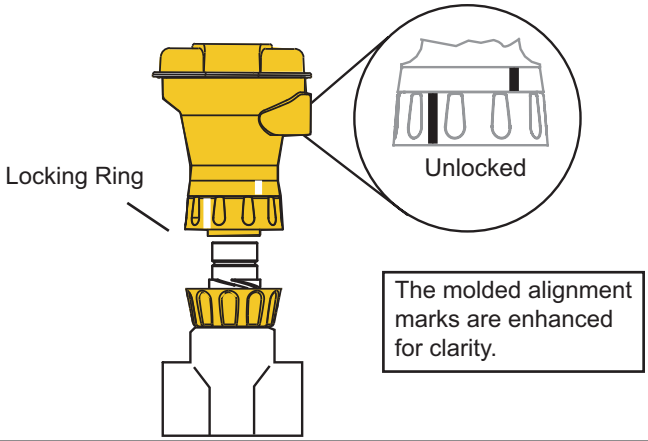


2. Thread the in-line retaining cap onto fitting to secure the electrode into place. Hand-tighten the cap. DO NOT use any tools to avoid damaging the threads.



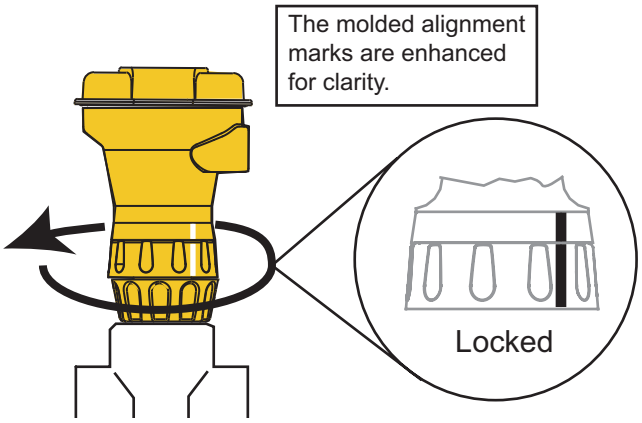
Note:
Keep the electrical interconnection between electrode and sensor electronics dry and clean at all times.

3. Unlock the ring on base of 2750 (The ring is unlocked when the lines on the ring and body of the 2750 are not aligned.)



4. Place 2750 onto top of electrode and turn until the assembly drops into position.

5. Turn locking ring ¼ turn to secure the 2750 assembly. (The ring is locked when the line on the ring and the line on the body of the 2750 are aligned.)



In-Line Sensor and Electrode Removal

- **To remove electronics assembly only:**
  Turn locking ring ¼ turn; lift assembly straight up.
- **To remove electrode from the pipe:**
  Remove electronics assembly, then unthread retaining cap; pull electrode straight up.
- **To remove the complete 2750 system:**
  Hold locking ring in place. Unthread retaining cap and pull electrode straight up.

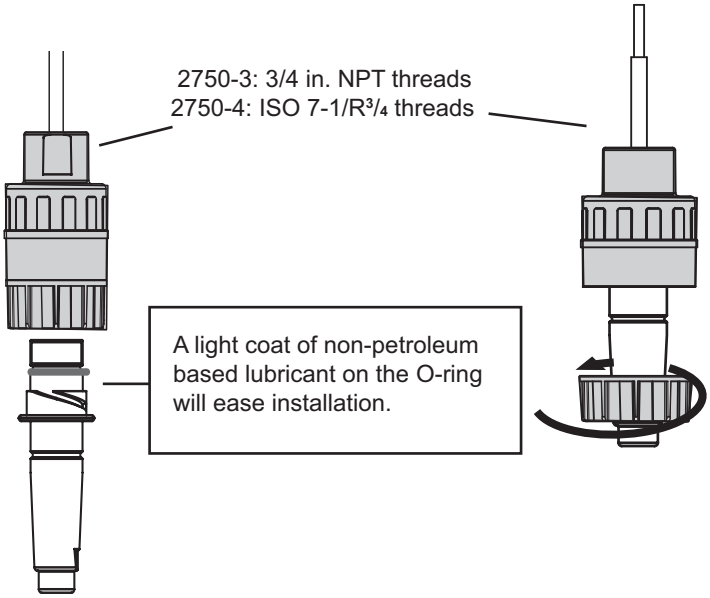
CAUTION!

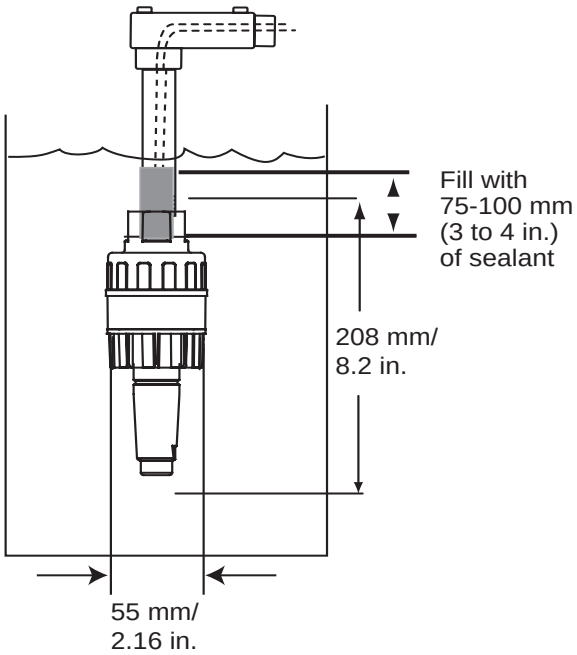
- Do not remove the electrode from a pressurized pipe.
- Wear appropriate protective clothing when working with chemicals in pressurized pipe.

5. 2750-3, -4 Submersible Sensor Assembly and Installation

1. Insert electrode into base of the 2750-3 or 2750-4 and turn until keyed contacts are seated.
2. Thread retaining cap over electrode and hand-tighten onto 2750.
3. Attach ³/₄ in. watertight pipe to the top of the 2750. Secure the threaded connection to prevent any leakage.

- For additional defense against possible accumulation of condensation at the back seal area of the sensor, fill the lower 3-4 inches (75-100 mm) of conduit or extension pipe with a flexible sealant such as silicone.





Note:
Keep the electrical interconnection between electrode and sensor electronics dry and clean at all times.

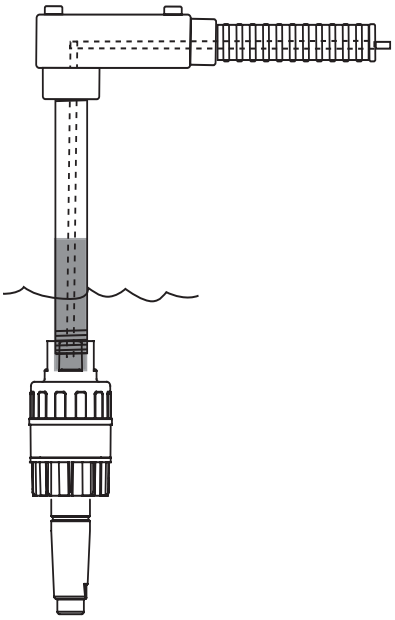
Use standard installation hardware to connect the submersible 2750-3 or -4 directly to external equipment.

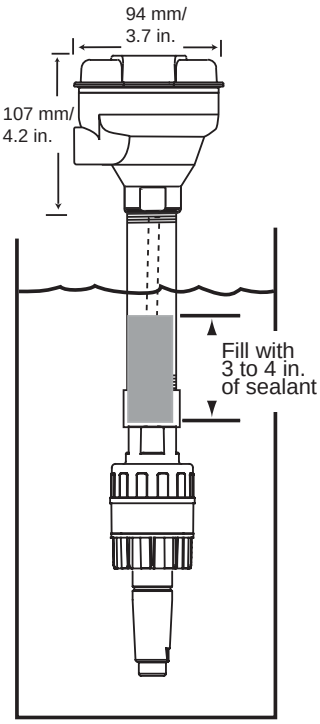
OR

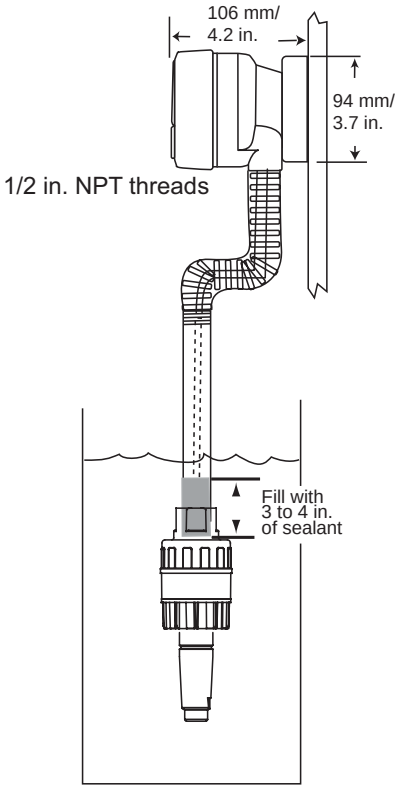
The 8052-1 NPT Mount Junction box (or 8052-2 with Easy-Cal) connects to ³/₄ in. pipe or conduit and provides convenient wiring termination.

OR

The 8050-1 Universal Mount junction box (or 8050-2 with Easy-Cal) mounts flat onto a wall or can be strapped to a post or pipe.





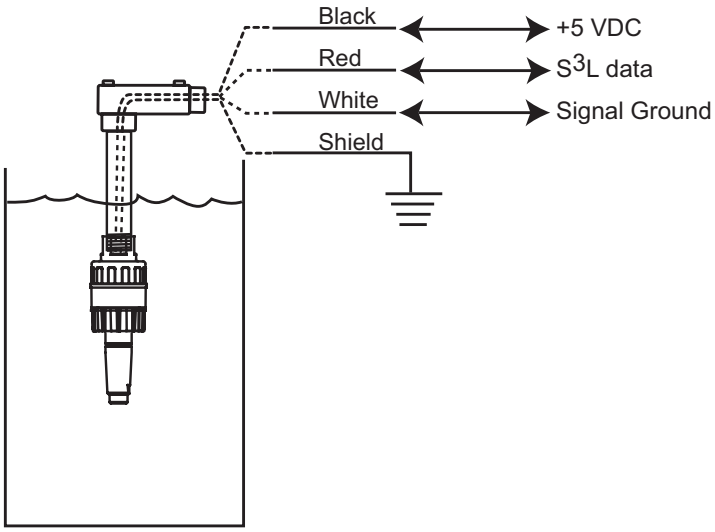


Cable supplied: 5 m (15 ft.) 3-conductor + shld, 22 AWG.
May be extended up to 183 m (600 ft) with current output.
May be extended up to 305 m (1000 ft) with S³L output.

6. Digital (S^3L) wiring

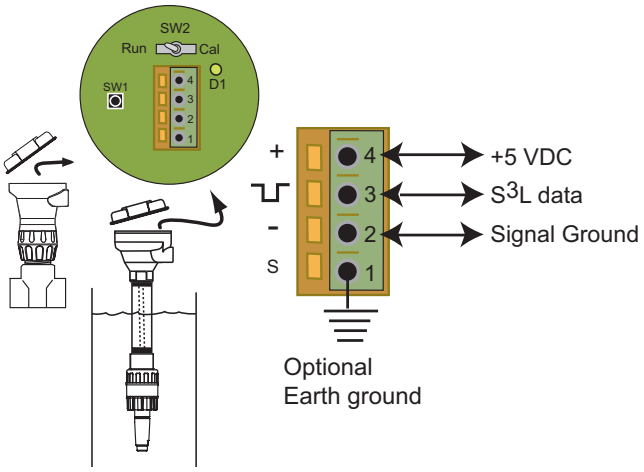
- When the 2750 is powered with 5 VDC, the digital (S^3L) serial data output is automatically selected.
- S^3L data is used exclusively by Signet instruments.
- Remove approximately 10 mm (0.4 in.) of insulation and tin each conductor before inserting into connectors.

S^3L with no junction box



- Connect the 2750 cable directly to S^3L I/O terminals.
- **8900 users:** If this direct wiring is used, set the CALIBRATE menu to "perform calibration at INSTRUMENT"

S^3L with Junction box

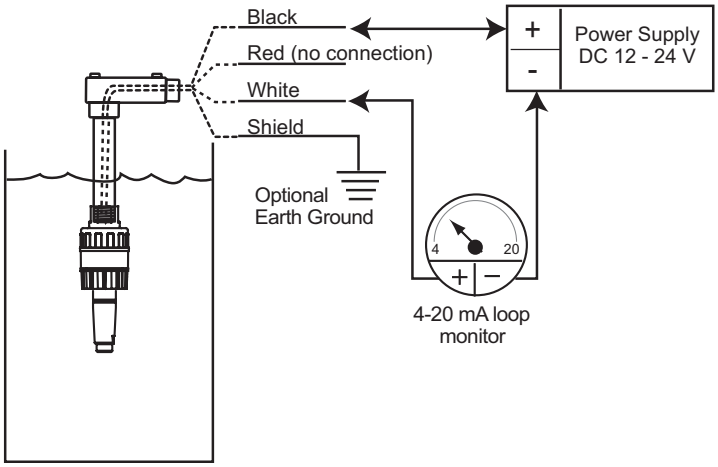


- When the 2750 includes a terminal block, connect the 2750 terminals as shown to any S^3L I/O port.
- **8900 users:** If the 2750 includes the Easy-Cal accessory, set the CALIBRATE menu to "perform Calibration at either SENSOR or INSTRUMENT"
- If SENSOR, use standard pH buffer values (pH 4, 7, or 10) to perform periodic calibration.
- If INSTRUMENT, any pH value can be used.

7. 4-20 mA Loop wiring

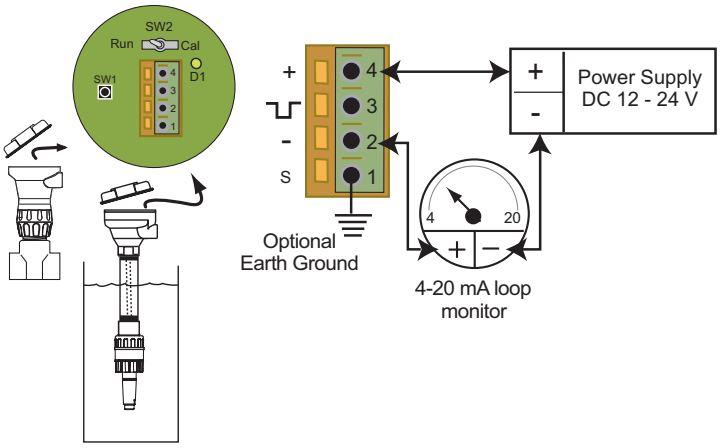
- When the 2750 is powered with 12 to 24 VDC, the 4-20 mA loop output is automatically selected.
- Remove approximately 10 mm (0.4 in.) of insulation and tin each conductor before inserting into connectors.

Current Loop with no junction box



- Connect the 2750 cable directly to a Loop device as shown.
- This configuration does not provide any calibration capability within the 2750 system. Periodic calibration must be performed at the external equipment.

Current loop with Junction box

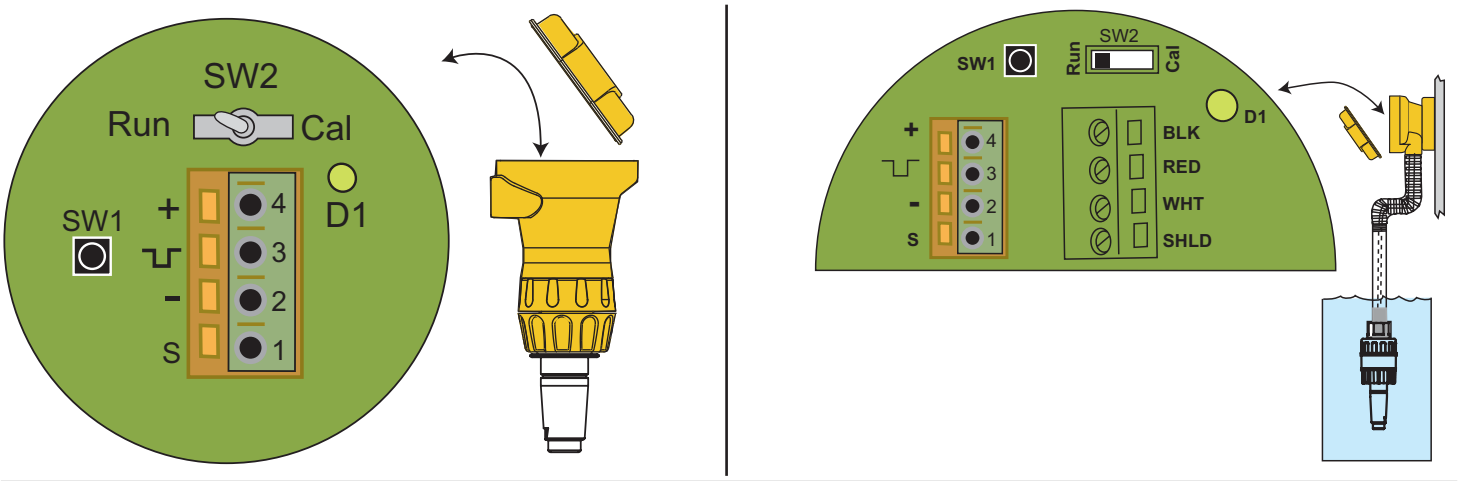


- When the 2750 includes a terminal block, connect the 2750 terminals to the Loop device as shown.
- If the 2750 includes the Easy-Cal accessory, use standard pH buffer values (pH 4, 7, or 10) to perform periodic calibration.

8. Calibration

All 2750 pH/ORP Sensor Electronics are factory-calibrated for maximum out-of-the-box accuracy. Periodic calibration is required to compensate for electrode aging.
The optional Easy-Cal feature allows calibration to be performed local to the sensor.

SW1 Easy-Cal button
SW2 RUN/CALIBRATE switch for S^3L system
D1 Easy-Cal Indicator (green LED)



Easy-Cal Procedure:
The first step (Reset) is recommended each time an electrode is replaced, but is NOT necessary upon initial installation or periodic calibration. In fact, for periodic calibration it is best for the electrode/sensor assembly to remain intact to minimize the possibility of moisture or other contamination entering the electrical interconnection area. The electrode/sensor connection must remain dry and clean at all times.

1. Reset the 2750 pH/ORP Sensor to factory calibration: With no electrode connected to the Sensor, press and hold SW1 until the LED (D1) comes on steady then goes off again (approx. 10 seconds). When the LED goes off, release SW1; reset is complete.

2. Connect an electrode to the 2750 pH/ORP Sensor.

3. **If S^3L output is being used, place SW2 in the "Cal" position. If 4-20 mA output is being used, SW2 position is of no consequence.**

4. Place the electrode/sensor assembly into a calibration solution as follows: (If the electrode is "healthy", then the 2750 will automatically recognize the solution. The order in which the solutions are used during the calibration procedure is of no consequence.)
   - For pH calibration, use any two of these international standards: pH 4.0, 7.0 or 10.0 buffer solutions. (Signet part number 3-0700.390 contains one capsule of each value)
   - To produce standards for ORP calibration, mix the chemical Quinhydrone into pH 7.0 and 4.0 buffers to saturation (1/8g per 50ml).
   - Regardless of the size of the container used for calibration, one inch of solution is adequate to completely submerge the tip of the electrode.
   - **Allow at least 30 seconds for the electrode response to stabilize before calibration.**

5. Press and hold SW1 for approximately 8 to 10 seconds. During this time, the LED (D1) will come on steady then go back off. Release SW1 (If the LED blinks several times rapidly, the calibration was not successful. See the troubleshooting section.)

6. Remove the electrode/sensor assembly from the first calibration solution, rinse the electrode with clean water, and place it in a second solution.
   - **Allow at least 30 seconds for the electrode response to stabilize before calibration.**

7. Press and hold SW1 for approximately 8 to 10 seconds. During this time, the LED will come on steady then go back off. Release SW1. (If the LED blinks several times rapidly, the calibration was not successful. See the troubleshooting section.)

8. **For S^3L systems ONLY: Return SW2 to the RUN position.**

Calibration is complete. Return the system to service.

9. Troubleshooting

LED and Output Condition	Possible Causes	Suggested Solutions
Current Out: **LED off, current output is 3.6 mA** **S^3L: Temp out is +999.9**	• No electrode installed • Bad/dirty contacts between electrode and 2750	• Install electrode • Check interconnection between electrode and 2750, clean contacts
During Easy-Cal, the LED blinks rapidly for 4 seconds and the current output is frozen at a random fixed value.	• The buffer solution is outside of the accepted tolerance for the 2750 • The electrode is depleted (> 1.1 pH or 65 mV offset)	• pH system: Use fresh 4 pH, 7 pH, or 10 pH buffer and restart the calibration. • ORP system: Use fresh 4pH and 7 pH buffer solution saturated with quinhydrone. • Replace the electrode.
After completing calibration procedure, the output values are inaccurate.	• Insufficient time allowed for electrode stabilization during calibration.	• Recalibrate, verify that test solutions are at room temperature and wait at least 30 seconds after placing electrode in solution before pressing S1 EasyCal button.

10. Ordering Information

Mfr. Part No.	Code	Description
3-2750-1	159 000 744	In-line Sensor Electronics w/Junction Box
3-2750-2	159 000 745	In-line Sensor Electronics w/Junction Box and Easy-Cal
3-2750-3	159 000 746	Submersible Sensor Electronics with 15 ft. cable, ¾ in. NPT threads
3-2750-4	159 000 842	Submersible Sensor Electronics with 15 ft. cable, ISO 7-1/R¾ threads

Parts and Accessories

Mfr. Part No.	Code	Description
DryLoc pH Electrodes		
3-2754	159 000 747	Electrode, pH, DryLoc, flat, PT1000
3-2754-1	159 001 380	Electrode, pH, DryLoc, flat, 3KΩ
3-2754-HF	159 000 748	Electrode, pH, DryLoc, flat, PT1000, HF-resist (<2%)
3-2754-HF-1	159 001 381	Electrode, pH, DryLoc, flat, 3KΩ, HF-resist (<2%)
3-2756	159 000 750	Electrode, pH, DryLoc, bulb, PT1000
3-2756-DI	159 000 751	Electrode, pH, DryLoc, bulb, PT1000, DI (<100 µS)
3-2756-DI-1	159 001 382	Electrode, pH, DryLoc, bulb, 3KΩ, DI (<100 µS)
3-2756-WT	159 000 834	Electrode, pH, DryLoc, bulb, PT1000, wet-tap
3-2756-WT-1	159 001 383	Electrode, pH, DryLoc, bulb, 3KΩ, wet-tap
3-2756-WTP	159 001 390	Electrode, pH, DryLoc, bulb, PT1000, wet-tap
3-2756-WTP-1	159 001 384	Electrode, pH, DryLoc, plastic bulb, 3KΩ, wet-tap
3-2764-1	159 000 943	Electrode, pH, DryLoc, flat, 3KΩ, differential, 1 in. NPT process connection
3-2764-2	159 000 944	Electrode, pH, DryLoc, flat, PT1000, differential, 1 in. NPT process connection
3-2764-3	159 000 945	Electrode, pH, DryLoc, flat, 300Ω, differential, 1 in. NPT process connection
3-2766-1	159 000 949	Electrode, pH, DryLoc, bulb, 3KΩ, differential, 1 in. NPT process connection
3-2766-2	159 000 950	Electrode, pH, DryLoc, bulb, PT1000, differential, 1 in. NPT process connection
3-2766-3	159 000 951	Electrode, pH, DryLoc, bulb, 300Ω, differential, 1 in. NPT process connection
3-2774	159 000 955	Electrode, pH, DryLoc, flat, 3KΩ, ¾ in. NPT process connection
3-2774-1	159 000 956	Electrode, pH, DryLoc, flat, PT1000, ¾ in. NPT process connection
3-2776	159 000 959	Electrode, pH, DryLoc, bulb, 3KΩ, ¾ in. NPT process connection
3-2776-1	159 000 960	Electrode, pH, DryLoc, flat, PT1000, ¾ in. NPT process connection
DryLoc ORP (Redox) Electrodes		
3-2755	159 000 749	Electrode, ORP, DryLoc, flat, 10KΩ ID
3-2757	159 000 752	Electrode, ORP, DryLoc, bulb, 10KΩ ID
3-2757-WT	159 000 835	Electrode, ORP, DryLoc, bulb, 10KΩ ID, wet-tap
3-2765-1	159 000 946	Electrode, ORP, DryLoc, flat, 10KΩ ID, differential, 1 in. NPT process connection
3-2765-2	159 000 947	Electrode, ORP, DryLoc, flat, PT1000, differential, 1 in. NPT process connection
3-2765-3	159 000 948	Electrode, ORP, DryLoc, flat, 300Ω, differential, 1 in. NPT process connection
3-2767-1	159 000 952	Electrode, ORP, DryLoc, bulb, 10KΩ ID, differential, 1 in. NPT process connection
3-2767-2	159 000 953	Electrode, ORP, DryLoc, bulb, PT1000, differential, 1 in. NPT process connection
3-2767-3	159 000 954	Electrode, ORP, DryLoc, bulb, 300Ω, differential, 1 in. NPT process connection
3-2775	159 000 957	Electrode, ORP, DryLoc, flat, 10KΩ ID, ¾ in. NPT process connection
3-2775-1	159 000 958	Electrode, ORP, DryLoc, flat, no tc, ¾ in. NPT process connection
3-2777	159 000 961	Electrode, ORP, DryLoc, bulb, 10 KΩ ID, ¾ in. NPT process connection
3-2777-1	159 000 962	Electrode, ORP, DryLoc, bulb, no tc, ¾ in. NPT process connection
Miscellaneous Accessories		
3-8050-1	159 000 753	Universal Mount Junction Box
3-8050-2	159 000 754	Universal Mount Jct. Box w/Easy-Cal
3-8052-1	159 000 755	¾ in. NPT Mount Junction Box
3-8052-2	159 000 756	¾ in. NPT Mount Jct. Box w/Easy-Cal
3-2759	159 000 762	pH/ORP Simulator/System tester
3-2759.391	159 000 764	Adapter cable to connect 2759 and 2750
3-0700.390	198 864 403	pH Buffer Kit
P31515-0P200	159 000 630	Universal Pipe Adapter PVC
P31515-0C200	159 000 631	Universal Pipe Adapter CPVC
P31515-0V200	159 000 459	Universal Pipe Adapter PVDF
5523-0322	159 000 761	Cable, 3-conductor + shield (blk/red/wht/shld) 22AWG (per ft)

+GF+

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For Worldwide Sales and Service, visit our website: www.gfsignet.com • Or call (in the U.S.): (800) 854-4090

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APPENDIX B: HANDHELD pH METER MANUAL

DISTRIBUTED BY:

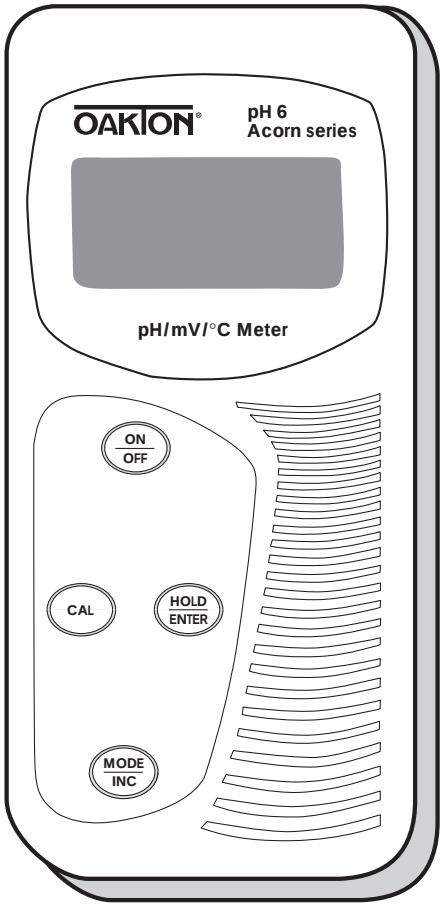
00702-41

OAKTON®

OPERATING INSTRUCTIONS

OAKTON WD-35613-00; -01; -10; -11

pH 5 and pH 6 Acorn Series Meters



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OAKTON®

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1. Introduction

Thank you for purchasing an OAKTON® Acorn Meter. These meters are economical, microprocessor-based meters that deliver ±0.01 pH accuracy.

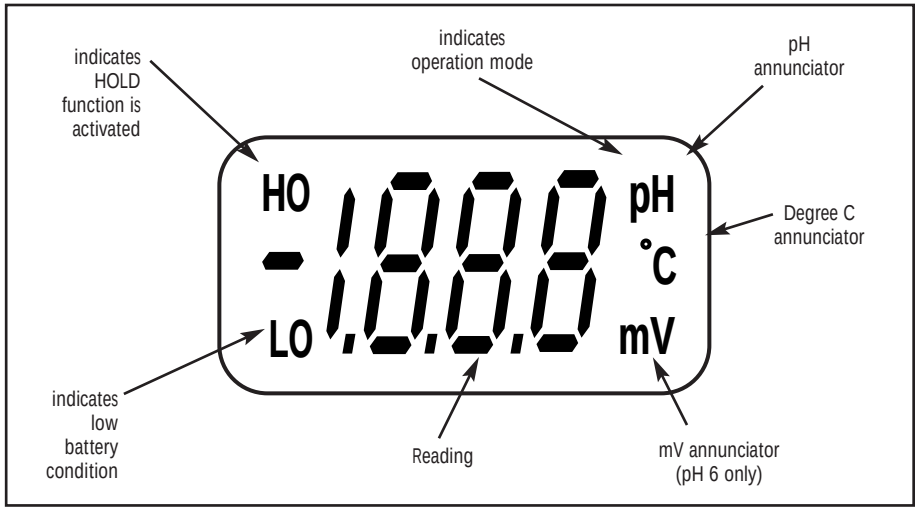
Some of the features of these meters are:

- Large LCD for clear and easy reading
- pH 5 and pH 6 series meters allow measurement in pH and Temperature (°C)
- pH 6 series meters also allow measurement in Millivolt (mV), for taking ORP (Redox) readings or checking pH electrode performance.

This instruction manual is organized for easy reference. For basic functions of this meter, read sections 2 through 5. These sections include basic instructions that will get you up and running quickly. The remaining sections of this manual (6 through 11) deal with electrode maintenance, error messages and troubleshooting. This part of the manual also includes the Specifications, Accessories, Warranty and Return of Items section.

2. Display and Keypad Functions

The Acorn has a large custom LCD with the following indicators:



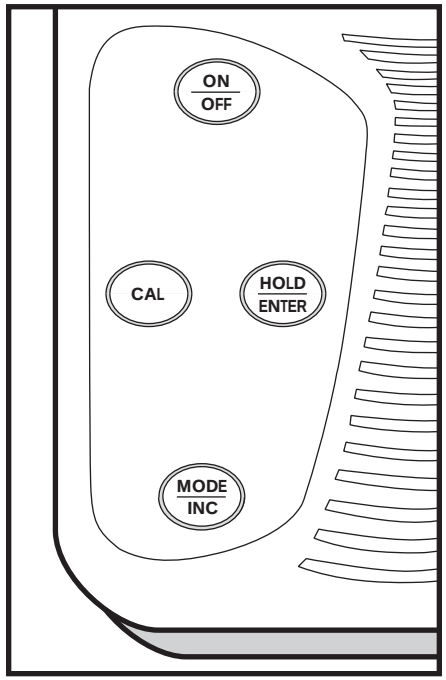
The OAKTON Acorn meter has four keys on its splashproof keypad. These keys are ON/OFF, HOLD/ENTER, CAL and MODE.

ON/OFF: Powers meter on and shuts unit off. Meter directly enters measurement mode when you turn it on.

HOLD/ENTER: Freezes the measured reading; confirms calibration value.

CAL: Allows calibration of the meter for pH, mV and Temperature

MODE/INC: Selects the parameter of measurement: pH, mV (pH 6 series only) and temperature.



3. Preparation

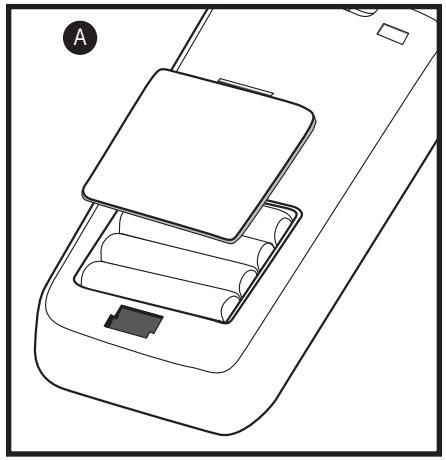
3.1 Inserting the batteries

The battery compartment is found at the back of the instrument. To open the battery compartment, push the lid up.

See figure A

Note the polarity of battery before inserting the batteries into position. After replacement, place the cover back into its position and press down until it locks tight.

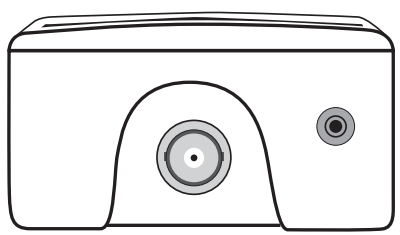
A "LO" annunciator in the LCD alerts you when battery power is running low. Replace batteries with a fresh set as soon as possible.



3.2 Connecting the Electrode and Temperature Probe

To connect the Acorn meter to your electrode, align the post of the meter's connector with the slots on the electrode's connector, push together and twist the electrode connector 1/2 turn until it clicks into place. To remove, simply rotate the connector counter-clockwise until it unlocks, and slide the connector off the socket.

Insert the phono jack of the temperature sensor into the socket on the meter. Unplug the phono jack when not in use.



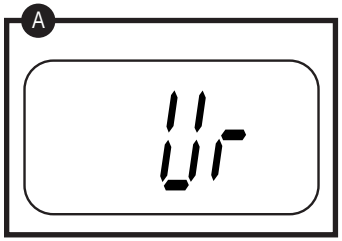
electrode and temperature probe connections at top of Acorn meter

3.3 Switching the meter on

Press the ON/OFF key to power up your meter. All the LCD segments display for a few seconds as the meter goes through a self-diagnostic test. The LCD then switches into pH measurement mode.

If the LCD then displays "Ur"., the electrode is faulty, the temperature sensor is faulty, or there is an open circuit.

See figure A



See page 13 for more troubleshooting information.

4. Calibration

4.1 pH calibration

This instrument is capable of up to three-point calibration to ensure accuracy across the entire range of the meter. You can perform 1-, 2- or 3-point calibration with standard pH buffers 4.01; 7.00; and 10.00.

We recommend you perform at least a 2-point calibration at room temperature using standard buffers that bracket (one above and one below) the expected sample range. You can also perform a 1-point calibration, but make sure that the buffer value is close to the sample value you are measuring.

All new calibrations will over-ride existing data.

NOTE: **Do not reuse buffer solutions after calibration.** Contaminants in the solution can affect the calibration, and the accuracy of the measurements.

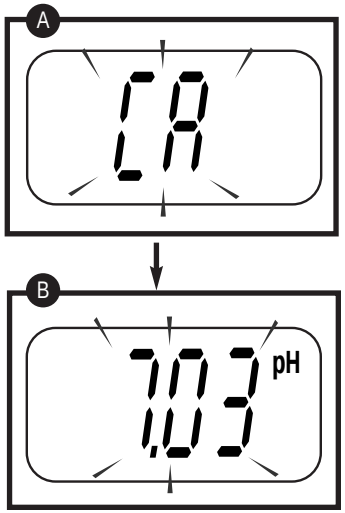
Before use: remove the electrode soaker bottle. If the electrode has been stored dry, condition the glass bulb by soaking it in tap water for 30 minutes. This hydrates the glass bulb if the electrode is too dry, or has not been used for a long period of time.

1. Turn meter on. Meter will automatically enter pH measurement mode.
2. Rinse electrode thoroughly with deionized water or a rinse solution. **DO NOT wipe the electrode;** this causes a build-up of electrostatic charge on the glass surface.
3. Dip both the electrode and temperature sensor into pH 7.00 buffer solution. The glass bulb must be completely immersed into the sample. Stir gently, and wait for reading to stabilize (approximately 40 seconds).
4. Press CAL key to enter the calibration mode. The display will momentarily flash “CA” to indicate CAlibration.

   See figure A

   The display will then show the current noncalibrated reading, blinking while in calibration mode.

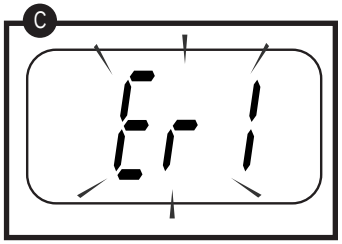
   See figure B
5. Allow the reading to stabilize. The meter automatically recognizes 7.00, 4.01 or 10.00 buffers.
6. Press ENTER key once to confirm calibration. The LCD displays “CO” to indicate the calibration point has been confirmed. The meter exits calibration mode and returns to measurement mode.



7. Repeat with pH buffers 4.01 and/or 10.00 for best accuracy.

NOTE: This meter has automatic buffer recognition which identifies the correct pH buffer values during calibration. If buffers other than 4.01, 7.00 or 10.00 are used, or the electrode has worn out, the LCD will flash "Er1".

See figure C

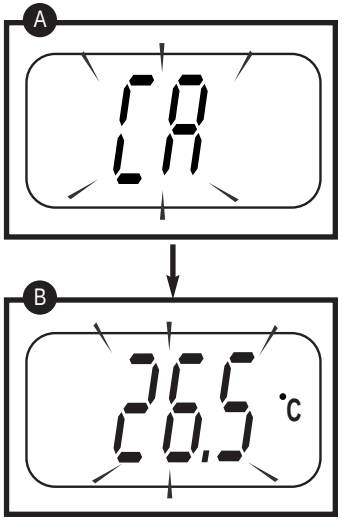


4.2 Temperature calibration

The temperature sensor included with your meter is factory calibrated. Over time, the temperature calibration may drift and require recalibration. If you replace the probe you should calibrate temperature prior to pH or mV calibration.

1. Connect your temperature probe to the meter.
2. Press the MODE/INC key until "°C" appears in the LCD.
3. Compare displayed value to a NIST certified thermometer or other thermometer known to be accurate. For best accuracy, place probe and thermometer in a constant temperature bath.
4. Press the CAL key. the LCD shows "CA" and the reading flashes.

   See figures A B
5. Press MODE/INC key until the display shows the correct temperature. The MODE /INC key will scroll to the maximum allowable value, and then loop back to the minimum allowable value adjustment (maximum adjustment is ±5°C from factory default).
6. Press ENTER key to confirm calibration. The LCD displays "CO", and the meter then reverts to measurement mode.

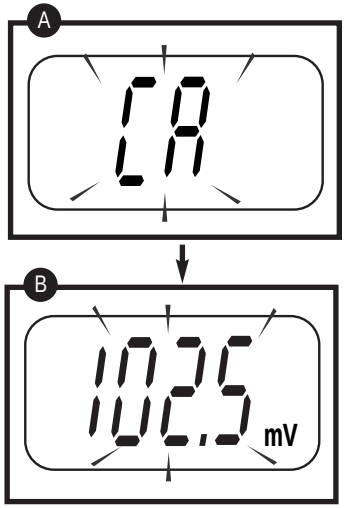


4.3 Millivolt (mV) Calibration

mV calibration is performed for ORP (Redox) measurements, where you can adjust its mV values as a base value for measurements. Contact your OAKTON distributor for ORP electrodes.

1. Press MODE/INC key to enter mV mode. LCD displays "mV".
2. Press the CAL key. LCD shows "CA", and the reading flashes

   See figure A B
3. Use the MODE/INC key to adjust the reading to your desired value. The maximum adjustment you can make is ±25 mV. If the MODE/INC key is pressed continuously, the reading scrolls to the maximum allowable value, and then loops back to the minimum allowable value.
4. Press ENTER key to confirm calibration. The LCD displays "CO" and the meter then reverts to measurement mode.



5. Measurement

5.1 Taking Measurements

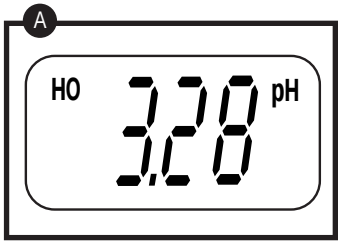
1. Rinse both electrode and temperature sensor with distilled water.
2. Turn meter on. Press MODE key to select desired parameter (pH, mV, Temperature).
3. Dip electrode and temperature sensor approximately 1" to 2" into sample. Stir gently and wait for display to stabilize. Note reading.

5.2 Hold function

To freeze your reading, press the HOLD key once. The LCD show "HO" to indicate the HOLD function is activated

See figure A

Press HOLD key again to deactivate the HOLD function and return to measurement mode.



6. Electrode care and maintenance

6.1 Storage

For best results, keep the pH bulb wet. Store the pH bulb in the electrode soaker bottle filled with electrode storage solution. Or you can store the electrode in a pH 4 buffer with 1/100 part saturated KCl. Other pH buffers are also suitable for storage. **NEVER use deionized water for storage.**

6.2 After measuring

1. Rinse the electrode and reference junction in deionized water.
2. Store the electrode as recommended in "Storage" or as recommended by the manufacturer.

6.3 Electrode cleaning

Because your pH electrode is susceptible to dirt and contamination, clean it every one to three months depending on extent and condition of use.

Clean the electrode in a mild detergent solution. Wipe the probe with a soft tissue paper. Avoid touching the glass membrane with your fingers. Wash thoroughly in tap water and then in distilled water. Recalibrate your meter after cleaning the electrode.

Special Cleaning Tips

Salt deposit: dissolve the deposit by immersing the electrode in tap water for ten to fifteen minutes. Then thoroughly rinse with distilled water.

Oil/grease film: wash electrode pH bulb gently in detergent solution. Rinse electrode tip with distilled water.

Clogged reference junction: heat a diluted KCl solution for 60-80°C. Place the sensing part of the electrode into the heated solution for about 10 minutes. Allow the electrode to cool in some unheated KCl solution.

Protein deposits: prepare a 1% pepsin solution in 0.1M of HCl. Set the electrode in the solution for five to ten minutes. Rinse the electrode with distilled water.

7. Troubleshooting

Problem	Cause	Solution
Err flashes on LCD	Wrong or contaminated buffer used during calibration	Use fresh buffer solution: pH 4.01, 7.00, or 10.00
	Bad electrode	Change electrode
"Ur" or "Or" on LCD with pH or °C annuciator	pH out of range	—
	Temperature out of range	Cool/Heat sample as needed
	Bad electrode	Change electrode
	Bad temperature sensor	Change temperature sensor
LO annuciator on LCD	Low battery	Replace batteries with fresh set
Power on but no display	Batteries not in place	Insert batteries
	Batteries not in correct polarity (+ and -)	Re-insert batteries with correct polarity
	Weak batteries	Replace batteries
Unstable reading	Electrode not deep enough in sample	Place electrode deeper in sample
	Insufficient reference electrolyte in electrode	Fill electrode with reference electrolyte (if electrode is refillable); replace electrode.
	Broken electrode	Replace electrode
	External "noises" or induction caused by by nearby electric motor	Remove or switch off interfering motor
	Dirty electrode	Clean electrode
Slow response	Dirty electrode	Clean electrode

8. Specifications

Mode	pH	Temperature	mV (pH 6 only)
Range	0.00 to 14.00 pH	0.0 to 100°C	-1000 to +1000 mV
Resolution	0.01 pH	0.1°C	1 mV
Accuracy	±0.01 pH	±0.5°C	±2 mV
Calibration	up to 3 points (push button)	Offset 0.1°C	Offset up to ±25 mV

pH slope range: 80% to 120%

Auto buffer recognition: pH 4.01; 7.00; 10.00

Display: Single line LCD

Inputs: BNC, phono jack

Auto shutoff: after 17 minutes

Hold Function indicator: HO

Error Message display: Err

Low battery indication: LO

Temperature Compensation: Automatic (ATC), 0.0 to 50.0°C

Operating temperature: 0 to 50°C

Power: 4 x AAA Alkaline batteries (>70 hours)

Dimensions: Meter only: 5.5" x 2.7" x 1.3" (14 x 7 x 3.5 cm);
Boxed: 9.25" x 6.5" x 3" (23.5 x 16.5 x 7.6 cm)

Weight: Meter only: 0.5 lb (210 g); Boxed: 1 lb (420 g)

9. Accessories

WD-35613-00 Additional pH 5 Series Acorn Meter (pH / °C) with pH electrode and temperature probe

WD-35613-01 Additional pH 5 Series Acorn Meter (pH / °C) with temperature probe (electrode not included)

WD-35613-10 Additional pH 6 Series Acorn Meter (pH / mV / °C) with pH electrode and temperature probe

WD-35613-11 Additional pH 6 Series Acorn Meter (pH / mV / °C) with temperature probe (electrode not included)

Accessories

WD-35606-80 Protective Rubber Boot, encases meter in sturdy rubber to protect it from drops and dings. Also features meter stand for convenient tabletop use.

WD-35801-00 Replacement electrode, 5.75"L x 0.47 OD (12 mm). Shpg wt. 0.5 lb (230 g).

WD-35805-05 Double junction electrode, use with solutions that are dirty, have heavy metal or organic ions. 5.75"L x 0.47 OD (12 mm). Shpg wt. 0.5 lb (230 g).

WD-35613-05 Replacement temperature probe, 316 SS, polypropylene cap, 3" cable. Shpg wt 0.15 lb (70g).

WD-35805-13 ORP electrode, epoxy body, single junction, 5.75"L x 0.49"OD (12.5 mm). Shpg wt 0.5 lb (230 g).

WD-00653-04 Electrode storage solution, 1 pint bottle. Keeps electrode bulb moist for faster, more accurate readings. Shpg wt 1.1 lbs (510 g).

WD-00653-06 Electrode cleaning solution, 1 pint bottle. Removes buildup from electrodes and maintains electrode sensitivity. Shpg wt 1.1 lbs / 510 g.

OAKTON calibration solutions

±0.01 pH accuracy at 25°C. Shpg wt 1.1 lb (510 g).

WD-00654-00 pH 4.01 calibration buffer, 1 pint.

WD-00654-04 pH 7.01 calibration buffer, 1 pint.

WD-00654-08 pH 10.01 calibration buffer, 1 pint.

OAKTON “Singles” calibration solution pouches 20/box.

±0.01 pH accuracy at 25°C. Shpg wt 1.1 lb (454 g) per box.

WD-35653-00 Deionized rinse water solution pouches,

WD-35653-01 pH 4.01 “Singles” buffer solution pouches

WD-35653-02 pH 7.00 “Singles” buffer solution pouches

WD-35653-03 pH 10.00 “Singles” buffer solution pouches

WD-35653-04 Assortment pack, 5 ea. deionized water, pH 4.01, pH 7.00, and pH 10.00 solution pouches.

Consult your OAKTON® Distributor for a complete selection of pH and ORP electrodes, solutions and accessories. Ask for bulletin Accessories A1.

NOTE: Remember to check the temperature calibration when replacing the ATC probe. See section 4.2, "Temperature calibration" (page 9).

10. Warranty

OAKTON warrants this meter to be free from significant deviations in material and workmanship for a period of one year from date of purchase. OAKTON warrants this probe to be free from significant deviations in material and workmanship for a period of six months from date of purchase. If repair or adjustment is necessary and has not been the result of abuse or misuse within the warrantied time period, please return—freight prepaid—and correction will be made without charge. OAKTON alone will determine if the product problem is due to deviations or customer misuse.

Out-of-warranty products will be repaired on a charge basis.

11. Return of items

Authorization must be obtained from your OAKTON distributor before returning items for any reason. When applying for authorization, please include data regarding the reason the items are to be returned. For your protection, items must be carefully packed to prevent damage in shipment and insured against possible damage or loss. We will not be responsible for damage resulting from careless or insufficient packing. A restocking charge will be made on all unauthorized returns.

NOTE: We reserve the right to make improvements in design, construction, and appearance of products without notice.

APPENDIX C: IN-LINE TURBIDIMETER MANUAL

OWNER'S MANUAL
MicroTOL Series Turbidimeter

HF scientific
3170 Metro Parkway
Ft. Myers, FL 33916
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Catalog No. 24034 (1/10)
Rev. 4.7

DECLARATION OF CONFORMITY

Application of Council Directive
Standards to Which Conformity is Declared:

Product Safety - Tested and passed ETL (tested to UL 61010B-1), 1st Edition, Dated January 24, 2003
- Tested and passed ETLc (tested to CSA C22.2#1010.1-92)
- Tested and passed CE to IEC 61010-1: 2001 Edition 2.0

Emissions & Immunity – Tested and passed EN61326-1:2006

Manufacturer's Name: HF scientific, inc.

Manufacturer's Address: 3170 Metro Parkway, Fort Myers, Florida 33916-7597

Importer's Name:

Importer's Address:

Type of Equipment: Process Turbidimeter

Model No: Micro TOL

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive and Standard

Place: Fort Myers, Florida USA

(Signature)

Rowan T. Connelly, General Manager

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Specifications

Measurement Range	0 – 1000.0 NTU 0 – 100 NTU (Model 20055 & 20056)
Accuracy	±2% of reading or ±0.02 NTU below 40 NTU whichever is greater ±5% of reading above 40 NTU
Resolution	0.0001 NTU (below 10 NTU)
Response Time	Adjustable
Display	Multi-Line Liquid Crystal Backlit Display
Alarms	Two Programmable, 120-240VAC 2A Form C Relay
Analog Output	Powered 4-20 mA, 600 Ω drive
Communications Port	Bi-directional RS-485, Modbus
Maximum Water Pressure	Integral pressure regulator rated 1380kPa (200 PSI.) Also refer to **Flow Rate**
Flow Rate	100 ml/min. – 1 liter/min. (.026-.26 Gal/min)
Operating Temperature	1°C – 50°C (34°F – 122°F)
Wetted Materials	Nylon, Borosilicate Glass, Silicon, Polypropylene, Stainless Steel
Sample Temperature Range	1°C – 50°C (34°F – 122°F)
Power Supply	100 – 240 VAC, 47 – 63 Hz, 80VA
Insulation Rating	Double Insulated, Pollution Degree 2, Overvoltage Category II
Environmental Conditions	Not recommended for outdoor use. Altitude up to 2000 meters Up to 95 % RH (non-condensing)
Enclosure Rating	Designed to meet IP 66 /NEMA 4X
Regulatory Compliance And Certifications	White Light Version compliant to U.S. EPA 180.1 Infrared Version compliant to ISO 7027 CE Approved, ETL listed to UL 61010B-1 & ETL Certified to CSA 22.2 No. 1010-1-92
Shipping Weight	2.5 kg (5.5 lbs.)
Warranty	1 Year from date of shipment

1.0 Overview

The MICRO TOL process turbidimeter allows for the measurement of the turbidity of process water on-line. The White Light MICRO TOL has been designed to meet the design criteria specified by the US EPA 180.1 on turbidity measurement. The infrared MICRO TOL was designed to meet the design criteria specified in ISO 7027 and DIN 27027 for the measurement of the turbidity of a sample. Both models have long life lamps.

Some models have ultrasonic cleaning. Refer to section 8.2 for more information.

A pressure regulator on the incoming line is a standard on all Micro TOL instruments and will reduce pressures up to 1380kPa (200 PSI) down to (104kPa) 15 PSI.

1.1 The Micro TOL Series

The Micro TOL series instruments have a wide variety of options available. Refer to the table below to determine which factory installed options are available.

Catalog No.	Description	RS-485	Modbus	Backlight	Ultrasonic Cleaning	Range NTU	Flow Alarm
20053	Micro TOL2 WL	Standard	Standard	Standard	N/A	0-1000	Option
20054	Micro TOL2 IR	Standard	Standard	Standard	N/A	0-1000	Option
20055	Micro TOL3 WL	Standard	Standard	Standard	Standard	0-100	Option
20056	Micro TOL3 IR	Standard	Standard	Standard	Standard	0-100	Option
20063	Micro TOL4 WL	Standard	Standard	Standard	Standard	0-1000	Option
20064	Micro TOL4 IR	Standard	Standard	Standard	Standard	0-1000	Option

1.2 Unpacking and Inspection of the Instrument and Accessories

The table below indicates the items in the turbidimeter shipment.

Item	Quantity
MICRO TOL Turbidimeter c/w Field Terminal Box & Flow Through Assembly	1
Instruction Manual	1
Desiccant Pack	1
Cuvette (Single Pack)	1
Tubing Kit: 1-shutoff clamp 1-backpressure valve 2-connecting tubing with fittings for flow through assembly 1-drain vent screw (used in pressurized systems)	1

Remove the instrument from the packing carton. Carefully inspect all items to ensure that no visible damage has occurred during shipment. If the items received do not match the order, please immediately contact the local distributor or the HF scientific Customer Service department.

Note: The spare cuvette part# 50033 is not included for models 20055, 20056 20063 & 20064.

1.3 The Display

Figure 1 illustrates all the items that can appear on the display. The upper row of the display (1) is used for reporting the turbidity levels and to provide user guidance in the customer setting routine. The lower row of the display (2) is used to communicate error messages and provide user guidance. The display has two icons (3) that are used to indicate the use of access code and offset mode. In addition, mode arrows (4) are used to indicate the current instrument operating mode; AUTO (normal operation), CAL (calibration) and CONFIG (configuration).

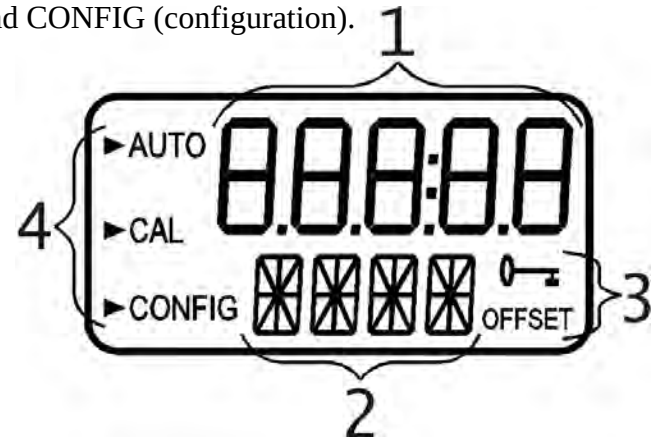


Figure 1 – Display used in the instrument.
All items used on the display are shown in this figure

1.4 The Touch Pad

Figure 2 illustrates the touch pad. The touch pad has four buttons: **MODE/EXIT,** ↵, ▲, and ▼. The **MODE/EXIT** button is used to cycle between the three operational modes of the instrument: **CAL, CONFIG,** and **AUTO** (Measurement) mode. The ↵ button enters the option (or mode that is highlighted or chosen. The ▲ and ▼ buttons are used to change settings.

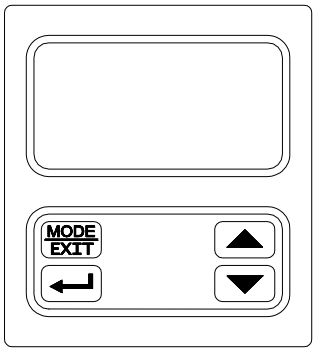


Figure 2: Touch Pad

1.5 Vapor Purge

The Micro TOL is equipped with a continuous vapor purge system. A replaceable desiccant pouch in the lower portion of the instrument dries the air. System heat is used to warm the air. A fan inside the instrument continuously circulates heated dry air around the optical well and the flow through cuvette. This feature eliminates the need for a dry purge line.

The Micro TOL monitors the replaceable desiccant pouch condition continuously. The LCD display will show **DESC** on the lower line in the event that the desiccant pouch needs replacement. Replacement desiccant pouches are available from HF scientific or the local representative (Part # 21555R). Refer to section 10.2 *Replacing or installing the Desiccant Pouch*.

The desiccant can activate an alarm to notify the operator of a saturated desiccant. See section 7.15 *Desiccant Alarm*.

Note: Prior to installing the desiccant pouch for the first time the shipping support must be removed. This tube can be discarded after installation.

2.0 Safety

This manual contains basic instructions that must be followed during the commissioning, operation, care and maintenance of the instrument. The safety protection provided by this equipment may be impaired if it is commissioned and/or used in a manner not described in this manual. Consequently, all responsible personnel must read this manual prior to working with this instrument.

In certain instances **Notes**, or helpful hints, have been highlighted to give further clarification to the instructions. Refer to the *Table of Contents* to easily find specific topics and to learn about unfamiliar terms.

3.0 Installation and Commissioning

Prior to use for the first time, the supplied desiccant pouch will need to be installed. Refer to section 10.2 *Replacing or Installing the Desiccant Pouch*.

3.1 Mounting & Site Selection

The instrument is designed for wall mounting. If wall mounting is not practical, the instrument can be mounted on any suitable level surface. For ease of service there should be about 20 cm (8") free area above the instrument; this will ensure enough room for calibration and cuvette maintenance. Choose a location that is easily accessible for operation and service and ensure that the front display rests at eye level. The overall mounting dimensions of the instrument are shown in Figure 3. The recommended mounting screws are M6 (¼") for the instrument enclosure and M4 (#8) for the field terminal box. The Micro TOL is designed to have the field terminal box cradled under the sensor portion of the instrument. It is recommended that the field terminal box be mounted first, and then the rest of the instrument be mounted on top. The template on the last page of this manual may be used to establish mounting hole locations.

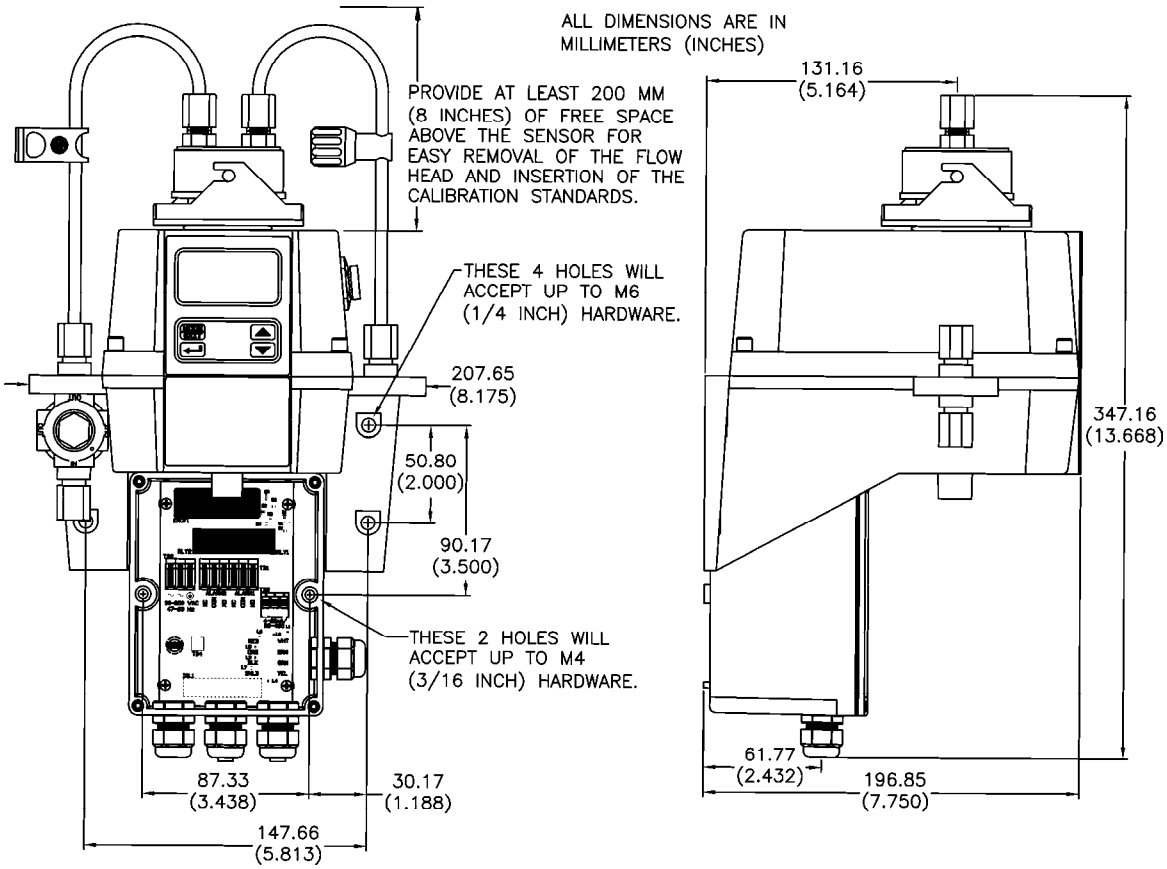


Figure 3: Overall Mounting Dimensions of the Instrument

It is critical that the instrument be mounted as close as possible to the sampling point to ensure a quick response time (within 2-3 meters (6-10 ft) of the sampling point).

3.2 Plumbing

The recommended plumbing for the instrument is shown in Figure 4. The instrument is designed to require very little head pressure to operate; around 6.9kPa (1 PSI). The flow through cuvette is rated for a flow of 100ml/min. – 1 liter/min. (0.026-0.26Gal/min). The integral pressure regulator is rated for a maximum pressure of 1380 kPa (200 PSI.). The maximum allowable fluid temperature is 50°C (122°F).

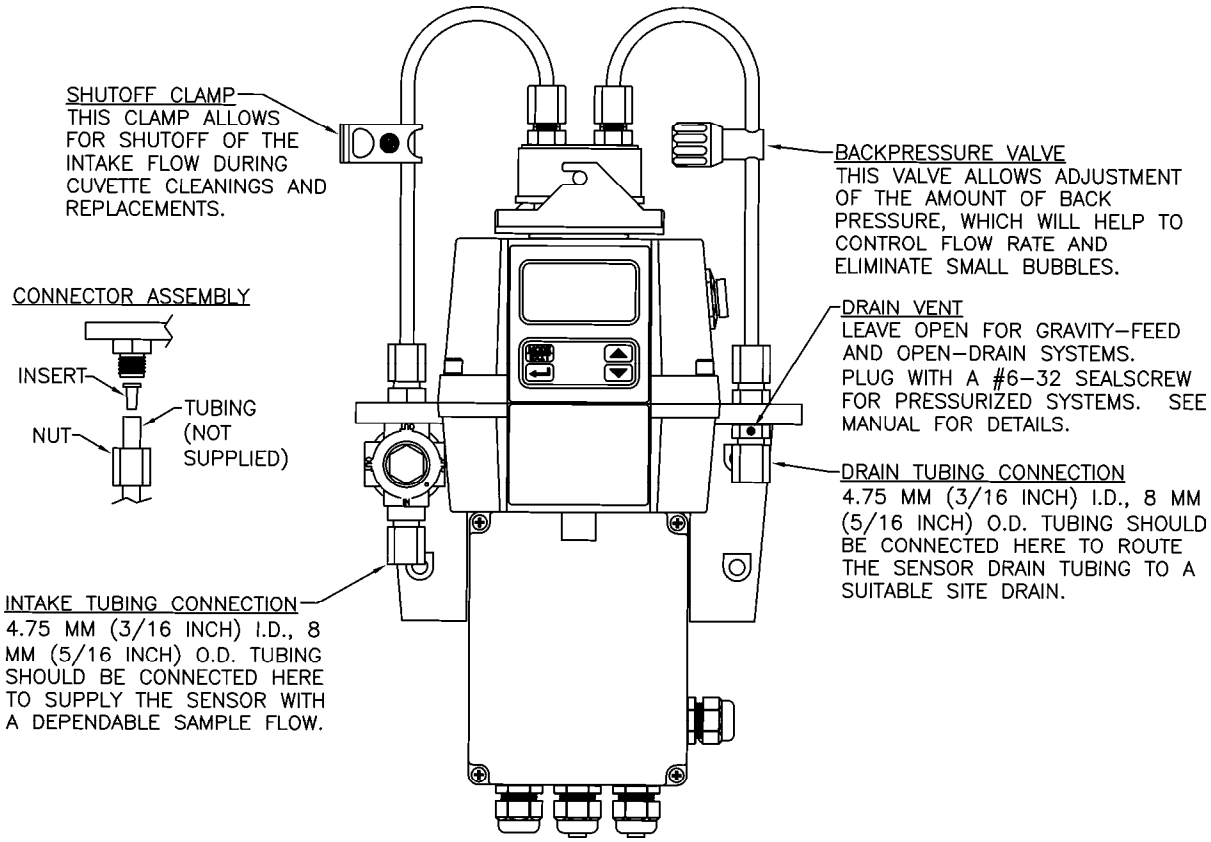


Figure 4: Recommended Plumbing for the Instrument

The instrument is equipped to be plumbed using 4.75 mm (3/16”) ID, 8 mm (5/16”) OD flexible tubing. Opaque tubing should be used if the tubing will be exposed to sunlight, to prevent algae growth.

In figure 4, there are two flow devices shown. The one on the input side is a shutoff clamp used during cuvette maintenance. The other device is a backpressure valve. Backpressure may be required to prevent air from coming out of solution, which may be observed as tiny air bubbles.

3.2.1 Drain Vent: The Micro TOL has been fitted with a drain vent in the "OUT" bulkhead fitting. This fitting allows for atmospheric equalization, thus helping to alleviate bubble formation in the cuvette. Refer to Figure 4.

Upon initial flow minor leakage may occur through the drain vent. This will subside once normal flow is established.

For some high pressure systems, where the vent hole continuously leaks, a 6:32 seal screw is provided which should be inserted into the vent hole and tightened.

The sensor drain tubing MUST be routed to a suitable drain. DO NOT reintroduce the drain sample to the process stream. This is due to the fact that the wetted materials are not FDA approved. See below for more information.

3.2.2 Wetted Materials: HF scientific accepts no responsibility for damage caused by the introduction of vapors, fluids or other materials into the instrument process stream which is not compatible with the instrument's wetted materials. A list of the wetted materials can be found in the specifications on page 1 of this manual.

3.3 Electrical Connections

All of the electrical connections to the instrument are made through the field terminal box, which should be located directly under the sensor portion of the instrument. The connections are labeled within the terminal box and are self-descriptive (see Figure 5). Please follow all local and government recommendations and methods for installation of electrical connections to and between the instrument and other peripheral devices.

Plugs are inserted into the alarm and 4-20mA/RS-485 cable bulkheads when shipped, to ensure a watertight seal. These plugs should be removed and discarded when cabling to either of these connections.

The power cable bulkhead will accept cable diameters from 5.8mm (.230 in.) up to 10 mm (.395 in.). All terminals are designed to accept wires in the range of 14-28 AWG. All wires should be stripped to a length of 6 mm (¼"). A strain relief strap is provided to reduce tension on the power terminals.

It is the user's responsibility to assure that the watertight seal is maintained after the terminal box has been wired for operation. If any of the bulkheads are not tightened properly around a cable or plug, the ratings of the instrument will be jeopardized and there is a possibility of creating a shock hazard.

Note: Only qualified electricians should be allowed to perform the installation of the instrument as it involves a line voltage that could endanger life.

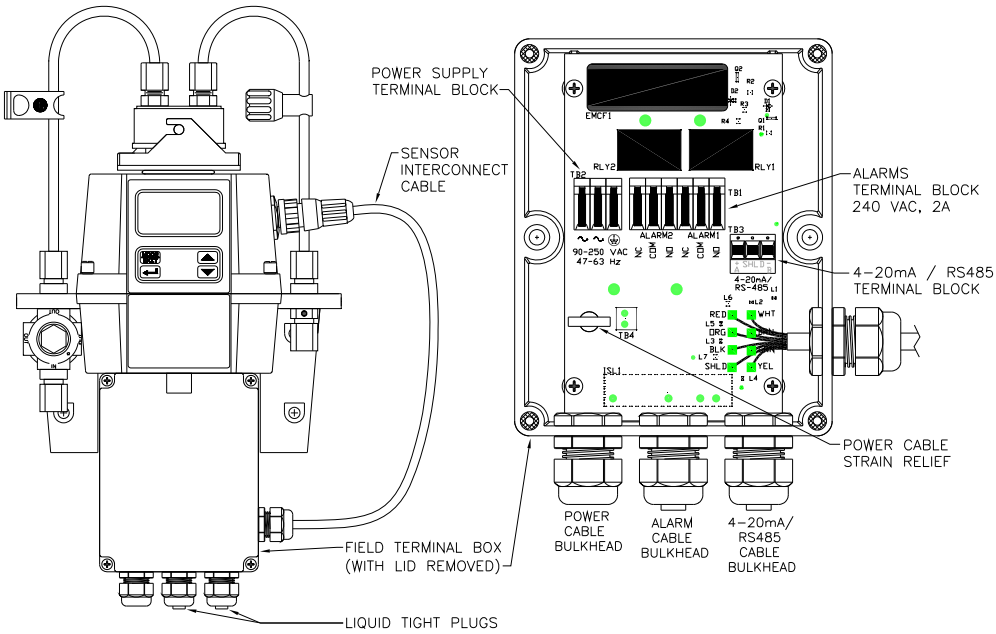


Figure 5: Electrical Connections for the Instrument

3.3.1 Power: The instrument is equipped with a 100-240 VAC, 47-63 Hz switching power supply; please verify that the line voltage falls within these specifications. It is recommended that a circuit breaker be placed prior to the power connection to allow for service. While making connections, refer to Figure 5. **The Micro TOL is not supplied with a power cord**.

3.3.2 RS-485: The RS-485 half-duplex (2-wire) digital interface operates with differential levels that are not susceptible to electrical interferences. This is why cable lengths up to 3000 ft can be implemented. The last device on each bus may require terminating with a 120-ohm resistor to eliminate signal reflection on the line. Do not run RS-485 cables in the same conduit as power.

To prevent damage to the instrument, ensure that power is disconnected prior to making connections. For ease of connecting, remove the plug in terminal block. Connections are labeled beneath this termination.

3.3.3 Relays: The Alarm 1 and Alarm 2 relays are mechanical relays rated at 240 VAC 2A. Please note that the relays are labeled NO (Normally Open), NC (Normally Closed) and C (Common). As these alarms are configured fail-safe, the normal condition is with power applied to the Micro TOL and in a non-alarm condition. Operation of these alarms is covered in section 7.5 *Configuring the Alarms*.

3.3.4 4-20 mA: The 4-20 mA output is driven by a 15 VDC power source and can drive recorder loads up to 600 ohms. This 4-20 mA output is isolated from line power and earth ground. Do not run 4-20 mA cables in the same conduit as power. Operation of this output is covered in section 7.2 *Setting the 4-20 mA*. Optional transformer isolated outputs are available as a factory installed option (Catalog No. 21045A).

Note: The installation of the 4-20 mA isolator will render the RS-485 non-operational.

Ensure each instrument is not powered when connecting the 4-20 mA. To prevent damage to the instrument, ensure that power is disconnected prior to making connections. For ease of connecting, remove the plug in terminal block. Polarities of the connections are labeled beneath this termination.

4.0 Operation

This process turbidimeter allows for the measurement of the turbidity of process water on-line. The turbidity of the process water is usually reported in **N**ephelometric **T**urbidity **U**nits (NTU), but may be reported in **F**ormazin **N**ephelometric **U**nits (FNU). Readings above 1000 NTU (100 for models 20055 & 20056) are outside the range of this instrument. Readings above 1100 NTU (110 for models 20055 & 20056) will cause the display to flash indicating an over range condition.

During normal operation, the instrument will have the arrow beside **AUTO** highlighted with the current scale displayed on the lower row of the display and the measured reading on the upper row of the display (see illustration below).

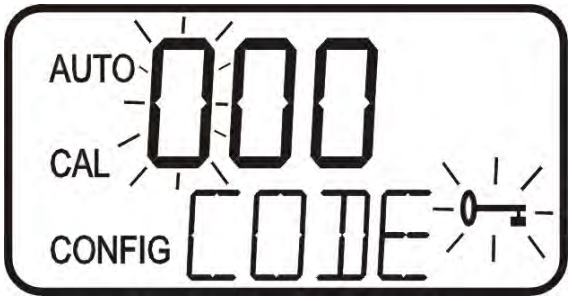
4.1 Routine Measurement

The following steps describe how to measure the turbidity of a sample using this instrument:

1. Apply power to the instrument and allow the unit to warm up (typically 45 minutes – 1 hour on initial commissioning).
2. When a continuous process stream is flowing through the instrument, the instrument will display the measured turbidity level of the sample by displaying it on the LCD screen. In addition, the equivalent signal is provided on the analog (4-20 mA) output, or the digital output, depending on the options selected.

4.2 Security Access Feature

The instrument is equipped with a security access code feature that can be activated in the configuration mode. If the security feature is enabled, the screen shown in the illustration below will appear when the **MODE/EXIT** button is pressed.



The security code (333) must be entered to gain access to **CAL** or **CONFIG** menus. Notice that the first number in the code is flashing; the flashing indicates that this is the number to be changed. Use the ▲ or ▼ arrows to select the first of the three numbers in the code and then press the ↵ button to accept the first number of the code. Now enter the second number in the code. Proceed as with the first number followed by ↵. Then repeat the process for the third number in the access code, and finish with the ↵ button.

If the valid access code has been selected, the instrument will be directed to the calibration mode. If the wrong access code is selected, the instrument will return to the **AUTO** mode. Refer to section 7.7 *Enabling the Security Access* for more information.

5.0 Instrument Calibration

The instrument was calibrated and tested prior to leaving the factory. Therefore, it is possible to use the instrument directly out of the box. Under normal conditions, re-calibration is recommended at least once every three months[1].

Relay contacts will change to the alarm state while the instrument is in the calibration and/or in the configuration mode. While in the calibration mode, the instrument has a time-out feature that automatically returns the system operation to the **AUTO** mode after a fifteen (15) minute period of inactivity.

5.1 Calibration Standards

If the Micro TOL will be used over the entire range of .02 to 1000 NTU a complete calibration as described below will be required. If instrument accuracy is only required below 10 NTU, such as potable water, a calibration may be performed using only a 10 NTU and a 0.02 NTU standard. To calibrate starting at the 10 NTU, press the ▼ button to bypass the 1000 NTU and proceed to Section 5.2 *Calibration Procedures*, step 5.

We recommend that the following materials be used during calibration to achieve the full-scale accuracy stated in this manual:

1. 0.02 NTU PRIME TIME Calibration Standard available from HF scientific
2. 10.0 NTU PRIME TIME Calibration Standard available from HF scientific
3. 1000 NTU PRIME TIME Calibration Standard available from HF scientific

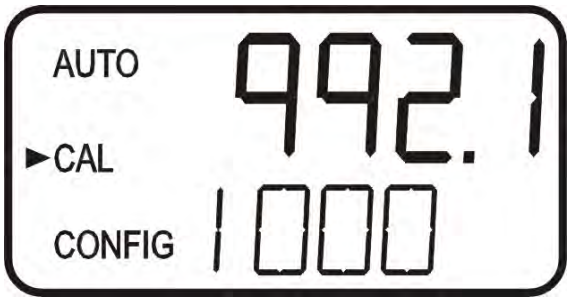
It is well known that diluted Formazin is unstable. If Formazin is used to calibrate the instrument, ensure that a fresh stock suspension of Formazin is used to achieve the accuracy quoted for the instrument. A Formazin Stock Solution Kit is available from HF scientific (Catalog No. 50040). The HF scientific PRIME TIME, primary calibration standards (refer to section 11.0 *Accessories and Replacement Parts List*) are more stable than Formazin and have a minimum shelf life of 12 months. Prior to recalibration, review the expiration dates, to ensure that the standards have not expired.

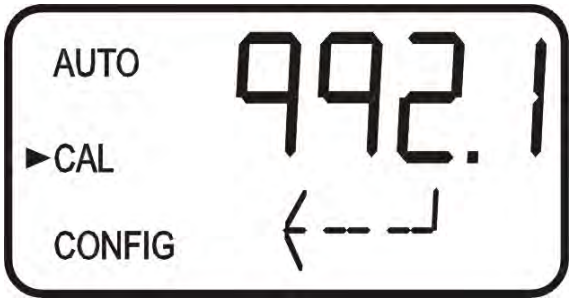
Note: The range of Models 20055 & 20056 is .02 to 100 NTU. For calibrating these models replace the 1000 NTU standard with a 100 NTU standard.

[1] The EPA recommends that on-line turbidimeters be calibrated with a primary standard at least once every three months if they are to be used for EPA reporting.

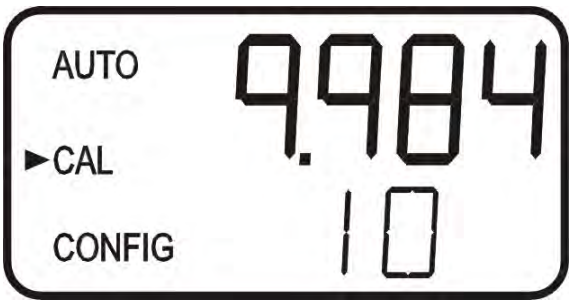
5.2 Calibration Procedures

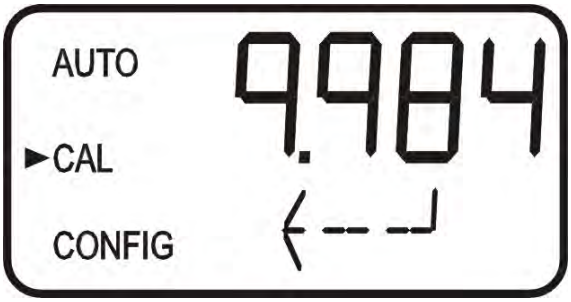
1. Select the calibration function of the instrument by pressing the **MODE/EXIT** button once. The arrow beside **CAL** will be illuminated on the display. The lower display shows alternating **1000 (**the value of the standard that is requested) and ↵. The upper display shows the real-time reading to allow the standard to be indexed. Refer to section 6.1 for information on indexing cuvettes.



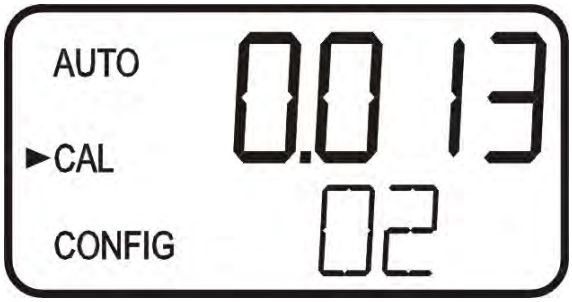


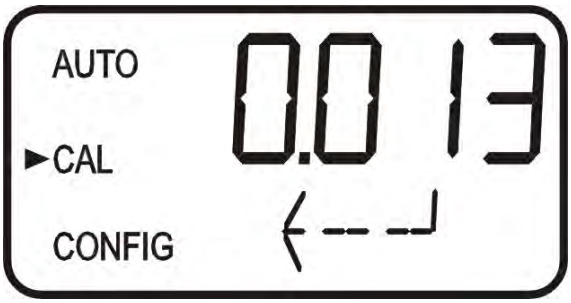
2. Remove the flow through unit.
3. Insert the requested 1000 NTU standard. Index the standard to the lowest value on the upper display.
4. Press the ↵ button to accept the calibration.
5. The lower display will count down the progress of the calibration step.
6. The lower display will now change to show alternating **10** and ↵, requesting the 10.0 NTU standard.





7. If the alternating **10** and ↵ is not displayed, push the ▲ or ▼ until this display is shown.
8. Insert the requested 10.0 NTU standard. Index the standard to the lowest value on the upper display.
9. Press the ↵ button to accept the calibration.
10. The lower display will count down the progress of the calibration step.
11. The lower display will now change to show **02** and ↵, requesting the 0.02 NTU standard.



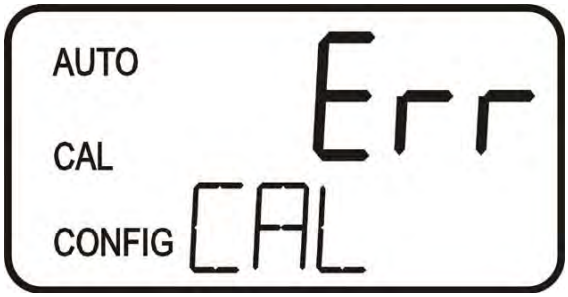


12. Insert the requested 0.02 NTU standard. Index the standard to the lowest value on the upper display.
13. Press the ↵ button to accept the calibration.
14. The lower display will count down the progress of the calibration step.
15. The instrument will return to **AUTO** mode at the end the calibration**.**

Note: During calibration, the fan inside the instrument is turned off to extend the life of the desiccant. The fan will be turned on during calibration countdowns and after returning to the AUTO mode or after five minutes, which ever comes first. It is recommended that the measurement chamber be kept covered during the calibration period and that the flow through cuvette be replaced immediately after the calibration to prevent premature saturation of the desiccant.

5.3 Calibration Error

If the screen shown below, is displayed after calibration, the internal diagnostics have determined that the calibration standards were either bad or that they were inserted in the wrong order. Either check the standards and recalibrate or restore the factory calibration see 6.2 *Restoring Factory Settings*. The instrument cannot be used without performing one of these operations.



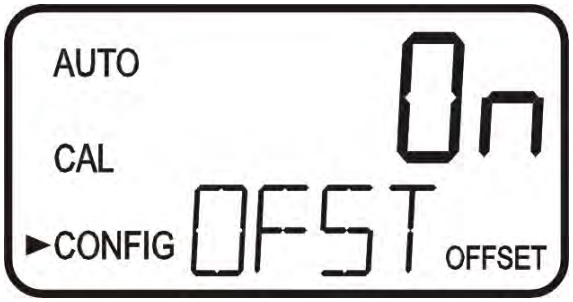
To recalibrate press the MODE key and start the calibration sequence again. To restore the factory calibration, push and hold the ▲ button. Now push and release the ↵ then release the ▲ button**.**

6.0 Instrument Offset

In certain instances, it may be desirable to use an offset factor to calibrate the instrument rather than performing a physical calibration of the instrument (as described in section 5.2). This procedure is not recommended in lieu of regular instrument calibration but it can be used in situations where the number of instruments used makes regular calibration prohibitive. This calibration technique will make the instrument accurate ***only*** at turbidity levels in the immediate vicinity of the grab sample and ***not*** in the full range of the instrument. Note that the **OFFSET** icon will be illuminated whenever an offset used. The maximum offset is ± 1.00 NTU. If instrument variation is greater than 1 NTU a full calibration is recommended.

The procedures are as follows:

1. Collect a grab sample of the process water that is being monitored by the instrument and record the turbidity reported by the instrument.
2. Take the grab sample and measure its turbidity using a laboratory turbidimeter (contact the HF scientific customer services department for examples of laboratory turbidimeters).
3. Compare the turbidity reported by the instrument to that obtained in the laboratory. If the readings are very close, then no offset adjustment or calibration is required and the procedure may be stopped at this step. However, if the readings are substantially different (but less that 1 NTU), continue on in this procedure to utilize the offset option to improve the turbidity reading of the instrument so that it will agree with the laboratory reading between calibrations.
4. Select the offset function of the instrument by pressing the **MODE/EXIT** button until the arrow beside **CONFIG** is illuminated on the display. Refer to the following screen.
5. Push the ↵ button until **OFST** is displayed on the lower row.
6. At this point, the lower row of the display will indicate the operational status of the offset function (**On** or **OFF**). Change this status by using the ▲ and ▼ buttons. Once the desired operational status of the offset function has been set, press the ↵ button to accept it. If the option was turned off, return to **AUTO** mode by pressing **MODE/EXIT.**



7. If the option was turned **On**, the upper row will display the offset required. This will add or subtract the value of the offset to the measured NTU value. As an example if the Micro TOL measures the process at 0.16 NTU but the laboratory instrument read the sample at 0.12 NTU, adding an offset of –0.04 would result in the Micro TOL displaying 0.12 NTU.

   Select the desired offset level using the ▲ and ▼ buttons. Once the desired level has been set, press the ↵ button to accept it.
8. This completes the offset configuration.
9. At this point, the instrument will continue through the configuration (**CONFIG**) mode of the instrument or press **MODE/EXIT** to return to the **AUTO** mode.

6.1 Indexing Calibration Cuvettes

To achieve the greatest accuracy, and account for normal scratches and aberrations in cuvette glass when calibrating, HF scientific recommends indexing the cuvettes.

Standards and standard kits purchased from HF scientific are supplied with indexing rings.

The following steps allow repeatable indexing of calibration standards:

1. With the instrument in AUTO mode insert the standard.
2. Slowly rotate the standard, inside the optical well, one complete revolution (360º). While rotating the standard slowly, observe the measured turbidity and locate the position of the cuvette having the lowest reading.
3. With the calibration standard positioned at the location having the lowest turbidity reading, install the Indexing Ring over the cap on the standard so that the pointer of the Indexing Ring faces directly forward.

When using the standards in future, always insert the standard so that the pointer of the indexing ring faces forward. Slowly rotate the standard back and forth about 5° to find the lowest point. The standard is now indexed and ready for use.

6.2 Restoring Factory Settings

If the instrument is unable to perform a calibration due to a low lamp output or a calibration using the wrong standards, the instrument will display **CAL** on the lower row of the display and **Err** on the upper row. The operator has two choices to correct this problem. If the operator can determine whether a poor calibration or a low lamp caused the problem, he/she can remedy the problem and recalibrate. If all else fails, the operator may restore the factory calibration and configuration settings by performing the following operation. Push and hold the ▲ button. Now push and release the ↵ then release the ▲ button**.** Factory calibration and factory configuration have now been restored.

Note: Restoring the factory settings allows the use of the Micro TOL with reduced accuracy. The original problem still exists and must be determined and corrected before accurate operation of the Micro TOL will be resumed.

7.0 Instrument Configuration (CONFIG mode)

The instrument has been designed to provide the ability to customize the instrument according to needs at any time during normal operation. This mode has been split into sub-menus to facilitate instrument configuration. This section describes how to use each of the sub-menus to configure the instrument. While in the configuration mode, the instrument has a time-out feature that automatically returns the system operation to the **AUTO** mode after a fifteen (15) minute period.

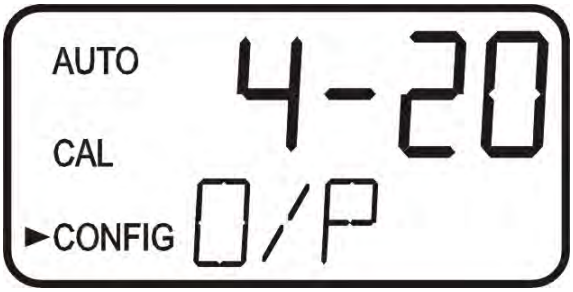
Enter the **CONFIG** mode of the instrument by pressing the **MODE/EXIT** button until the arrow beside **CONFIG** is illuminated, then press the ↵ button.

Note: To exit the CONFIG mode, press the MODE/EXIT button.

7.1 Selecting the Output (O/P)

The first configuration selection is the **O/P**. The selections are **4-20** for the 4-20 mA output, **485** for the RS-485 and **OFF** if no outputs are required. Select the desired output by using the ▲ and ▼ buttons. Once the desired output has been set, press the ↵ button to accept it. The next prompts will depend on the output selected.

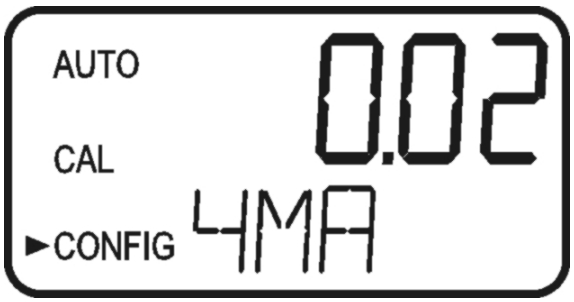
7.2 Setting the 4-20 mA



If the 4-20 mA output was turned on, prompts to set the 4mA **(4MA)** and 20mA **(20MA)** turbidity limits levels will be displayed. There is also a menu to adjust the error level **(ERLV**). The first prompt will be the turbidity limit assigned to the 4 mA output level:

Select the turbidity level to assign to the **4MA** using the ▲ and ▼ buttons.

The factory setting is 0.02 NTU.

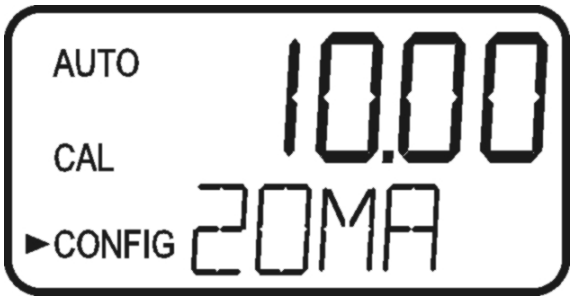


Once the desired level has been set, press the ↵ button to accept it.

Note: The 4MA can be set higher than the 20 MA level to invert the output current if required. This may be required to control a dosing pump

The next, prompt will be the turbidity level assigned to the 20 mA output level (**20MA)** on the lower row of the LCD display). Select the turbidity level to assign to the **20MA** using the ▲ and ▼ buttons. Once the desired level has been set, press the ↵ button to accept it.

The factory setting is 10.00 NTU.



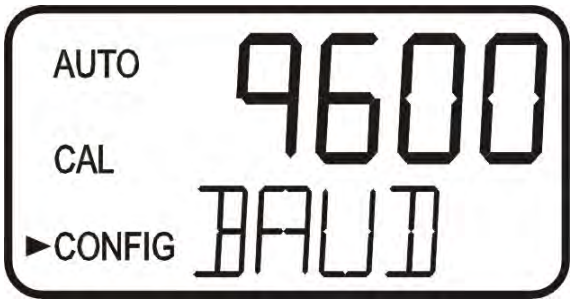
7.3 Configuring the Error Level

In case of an error in the Micro TOL, the 4-20 mA reading can be used to indicate a problem by sending the current to either 4.00 mA, 2.00 mA or 0 mA or OFF. In the case of OFF, the 4-20mA is unaffected by any error condition. The factory default setting is OFF. Select the desired ERLV by using the ▲ and ▼ buttons then press the ↵button to accept the desired error response.

7.4 Configuring the RS–485 Port

If the instrument is equipped with this option, and the I/O selection is changed to **485**, prompts will appear for setting the baud rate and the address.

Select the correct baud rate (1200, 2400, 4800, 9600, or 19200) for operation of the I/O port by pressing the ▲ or ▼ buttons to change the displayed baud rate.



Press the ↵ button to continue on and select the desired instrument address using the ▲ or ▼ buttons. Once the selection is satisfactory, press the ↵ button.

Select the address using ▲ or ▼ buttons. Press the ↵ button to save.

To enable the Modbus mode, select **ASCII** or **RTU**. For more information refer to the Modbus Manual (Catalog #19777). This manual can also be downloaded for no charge at www.hfscientific.com.

7.5 Configuring the Alarms

Two relays are provided that are designed to operate as two independent programmable alarms. Three types of information must be input to fully program each alarm:

1. The alarm function (HI, LO, OFF or Error)
2. The alarm set point (level at which the alarm activates)
3. The delay time for the alarm: the time that the set point must be exceeded prior to alarm activation and the time before resetting the alarm (prevents chatter in the relay)

These three items are described below:

Alarm Function: The alarms can either be turned OFF or programmed to operate in one of three different manners:

1. HI alarm: the relay changes state when the measured turbidity level is higher than the programmed alarm level for a prescribed amount of time.
2. LO alarm: the relay changes state when the measured turbidity level is lower than the programmed alarm level for a prescribed amount of time.
3. Error: the relay changes state when a system error occurs. If a system error occurs a message will appear on the lower row of the screen describing the problem.

Alarm Set Point: The level at which an alarm activates is called the alarm set point. On the instrument, the alarm set point is designated as "S/P". The set point is adjustable to any valid turbidity level over the range of the instrument in steps of 0.01 NTU.

Alarm Delay Time: The alarm delay times are used to prevent ringing of the alarm when the measured turbidity level is close to the set point. The function of the delay times is as follows:

Delay On: The turbidity level must exceed the alarm set point continuously for at least this number of seconds before the alarm activates.

If the delay on time is set at 5 seconds and the process turbidity exceeds the set point continuously for only 4 seconds, the alarm will not be activated. However, process turbidity exceeds the set point continuously for 5 seconds or more, the instrument will activate the alarm.

Delay Off: The turbidity level must not exceed the alarm set point continuously for at least this number of seconds prior to deactivation of the alarm.

If the delay off time is set to 5 seconds and the process has exited out of the alarm condition, the alarm will be reset only if the process is out of the alarm condition for a continuous 5 seconds. Otherwise, the instrument will still signal an alarm condition.

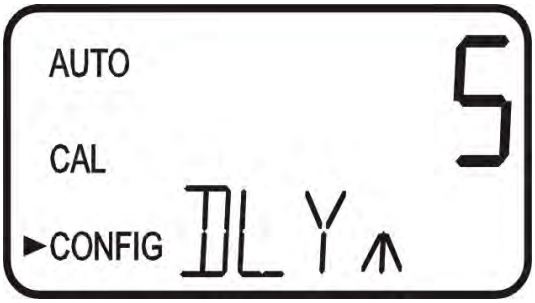
7.5.1 Alarm 1

Alarm 1 Function: The **ALM1** is displayed and the display indicates the current function of alarm 1 (**HI**, **LO**, **OFF** or **Error**). Use the ▲ or ▼ buttons to cycle through and select the desired function. Press the ↵ button to accept the selection.

If the alarm was turned **OFF** a prompt will appear to set up alarm 2 (go to section 7.5.2). If, on the other hand, one of the other functionalities was selected a prompt will appear to set the delay times.

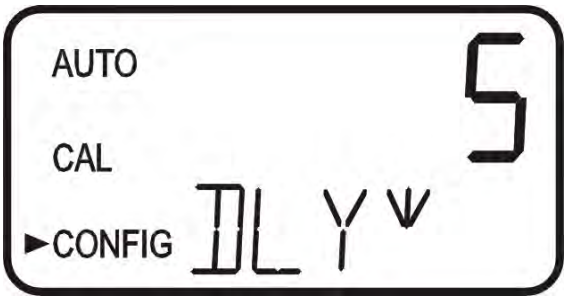
Alarm 1 Set Point: This prompt is used to select the set point for this alarm; this is indicated by "S/P" shown on the lower row of the display. Select the desired alarm level by using the ▲ and ▼ buttons. Once the desired set point has been set, press the ↵ button to accept it.

Alarm 1 Delay Times: *Delay On*: The following display will appear to allow to select the number of seconds currently set for the "delay on" time.



The current selected number of seconds will be shown. Select the desired number of seconds for the "delay on" time for this alarm using the ▲ and ▼ buttons. Once the desired delay time has been set, press the ↵ button to accept it.

Delay Off: Next, the following display will appear to select the number of seconds currently set for the "delay off" time.



The current selected number of seconds will be shown. Select the desired delay off time for this alarm using the ▲ and ▼ buttons. Once the desired delay time has been set, press the ↵ button to accept it. After the settings for alarm 1 have been completed, prompts will allow for the set up of the information on alarm #2.

7.5.2 Alarm 2

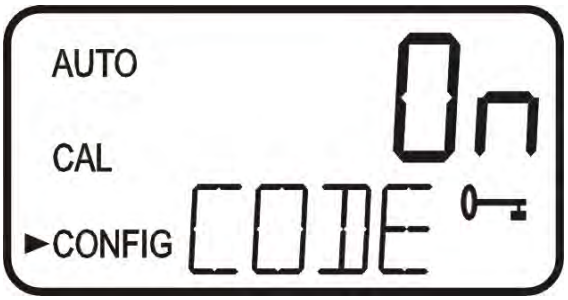
Repeat the procedure listed in section 7.5.1 to set up the parameters for alarm 2. If one of the other functionalities is selected, a prompt to set the delay times and the set point, as with Alarm #1, will be displayed.

7.6 Offset Calibration

Refer to section 6.0 for more information on this selection.

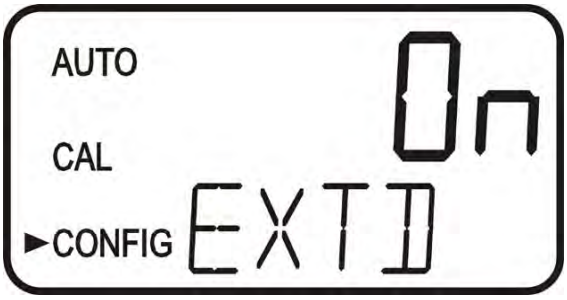
7.7 Enabling the Security Access

The instrument is equipped with a security access. If this option is turned on, the user is required to input the access code into the instrument to get to any mode other than **AUTO**. The only code is **333**. This code may not be changed. See section 4.2 for more information on this security feature. The security key icon will be visible and flashing on the display whenever the access option is selected using the ▲ or ▼ buttons. (**On** or **OFF**).



7.8 Extended Settings

The last few settings are grouped together to prevent them from being adjusted by accident. To gain access to the extended settings, select **On** using the ▲ or ▼ buttons and press the ↵ button.



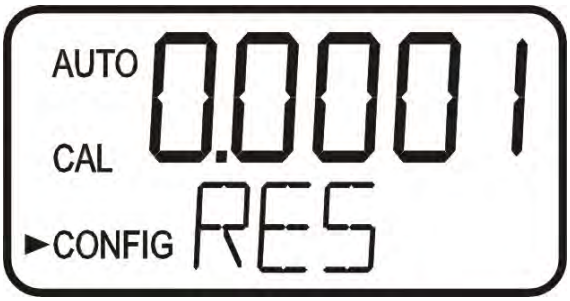
7.9 Speed of Response

The speed of response for both displayed and output values of NTU can be adjusted in this menu. The default setting is 10, however 100 response speeds are available. Although the displayed number is a relative speed, the approximate response time, in seconds, is the displayed number multiplied by 5. Select the desired speed of response using the ▲ and ▼ buttons. Press the ↵ button to accept it.

To avoid reading air and other anomalies, select the slowest speed (highest number). Select the fastest response where monitoring of rapid changes is needed.

7.10 Displayed Resolution

The instrument is equipped with the ability to display several levels of resolution. The instrument can display up to four digits to the right of the decimal place for turbidity readings below 10 NTU. The default setting is 0.01 NTU. If the last digit or two is not stable, adjust the resolution to hide these digits.



Change the resolution by pressing the ▲ or ▼ button. When the desired digit resolution has been selected, press the ↵ button.

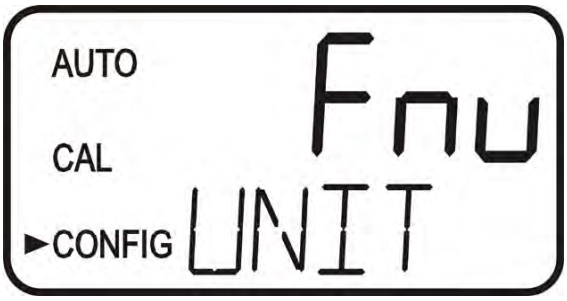
7.11 LCD Backlight Brightness

The LCD backlight brightness may need to be adjusted. This is of particular interest if multiple instruments are located in the same area and it is desired for the entire group to have the same appearance. Ten levels are available. The default brightness is 8.

Change the brightness by pressing the ▲ or ▼ button. When the desired brightness has been selected, press the ↵ button.

7.12 Setting the Units

The most common unit is **NTU** (Nephelometric Turbidity Units) however the instrument can display in **FNU** (Formazin Nephelometric Units). All instruments are shipped from the factory set in NTU mode. Make a selection using the ▲ and ▼ buttons then press the ↵ button.

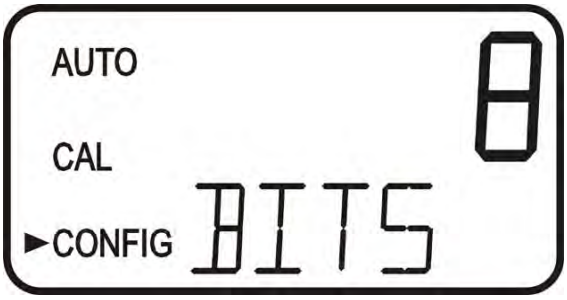


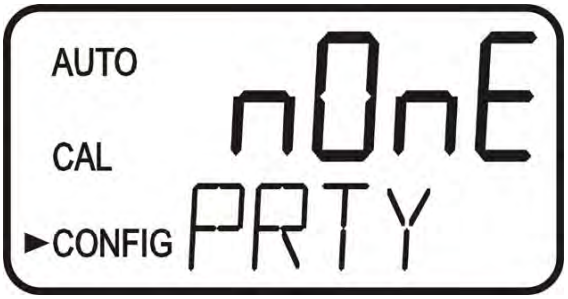
7.13 Ultrasonic Cleaning (Model 20055, 20056, 20063 & 20064)

This allows for a selection menu to turn off the ultrasonic cleaning function if desired. The default mode is On. Make a selection using the ▲ and ▼ buttons then press the ↵ button.

7.14 RS-485 Parameters

For instruments manufactured on or after June 2003, the following menus can be used to modify the RS-485 parameters. These menus will only appear if the RS-485 is enabled (see 7.1). The default is 8 Bit, no (nOnE) Parity, 1 Stop Bit. Make selections using the ▲ and ▼ buttons then press the ↵ button to move to the next menu.





7.15 Desiccant Alarm

When the humidity detector in the Micro TOL indicates that the internal environment is close to the point where humidity could cause condensation, the instrument will display **DESC** as a screen warning.

If desired, a desiccant warning can:

- Activate the alarms relays.
- Can activate an alarm condition on the 4-20mA.

To activate the alarm relays when the desiccant fails, select set one or both alarms to Error (see section 7.5 *Configuring the Alarms*).

To activate an alarm condition on the 4-20 mA set the ERLV to one of the three alarm states (see section 7.3 *Configuring the Error Level*)

For either alarm modes to activate **On** must be selected in the **DESC** menu. The default for this menu is **OFF**. Make selections using the ▲ and ▼ buttons then press the ↵ button to move to 4-20 mA calibration.

7.16 4mA Adjustment

If the 4-20 mA setting is turned ON (7.2 *Setting the 4-20 mA Output*), the following two menus will appear. The first menu outputs a constant 4 mA while allowing for a small amount of adjustment. The adjustment can be made using the ▲ and ▼ buttons. This adjustment will allow the operator to make the Micro TOL agree with a PLC or SCADA system. The adjustment limits are ± 200 counts or about ± 0.2 mA.

This setting will be slightly different on each instrument as each Micro TOL will be factory set to 4.00mA. Press the ↵ button when adjustments are complete to save this setting and move on to the 20mA adjustment.

7.17 20mA Adjustment

This menu operates similar to the previous menu. This menu outputs a constant 20 mA while allowing for a small amount of adjustment. The adjustment can be made using the ▲ and ▼ buttons. The adjustment limits are ± 1000 counts or about ± 1 mA.

This setting will be slightly different on each instrument as each Micro TOL will be factory set to 20.00mA.

7.18 Saving Configuration Settings

If extended settings are set to **OFF**, pressing the ↵ button will save all settings and the Micro TOL will automatically return to the normal **AUTO** mode of the instrument.

If extended settings are set to **On**, after the last menu of the extended settings, pressing the ↵ button will save all settings and the Micro TOL will automatically return to the normal **AUTO** mode of the instrument.

The **CONFIG** menu may be used at any time to reset or change any of the parameters. The **CONFIG** menu may be exited at any point in the menu by using the **MODE/EXIT** key. Any features that have been modified will be saved.

8.0 Additional Features and Options

8.1 Backlit LCD

The backlit LCD allows for easier readability of the LCD display in low light or no light conditions. The backlight is intended for continuous operation. The brightness is adjustable from a menu in the **CONFIG** mode.

8.2 Ultrasonic Cleaning (Models 20055, 20056, 20063 & 20064)

This factory installed option is used to continuously clean the flow through cuvette. It is not intended to clean cuvettes that are already dirty, or replace manual cleaning entirely. The system will increase the time between cleanings dramatically. Please note that the system requires the use of a special cuvette. This cuvette must be used for the system to operate correctly.

The system works by sending an ultrasonic frequency through spring connections into a piezo transducer bonded to the bottom of a flow through cuvette (refer to figure 6).

The system can detect that an incorrect cuvette is installed, an error has occurred in the transducer or the transducer is not making contact with the spring connections. This error is indicated by **CLN** being posted to the lower screen. Since this is an error condition, this may affect the 4-20 mA and alarms depending in the setting of the ERLV (4-20 mA) and if an alarm is set up to Error.

If the correct cuvette is installed, and the error is still posted, try rotating the flow through unit slightly to improve the connection. If this fails to work, the cuvette may have to be replaced (Catalog #24166S). The detection for this cuvette only operates in **AUTO** mode. If the system is operating correctly **AUTO** will flash on the display.

Hint: The connection can be improved with use of a small film of an anti-oxidant compound such as OX-GARD ™ made by GB Electrical Inc. This product is available in the electrical section at most hardware stores.

Note: The cuvette must be completely dry before it is inserted into the sensor. If there is any visible moisture present on the cuvette or transducer, there is a great risk of damaging the sensor electronics and the transducer. Be sure to clean and dry the cuvette completely just before inserting it into the sensor.

The Vapor Purge system can NOT remove large droplets of water, only residual moisture.

Note: For the Vapor Purge system to function properly, all instrument seals must be maintained and the desiccant pack must be in good condition (no DESC display).

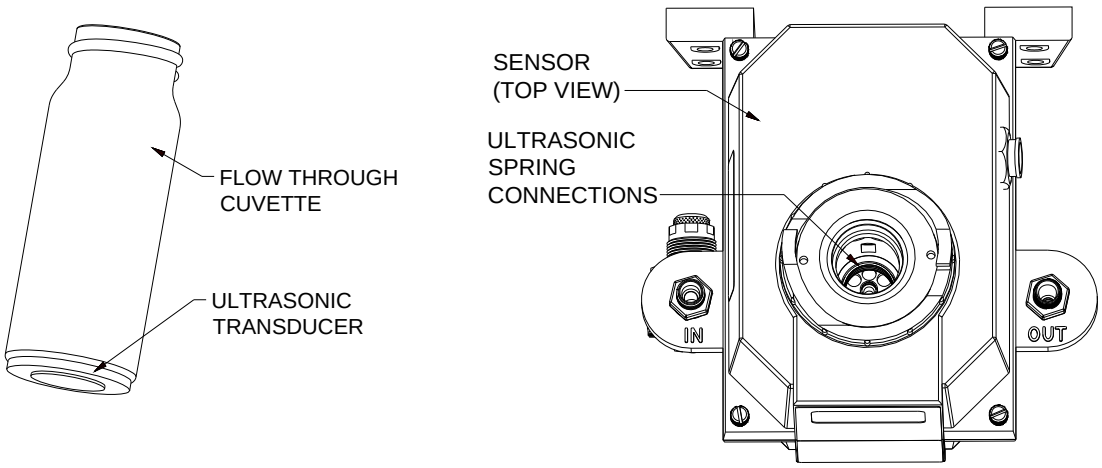


Figure 6: Operational parts of the Ultrasonic Cleaning System

8.3 RS-485 Outputs

The Micro TOL has the capability to operate in three different RS-485 modes for all models. Included is a mode for interfacing into the HF Online software package (section 8.3.1 below), and a simple communication mode. A third operating mode is the Modbus communications. All modes will automatically configure and do not require any changes or selections.

8.3.1 HF Online (HF catalog # 19783)

The Micro TOL can operate as a small SCADA system with an optional PC software package, called HF ONLINE. This system allows for an interface with up to 255 Micro TOL's for the purpose of data logging. This system will interface directly with common database and spreadsheet software.

8.3.2 Simple Communication

The Micro TOL can provide basic communications over simple programs such as the Hilgraeve HyperTerminal that is included with most Microsoft Windows packages. The user could also use Visual Basic or other programs. The default communication parameters are 8 bits, no parity and 1 stop bit. These can be changed in the Extended **CONFIG** menus 7.14 *RS-485 Parameters*.

The master computer will send out:

- Byte #1 the attention character "**:**" in ASCII or **3A** Hex
- Byte #2 the address of the Micro TOL being queried
- Byte #3 & 4 CR LF or 0D 0A in hex

The Micro TOL will respond with:

- The same attention character "**:**" in ASCII or **3A** Hex
- The address of the Micro TOL
- The Reading
- The Unit (NTU)

A sample communication would look like this:

(Master computer requesting a report from address #1) **: 1 CRLF**

(Micro TOL set to address #1 Response) **:001 0.0249 NTU**

8.3.3 Modbus Communication

Modbus protocol communication is operational on all models. The Modbus information is covered in a separate manual (Catalog # 19777). This manual is also available as a free download from our website at www.hfscientific.com.

8.4 Flow Alarm (Catalog # 19945A)

The flow switch for the Micro TOL is a factory-installed option. This option indicates a "Low Flow" condition by switching both relays to the fail state and setting the 4-20 mA signal to 2 mA. There is also a screen indication of the low flow condition and a modbus register is set.

8.5 Flow Controller (Catalog # 19778)

The flow controller limits the flow, in high-pressure systems, to safe flow limits of less than 1 liter/minute.

8.6 Remote Panel Meter (Catalog # 19609)

The remote panel meter allows for remote indication of the NTU reading using the 4-20 mA loop. No external power is required as the meter is run off of the 4-20 mA source.

9.0 Troubleshooting & Maintenance

9.1 Micro TOL Fault Detection

The Micro TOL performs continuous diagnostic monitoring. In the Micro TOL there are three levels of fault detection; warnings, errors and failures. Any faults are displayed in a queue form in the bottom row of the LCD. How these faults are indicated depends on the settings made in sections 7.3 ***Configuring the Error Level*** and 7.5 *Configuring the Alarms*. If ERLV is set to OFF and Alarms are not set to Error, there will be no remote, indication of a problem.

If the desiccant alarm is turned off and the desiccant becomes saturated only a screen **warning** of **DESC** will appear and no alarms are activated. Another **warning** of **ALM1** or **ALM2** is displayed if an alarm is set and the threshold is exceeded.

An **error** indicates a failure or a problem that usually can be corrected by the operator. These errors consist of:

- Lamp out **LAMP**.
- 4-20 mA loop open **MA**.
- Bad calibration **CAL**.
- If desiccant alarm activated and replacement required **DESC**.
- If enabled and no flow **FLOW** (if equipped with the flow switch).
- If the Micro TOL is equipped with ultrasonic cleaning, an additional message will indicate that the ultrasonic transducer is not making contact or the flow through has been removed **CLN**.

If any of these errors occur the instrument will still display readings, however the accuracy is not known and the instruments readings may not be reliable.

A **failure** is a system fault. This is NOT a problem that the operator can correct, and the unit must be returned to the factory for service. These failures consist of failures in the CPU, A/D, EEPROM or other devices internal to the instrument (**FAIL**). If a failure occurs, the instrument will not function properly and will display the word FAIL on the lower row.

If any fault conditions occur, the message indicating the fault will be shown on the lower row of the display.

9.2 System FAIL Message

Normally, this condition indicates that the instrument will require servicing. Contact either the HF scientific Technical Service Department or the HF scientific Customer Service Department.

HF scientific
3170 Metro Parkway
Fort Myers, Florida 33916-7597
Phone: (239) 337-2116
Fax: (239) 332-7643
Email:HFinfo@Watts.com
www.hfscientific.com

9.3 Diagnostic Chart

Symptom	Cause	Cure
Lower display shows **MA**	4-20 mA loop open	Check wiring. See sections 3.3.4 and 7.2
Lower display shows **DESC**	Desiccant pouch bad	Change desiccant pouch. See section 10.2
Lower display shows **LAMP**	Lamp failed	Replace lamp. Refer to section 10.3
Lower display shows **FLOW**	Sample flow has stopped	Restore flow. Contact HF about factory installed option
Lower display shows **FAIL**	Major system fault	Refer to section 9.1 & 9.2
Readings are higher than expected	**(1)** Bubbles in solution **(2)** Condensate or leaky cuvette **(3)** Flow through cuvette dirty Instrument out of calibration	**(1)**Ensure that the drain vent is open and is not obstructed. See section 3.2.2. **(2)**Apply backpressure. See section 3.2 and figure 4 **(3)** For sever cases of bubbles a stilling chamber is available. Call HF scientific. Part# 20106 Check flow through cuvette for condensate or leaks. Clean cuvette. See section 10.1 Recalibrate. Refer to section 5
Readings are erratic	**(1)** Bubbles in solution **(2)** Debris in flow through	**(1)** See above **(2)** Clean debris from cuvette
Readings are lower than expected	Instrument out of calibration	Recalibrate. Refer to section 5
Upper display flashes	Sample Over-Range	Check sample. Sample may be too high to read.

9.4 Technical and Customer Assistance

If for any reason assistance is needed regarding this instrument please do not hesitate to contact either the HF scientific Technical Service Department or the HF scientific Customer Service Department:

HF scientific
3170 Metro Parkway
Fort Myers, Florida 33916-7597
Phone: (239) 337-2116 Fax: (239) 332-7643
Email: HFinfo@Watts.com
www.hfscientific.com

10.0 Routine Maintenance

10.1 Cleaning the Flow Through Cuvette

Measurement cuvettes used for both grab sample and the flow through should be clean and free of marks or scratches. Cleaning is accomplished by cleaning the interior and exterior with a detergent solution and then rinsing several times with distilled or de-ionized water. The cuvette can be replaced by first shutting off the flow using the provided shutoff clamp; unscrewing the old cuvette and replacing with a fresh clean one.

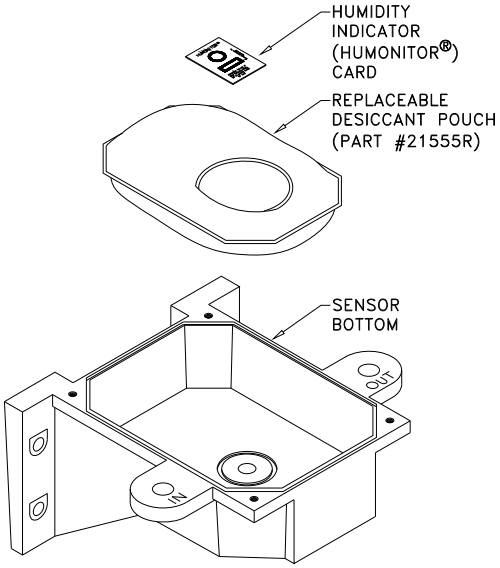
10.2 Replacing or Installing the Desiccant Pouch

The Micro TOL continuously checks the condition of the desiccant. When the desiccant gets in such a condition that it may cause problems, the instrument will display **DESC** on the lower portion of the display to indicate the presence of humidity. See 7.15 *Desiccant Alarm*.

Proper use of the supplied desiccant is essential in maintaining the performance of the instrument. The desiccant has been designed to have a long life; however, replacement of the desiccant pouch will be required from time to time.

It is essential that the enclosure seal on the instrument base be maintained to ensure adequate desiccant life. Inspect the seal each time the desiccant pouch is replaced. Replace or reseat the seal if it is found to be defective.

The desiccant should be replaced when the instrument displays **DESC**. A new sealed desiccant pouch and indicator card are available from HF scientific part #21555R.To initially install or remove the old desiccant, simply unscrew the four corner thumbscrews and remove the electronics half of the instrument. Open the bag protecting the new desiccant pouch and replace (or install for a new instrument) in the instrument base assembly. To speed up the recognition, by the instrument, of the new desiccant it will be necessary to reset the instrument by disconnecting the sensor interconnect cable for 2 seconds and then reconnecting it.



Note: Once the bag is opened, install the desiccant pouch immediately to prevent premature degradation of the desiccant.

10.3 Replacing the Source Lamp

The source lamps in the Micro TOL's are designed for long life. The IR lamp is rated for 10 years and the white light version is rated for 7 years. If the lamp should need replacement, we recommend calling HF Service Department for assistance.

11.0 Accessories and Replacement Parts List

The items shown below are recommended accessories and replacement parts.

Accessory	Catalog Number	
	White Light	**Infrared**
Electronic Service Module For Micro TOL 2	02053	02054
Electronic Service Module For Micro TOL 3	02055	02056
Electronic Service Module For Micro TOL 4	02063	02064
Operating Manual, Micro TOL	24034	
PRIMELIME Calibration Kit, .02, 10 & 100 NTU	29953	
PRIMELIME Calibration Kit, Full Range, .02, 10 & 1000 NTU	29957	
Formazin Stock Kit	50040	
Formazin Stock Solution, 4000 NTU, 500 ml	70914	
Replacement Desiccant Pouch	21555R	
Software for data collection and reporting	19783	
Flow Regulator, Micro TOL	19778	
Pressure Regulator	24306S	
Replacement Cuvette – MicroTOL 2 (3 pack)	50036	
Replacement Cuvette with Ultrasonic Transducer	24166S	
Tubing Kit Containing: 1-shutoff clamp, 1-backpressure valve, 2-connecting tubing with fittings for flow through assembly, drain vent.	21062	

To order any accessory or replacement part, please contact the HF scientific Customer Service Department. If for any reason technical assistance is needed regarding this instrument please do not hesitate to contact the HF Technical Services Department.

HF scientific
3170 Metro Parkway
Fort Myers, Florida 33916-7597
Phone: (239) 337-2116
Fax: (239) 332-7643
Email: HFinfo@Watts.com
www.hfscientific.com

12.0 Warranty

HF scientific inc., as vendor, warrants to the original purchaser of this instrument that it will be free of defects in material and workmanship, in normal use and service, for a period of one year from date of delivery to the original purchaser. HF scientific inc.'s obligation under this warranty is limited to replacing, at its factory, the instrument or any part thereof. Parts, which by their nature are normally required to be replaced periodically, consistent with normal maintenance, specifically reagent, desiccant, sensors, electrodes and fuses are excluded. Also excluded are accessories and supply type items.

Original purchaser is responsible for return of the instruments, or parts thereof, to HF scientific' inc.'s factory. This includes all freight charges incurred in shipping to and from HF scientific inc.'s factory.

HF scientific inc .is not responsible for damage to the instrument, or parts thereof, resulting from misuse, environmental corrosion, negligence or accident, or defects resulting from repairs, alterations or installation made by any person or company not authorized by HF scientific inc.

HF scientific inc. assumes no liability for consequential damage of any kind, and the original purchaser, by placement of any order for the instrument, or parts thereof, shall be deemed liable for any and all damages incurred by the use or misuse of the instruments, or parts thereof, by the purchaser, its employees, or others, following receipt thereof.

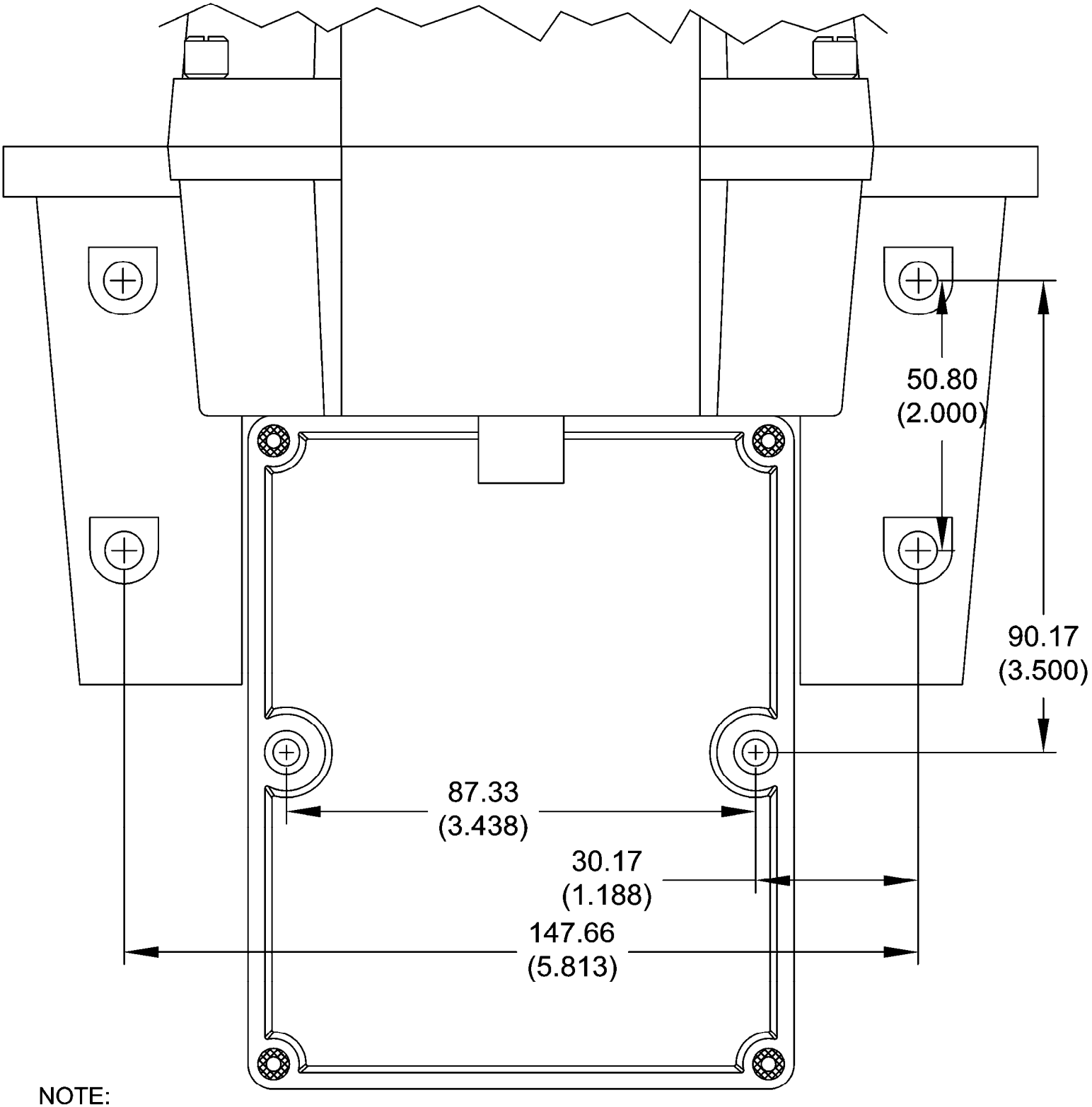
Carefully inspect this product for shipping damage, if damaged, immediately notify the shipping company and arrange an on-site inspection. HF scientific inc cannot be responsible for damage in shipment and cannot assist with claims without an on-site inspection of the damage.

This warranty is given expressly and in lieu of all other warranties, expressed or implied. Purchaser agrees that there is no warranty on merchantability and that there are no other warranties, expressed or implied. No agent is authorized to assume for HF scientific inc., any liability except as set forth above.

HF scientific, inc.
3170 Metro Parkway
Fort Myers, Florida 33916-7597
Phone: (239) 337-2116
Fax: (239) 332-7643
Email: HFinfo@Watts.com
Website:www.hfscientific.com

MOUNTING TEMPLATE

ALL DIMENSIONS ARE IN MILLIMETERS (INCHES)



NOTE:

1) SEE THE MOUNTING INSTRUCTIONS IN THE MANUAL FOR MOUNTING HARDWARE SIZES.

2) PROVIDE AT LEAST 200 MM (8 INCHES) OF FREE SPACE ABOVE THE SENSOR FOR EASY REMOVAL OF THE FLOW HEAD AND INSERTION OF THE CALIBRATION STANDARDS.

REV 16-MAR-07

APPENDIX D: HANDHELD TURBIDIMETER MANUAL

CAT. NO. 46500-88

PORTABLE TURBIDIMETER

Model 2100P

Instrument and Procedure Manual

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CERTIFICATION

Hach Company certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory.

The Model 2100P Portable Turbidimeter has been tested and is certified as indicated to the following instrumentation standards:

Product Safety

Battery/Eliminator Power Supply Only:
120 Vac, 60 Hz, UL Listed & CSA Certified, Class 2
230 Vac, 50 Hz, VDE Approved, GS & CE marked

Immunity

2100P Turbidimeter Tested with external Battery/Eliminator Power Supply:
EN 50082-1 (European Generic Immunity Standard) **per 89/336/EEC EMC:** Supporting test records with Dash Straus and Goodhue, Inc. (now Intertek Testing Services), certified compliance by Hach Company.

Standards include:
IEC 801-2 Electro-Static Discharge
IEC 801-3 Radiated RF Electro-Magnetic Fields
IEC 801-4 Electrical Fast Transients/Burst

Emissions

2100P Turbidimeter Tested with external Battery/Eliminator Power Supply:
EN 50081-1 (Emissions) **per 89/336/EEC EMC:** Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company

Standards include:
EN 55022 (CISPR 22) Emissions, Class B Limits

Canadian Radio Interference-Causing Regulation, Chapter 1374, Class A: Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

FCC Part 15, Class "A" Limits: Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. this device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area may cause harmful interference in which case the user will be required to correct the interference at his own expense.

The following techniques of reducing interference problems are applied easily:

1. Disconnect the battery eliminator from it's power source and from the 2100P Portable Turbidimeter to verify if it is the source of the interference
2. If the battery eliminator for the 2100P Portable Turbidimeter is plugged into the same outlet as the device with which it is interfering, try another outlet.
3. Move the 2100P Portable Turbidimeter away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

SAFETY PRECAUTIONS

Please read this entire manual before unpacking, setting up, or operating this instrument. Pay particular attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that which is specified in this manual.

Use of Hazard Information

If multiple hazards exist, this manual will use the signal word (Danger, Caution, Note) corresponding to the greatest hazard.

DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTE
Information that requires special emphasis.

Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

⚠ This symbol, if noted on the instrument, references the instruction manual for operational and/or safety information.

SPECIFICATIONS

Specifications subject to change without notice.
Operating specifications applicable at 25 °C unless noted.
Program software copyrighted by Hach Company, 1991.

Measurement Method: Ratio Nephelometric signal (90°) scatter light ratio to transmitted light

Range: 0-1000 NTU with automatic decimal point placement or manual range selection of 0-9.99, 0-99.9 and 0-1000 NTU

Accuracy: ± 2% of reading plus stray light from 0-1000 NTU

Resolution: 0.01 NTU on lowest range

Repeatability: ±1% of reading or 0.01 NTU, whichever is greater (with Gelex standards)

Response Time: 6 seconds for full step change without signal averaging in constant reading mode

Stray Light: <0.02 NTU

Standardization: StablCal® Stabilized Formazin primary standards or Formazin primary standards

Secondary Standards: Gelex® Secondary Standards

Display: Four-digit liquid crystal; 10.16 mm (0.4 in) high digits with custom icons

Light Source: Tungsten filament lamp; lamp life typically greater than 100,000 readings

Detectors: Silicon photovoltaic

Signal Averaging: Operator selectable on or off

Sample Cells: (Height X width) 60.0 X 25 mm (2.36 X 1 in) Borosilicate glass with screw caps, marking band and fill line

Sample Required: 15 mL (0.5 oz.)

Storage Temperature: -40 to 60 °C (-40 to 140 °F) (instrument only)

Operating Temperature: 0 to 50 °C (32 to 122 °F) (instrument only)

Operating Humidity Range: 0 to 90% RH noncondensing at 30 °C;
0 to 80% RH noncondensing at 40 °C;
0 to 70% RH noncondensing at 50 °C

Power Requirements: Four AA Alkaline cells or optional battery eliminator

Battery Life: Typically 300 tests with signal average mode off;
180 tests with signal average mode on

Battery Eliminator (optional):

For 120 V eliminator: CSA and UL approved for 120 VAC ±10%, 60 Hz, 6 V at 800 mA DC output

For 230 V eliminator: CE (VDE) approval pending for 230 VAC ±10%, 50 Hz, 6 V at 900 mA DC output

Enclosure: High impact ABS plastic

Dimensions: 22.2 X 9.5 X 7.9 cm (8.75 X 3.75 X 3.12 in)

Instrument Weight: 520 kg (1 lb 2.5 oz)

Shipping Weight: 3.1 kg (6 lbs 8.5 oz)

OPERATION

DANGER

Handling chemical samples, standards, and reagents can be dangerous. Review the necessary Material Safety Data Sheets and become familiar with all safety procedures before handling any chemicals.

DANGER

La manipulation des échantillons chimiques, étalons et réactifs peut être dangereuse. Lire les Fiches de Données de Sécurité des Produits (FDSP) et se familiariser avec toutes les procédures de sécurité avant de manipuler tous les produits chimiques.

PELIGRO

La manipulación de muestras químicas, estándares y reactivos puede ser peligrosa. Revise las fichas de seguridad de materiales y familiarícese con los procedimientos de seguridad antes de manipular productos químicos.

GEFAHR

Das Arbeiten mit chemischen Proben, Standards und Reagenzien ist mit Gefahren verbunden. Es wird dem Benutzer dieser Produkte empfohlen, sich vor der Arbeit mit sicheren Verfahrensweisen und dem richtigen Gebrauch der Chemikalien vertraut zu machen und alle entsprechenden Materialsicherheitsdatenblätter aufmerksam zu lesen.

PERIGO

A manipulação de amostras, padrões e reagentes químicos pode ser perigosa. Reveja a folha dos dados de segurança do material e familiarize-se com todos os procedimentos de segurança antes de manipular quaisquer produtos químicos.

PERICOLO

La manipolazione di campioni, standard e reattivi chimici può essere pericolosa. La preghiamo di prendere conoscenza delle Schede Techniche necessarie legate alla Sicurezza dei Materiali e di abituarsi con tutte le procedure di sicurezza prima di manipolare ogni prodotto chimico.

SECTION 1 DESCRIPTION

1.1 General Description

The Hach Model 2100P Portable Turbidimeter (*Figure 1*) measures turbidity from 0.01 to 1000 NTU in automatic range mode with automatic decimal point placement. The manual range mode measures turbidity in three ranges: 0.01 to 9.99, 10 to 99.9 and 100 to 1000 NTU. Designed primarily for field use, the microprocessor-based Model 2100P has the range, accuracy, and resolution of many laboratory instruments. The instrument operates on four AA batteries or with an optional battery eliminator. Rechargeable nickel-cadmium cells may be used, but cannot be recharged in the instrument. The instrument automatically shuts off after 5.5 minutes if no keystrokes occur (does not influence operation). If this occurs, simply turn the instrument on – the 2100P will resume operation as if the power had not been interrupted. The instrument, all standard accessories, and the optional battery eliminator may be conveniently stored in the carrying case.

Figure 1 2100P Turbidimeter and Accessories

Note: *Avoid prolonged exposure to ultraviolet light and sunlight.*

Note: *Do not hold the instrument during measurements; place the instrument on a flat, steady surface.*

1.2 Accessories

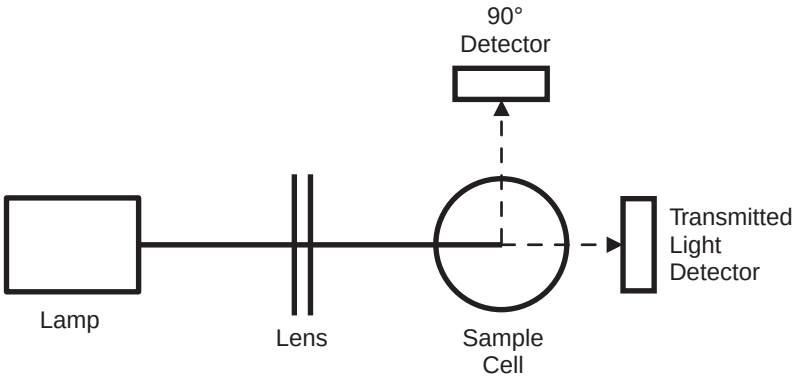
Accessories supplied with the turbidimeter include nine sample cells; three Gelex® Secondary Standards (included with 4650000 only); one sealed vial each of:
<0.1-NTU, 20-NTU, 100-NTU, and 800-NTU StablCal® Stabilized Formazin Standards; 4 AA alkaline batteries; 15 mL of silicone oil; oiling cloth; carrying case; instrument manual; and quick reference card.

1.3 Principle of Operation

The Model 2100P Portable Turbidimeter operates on the nephelometric principle of turbidity measurement. This instrument meets the design criteria specified by the United States Environmental Protection Agency, Method 180.1.

The optical system* (*Figure 2*) includes a tungsten-filament lamp, a 90° detector to monitor scattered light and a transmitted light detector. The instrument's microprocessor calculates the ratio of the signals from the 90° and transmitted light detectors. This ratio technique corrects for interferences from color and/or light absorbing materials (such as activated carbon) and compensates for fluctuations in lamp intensity, providing long-term calibration stability. The optical design also minimizes stray light, increasing measurement accuracy.

Figure 2 Ratio Optical System



* Patent number 4,198,161; other patents pending.

1.4 Preparation for Use

1.4.1 Unpacking

Remove the instrument and accessories from the shipping box and inspect them for damage that may have occurred due to rough handling or extreme weather conditions. Verify the following are present:

- Model 2100P Portable Turbidimeter
- Instrument Manual (with quick reference card)
- Set of StablCal Primary Standards in sealed vials, one each of:
  <0.1 NTU*
  20 NTU
  100 NTU
  800 NTU
- Standardization Kit containing Gelex Secondary Standards (0-10, 0-100 and 0-1000 ranges) (included with 4650000 only) plus nine sample cells with caps.
- Silicone Oil, 15-mL (0.5 oz) dropping bottle
- Oiling Cloth
- Carrying Case
- Four AA alkaline batteries

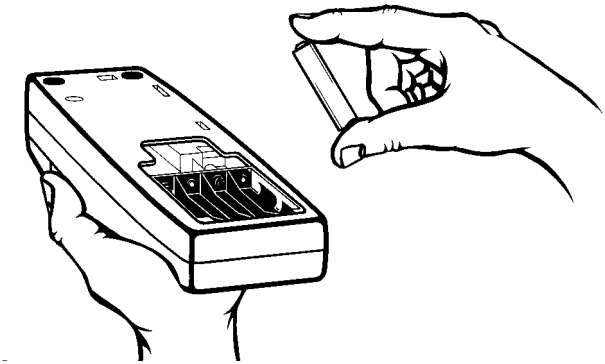
If any of the items are missing or damaged, please contact the Customer Service Department, Hach Company, Loveland, Colorado. The toll-free number in the United States is 800-227-4224. International customers should contact the Hach office or authorized distributor serving your area. Refer to *REPAIR SERVICE* on page *77*. **Please do not return the instrument without prior authorization from Hach.**

* Used in place of the dilution water standard when performing a calibration.

1.4.2 Battery Installation

The instrument is shipped completely assembled without the batteries installed. Before use, install the four AA alkaline batteries or connect the battery eliminator (*Figure 3*). For battery operation, remove the battery compartment cover on the instrument bottom and install the batteries. Correct battery polarity is shown on the battery holder. The instrument will not function if the batteries are not installed correctly. Reinstall the battery compartment cover.

Figure 3 Battery Installation



1.4.3 Using the Battery Eliminator and Rechargeable Batteries

For operation with the optional battery eliminator, plug the eliminator jack into the connector on the turbidimeter side. The battery eliminator may be used with or without the batteries installed. **The eliminator will not charge batteries.** Rechargeable batteries may be used in the instrument, but must be removed for recharging. See *HOW TO ORDER* on page *76* for ordering information. To prolong battery life, the instrument lamp turns on temporarily when the **READ** key is depressed. Batteries are not necessary for battery eliminator operation.

1.4.4 Calibration

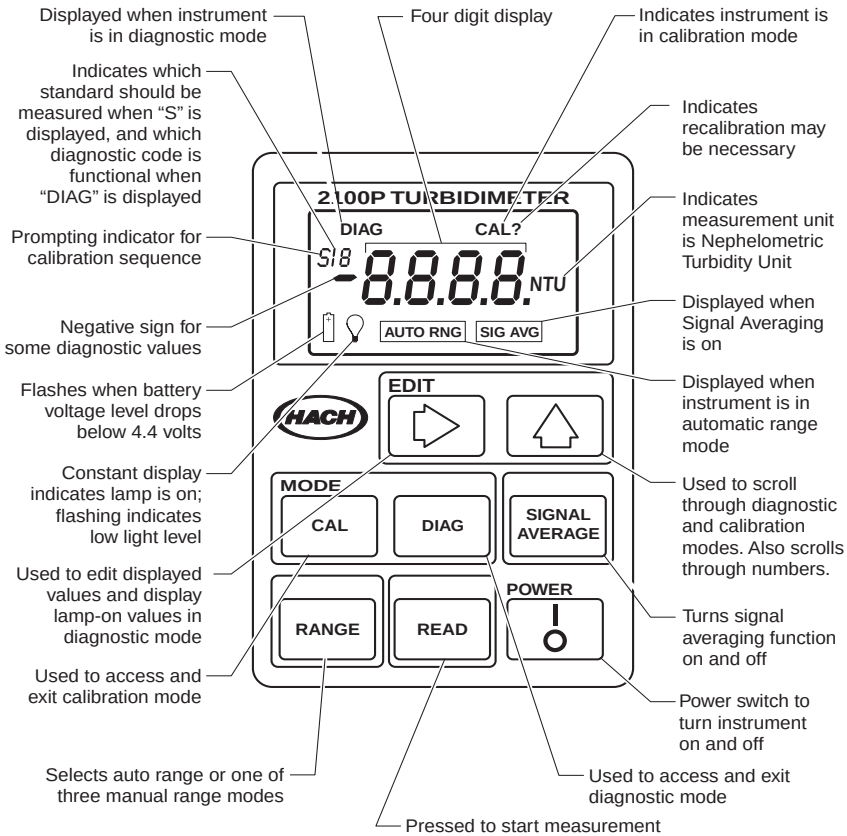
The 2100P Portable Turbidimeter is calibrated with Formazin Primary Standard at the factory**.** However, the instrument should be calibrated upon receipt for best results. Hach recommends recalibration with

formazin once every three months, or more often as experience dictates. The Gelex Secondary Standards supplied with the instrument (included with 4650000 only) are labelled with general ranges for application, but must be assigned values before use from formazin calibration. See *Section 3.6* on page *37* for calibration instructions.

2.1 Operating Controls and Indicators

Figure 4 shows the 2100P controls and indicators. Refer to *SECTION 3* for a detailed description of each control and indicator.

Figure 4 Keyboard and Display with Descriptions



2.2 Turbidity Measurement

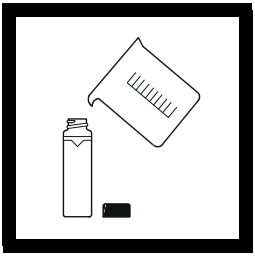
Measurements may be made with the signal average mode on or off and in manual or automatic range selection mode. Using automatic range selection is recommended. Signal averaging uses more power and should be used only when the sample causes an unstable reading. Signal averaging measures and averages ten measurements while displaying

intermediate results. The initial value is displayed after about 11 seconds and the display is updated every 1.2 seconds until all ten measurements are taken (about 20 seconds). After this, the lamp turns off, but the final measured turbidity value continues to be displayed until another key is pressed.

When not in signal average mode, the final value is displayed after about 13 seconds.

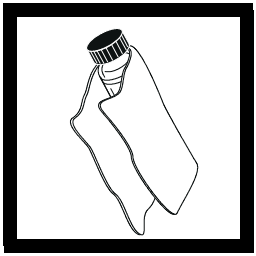
Accurate turbidity measurement depends on good measurement technique by the analyst, such as using clean sample cells in good condition and removing air bubbles (degassing). Refer to *Section 2.3* on page *22* for a detailed discussion of measurement techniques.

2.2.1 Turbidity Measurement Procedure

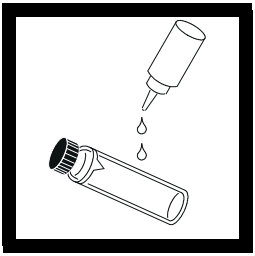


1. Collect a representative sample in a clean container. Fill a sample cell to the line (about 15 mL), taking care to handle the sample cell by the top. Cap the cell. (See *Section 2.3* on page *22* for more information about collecting a representative sample).

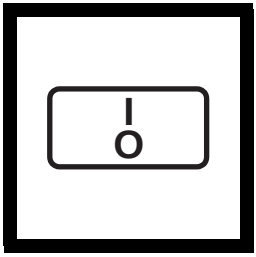
Note: *The instrument automatically shuts off after 5.5 minutes if no keystrokes occur. To resume operation, press* **I/O**.



2. Wipe the cell with a soft, lint-free cloth to remove water spots and fingerprints.

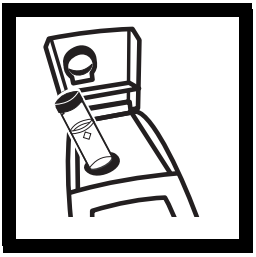


3. Apply a thin film of silicone oil. Wipe with a soft cloth to obtain an even film over the entire surface.



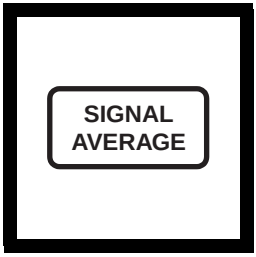
4. Press: **I/O**.

The instrument will turn on. Place the instrument on a flat, sturdy surface. Do not hold the instrument while making measurements.

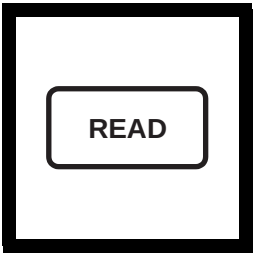


5. Insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment.
Close the lid.

6. Select manual or automatic range selection by pressing the **RANGE** key. The display will show **AUTO RNG** when the instrument is in automatic range selection.



7. Select signal averaging mode by pressing the **SIGNAL AVERAGE** key. The display will show **SIG AVG** when the instrument is using signal averaging. Use signal average mode if the sample causes a noisy signal (display changes constantly).



8. Press: **READ**

The display will show **- - - - NTU**, then the turbidity in NTU. Record the turbidity after the lamp symbol turns off.

Note: *The instrument defaults to the last operating mode selected. If automatic range mode and signal averaging were used on the previous measurements, these options will automatically be selected for subsequent samples.*

2.2.2 Measurement Notes

- Always cap the sample cell to prevent spillage of sample into the instrument.
- When taking a reading, place the instrument on a level, stationary surface. It should not be held in the hand during measurement.
- Always close the sample compartment lid during measurement and storage.
- Always use clean sample cells in good condition. Dirty, scratched, or damaged cells can cause inaccurate readings.
- Do not leave a sample cell in the cell compartment for extended periods of time. This may compress the spring in the cell holder.
- Remove sample cell and batteries from instrument if the instrument is stored for extended time period (more than a month).
- Avoid operating in direct sunlight.
- Make certain cold samples do not “fog” the sample cell.
- Avoid settling of sample prior to measurement.
- Keep sample compartment lid closed to prevent dust and dirt from entering.

2.3 Measurement Techniques

Proper measurement techniques are important in minimizing the effects of instrument variation, stray light and air bubbles. Regardless of the instrument used, measurements are more accurate, precise and repeatable if the analyst pays close attention to proper measurement techniques.

Measure samples immediately to prevent temperature changes and settling. Avoid sample dilution when possible. Particles suspended in the original sample may dissolve or otherwise change characteristics when the sample temperature changes or when the sample is diluted, resulting in a non-representative sample measurement.

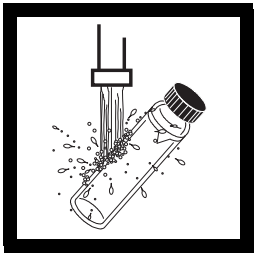
2.3.1 Cleaning Sample Cells

Cells must be extremely clean and free from significant scratches. The glass used to make cells is easily scratched – manufacturing cells free of minor scratches and other imperfections is difficult. However, minor imperfections are effectively masked by applying silicone oil as outlined in *Section 2.3.2*.

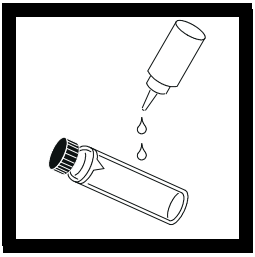
Clean the inside and outside of the cells by washing with laboratory detergent. Follow with multiple rinses of distilled or deionized water. Allow cells to air dry. Handle cells only by the top to minimize dirt, scratches and fingerprints in the light path.

2.3.2 Oiling the Sample Cell

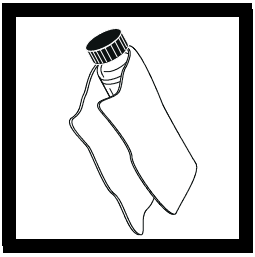
Applying a thin coat of silicone oil will mask minor imperfections and scratches which may contribute to turbidity or stray light. Use silicone oil equivalent to Hach Cat. No. 1269-36. This silicone oil has the same refractive index as glass. When applied in a thin, uniform coat, the oil fills in and masks minor scratches and other imperfections in the glass. Apply the oil uniformly by wiping with a soft, lint-free cloth.
Avoid application of excess oil. Applying excess oil may retain dirt and contaminate the instrument's cell compartment.



1. Thoroughly clean the sample cell.



2. Apply a small bead of silicone oil from the top to the bottom of the cell-- just enough to coat the cell with a thin layer of oil.



3. Using a soft, lint-free cloth, spread the oil uniformly, then wipe off the excess so that only a thin coat of oil is left. The cell should appear nearly dry with little or no visible oil.

Note: *Soft, lint-free cloth (velvet) works well for oiling. Store the oiling cloth with the sample cells and keep it free of dirt. After a few applications of oil, the cloth will contain enough residual oil that simply wiping the cell with the oiled cloth will provide a sufficient oil coat on the sample cell. Periodically, add a small amount of oil to the sample cell surface to replenish the oil in the cloth.*

Note: *Only a thin coat of oil on the sample cells is necessary.* ***Avoid using excessive amounts of oil.***

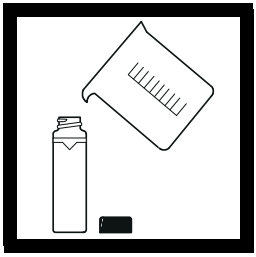
2.3.3 Orienting Sample Cells

Note: *When orienting and matching cells, it may be more efficient to use the continuous reading mode. The instrument performs continuous readings if the* **READ** *key is pressed and held. As long as the key is held, the lamp remains on and the display is updated every 1.2 seconds. The instrument cannot be used in continuous read mode if the Signal Averaging mode is on.*

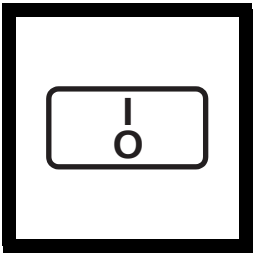
Precise measurements for very low turbidity samples require using a single cell for all measurements or optically matching the cells. Using one cell provides the best precision and repeatability. When one cell is used, an orientation mark (other than the factory-placed diamond) can be placed on the cell so it's inserted into the instrument with the same orientation each time.

2.3.3.1 Orienting a single cell

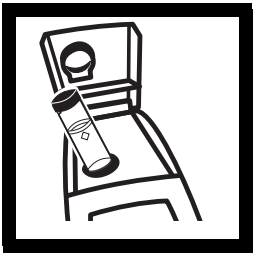
When using a single cell, make an index or orientation mark on the cell as follows:



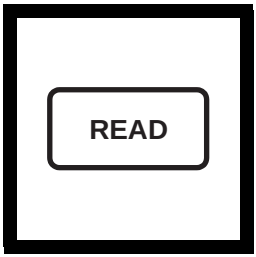
1. Fill the clean sample cell to the line with high quality water (< 0.5 NTU). Cap and wipe with lint-free cloth. Apply silicone oil. See *Section 3.6.2.2* on page *40* for more information about high quality water.



2. Press: **I/O** to turn the instrument on.



3. Insert the sample cell into the sample compartment. Close the cover.



4. Press: **READ**

Record the cell's position in the cell compartment and the displayed reading.

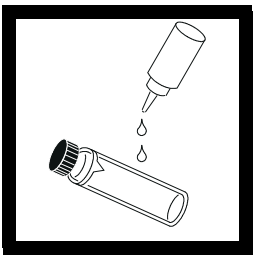
Note: *This procedure may be easier if the user holds the* **READ** *key through the whole process. This allows the lamp to remain on and make continuous readings.*

5. Remove the cell, rotate it slightly and reinsert it into the cell compartment. Close the cover, then press **READ**. Record the cell's position and the displayed reading.

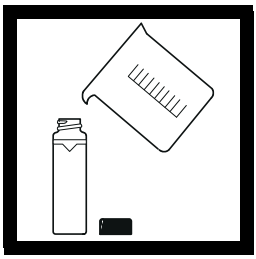
6. Repeat *step 5* until the lowest reading is displayed. Place an orientation mark on the cell's marking band near the top of the cell so the cell can be consistently inserted in the position that yields the lowest reading. When using the cell, always place it in the instrument so the orientation mark aligns with the raised mark on the instrument.

2.3.4 Matching multiple sample cells

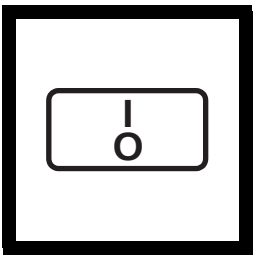
Precise measurements of very low turbidity samples require the cells be optically matched or a single cell be used for all measurements. If more than one cell is used, follow this procedure to match (index) the cells:



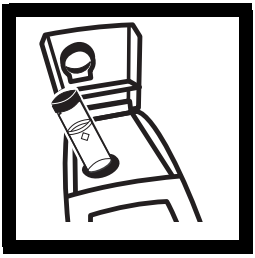
1. Clean and oil the sample cells as instructed in *Section 2.3.1* on page *23* and *Section 2.3.2* on page *23*.



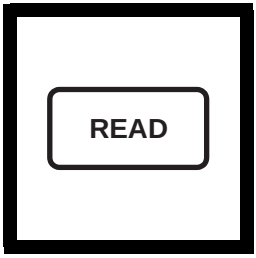
2. Fill the clean sample cells to the line with the same sample.



3. Press: **I/O** to turn the instrument on.



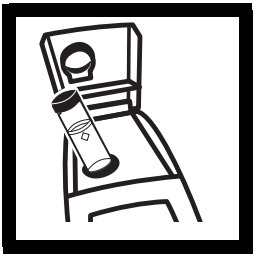
4. Insert the **first** sample cell into the sample compartment and close the cover.



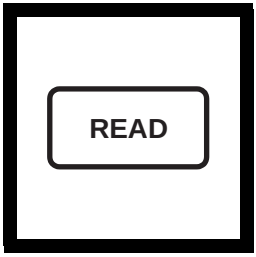
5. Press: **READ**

Record the cell's position in the cell compartment and the displayed reading. Place an orientation mark on the cell's marking band.

Note: *This procedure may be easier if the user holds the* **READ** *key through the whole process. This allows the lamp to remain on and make continuous readings.*



6. Insert the **second** sample cell into the cell compartment and close the cover.



7. Press: **READ**

Record the cell's position in the cell compartment and the displayed reading.

8. Remove the cell, rotate it slightly and reinsert into the cell compartment. Close the cover, then press **READ** again. Record the cell's position and the displayed reading.

9. Repeat *step 8* until the value displayed for the second cell is within 0.01 NTU (or 1%) of the value obtained for the first cell. Place an orientation mark on the second cell's marking band so it is consistently inserted in this position.

Note: *Due to variability in glass, it may not be possible to match all cells.*

10. Repeat *step 6* through *step 9* if matching other sample cells.

2.3.5 Removing Bubbles (Degassing)

Before measurement, removing air and other trapped gasses from the sample is strongly recommended, even if bubbles are not visible. Four degassing methods are commonly used:

1. applying a partial vacuum
2. adding a surfactant
3. using an ultrasonic bath
4. heating the sample

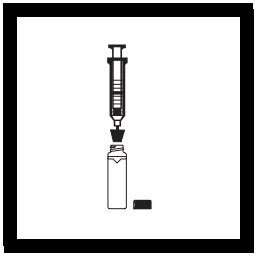
In some cases, more than one method may be necessary for effective bubble removal. For example, use of both a surfactant and ultrasonic bath may be necessary for some severe conditions. Use care with these techniques. If misused, sample turbidity can be altered.

Removing air bubbles by letting the sample stand for a period of time is not recommended. Particulates that cause turbidity may settle and the sample temperature may change. Both conditions may alter sample turbidity, resulting in measurements not representative of the original turbidity.

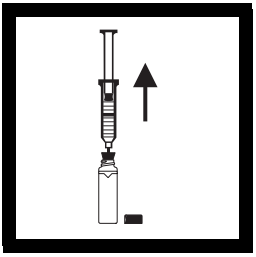
2.3.5.1 Application of vacuum

Apply a vacuum with any convenient, clean, oil-free vacuum source. The vacuum lowers the atmospheric pressure, allowing trapped bubbles to escape into the air above the sample. Vacuum works well with non-viscous samples (such as water) that don’t contain volatile components. Applying vacuum to viscous, volatile-containing samples (paint resins) may cause the volatile components to come out of solution and aggravate the bubble problem.

To apply a vacuum, use a sample degassing kit equivalent to Cat No. 43975-00 (Degassing Kit) or 43975-10 (Degassing and Filtration Kit). These kits contain a syringe and rubber stopper for vacuum degassing. An electric or hand-operated pump equivalent to Cat No. 14283-00 or 14697-00, respectively, may also be used.



1. Fill a sample cell to the mark with sample. Insert a #2 single-hole rubber stopper and syringe into the cell. If using a pump, insert a piece of glass tubing into the stopper.



2. **Slowly** apply the vacuum by carefully pulling the plunger upward, then holding it. If using a hand or electric pump, connect the tubing to the vacuum pump with vacuum hose. Apply vacuum until visible gas bubbles disappear. **Slowly** release the vacuum. Remove the vacuum apparatus and cap the cell.

2.3.5.2 Adding a surfactant

Surfactants should be limited to severe problems when other degassing methods are ineffective. Surfactants change the surface tension of the water, which releases trapped gases. Hach recommends a surfactant such as Triton X-100 or the equivalent, Hach Cat No. 14096-37. Put one drop of Triton X-100 in the sample cell before adding sample.

Note: *Any turbidity contributed by surfactant addition is negligible.*

This technique is very effective when the water is super-saturated with air. However, changing the surface tension may accelerate settling of turbidity-causing particles. Mix the sample gently, but thoroughly, and analyze as soon as possible after adding the surfactant. Avoid vigorous mixing as the surfactant may foam. Rinse the sample cells thoroughly between samples to prevent surfactant accumulation.

2.3.5.3 Using an ultrasonic bath

Note: *The time necessary to expel bubbles may vary from a few seconds to a minute or more. To avoid excessive application of ultrasound, a simple procedure can be followed. First, apply ultrasound until all visible bubbles are absent. Then measure the sample turbidity. Apply ultrasound for a short time period and again measure turbidity. Continue for several repetitions, noting the treatment time and turbidity readings. If turbidity begins to increase instead of decrease, the ultrasound waves have probably started to alter the suspended particles. Note the time it takes for this to occur and record it as the maximum time limit for ultrasonic treatment.*

Ultrasonic baths effectively remove gas bubbles from most samples, especially viscous liquids. However, the ultrasonic waves which cause degassing may also alter the characteristics of the particles causing the turbidity. Turbidity depends on the size, shape, composition and refractive index of the suspended particles. Excessive ultrasound application may alter particle size and shape, thus changing sample turbidity. In some cases, ultrasound may aggravate air bubble removal by fracturing the bubbles, making degassing more difficult.

1. Fill a clean sample cell to the line with sample. Leave uncapped.

2. Immerse the cell (1/2 to 2/3 immersed) in an ultrasonic bath and allow it to stand until visible bubbles are expelled.

3. Remove the cell, cap, then thoroughly dry the cell. Apply silicone oil as directed.

2.3.5.4 Application of heat

Whenever possible, avoid using heat to degas samples because heat may change the characteristics of the suspended particles and cause volatile components to come out of solution. Gentle heating may be helpful for degassing some very viscous samples when combined with application of vacuum or ultrasound. If heat is necessary, heat the sample only until degassing occurs. The simplest technique is to prepare a warm water bath and partially immerse the filled sample cell. Use the shortest time necessary for expelling visible bubbles. Cool sample to original sample temperature before taking measurements.

2.3.6 Measuring Overrange Samples

Nephelometric turbidity measurement depends on detection of light scattered from particles suspended in the liquid. If the turbidity is very high, a significant amount of light is blocked or absorbed by the particles and only a small amount of light reaches the detector. This results in a negative interference – the measured turbidity is lower than the actual turbidity. This condition is called “going blind”. A multidetector ratioing instrument, such as the Hach 2100P Turbidimeter, minimizes this effect and extends the instrument range. Highly turbid samples may also be diluted, but this should be avoided when possible since it may alter the characteristics of the suspended particles and produce erroneous results.

Light absorbing particles such as activated carbon and highly colored samples may also cause an instrument to “go blind”. Dilution may not correct for these interferences. A ratioing instrument will correct for the presence of light absorbing particles and color.

2.3.7 Condensation (fogging)

Condensation may occur on the outside of the sample cell when measuring a cold sample in a warm, humid environment. Condensation interferes with turbidity measurement, so all moisture must be thoroughly wiped off the sample cell before measurement. If fogging recurs, let the sample warm slightly by standing at room temperature or immersing it in a warm bath for a short period. After warming, mix the sample thoroughly before measurement. Allowing samples to warm can alter sample turbidity, so it is best to avoid warming samples before measurement when possible.

2.3.8 Calibration

Turbidimeters must be properly calibrated with a primary standard. Hach recommends formazin or StablCal Stabilized Formazin for calibration. For U.S. Environmental Protection Agency (USEPA) reporting, calibrate at least as often as required by the appropriate regulatory agencies. The frequency of calibration depends on environmental conditions (humidity, temperature) and use. If necessary, calibrate more frequently.

Use secondary standards for periodic calibration checks. Please note that Gelex® standards must be assigned values after StablCal Stabilized Formazin calibration or formazin calibration and before use as secondary standards. Gelex standards must be recalibrated (values assigned) each time the instrument is calibrated with StablCal Stabilized Formazin or formazin. See *Section 3.6* on page *37* for detailed information on the use of StablCal Stabilized Formazin, formazin, and Gelex standards.

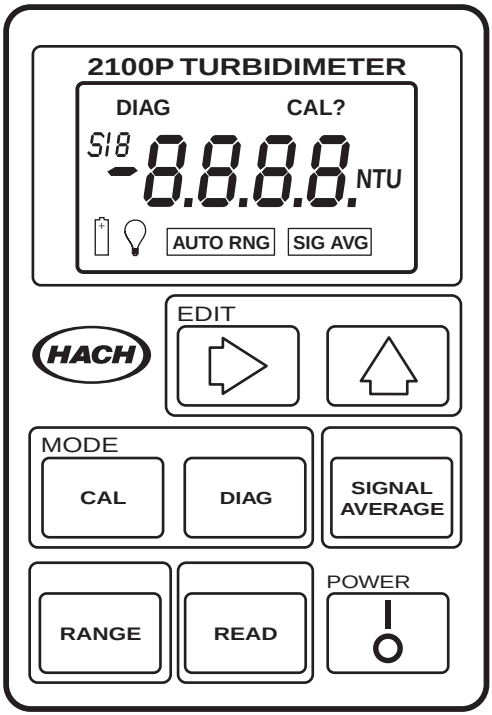
2.3.9 Representative Sampling

A representative sample accurately reflects the true condition of the water source from which the sample was taken. To ensure a representative sample, gently, but thoroughly, mix every sample before aliquots are taken. Do not allow the sample to settle.

When sampling from a tap in a distribution system or treatment plant, allow the water to run for at least five minutes before sampling. When sampling from a stream, reservoir, clarifier, or storage tank, collect at least one liter (l quart) and thoroughly mix before measurement. If the water source is not uniform, it may be necessary to sample several locations at varying depths and combine the samples into a single, well-mixed composite sample before measurement.

SECTION 3 OPERATION

3.1 Operational Controls and Indicators



Key	Description
I O	Power key to turn instrument on and off. If no keys are pressed for 5.5 minutes, the instrument turns off automatically.
READ	Depressed to perform a measurement. To conserve battery power, the lamp turns on only when **READ** is depressed. A reading is displayed about 12 seconds after the key is depressed. During the delay, a flashing **NTU** is displayed. After the reading is displayed, the lamp turns off and the reading continues to be displayed. Continuous readings may be done by holding this key if **not** in the Signal Averaging mode. After the initial delay, the reading is updated every 1.2 seconds.
CAL	Used to perform a calibration or review calibration data. Also terminates a calibration or calibration review and returns to the 2100P measurement mode.

Key	Description
△	Edits a flashing digit in the calibration mode or sequences through the calibration standards (S0,S1, S2, S3) or diagnostic menu.
▷	Used to move the editing cursor to the digits being edited in the calibration mode or initiate editing of a standard value.
SIGNAL AVERAGE	Turns the signal averaging function on or off.
DIAG	Selects the diagnostic mode.
RANGE	Selects Auto Range or Manual Range (one of three manual modes).

Display Icon	Description
DIAG	Turns on after the **DIAG** is pressed to access the diagnostic mode. A number displayed under the **DIAG** icon (1-9) indicates which diagnostic function is active. See *Section 5.1* on page *67* for more information on diagnostic codes.
CAL	Turns on after the **CAL** key is pressed to access the calibration mode and remains on during the calibration.
CAL?	Appears after calibration if a value entered during calibration is outside an acceptable range. May indicate an operator error or possible instrument malfunction. Flashing **CAL?** indicates the default calibration coefficients are being used (even after a user-calibration has been done) or that no calibration data is currently stored.
S__	Displayed during calibration. The S is followed by a number to indicate which standard value is currently being edited or displayed. Flashing number is prompting user for measurement of **S0**, **S1**, **S2** or **S3** to establish a calibration. Steady number identifies which standard's value is being displayed.
+	Flashes when the battery voltage drops to 4.4 volts as an indication to change batteries. At <4.0 volts, the instrument automatically shuts off.
	The lamp symbol is constantly on when the lamp is on and flashes after a reading if a marginal light level reaches the transmitted light detector. A flashing icon indicates the sample may be too turbid (not within measurement range) and needs dilution or the lamp needs replacing.
SIGNAL AVERAGE	Indicates the signal averaging mode is on. The icon turns off if signal averaging is not selected.

Display Icon	Description
AUTO RNG	Indicates instrument is in automatic range mode. The icon turns off when manual range mode is selected.
8888	The 4-digit display is active when the instrument is on (measurements are displayed to three digits). After the **READ** key is pressed **- - - -** is displayed during wait periods.
NTU	Identifies the measurement units- Nephelometric Turbidity Units. This icon is active during measurements and in the calibration mode.

3.2 Using the Read Key

To preserve battery power and prolong lamp life, the lamp turns on only after the **READ** key is pressed. Pressing the key turns the instrument lamp on; after about 12 seconds, the lamp turns off, but the measurement value continues to be displayed. After the first measurement, a four-second recovery time occurs before another measurement can be started. If **READ** is pressed during the recovery time, the display will begin flashing, but the lamp will not turn on until the full four seconds have passed. If no other key strokes occur within 5.5 minutes, the instrument turns off.

3.2.1 Continuous Reading

The instrument cannot be used in continuous read mode if the Signal Averaging mode is on.

The instrument will perform continuous readings if the **READ** key is pressed and held. As long as the key is held, the lamp remains on and the display is updated every 1.2 seconds.

3.3 Using the Signal Averaging Key

The signal averaging mode compensates for reading fluctuations caused by drifting of sample particles through the light path. Signal averaging is turned on or off by pressing the **SIGNAL AVERAGE** key. The **SIG AVG** icon is displayed when signal averaging is on.

Signal averaging measures and averages ten measurements while displaying intermediate results. The initial value is displayed after about 11 seconds and the display is updated every 1.2 seconds until all ten measurements are taken (about 22 seconds). After 22 seconds, the lamp

turns off, but the final measured turbidity value continues to be displayed until another key is pressed.

When signal averaging is off, the instrument takes three measurements, the microprocessor averages them, then displays the average. If the **READ** key is held during measurement, the initial value is displayed in 12 seconds and is updated every 1.2 seconds as long as the **READ** key is held.

When the instrument is turned on, the instrument defaults to the signal averaging mode which was used during the last measurement.

3.4 Using the Range Selection Key

As shipped, the instrument defaults to automatic range mode. The first time the **RANGE** key is pressed, the instrument goes into manual range mode. The second, third, and fourth key strokes put the instrument in the 0.00-9.99, 10 to 99.9 or 100-1000 NTU range, respectively. Another key stroke brings the selection back to automatic range mode. When the automatic range mode is selected, the **AUTO RNG** icon is displayed. Range selection can be done any time except when a measurement or calibration is in progress.

When the instrument is turned on, the instrument defaults to the range mode and measurement range which was used during the last measurement.

3.5 Restoring the Default Calibration

To restore and use the default calibration, turn the instrument off. Press and hold **DIAG**, then press and release **I/O**. Release **DIAG** when the software version number disappears from the display. (For models with serial number less than 920300000800, **2100** disappears). This clears any user-entered calibration from memory; the 2100P will use the default calibration for measurement. **CAL?** will appear and continue to flash until a user-entered calibration is successfully completed.

For best results, a user-entered calibration should be done every three months.

3.6 Calibration

Calibration of the 2100P Turbidimeter is based on formazin, the primary standard for turbidity. The instrument's electronic and optical design provide long-term stability and minimize the need for frequent calibration. The two-detector ratioing system compensates for most fluctuations in lamp output. **A formazin recalibration should be performed at least once every three months,** more often if experience indicates the need. When calibration is necessary, use a primary standard such as StablCal™ Stabilized Standards or formazin standards.

Hach Company only recommends the use of StablCal® Stabilized Formazin or formazin standards for the calibration of Hach turbidimeters. Hach Company cannot guarantee the performance of the turbidimeter if calibrated with co-polymer styrene divinylbenzene beads or other suspensions.

Important Note: DO NOT calibrate with Gelex® Secondary Standards. Gelex standards are designed for instrument verification, not calibration.

3.6.1 StablCal Stabilized Formazin Standards*

Most consistent results will be achieved with the use of StablCal Stabilized Formazin Standards for calibration. Refer to *Section 3.6.1.2* and *Section 3.6.1.3* for information on preparing the standards for use.

Note: *Hach StablCal Stabilized Formazin in 20-, 100-, and 800-NTU values is packaged in convenient sets for calibration of the 2100P Turbidimeter. The set may be ordered in 500-mL size bottles by specifying Cat. No. 26594-00, in 100-mL size bottles by specifying Cat. No. 26594-10 or in sealed vials by ordering Cat. No. 26594-05. (See OPTIONAL ACCESSORIES AND REAGENTS on page 74.)*

3.6.1.1 Storing and Handling StablCal Stabilized Standards

For optimum results when using StablCal Stabilized Standards, adhere to the following recommendations:

* StablCal Stabilized Formazin is cited as a primary standard in Hach Method 8195, an acceptable version of USEPA Method 180.1.

- Do not transfer the standard to another container for storage.
- Do not return standard from the sample cell back into the its original container. Standard contamination will result.
- Store standards between 0 and 25 °C.
- For long-term storage, refrigeration at 5 °c is recommended. Do not store above 25 °C.
- Allow the standard to acclimate to ambient instrument conditions before use (not to exceed 40 °C).
- Store away from direct sunlight. Store vials in their respective kit or shipping box with the cover in place.

3.6.1.2 Preparing Bulk StablCal Stabilized Standards

Bulk standards that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3*.

Important Note: These instructions do not apply to <0.1-NTU* StablCal Standards; <0.1NTU StablCal Standards should not be shaken or inverted.

1. Shake the standard vigorously for 2-3 minutes to resuspend any particles.
2. Allow the standard to stand undisturbed for 5 minutes.
3. Gently invert the bottle of StablCal 5 to 7 times.
4. Prepare the sample cell for measurement using traditional preparation techniques. This usually consists of oiling the sample cell (see*Section 2.3.2* on page *23*) and marking the cell to maintain the same orientation in the sample cell compartment (see *Section 2.3.3* on page *24*). This step will eliminate any optical variations in the sample cell.

* Used in place of the dilution water standard when performing a calibration.

5. Rinse the sample cell at least one time with the standard and discard the rinse.

6. Immediately fill the sample cell with the standard. Cap the sample cell and let it stand for one minute. The standard is now ready for use in the calibration procedure, *Section 3.6.3*.

3.6.1.3 Preparing StablCal Stabilized Standards in Sealed Vials

Sealed vials that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3*

Important Note: These instructions do not apply to <0.1-NTU* StablCal Standards; <0.1NTU StablCal Standards should not be shaken or inverted.

1. Shake the standard vigorously for 2-3 minutes to resuspend any particles.

2. Allow the standard to stand undisturbed for 5 minutes.

3. Gently invert the vial of StablCal 5 to 7 times.

4. Prepare the vial for measurement using traditional preparation techniques. This usually consists of oiling the vial (see *Section 2.3.2* on page *23*) and marking the vial to maintain the same orientation in the sample cell compartment (see *Section 2.3.3* on page *24*). This step will eliminate any optical variations in the sample vial.

5. Let the vial stand for one minute. The standard is now ready for use in the calibration procedure, *Section 3.6.3*.

3.6.2 Formazin Primary Standards

Perform the procedure in *Section 3.6.2.1* to prepare a 4000-NTU standard. Alternately, order a 4000-NTU stock solution from Hach by specifying Cat. 2461-49. Prepare the dilutions from the 4000-NTU stock solution by following the instructions in *Section 3.6.2.4*.

3.6.2.1 Preparing Formazin Stock Solution

Dilute formazin standard solutions from a 4000 NTU stock solution equivalent to Hach Cat. No. 2461-49. The prepared stock solution is stable for up to one year when properly prepared. An alternative to purchasing the 4000 NTU stock solution is preparing a stock solution as follows:

1. Dissolve 5.000 grams of reagent grade hydrazine sulfate ($N_2H_4 \cdot H_2SO_4$) in 400 mL of distilled water.

2. Dissolve 50.000 grams of pure hexamethylenetetramine in 400 mL of distilled water.

3. Pour the two solutions into a 1000-mL volumetric flask and dilute to the mark with distilled water.

4. Let the solution stand for 48 hours at 25 °C (77 °F) to develop the 4000-NTU stock suspension. The standing temperature is critical for correct formation of formazin polymers.

5. Mix the 4000 NTU suspension for at least ten minutes before use. Then it can be diluted with distilled or demineralized water to achieve a solution of the desired NTU value.

Instead of diluting a formazin stock solution, StablCal Stabilized Formazin Standards may be used. Order the StablCal Calibration Set for the 2100P Turbidimeter, Cat.No. 26594-00 (500-mL bottles), Cat. No. 26594-10 (100 mL bottles), or Cat. No. 26594-05 (sealed vials). (See *OPTIONAL ACCESSORIES AND REAGENTS* on page *74*.)

3.6.2.2 Correcting for Turbidity of Dilution Water

The 2100P Turbidimeter automatically compensates for turbidity contributed by dilution water when calculating the true value of the lowest formazin standard. Use high quality distilled or deionized water less than 0.5 NTU. The instrument will display E 1 after calibration if

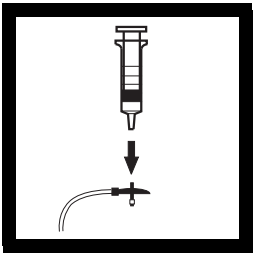
the dilution water turbidity is greater than 0.5 NTU. In this case, prepare the water as directed below.

The value of the dilution water can be arbitrarily forced to zero (see calibration procedure). This is not recommended for most applications and, if done, should be done only if the dilution water turbidity is less than 0.2 NTU.

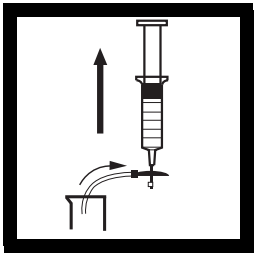
3.6.2.3 Preparing Dilution Water

Note: *Use the same dilution water for all dilutions and the sample blank.*

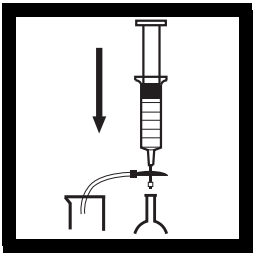
Collect at least 1000 mL of high quality dilution water (distilled or deionized water). The 2100P Turbidimeter, as received from the factory, is precalibrated and may be used to check the dilution water turbidity. If the turbidity is greater than 0.5 NTU, filter the water with the Sample Filtration and Degassing Kit (Cat. No. 43975-10) or equivalent. When measuring low range turbidity, clean all glassware with 1:1 hydrochloric acid and rinse several times with dilution water. If the glassware is not used immediately, use stoppers to prevent contamination from small particles.



1. Attach the syringe to the 3-way valve by gently twisting the square end into the syringe tip. Attach the connector, tubing and a 0.2 micron filter (clear part faces syringe) as shown. Be sure the connections are tight.



2. Fill a beaker or container with the water to be filtered. Insert the tubing into the container. Slowly draw the water into the syringe by pulling up on the syringe plunger.



3. Draw about 50 mL of sample into the syringe. Slowly push on the plunger to force the water through the filter and into a graduated cylinder or volumetric flask. Repeat Steps 2 and 3 until the desired amount of water is obtained.

Note: *As the filter clogs, it gets more difficult to push water through it. At this point, discard the filter and attach a new filter. Replacement filters are available in packages of 10 (Cat. No. 23238-10).*

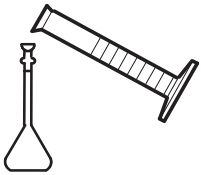
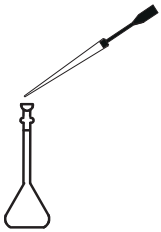
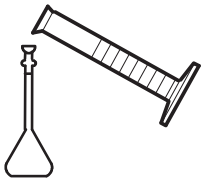
3.6.2.4 Preparing Formazin Dilutions (Factory recommended)

Hach Company recommends using 20, 100, and 800 NTU formazin standards for calibrating the 2100P Turbidimeter. Dilutions with other NTU values can be prepared and used (see *Section 3.6.3.1* on page *48*). If problems occur when using alternate solutions, use the dilutions specified here.

Prepare all formazin dilutions immediately before use and discard after calibration. The 4000 NTU solution is stable for up to a year, but dilutions deteriorate more rapidly. Use the same high quality water (turbidity <0.5 NTU) for the dilutions and the blank.

Preparing the 20, 100 and 800 NTU standards

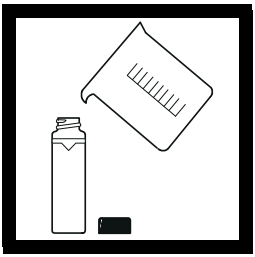
Table 1 Formazin Standard Preparation

	Step 1	Step 2	Step 3
Standards			
20 NTU	Add 100 mL of dilution water to a clean **200-mL** class A volumetric flask.	With a TenSette* pipet, add 1.00 mL of well-mixed 4000 NTU Formazin stock solution to the 200-mL flask.	Dilute to the mark with dilution water. Stopper and mix.
100 NTU	Add 100 mL of dilution water to a clean **200-mL** class A volumetric flask.	With a TenSette pipet, add 5.00 mL of well-mixed 4000 NTU Formazin stock solution to the 200-mL flask.	Dilute to the mark with dilution water. Stopper and mix.
800 NTU	Add 50 mL of dilution water to a clean **100-mL** class A volumetric flask.	With a TenSette pipet, add 20.00 mL of well-mixed 4000 NTU Formazin stock solution to the 100-mL flask.	Dilute to the mark with dilution water. Stopper and mix.

* A class A volumetric pipet may be used in place of a TenSette Pipet.

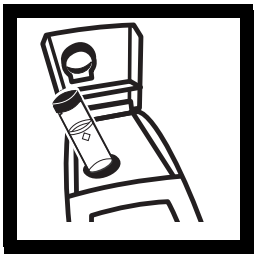
3.6.3 Calibrating the Turbidimeter

Note: *For best accuracy use the same sample cell or four matched sample cells for all measurements during calibration. Always insert the cell so the orientation mark placed on the cell during the matching procedure is correctly aligned. (See Section 2.3.4 on page 26 for matching sample cells).*



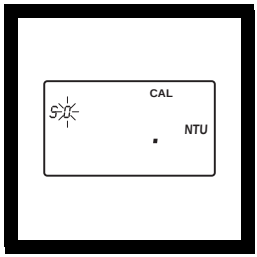
1. Rinse a clean sample cell with dilution water several times. Then fill the cell to the line (about 15 mL) with dilution water or use StablCal <0.1 NTU standard.

Note: *The same dilution water used for preparing the standards must be used in this step.*



2. Insert the sample cell in the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid. Press **I/O**.

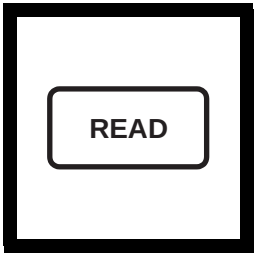
Note: *Choose signal average mode option (on or off) before pressing* **CAL** *– the* **SIGNAL AVERAGE** *key is not functional in calibration mode.*



3. Press: **CAL**

The **CAL** and **S0** icons will be displayed (the **0** will flash). The 4-digit display will show the value of the S0 standard for the previous calibration. If the blank value was forced to 0.0, the display will be blank (as shown). Press → to get a numerical display.

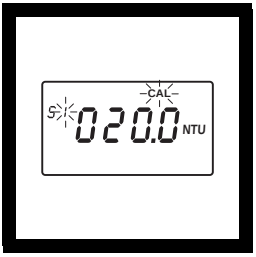
Hach Company only recommends the use of StablCal® Stabilized Formazin or formazin standards for the calibration of Hach turbidimeters. Hach Company cannot guarantee the performance of the turbidimeter if calibrated with co-polymer styrene divinylbenzene beads or other suspensions. DO NOT calibrate with Gelex® Secondary Standards.



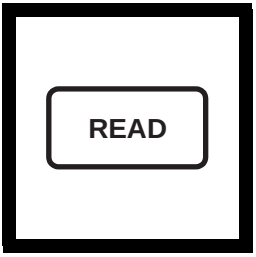
4. Press: **READ**

The instrument will count from 60 to 0, (67 to 0 if signal average is on), read the blank and use it to calculate a correction factor for the 20 NTU standard measurement. If the dilution water is ≥ 0.5 NTU, E 1 will appear when the calibration is calculated (See *Section 3.6.2.3* on page *41* for more dilution water information). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

Note: *The turbidity of the dilution water can be "forced" to zero by pressing → rather than reading the dilution water. The display will show* **S0 NTU** *and the ↑ key must be pressed to continue with the next standard.*



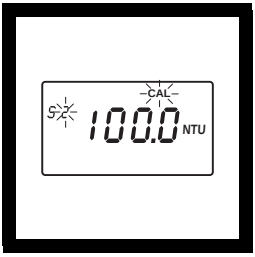
5. The display will show the **S1** (with the 1 flashing) and **20 NTU** or the value of the S1 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 20 NTU StablCal Standard or 20 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.



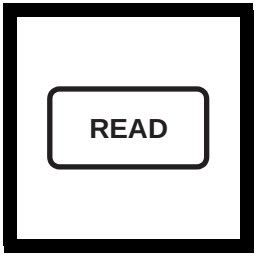
6. Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

Note: *For potable water applications with low turbidity values the instrument calibration may be stopped after the 20 NTU StablCal Standard has been read. Press* **CAL** *after reading the 20 NTU standard. The instrument calibration is now complete for the range of 0-20 NTU only. The instrument will continue to read turbidity values above 20 NTU. These values were not updated during the 0-20 NTU calibration.*

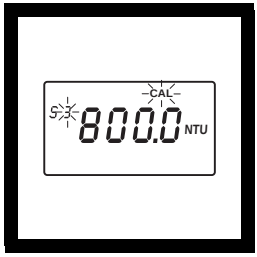


7. The display will show the **S2** (with the 2 flashing) and **100 NTU** or the value of the S2 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 100 NTU StablCal Standard or 100 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

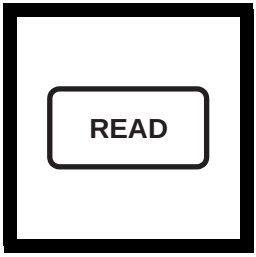


8. Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Then, the display will automatically increment to the next standard. Remove the sample cell from the cell compartment.



9. The display will show the **S3** (with the 3 flashing) and **800 NTU** or the value of the S3 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 800 NTU StablCal Standard or 800 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.



10. Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Then the display will increment back to the S0 display. Remove the sample cell from the cell compartment.

11. Press: **CAL** to accept the calibration. The instrument will return to measurement mode automatically.

Note: *Pressing* **CAL** *completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after* **CAL** *is pressed. If* **E 1** *or* **E 2** *appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If* **CAL?** *appears, an error may have occurred during calibration. If* **CAL?** *is flashing, the instrument is using the default calibration.*

NOTES

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ, I/O,** ↑, and → keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. Press **DIAG** to cancel the error message (**E 1** or **E 2**). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If **CAL?** is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.

- To review a calibration, press **CAL** and then ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** is not flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

3.6.3.1 Preparing User-selected Formazin Dilutions

The formazin solutions should span the entire range of the instrument. Hach recommends preparing three standards:

1. 10 to 30 NTU

2. 90 to 110 NTU

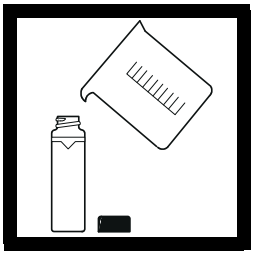
3. 700 to 900 NTU

The standards must have a difference of at least 60 NTU.
In addition, a blank made from the dilution water should be prepared.

Prepare the formazin standard solutions from the well mixed 4000 NTU stock solution as specified in *Section 3.6.2.4* on page *42* and dilution water as specified in *Section 3.6.2.2* and *Section 3.6.2.3* on page *41*. Make the standards **immediately** before use and discard them after calibration is done.

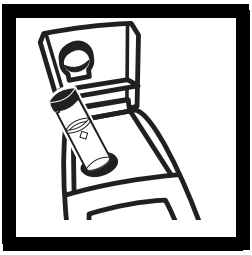
3.6.3.2 Calibrating with User-selected Standards

Note: *For best accuracy use the same sample cell or four matched sample cells for all measurements during calibration. Always insert the sample cell with the same orientation.*



1. Fill a clean sample cell to the line (about 15 mL) with dilution water.

Note: *The same dilution water used for preparing the standards must be used in this step.*

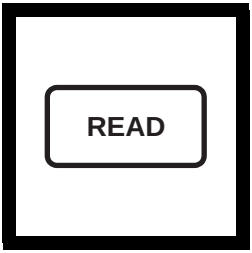


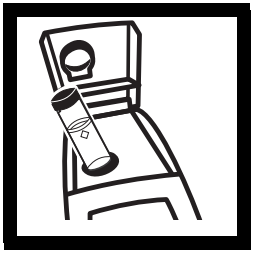
2. Insert the sample cell into the cell compartment and close the lid. Press **I/O**.

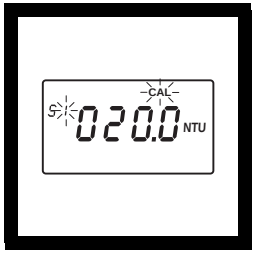
Note: *Choose signal average mode option (on or off) before pressing* **CAL** *– the* **SIGNAL AVERAGE** *key is not functional in calibration mode.*

3. Press: **CAL**.

The **CAL** and **S0** icons will appear (the **0** will flash). The 4-digit display will show the value of the S0 standard for the previous calibration.





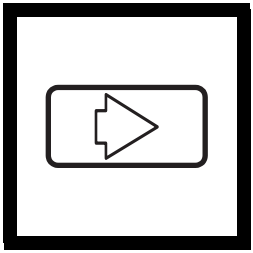


4. Press: **READ**.

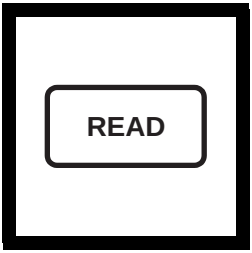
The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the blank and use it to calculate a correction factor for the lowest standard. If the dilution water is ≥0.5 NTU, **E 1** will appear (see *Section 3.6.2.3* on page *41* for more dilution water information). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

5. Thoroughly mix the 10 to 30 NTU range standard, then fill a clean sample cell to the line with the standard. Insert the sample cell into the cell compartment

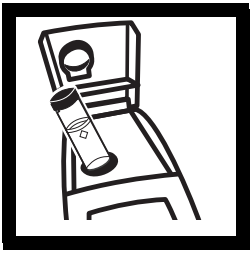
6. The display will show the **S1** icon (with the **1** flashing) and **20 NTU** or the value of the S1 standard for the previous calibration.



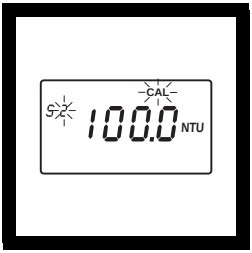
7. Edit the standard concentration by pressing →. The **1** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.



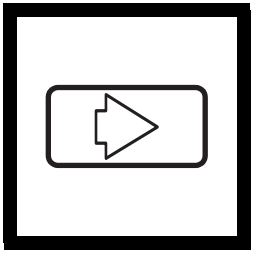
8. When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.



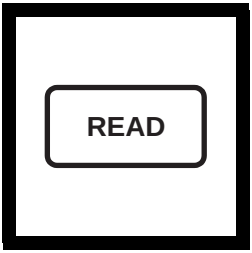
9. Thoroughly mix the 90 to 110 NTU standard, then fill a clean sample cell to the line with the standard. Insert the cell into the cell compartment.



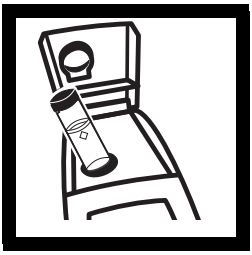
10. The display will show the **S2** icon (with the **2** flashing) and **100 NTU** or the value of the S2 standard for the previous calibration.



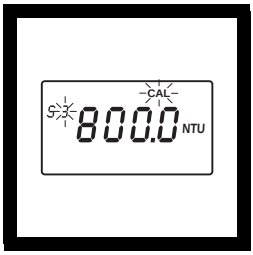
11. Edit the standard concentration by pressing →. The **2** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.



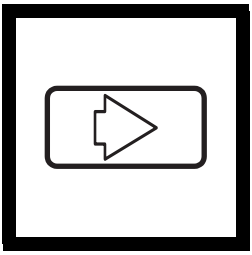
12. When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Remove the sample cell from the cell compartment.



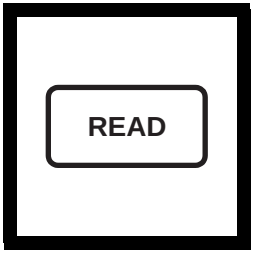
13. Thoroughly mix the 700 to 900 NTU standard, then fill a clean sample cell to the line with the standard. Insert the cell into the cell compartment.



14. The display will show the **S3** icon (with the **3** flashing) and **800 NTU** or the value of the S3 standard for the previous



15. Edit the standard concentration by pressing →. The **3** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.



16. When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The instrument will increment back to **S0**. Remove the sample cell from the cell compartment.

17. Press: **CAL**.

The instrument will store the new calibration data and return the instrument to the measurement mode. It will use the new calibration to calculate turbidity for subsequent measurements.

Note: *Pressing* **CAL** *completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after* **CAL** *is pressed. If* **E 1** *or* **E 2** *appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If* **CAL?** *appears, an error may have occurred during calibration. If* **CAL?** *is flashing, the instrument is using the default calibration.*

NOTES

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ, I/O,** ↑, and → keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. If the error messages recur, calibrate using the factory specified standards, *Section 3.6.2.4* on page *42* and *Section 3.6.3* on page *44*. Press **DIAG** to cancel the error message (**E 1** or **E 2**). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If **CAL?** is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.

- To review a calibration, press **CAL** and then only ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** isn't flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

3.6.4 Using Gelex® Secondary Turbidity Standards

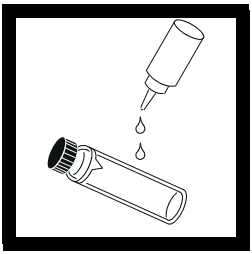
Note: *Store Gelex standards at room temperature. Do not allow to freeze or exceed 50 °C.*

Gelex Secondary Standards (included with 4650000 only) are particulate suspensions similar to formazin primary standards in light scattering characteristics. NTU values on the Gelex standards indicate the range for which they should be used. Due to minor variations in glass and individual instrument optical systems, the true value of the Gelex standards must be determined against formazin in the same instrument they will be used with for later calibration checks.

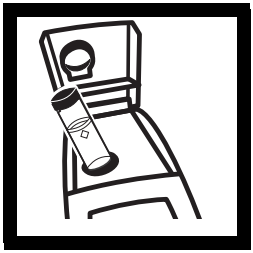
3.6.4.1 Assigning Values to Gelex Standards

1. Calibrate the instrument with formazin.

2. Select automatic range mode using the **RANGE** key.

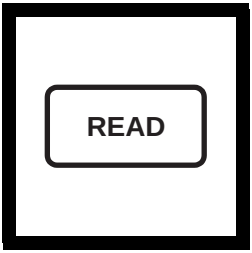


3. Thoroughly clean the outside of the Gelex vials and apply a thin coating of silicone oil.



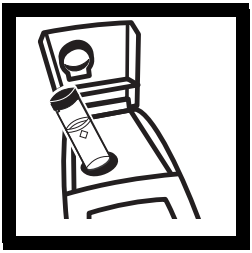
4. Place the 0-10 NTU Gelex standard in the cell compartment so the diamond on the vial aligns with the orientation mark on the instrument. Close the sample lid.

Note: *Correct cell orientation is essential to obtain accurate Gelex values. Always orient the cell so the diamond mark aligns with the orientation mark on the instrument.*



5. Press: **READ**.

Record the displayed value, remove the vial from the instrument and mark the value on the band near the top of the vial.



6. Repeat *step 3* through *step 5* for the other Gelex standards, being careful to orient the cells properly.

Re-assign with every formazin calibration

7. Re-assign values to the Gelex standards each time the instrument is calibrated with formazin.

3.6.4.2 Routine Calibration Check With Gelex Standards

The 2100P Turbidimeter does not require standardization before every measurement as some turbidimeters do. Periodically, as experience dictates, check the instrument calibration using the appropriate Gelex Secondary Standard. Be sure the Gelex standards are aligned correctly when inserting them (diamond aligns with orientation mark). If the reading is not within 5% of the previously established value, recalibrate the instrument with StablCal Stabilized Formazin Primary Standard or formazin primary standard (*Section 3.6.3* on page *44*).

Important Note: DO NOT calibrate with Gelex® Secondary Standards. Gelex standards are designed for instrument verification, not calibration.

MAINTENANCE

Some of the following manual sections contain information in the form of warnings, cautions and notes that require special attention. Read and follow these instructions carefully to avoid personal injury and damage to the instrument. Only personnel qualified to do so, should conduct the maintenance tasks described in this portion of the manual.

Certains des chapitres suivants de ce mode d'emploi contiennent des informations sous la forme d'avertissements, messages de prudence et notes qui demandent une attention particulière. Lire et suivre ces instructions attentivement pour éviter les risques de blessures des personnes et de détoriation de l'appareil. Les tâches d'entretien décrites dans cette partie du mode d'emploi doivent être seulement effectuées par le personnel qualifié pour le faire.

Algunos de los capítulos del manual que presentamos contienen muy importante información en forma de alertas, notas y precauciones a tomar. Lea y siga cuidadosamente estas instrucciones a fin de evitar accidentes personales y daños al instrumento. Las tareas de mantenimiento descritas en la presente sección deberán ser efectuadas únicamente por personas debidamente cualificadas.

Einige der folgenden Abschnitte dieses Handbuchs enthalten Informationen in Form von Warnungen, Vorsichtsmaßnahmen oder Anmerkungen, die besonders beachtet werden müssen. Lesen und befolgen Sie diese Instruktionen aufmerksam, um Verletzungen von Personen oder Schäden am Gerät zu vyyyermeiden. In diesem Abschnitt beschriebene Wartungsaufgaben dürfen nur von qualifiziertem Personal durchgeführt werden.

Algumas das seguintes secções do manual contêm informações em forma de advertências, precauções e notas que requerem especial atenção. Leia e siga atentamente as presentes instruções para evitar ferimentos pessoais e não danificar o instrumento. As tarefas de manutenção descritas nesta parte do manual só poderão ser executadas por pessoal qualificado.

SECTION 4 MAINTENANCE

4.1 Cleaning

Keep the turbidimeter and accessories as clean as possible and store the instrument in the carrying case when not in use. Avoid prolonged exposure to sunlight and ultraviolet light. Wipe spills up promptly. Wash sample cells with non-abrasive laboratory detergent, rinse with distilled or demineralized water, and air dry. Avoid scratching the cells and wipe all moisture and fingerprints off the cells before inserting them into the instrument. Failure to do so can give inaccurate readings. See *Section 2.3.1* on page *23* for more information about sample cell care.

4.2 Battery Replacement

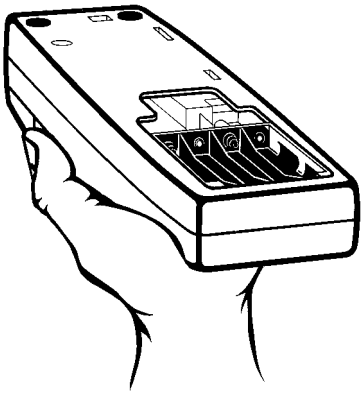
AA alkaline cells typically last for about 300 tests with the signal averaging mode off, about 180 tests if signal averaging is used. The “battery” icon flashes when battery replacement is needed. Refer to *Section 1.4.2* on page *16* for battery installation instructions. If the batteries are changed within 30 seconds, the instrument retains the latest range and signal average selections. If it takes more than 30 seconds, the instrument uses the default settings.

If, after changing batteries, the instrument will not turn off or on and the batteries are good, remove the batteries and reinstall them. If the instrument still won't function, contact Hach Service or the nearest authorized dealer.

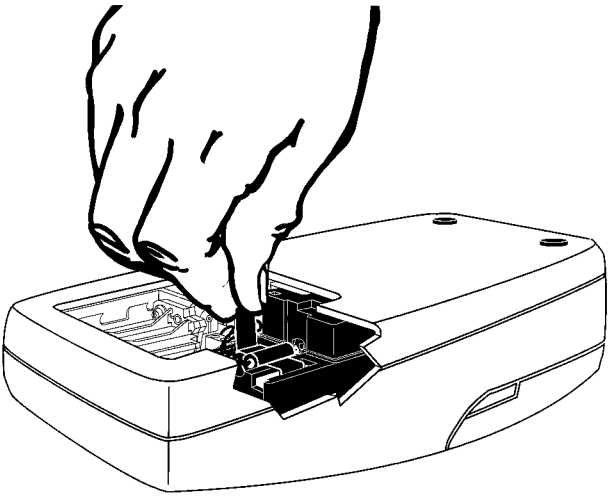
4.3 Lamp Replacement

The procedure below explains lamp installation and electrical connections. Use a small screwdriver to remove and install the lamp leads in the terminal block. The instrument requires calibration after lamp replacement.

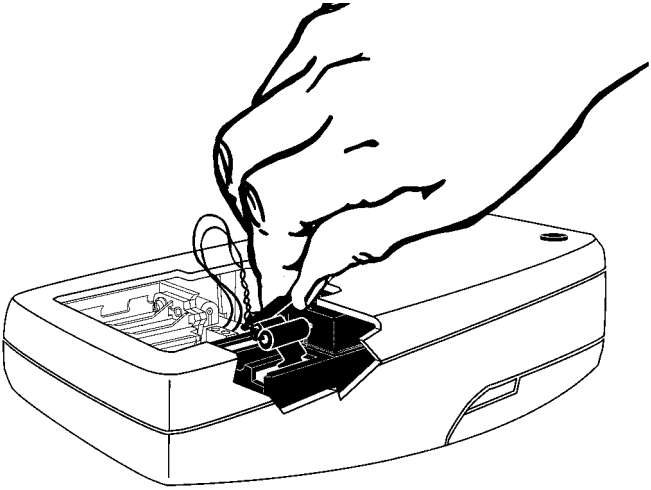
1. Orient the instrument so it is upside down and the top faces away from you. Remove the battery cover and at least one battery.



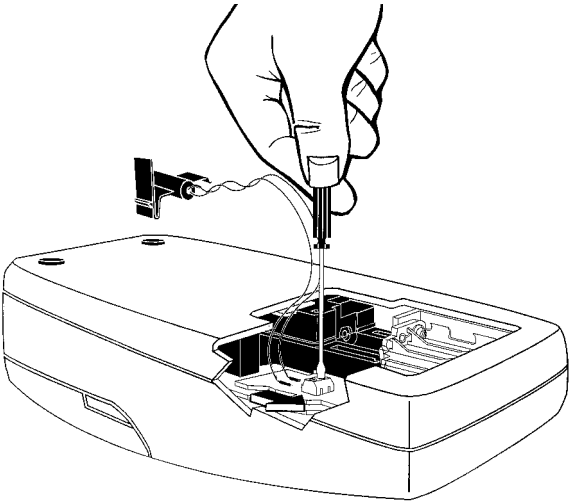
2. Remove the lamp assembly by grasping the tab on the left side of the assembly. Firmly, but gently, slide the assembly towards the rear of the instrument.



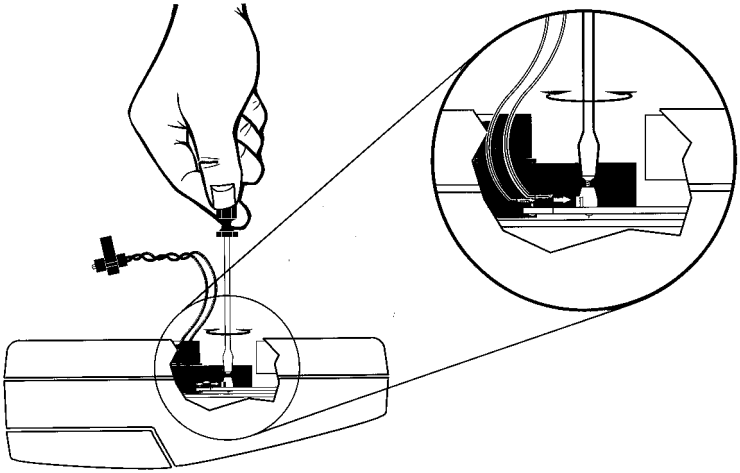
3. Rotate the tab towards the nearest outside edge. The assembly should release and slip out easily.



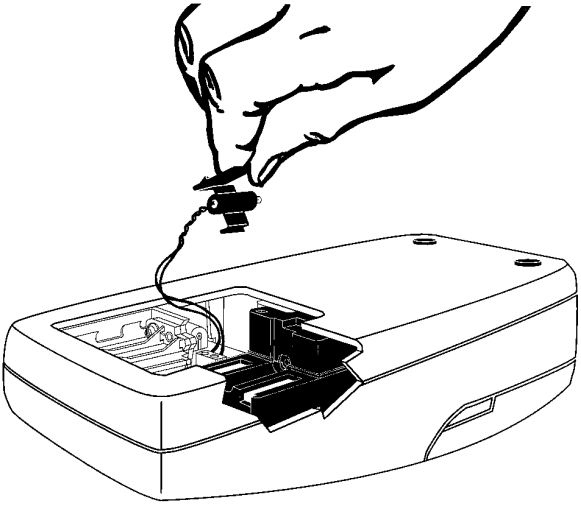
4. Back the terminal block screws **partially** out (1 to 2 turns) and remove the old lamp leads.



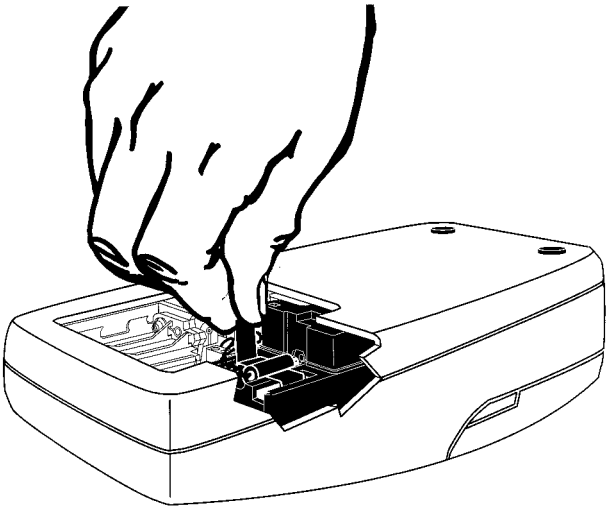
5. Gently bend the wires of the new lamp assembly into an “L” shape so they fit easily into the housing. Insert the leads into the terminal screws and tighten with clockwise turns. Gently tug on the wires to make sure they are connected to the terminal block.



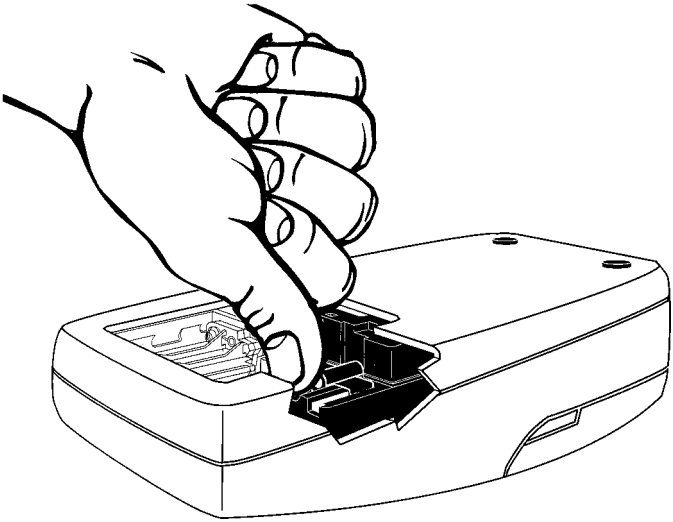
6. Hold the new lamp assembly by the tab with the lamp facing the tope (keyboard) of the instrument. Slide the small catch on the other side of the assembly into the black plastic slot (towards the nearest edge of the instrument).



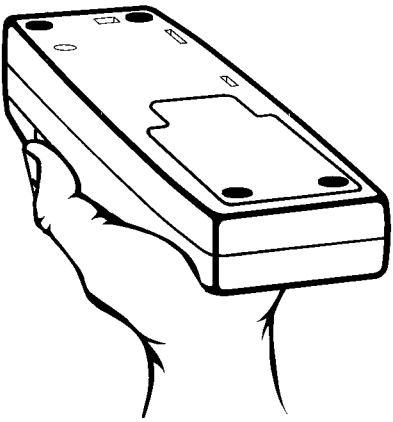
7. Snap the U-shaped bottom of the tab into the slot on the left side of the black plastic that holds the lamp assembly.



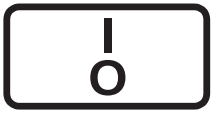
8. With your thumb, firmly slide the assembly forward until it stops. Again, push firmly against the tab to make sure the lamp is seated correctly.



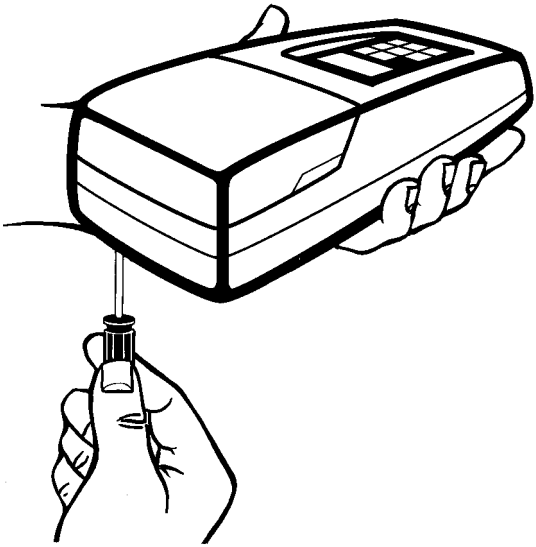
9. Replace the battery(s) and battery cover.



10. Insert the 800 NTU formazin standard into the sample cell. Press and hold **READ**. Then press **I/O**. Release the **READ** key after the software version number disappears from the display (for models with serial numbers less than 920300000800, **2100** disappears).



11. Adjust the scattered light amplifier output by inserting a small flat-bladed screwdriver into the trimpot hole (located on bottom). Adjust the display to read 2.5 ± 0.3 volts (2.0 volts for models that display **2100** when turned on).



12. Press **I/O** to exit gain adjust mode.

13. Perform a formazin calibration according to *Section 3.6.3* on page *44* or *Section 3.6.3.1* on page *48*.

SECTION 5 TROUBLESHOOTING

5.1 Using the Diagnostic Functions Key

Enter the diagnostic mode by pressing the **DIAG** key. Exit this mode at any time by pressing the key again. The diagnostic mode allows access to information about instrument function which may be useful for servicing and troubleshooting.

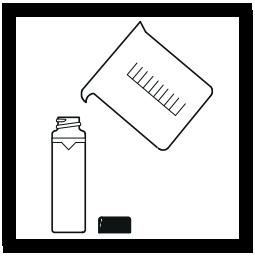
5.1.1 Basic Diagnostic Codes

The diagnostic codes are:

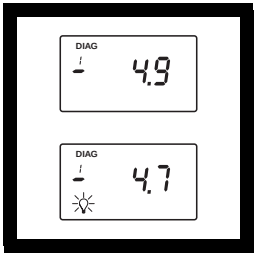
Code	Description
1	Checks the battery voltage with the lamp on, then with the lamp off. This is a dual diagnostic code.
2	Displays calibration coefficient a_o
3	Displays calibration coefficient a_1
4	Displays calibration coefficient b_o
5	Displays calibration coefficient b_1
6	Displays the lamp voltage (about 3 volts)
7	Displays the dark voltage of the transmitted light detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.
8	Displays the high gain dark voltage of the 90° detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.*
9	Displays the low gain dark voltage of the 90° detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.

* Samples with turbidity >10 NTU may display **- - -** for the lamp-on amplifier voltage.

5.2 The Diagnostic Procedure

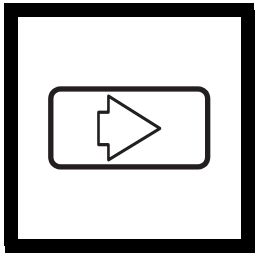


1. Fill a clean sample cell to the line with clear water, cap the cell and place it in the cell compartment. Press the **READ** key and wait until the reading is finished.

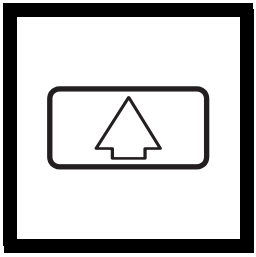


2. Press: **DIAG**

The **DIAG** icon will turn on and **1** will be displayed below the icon. The instrument will measure the battery voltage with the lamp off and display the result in volts (V). Then the lamp icon will turn on and the instrument will measure the voltage with the lamp on. The value is briefly displayed before defaulting to the lamp-off reading. To repeat the measurement, press **READ**.



3. To continuously display the lamp-on voltage, press →. The lamp icon will flash. Press → to turn the lamp icon off (the lamp is not on during this display).



4. Press the ↑ key to scroll through the other diagnostics. Each press of the key increments the digit in the small numerical display below the **DIAG** icon and the result of the diagnostic measurement is then displayed. Each press of the **READ** key updates the value. For measurements made with the lamp off and again with the lamp on, the measurement with the lamp off is displayed when the diagnostic is entered. To see the second measurement with the lamp on, press the → key (only works with diagnostic codes 1, 7, 8, & 9). The lamp icon will flash and the lamp-on measurement will be displayed in volts. Press → to turn the lamp icon off.

Note: *DIAG 8 will display* ---- *for the lamp-on voltage if a of >10 NTU is placed in the cell compartment.*

5.3 Other Instrument Diagnostics

5.3.1 Display Test

Pressing and holding the **I/O** key turns on all the display icons and elements so you can determine if all the elements and icons are functioning. The display test sequence will cycle as long as the key is held down.

5.4 Error Messages

Error messages indicate sample interferences and/or instrument malfunction.

5.4.1 Flashing Numeric Display

If the highest value in the range selected is flashing in the display, the sample is too turbid (or overrange) for the selected range. In automatic or manual range, **1000** flashes if the sample is over the instrument's range. In manual range mode, select the next higher range mode if **9.99** or **99.9** flashes. See *Section 2.3.6* on page *31* for measuring overrange samples. The display will stop flashing if a sample within range is inserted and read.

5.4.2 E Messages

An error message indicates either an instrument failure or an operation cannot be performed. **An error message can be cleared by pressing DIAG** (display will return to previous measurement or calibration value). The meter continues to operate as best it can. If the message occurs during a calibration, calibration can continue. If the error message occurs when a calibration is being calculated, the instrument will discard the new calibration and retain the old calibration. Error messages and corrective actions are listed below.

5.4.3 CAL?

A flashing **CAL?** appears when the instrument is using the default calibration programmed at the factory. It will appear if the analyst has erased the user-entered calibration using the procedure to restore the default calibration or after and E 4 error is cleared by pressing DIAG. Recalibrate as soon as possible when **CAL?** appears. **CAL?** (not flashing) appears when a calibration has questionable validity.

Message*	Probable Cause	Corrective Action
E1	Dilution water is ≥ 0.5 NTU.	Start calibration over with better quality dilution water or use a membrane filter to filter the water before use.
E2	Two standards have the same value or their difference is less than 60 NTU. Not all standards were read during the calibration. Standard 1 is too low (<10 NTU).	Recheck preparation of standards and repeat calibration.
E3	Low light error.	Re-read measurement. Check lamp** Check for obstructed light path. Dilution may be necessary.
E4	EEPROM malfunction.	Check sum failed. Press **I/O**. If E 4 reappears, call Hach service. If **CAL?** appears, recalibrate.
E5	A/D overrange.	Check for obstructed light path. Call Hach Service.
E6	A/D underrange.	Check for open lid during reading and re-read. Check for obstructed light path. If persists, call Hach Service.
E7	Light Leak.	Close lid before pressing **READ** key.
E8	Bad lamp circuit.	Reinsert lamp leads at terminal block-make sure the lead ends are not touching each other.If this fails, call Hach Service.

* Error messages 4, 5, and 6 may indicate a failure in the internal electronics.
** Check lamp by inserting a pencil or piece of paper into the cell compartment and pressing READ. Light should be visible on the inserted object.

GENERAL INFORMATION

At Hach Company, customer service is an important part of every product we make.

With that in mind, we have compiled the following information for your convenience.

Replacement Parts & Accessories

REPLACEMENT PARTS

Description	Cat. No.
StablCal Calibration Set for 2100P, Sealed Vials: <0.1 NTU, 20 NTU, 100 NTU, and 800 NTU	26594-05
AA Batteries, 4/pkg	19380-04
Battery Door	46005-00
Carrying Case	46506-00
Gelex® Standards, set (includes standards and 3 sample cells)	24641-05
Instrument Manual	46500-88
Lamp Assembly, with leads	46539-00
Oiling Cloth	47076-00
Sample Cells, 1 inch, with cap, 6/pkg	24347-06
Silicone Oil, 15 mL	1269-36

OPTIONAL ACCESSORIES AND REAGENTS

Deionized Water, 3.78 L	272-17
Bath, Ultrasonic, 2.8 L (0.75-gal), w/heater	24895-00
Battery Eliminator, 120 V	46079-00
Battery Eliminator, 230 V	46080-00
Filter, 0.2 micron, 10/pkg	23238-10
Formazin, 4000 NTU, 500 mL	2461-49
Formazin, 4000 NTU,100 mL	2461-42
Hexamethylenetetramine, 500 g	1878-34
Hydrazine Sulfate, 100 g	742-26
NiCad Rechargeable Battery (4 required)	16077-00

OPTIONAL ACCESSORIES AND REAGENTS, continued

Description	Cat. No.
Pipet, TenSette®*, 1-10 mL	19700-10
Pipet Tips, for 1-10 mL TenSette Pipet, 50/pkg	21997-96
Pipet Tips, for 1-10 mL TenSette Pipet, 1000/pkg	21997-28
Pipet, Volumetric, Class A, 1.00 mL	14515-35
Pipet, Volumetric, Class A, 5.00 mL	14515-37
Pump, Vacuum, Hand-Operated	14283-00
Sample Degassing Kit	43975-00
Sample Filtration and Degassing Kit	43975-10
StablCal® Calibration Set for 2100P Turbidimeter	
<0.1, 20, 100, 800 NTU, 500 mL each	26594-00
<0.1, 20, 100, 800 NTU, 100 mL each	26594-10
<0.1 NTU** StablCal®*** Stabilized Formazin Standard,100 mL	26597-42
20 NTU StablCal® Stabilized Formazin Standard, 100 mL	26601-42
100 NTU StablCal® Stabilized Formazin Standard, 100 mL	26602-42
800 NTU StablCal® Stabilized Formazin Standard, 100 mL	26605-42
Triton-X Solution, 118 mL (4 oz)	14096-32
Volumetric Flask, 100 mL	14574-42
Volumetric Flask, 200 mL	14574-45

* TenSette™ is a Hach Company trademark.

** <0.1 NTU StablCal® Standard is used in place of dilution water standard when performing a calibration.

*** StablCal® is a registered trademark of Hach Company.

HOW TO ORDER

By Telephone:

6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH
(800-227-4224)
By FAX: (970) 669-2932

By Mail:

Hach Company
P.O. Box 389
Loveland, CO 80539-0389
U.S.A.

Ordering information by E-mail: orders@hach.com

Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

Technical and Customer Service (U.S.A. only)

Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use. Specialists in analytical methods, they are happy to put their talents to work for you. Call **1-800-227-4224** or E-mail **techhelp@hach.com**.

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Hach maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send E-mail to **intl@hach. com** or contact:

In Canada, Latin America, Africa, Asia, Pacific Rim:
Telephone: (970) 669-3050; FAX: (970) 669-2932

In Europe, the Middle East, or Mediterranean Africa:
HACH Company, c/o
Dr. Bruno Lange GmbH
Willstätterstr. 11
D-40549 Düsseldorf
Germany
Telephone: +49/[0]211.52.88.0
Fax: +49/[0]211.52.88.231

REPAIR SERVICE

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the HACH Service Center serving your location.

In the United States:
Hach Company
100 Dayton Avenue
Ames, Iowa 50010
(800) 227-4224 (U.S.A. only)
Telephone: (515) 232-2533
FAX: (515) 232-1276

In Canada:
Hach Sales & Service Canada Ltd.
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4
(800) 665-7635 (Canada only)
Telephone: (204) 632-5598
FAX: (204) 694-5134
E-mail: canada@hach.com

In Latin America, the Caribbean, the Far East, the Indian Subcontinent, Africa, Europe, or the Middle East:
Hach Company World Headquarters
P.O. Box 389
Loveland, Colorado, 80539-0389
U.S.A.
Telephone: (970) 669-3050
FAX: (970) 669-2932
E-mail: intl@hach.com

WARRANTY

Hach warrants most products against defective materials or workmanship for at least one year from the date of shipment; longer warranties may apply to some items.

HACH WARRANTS TO THE ORIGINAL BUYER THAT HACH PRODUCTS WILL CONFORM TO ANY EXPRESS WRITTEN WARRANTY GIVEN BY HACH TO THE BUYER. EXCEPT AS EXPRESSLY SET FORTH IN THE PRECEDING SENTENCE, HACH MAKES NO WARRANTY OF ANY KIND WHATSOEVER WITH RESPECT TO ANY PRODUCTS. HACH EXPRESSLY DISCLAIMS ANY WARRANTIES IMPLIED BY LAW, INCLUDING BUT NOT BINDING TO ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

LIMITATION OF REMEDIES: Hach shall, at its option, replace or repair nonconforming products or refund all amounts paid by the buyer. **THIS IS THE EXCLUSIVE REMEDY FOR ANY BREACH OF WARRANTY.**

LIMITATION OF DAMAGES: IN NO EVENT SHALL HACH BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND FOR BREACH OF ANY WARRANTY, NEGLIGENCE, ON THE BASIS OF STRICT LIABILITY, OR OTHERWISE.

This warranty applies only to Hach products purchased and delivered in the United States.

Catalog descriptions, pictures and specification, although accurate to the best of our knowledge, are not a guarantee or warranty.

For a complete description of Hach Company’s warranty policy, request a copy of our Terms and Conditions of Sale for U.S. Sales from our Customer Service Department.

APPENDIX E: PADDLE WHEEL FLOW METER MANUAL

Signet 2537 Paddlewheel Flowmeter

English

3-2537.090 Rev C 06/09 English

SAFETY INSTRUCTIONS

1. Depressurize and vent system prior to installation or removal.
2. Confirm chemical compatibility before use.
3. Do not exceed maximum temperature/pressure specifications.
4. Wear safety goggles or faceshield during installation/service.
5. Do not alter product construction
6. If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
7. **This device is not approved for use or installation in hazardous locations.**

Description

The 2537 Paddlewheel Flowmeter Series offer low flow, low power and high resolution with various output options such as a flow switch, pulse divider, Digital (S^3L), or 4-20 mA. This unit can be configured on-site directly through the built-in user interface.

- The Digital model provides a digital (S^3L) output for use with the Signet 8900 Multi-Parameter Controller.
- The 4-20 mA model provides a blind current loop output.
- The Flow Switch Model uses a single relay (mechanical or solid state) for Hi or Lo alarm operation.
- The Pulse model uses a single relay (mechanical or solid state) and has two selectable operating modes:
  - The Divider mode scales the paddlewheel frequency down to accommodate low frequency input devices.
  - In Total mode, the Pulse Model becomes a traditional pump pulser, able to output one pulse per a set volume of fluid.

A small LCD enables the 2537 to be programmed without any external equipment. During normal operation the display is not visible.

Specifications

General

Wetted Materials

Model Suffix	Sensor Body	Rotor	Pin	O-ring
-P0, -P1	glass-filled PP	PVDF, Black	Titanium	FPM
-T0	PVDF, Natural	PVDF, Natural	PVDF, Natural	FPM

Case:	PBT, yellow
Inside cover:	Valox, black
Wiring ports	½ in. NPT threads; liquid-tight connector accepts cables 7-10 mm od (0.275-0.394 in.)

Power requirements

Pulse, Flow Switch

With dry-contact relay:	24 VDC nominal (21.6 VDC min. to 26.4 VDC max.) 30 mA max current
With solid-state relay:	5 to 24 VDC nominal (5.0 VDC min to 26.4 VDC max.) 30 mA max current
Digital (S^3L):	5 VDC nominal (5.0 VDC min to 6.5 VDC max.) 30 mA max current (1.5 mA nominal)
4-20 mA:	12 VDC to 32 VDC nominal (10.8 VDC min to 35.2 VDC max.) 400 mV max ripple voltage 30 mA max current

Reverse Polarity and short circuit protected: Up to 40V, 1 hour
Over-voltage protection: +60 VDC, -50 VDC

Paddlewheel sensor performance specifications

Pipe Size Range:	DN15 to DN 200 (½ in. to 8 in.)
Min. Reynolds Number:	4500
Paddlewheel Frequency:	49 Hz per m/s nominal (15 Hz per ft/s nominal)
Operating Range:	0.1 m/s to 6 m/s (0.3 ft/s to 20 ft/s)
Linearity:	±1% of max. range @ 25°C (77°F)
Repeatability	±0.5% of max. range @ 25°C (77°F)

Electronics performance specifications

Input Frequency Range:	1 Hz to 1000 Hz
System Response:	100 ms update rate nominal

Environmental Requirements

Enclosure rating:	NEMA 4X/IP65
Storage Temperature:	-10°C to 75°C
Ambient Temperature:	0°C to 65°C
Relative Humidity:	0 to 90% RH, non-condensing
Altitude:	2000 m (6562 ft.)
Pollution Degree:	2

Output specifications

Signal Averaging:	Programmable 0 to 100 seconds
Sensitivity Response:	Programmable 0 to 9 scale

Pulse divider/Total pulse output

Pulse Divider Setting:	1.0000 to 99999 Maximum pulse rate: 300 Hz Maximum pulse width: 50 ms

Flow switch output

Relay Modes:	Low, High
Time Delay:	0.0 to 6400.0 seconds
Hysteresis:	Adjustable in Engineering Units

Relay Specifications

Mechanical SPDT:	5A @ 30 VDC, 5A @ 250VAC
Solid-State Relay:	100mA @ 40VDC, 70 mA @ 33 VAC

Digital (S^3L) output

Type:	Serial ASCII, TTL level 9600 bps
Maximum cable length:	See S^3L specifications

Current output (Passive 4 to 20 mA)

Loop Accuracy:	±32 µA (@ 25°C @ 24 VDC)
Loop resolution:	5 µA
Temp. drift:	±1 µA per °C max.
Power supply rejection:	±1 uA per V
Maximum cable:	300 m (1000 ft.)
Max Loop Resistance:	600Ω @ 24 VDC, 1KΩ @ 32 VDC

Standards & Approvals

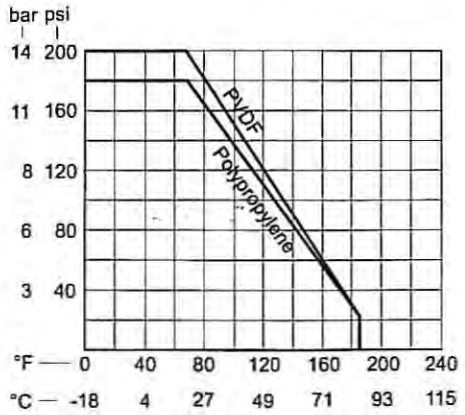
- UL
- CE
- ISO 9001 and ISO 14001

(25) China RoHS (Go to www.gfsignet.com for details)

Fluid Conditions

Pressure/Temperature Ratings:
Polypropylene Body:
- 12.5 bar (180 psi) max. @ 20 °C (68 °F)
- 1.7 bar (25 psi) max. @ 85 °C (185 °F)

PVDF Body:
- 14 bar (200 psi) max @ 20 °C (68 °F)
- 1.7 bar (25 psi) max @ 85 °C (185 °F)

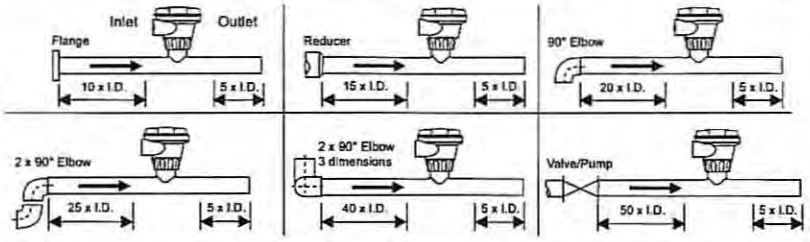


Intended Use: This product is intended for use in industrial water treatment and waste water treatment applications where the chemical content and the fluid temperatures are consistent with the specifications listed herein.
This device is not approved for use or installation in flammable liquids.

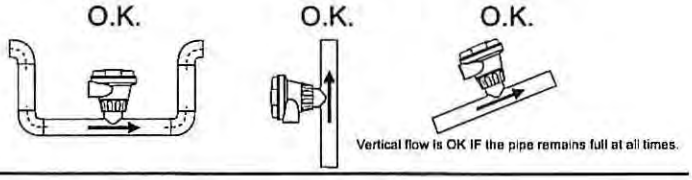
Location of Fitting

Recommended sensor upstream/downstream mounting requirements

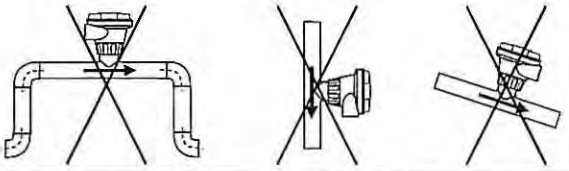
Select a location with sufficient length of straight pipe immediately upstream of the sensor.



Locating the sensor in a trap or where the flow is upward helps to protect the sensor from exposure to air bubbles when the system is in operation.

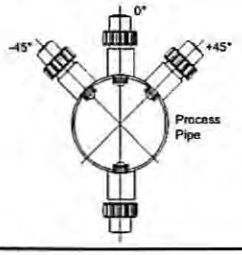


These configurations are not recommended because it is difficult to keep the pipe full.



Sensor Mounting Position

- Horizontal pipe runs: Mount sensor in the upright (0°) position for best performance. Mount at a maximum of 45° when air bubbles are present (pipe must be full). Do not mount on the bottom of the pipe when sediments are present.
- Vertical pipe runs: Mount sensor in any orientation, however, downward flow is not recomended. Upward flow is preferred to ensure full pipe.



Installation: Pipe fittings

George Fischer Signet offers a wide selection of installation fittings that control the position of the paddlewheel in relation to the dimensions of the pipe.

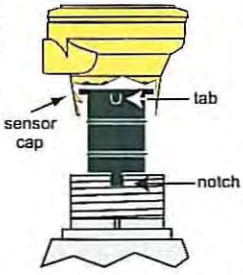
Type	Description
Plastic tees	• 0.5 to 4 inch versions • PVC or CPVC
Metric Union Fitting	• For pipes from DN 15 to 50 mm • PP or PVDF
PVC Saddles	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • 6 to 8 inch, cut 2-1/8 inch hole in pipe
Iron Strap-on saddles	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/8 inch hole in pipe

Type	Description
Iron, Carbon Steel, 316 SS Threaded tees	• 0.5 to 2 inch versions • Mounts on threaded pipe ends
Carbon steel & stainless steel Weld-on Weldolets	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/8 inch hole in pipe
Fiberglass tees & saddles: FPT FPS	• 1.5 inch to 8 in. PVDF insert • > 8 inch PVC insert
Metric Wafer Fitting	• For pipes DN 65 to 200 mm • PP or PVDF

3. Installation

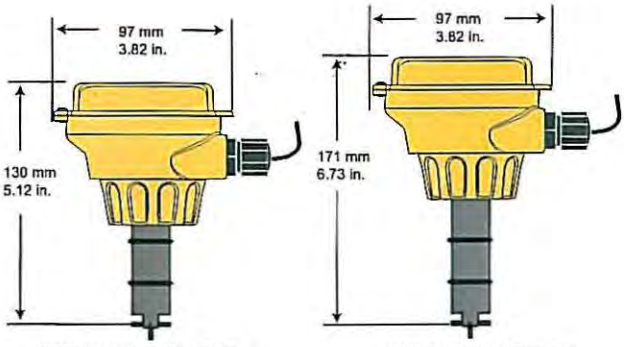
3.3 Plastic sensor installation tips

- Inspect the sensor O-rings for nicks and other damage that may compromise the seal.
- Lightly lubricate the sensor O-rings with a suitable lubricant before each installation. Do not use petroleum based lubricants.
- Using an alternating/twisting motion, lower the sensor into the fitting, making sure the conduit ports on the yellow housing are pointing in the direction of flow.
- Engage one thread of the sensor cap then turn the sensor until the alignment tab is seated in the fitting notch.
-



HAND-TIGHTEN THE THREADED NUT ONTO THE INSTALLATION FITTING. DO NOT USE TOOLS! DO NOT USE THREAD SEALANT OR LUBRICANTS ON THE FITTING THREADS OR THE SENSOR CAP.

Dimensions

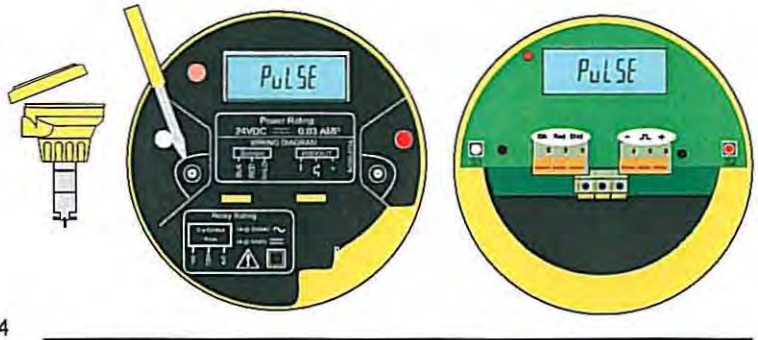


2537 Paddlewheel Flowmeter for ½ in. to 4 in. pipe

2537 Paddlewheel Flowmeter for 5 to 8 in. pipe

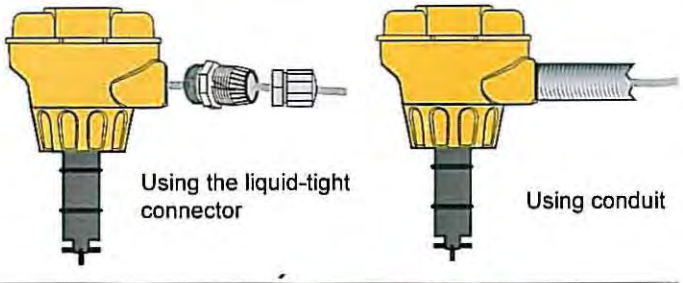
Wiring

Electrical connections to this product should be made only by qualified personnel.



To access the wiring terminals:

- Turn yellow cap ¼ turn counterclockwise to remove.
- Remove the two retaining screws and remove the black cover.
- Route all cables through the conduit ports before connecting them to the terminals.
- Wiring terminals are rated for 16-22 AWG conductors.
- The cable must be 7 to 10 mm in diameter (0.275 to 0.394 in.) to seal properly in the liquid tight connector.
- The conduit ports have ½ inch NPT threads. After routing the cables, seal the port with a liquid tight conduit connector (3-9000.392-1) or with conduit.
- For conduit installations:
  - Thread conduit with ½ in. NPT threads directly into the conduit port.
  - For conduit with ISO threads, use the black thread adapter included with the connector kit.
  - To comply with NEC requirements, do not use any metal conduit in the installation.

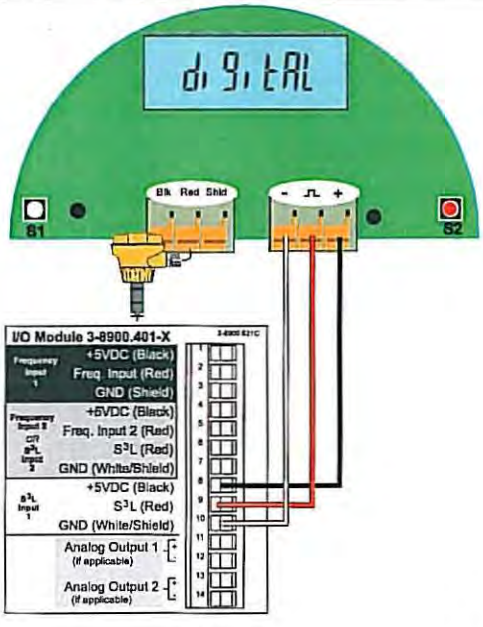


Using the liquid-tight connector

Using conduit

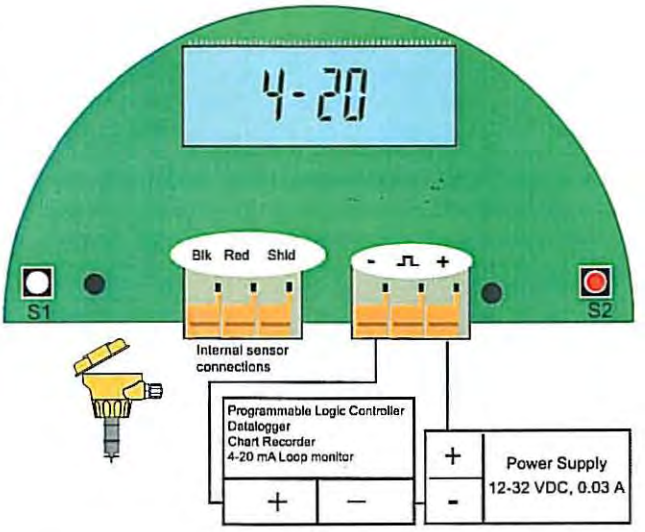
Wiring: Digital (S³L) Output

The Digital (S³L) output is compatible with the 3-8900 Multi-Parameter Controller.



Wiring: 4-20 mA Output

The 4-20 mA output can be connected to Chart Recorders, PLCs or any device that requires a 4-20 mA signal.
The 4-20 mA model requires an external power source of 12-32 VDC.

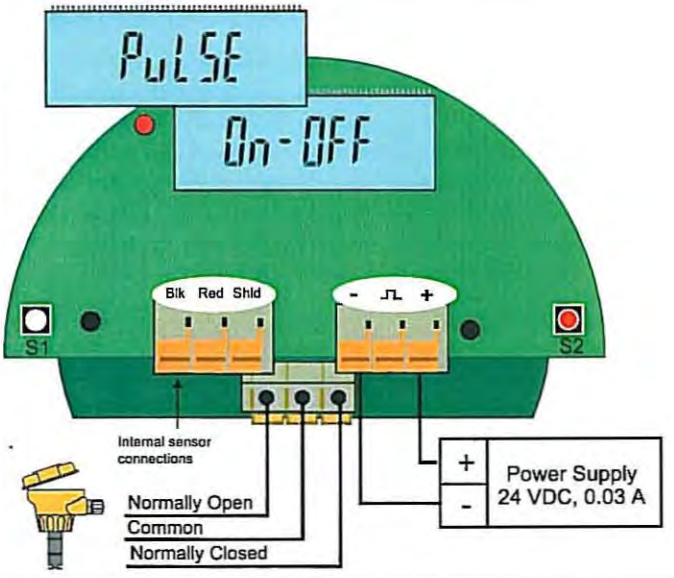


Wiring: Flow Switch Output (On-Off)

- The Flow Switch models provide a single relay that is programmable as a HIGH setpoint or LOW setpoint.
- The relay may be a dry-contact type or a solid state type.
- The dry contact relay requires an external power source of 24 VDC ± 10%.
- The solid state relay requires an external power source of 5 to 24 VDC.

Dry Contact Relay Wiring

- The wiring is identical for On-Off and Pulse models.

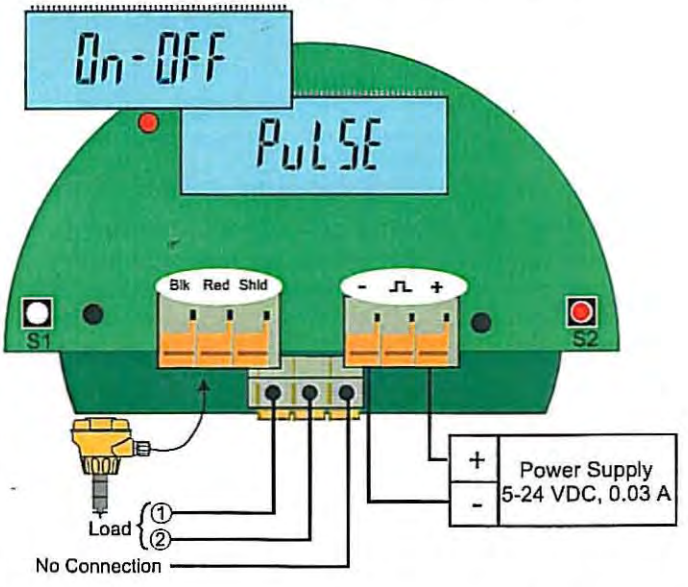


Wiring: Pulse Output

- The Pulse model provides a single relay that is programmable as a Volumetric pulse output or as a simple pulse divider output.
- The relay may be a dry-contact type or a solid state type.
- The dry contact relay requires an external power source of 24 VDC ± 10%.
- The solid state relay requires an external power source of 5 to 24 VDC.

Solid State Relay Wiring

- The wiring is identical for On-Off and Pulse models.



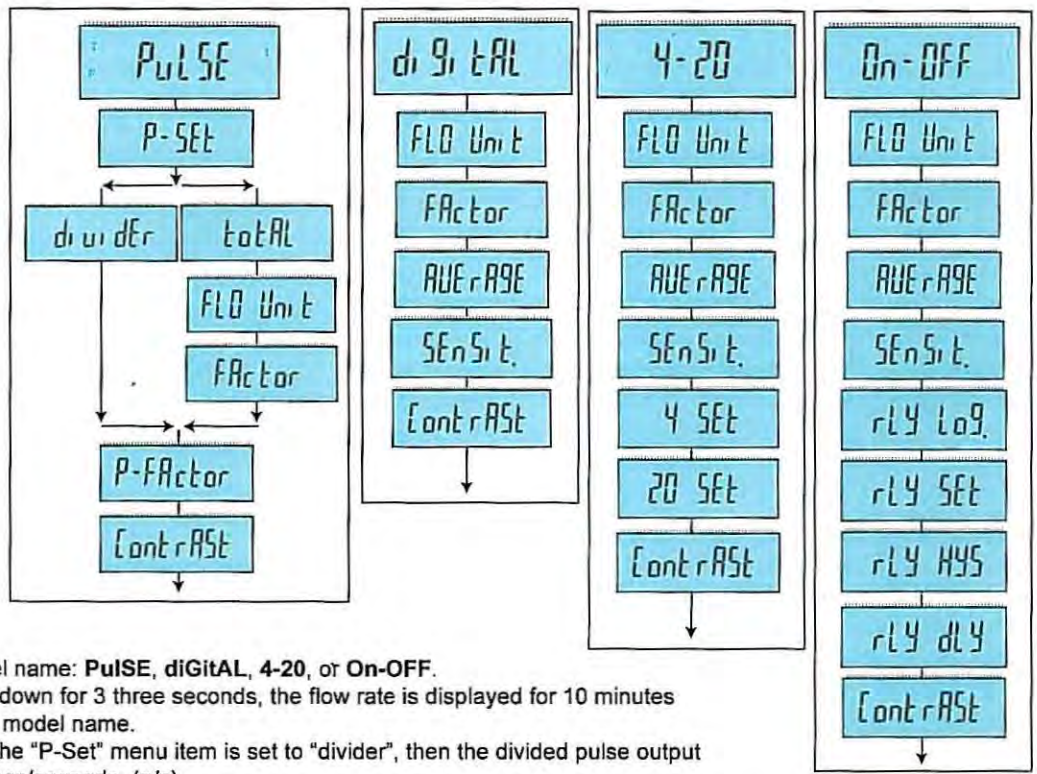
Operation

The 2537 Flowmeter is available in 4 different models. The programming menus vary significantly from one model to another.

This chart is provided inside the yellow cover to assist in navigating the menus in the 2537.

Mode			
View	→ Display Flow Rate	→ Go to MENU	Go to VIEW
Menu	1X→Next Menu	1X→ Display Current Val	Previous Mode
		→ Go to Edit	Previous Mode
		1X → Shift digit to right	Previous Mode
Edit	1X →Increment Value	→ Go to SAVE	Previous Mode
SAVE	1X → Toggle	1X → Store Change	N/A

This table shows the menu sequence for each model.



View Mode Function

- All models display the model name: **PulSE**, **diGitAL**, **4-20**, or **On-OFF**.
- If the white key (S1) is held down for 3 three seconds, the flow rate is displayed for 10 minutes before reverting back to the model name.
  - In the **PulSE** Model, if the "P-Set" menu item is set to "divider", then the divided pulse output will be displayed in pulses/seconds, (p/s).

This table shows the definition of each menu function, the setting parameters and the page where detailed instructions can be located.

Menu Function	Definition	Setting Parameters	More Information On
Flow Unit	Liters or Gallons per sec, min, hour or day	See list on page 6	page 6
(K)Factor	Set PULSES per VOLUME UNIT	0.0001 to 999999	page 6
Average	Smooths out erratic flow conditions	0 to 100 seconds	page 7
Sensitivity	Overrides Average for large rate changes	0 to 9	page 7
P-Set	Select the mode for the PULSE OUT	Total or Divider	page 8
P-Factor	As PULSE **DIVIDER**, divides input freq.	1.0000 to 99999	page 8
P-Factor	As PULSE **TOTAL**, multiplies K-Factor	1.0000 to 99999	page 8
Relay Logic	Select Hi alarm or Lo alarm mode	Hi or Lo	page 9
Relay Set	Set Relay Setpoint	0.0000 to 99999	page 9
Relay Hysteresis	Rate inside Setpoint to DEENERGIZE relay	0.0000 to 99999	page 9
Relay Delay	Time delay before relay is ENERGIZED	0000.0 to 6400.0	page 9
4 Set	Set flow RATE to be represented by 4 mA	0.0000 to 99999	page 6
20 Set	Set flow RATE to be represented by 20 mA	0.0000 to 99999	page 6
Contrast	Adjust visibility of liquid crystal display	1 to 3	page 6

Flow Units

This function is available on these versions of the 2537.

PulSE | totAL | di9itAL | On-OFF | 4-20

Select the volumetric units for the flow measurement.

L/S	Liters/second	G/S	Gallons/second
L/m	Liters/minute (Factory setting)	G/m	Gallons/minute
L/h	Liters/hour	G/h	Gallons/hour
L/d	Liters/day	G/d	Gallons/day

Example: Set the Flow Units to Gallons per minute:

1. 2s — FLO Unit
2. 2s — FLO Unit
3. — FLO Unit

Save the new setting:

2s — SAUE ? n
— SAUE ? Y
— Storing..

Go to next menu item — Return to Normal Operation

K-Factor

This function is available on these versions of the 2537.

PulSE | totAL | di9itAL | On-OFF | 4-20

The factory setting is 60.0000.
Locate the K-factor in the tables on page 10.

FActor

Minimum value 0.0001

Maximum value 999999

Example: Set the K-Factor to 63.5 Pulses per Gallon:

1. 2s — FLO Unit
2. — FActor
3. 2s — 060.000
4. x2 — 060.000
5. x3 — 063.000
6. — 063.000
7. x5 — 063.500

Save the new setting:

2s — SAUE ? n
— SAUE ? Y
— Storing..

Go to next menu item — Return to Normal Operation

Set 4 and Set 20

This function is available on these versions of the 2537.

~~PulSE~~ | ~~di9itAL~~ | ~~On-OFF~~ | 4-20

These two functions are used to span the 4-20 mA output signal to the required range.
The factory setting is 4-20 mA = 0 to 10.000

Only the 20 mA span is illustrated here.
Example: Set 20 mA = 500 GPM.

2s — FLO Unit
x5 — 20 SEt
2s — 10.000
x4 — 50.000
x2 — 50000
— 50000

Save the new setting:

2s — SAUE ? n
— SAUE ? Y
— Storing..

Go to next menu item — Return to Normal Operation

Set Contrast

This function is available on these versions of the 2537.

PulSE | di9itAL | On-OFF | 4-20

All models of the 2537 have the CONTRAST adjustment. It is always located at the end of the menu.

1. 2s
2. x1

Repeat until ⋮

To access the adjustment, enter the menu and scroll until the Contrast display appears.

ContrASt

There are three levels of adjustment. The factory setting of 3 is the highest contrast setting.

Choose:

1 OR 2 OR 3

Save the new setting:

2s — SAUE ? n
— SAUE ? Y
— Storing..

Go to next menu item — Return to Normal Operation

Averaging and Sensitivity Settings

- Because ideal flow conditions are often impossible to achieve, the flow rate is often erratic, which causes any control features (ie; relays, 4-20 mA loops, etc.) that are associated with the flow rate to be erratic.
- The best solution to these problems is to correct any piping deficiency that causes the instability. This may involve longer straight runs upstream, reducing the pipe size to maintain a full pipe at all times, and other installation changes. But in many situations these measures are simply not possible.
- The 2537 meter provides two tools that are designed to "work around" these deficiencies. The Averaging and the Sensitivity features should be studied before making adjustments.

Averaging Time in Seconds (Factory set: 0 seconds)

- Set the time the meter will use as the averaging period. The range is from 0 (no average applied to input) to 100 (seconds of averaging applied to input).
  Use higher averaging times to smooth the display and current output where the flow in the pipe is erratic.

Quick Response Sensitivity (Factory set: 0)

- Set the relative degree of change in the flow rate required to allow the 2537 to disable the AVERAGING and jump to a new flow rate immediately. The scale is from 0 (Least sensitive, averaging is never disabled.) to 9 (a very small change in flow rate will disable the averaging).

No AVERAGING, no SENSITIVITY

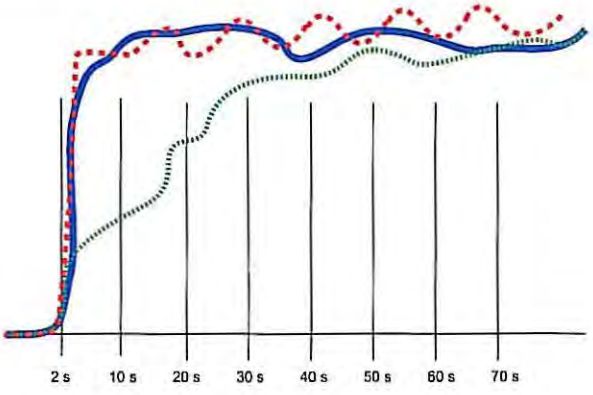
With AVERAGING set to 0 (zero) and with SENSITIVITY set to zero, the 2537 responds to every unstable shift in the flow. The dashed red line represents the actual output of the flow sensor in unstable flow conditions.

AVERAGING only

With AVERAGING set to 50 seconds and SENSITIVITY still set to zero the flow rate is stabilized, but a sharp change in flow rate is not represented for 50 seconds or longer. (dotted green line).

AVERAGING and SENSITIVITY

With AVERAGING at 50 seconds and SENSITIVITY set to 4 OR 5, the flow rate is stabilized, while the sudden shift in flow is reflected very quickly. (Solid blue line)



NOTE: The SENSITIVITY function is ineffective if the AVERAGING function is set to zero (seconds).

Set Averaging

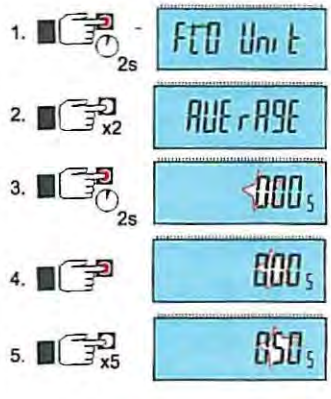
This function is available on these versions of the 2537:

The factory setting is 0 (zero).

Minimum value

Maximum value

Example:
Set the Averaging for 50 seconds.



Save the new setting:

Set Sensitivity

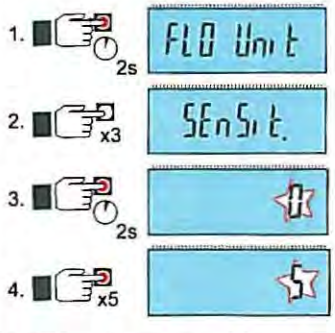
This function is available on these versions of the 2537:

The factory setting is 0 (zero).

Minimum value

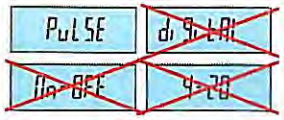
Maximum value

Example: Set the Sensitivity to 5.



Save the new setting:

P-Set



This function is available on these versions of the 2537:

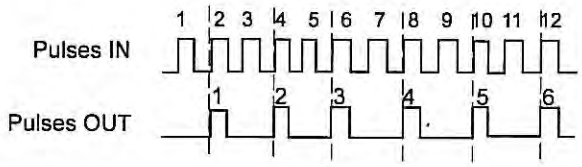
Select DIVIDER or TOTAL operation.
The factory setting is TOTAL.

PULSE DIVIDER Output = Input pulses ÷ P-Factor

DIVIDER allows you to set a scaling value (P-Factor) from 1.0000 to 99999.

Example: If the P-Factor is set for 2, then the 2537 will output one pulse for every 2 pulses received from the sensor.
This selection enables the output frequency to be scaled down to match associated equipment capabilities.

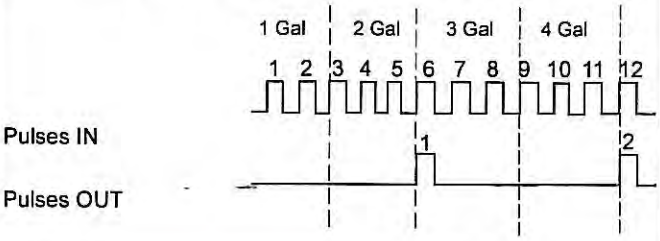
When using the PULSE DIVIDER output, associated equipment must divide the K-factors in this manual by the P-Factor for correct calibration.

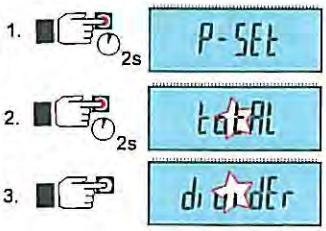


PULSE TOTAL Output = Input pulses ÷ (K-Factor • P-Factor)
TOTAL is a traditional pump pulser function. This selection will allow the entry of a K-Factor to define a volumetric unit, then set a P-Factor to define the number of volumetric units required to generate one pulse out.

Example:
Set the Total Pulse output so there is one pulse out for each 2 gallons that passes the sensor if the K-factor is 3.0.

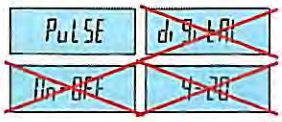
1. (K) Factor = 3.0 (pulses in per gallon)
2. P- Factor = 2 (gallons out per pulse)





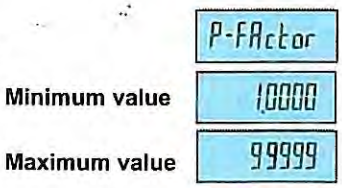
Save the new setting:

P-Factor



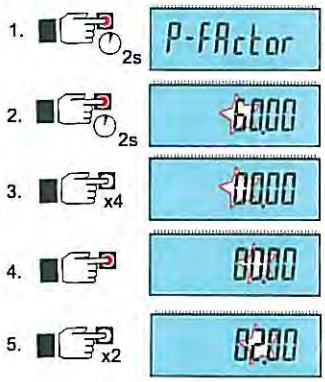
This function is available on these versions of the 2537:

The factory setting is 1.0000



In PULSE DIVIDER mode the P-Factor divides:
The pulse stream from the paddlewheel sensor will be divided by the P-Factor. The resulting frequency is output through a relay.

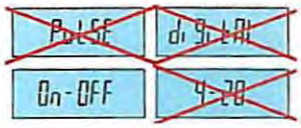
In PULSE TOTAL mode the P-Factor multiplies:
The pulse stream from the paddlewheel sensor is divided by the K-Factor MULTIPLIED by the P-factor. The resulting frequency is output through a relay.



Save the new setting:

Set Relay operation

The Flow Switch has one relay (SPDT or solid-state) that can be programmed as a HIGH (Hi) alarm or a LOW (Lo) alarm.



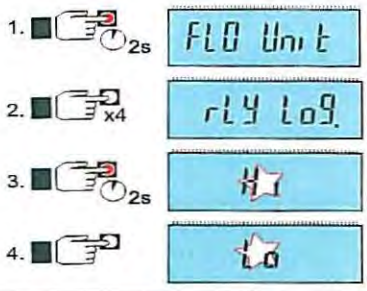
1. Select HI or LO Relay Alarm logic

A HI alarm will be activated when the flow rate rises ABOVE the setpoint.

A LO alarm will be activated when the flow rate falls BELOW the setpoint.

The factory setting is Hi(gh).

Example: Change the Relay Logic to Low:

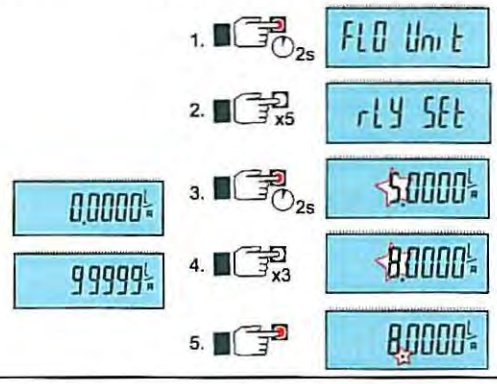


Save the new setting:

2. Program the SETPOINT.

The SETPOINT is the flow rate where the relay will be energized. The factory setting is 5.0000.

Example: Change the Setpoint to 8.0000:



Save the new setting:

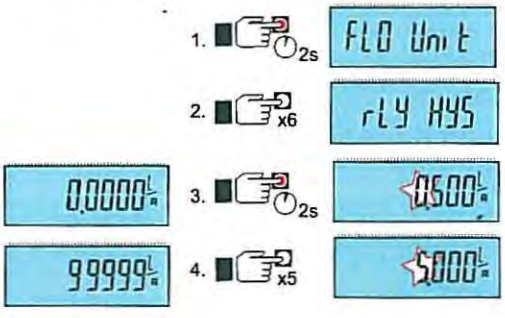
Minimum value 0.0000

Maximum value 99999

3. Program the HYSTERESIS.

Hysteresis holds a relay energized until the flow rate moves this amount past the setpoint. The factory setting is 0.5000

Example: Change the Hysteresis to 5.0000:



Save the new setting:

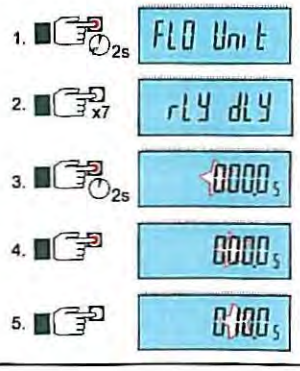
Minimum value 0.0000

Maximum value 99999

4. Program the DELAY.

When the flow rate reaches the setpoint, the 2537 will wait this long (in seconds) before triggering the alarm.
The factory setting is 0000.0 seconds.

Example: Change the Delay to 10.0:



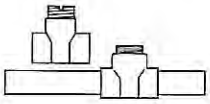
Save the new setting:

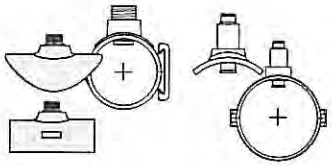
Minimum value 00000

Maximum value 64000

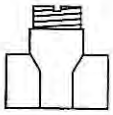
K-Factors

When using the PULSE DIVIDER output, associated equipment must divide the K-factors by the P-Factor.

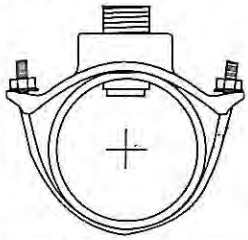


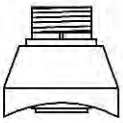


PIPE SIZE (IN.)	FITTING	2536/8512-XX	
		U.S. GAL	LITERS
SCH 80 PVC TEES FOR SCH 80 PVC PIPE			
1/2	PV8T005	991.71	262.01
3/4	PV8T007	545.14	144.03
1	PV8T010	352.44	93.114
1-1/4	PV8T012	177.18	46.812
1-1/2	PV8T015	117.85	31.137
2	PV8T020	66.739	17.633
2-1/2	PV8T025	42.994	11.359
3	PV8T030	26.652	7.0414
4	PV8T040	15.006	3.9645
SCH 80 CPVC TEES FOR SCH 80 CPVC PIPE			
1/2	CPV8T005	991.71	262.01
3/4	CPV8T007	545.14	144.03
1	CPV8T010	352.44	93.114
1-1/4	CPV8T012	177.18	46.812
1-1/2	CPV8T015	117.85	31.137
SCH 80 PVC SADDLES FOR SCH 80 PVC PIPE			
2	PV8S020	66.739	17.633
2-1/2	PV8S025	42.994	11.359
3	PV8S030	26.652	7.0414
4	PV8S040	15.006	3.9645
6	PV8S060	8.3246	2.1994
8	PV8S080	5.0164	1.3253
SCH 80 PVC SADDLE ON SCH 40 PVC PIPE			
2	PV8S020	54.700	14.452
2-1/2	PV8S025	37.159	9.8175
3	PV8S030	23.697	6.2608
4	PV8S040	13.456	3.5552
6	PV8S060	7.4594	1.9708
8	PV8S080	4.5292	1.1966



PIPE SIZE (IN.)	FITTING	2536/8512-XX	
		U.S. GAL	LITERS
CARBON STEEL TEES ON SCH 40 PIPE			
1/2	CS4T005	756.00	199.74
3/4	CS4T007	438.69	115.90
1	CS4T010	286.78	75.768
1-1/4	CS4T012	121.22	32.026
1-1/2	CS4T015	91.139	24.079
2	CS4T020	54.468	14.391
STAINLESS STEEL TEES ON SCH 40 PIPE			
1/2	CR4T005	734.20	193.98
3/4	CR4T007	412.10	108.88
1	CR4T010	252.70	66.764
1-1/4	CR4T012	128.12	33.849
1-1/2	CR4T015	77.320	20.428
2	CR4T020	45.780	12.095
GALVANIZED IRON TEES ON SCH 40 PIPE			
1	IR4T010	213.01	56.277
1-1/4	IR4T012	127.75	33.751
1 1/2	IR4T015	94.401	24.941
2	IR4T020	59.420	15.699
BRONZE TEES ON SCH 40 PIPE			
1	BR4T010	213.01	56.277
1-1/4	BR4T012	127.75	33.751
1-1/2	BR4T015	94.401	24.941
2	BR4T020	59.420	15.699
COPPER TEE FITTINGS ON COPPER PIPE SCH K			
1/2	CUKT005	917.84	242.50
3/4	CUKT007	428.27	113.15
1	CUKT010	256.43	67.749
1-1/4	CUKT012	176.44	46.615
1-1/2	CUKT015	115.69	30.565
2	CUKT020	63.385	16.746
COPPER TEE FITTINGS ON COPPER PIPE SCH L			
1/2	CUKT005	858.22	226.74
3/4	CUKT007	385.74	101.91
1	CUKT010	241.64	63.841
1-1/4	CUKT012	170.90	45.152
1-1/2	CUKT015	112.03	29.598
2	CUKT020	61.74	16.310



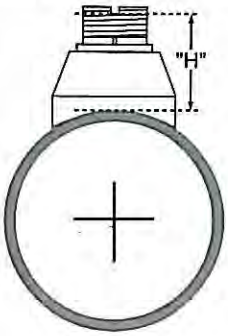


PIPE SIZE (IN.)	FITTING	2536/8512-XX	
		U.S. GAL	LITERS
STAINLESS STEEL WELDOLETS ON SCH 40 PIPE			
2-1/2	CR4W025	37.600	9.9339
3	CR4W030	24.340	6.4306
4	CR4W040	13.920	3.6777
5	CR4W050	10.860	2.8692
6	CR4W060	7.5200	1.9868
8	CR4W080	4.3400	1.1466
CARBON STEEL WELDOLETS ON SCH 40 PIPE			
2-1/2	CS4W025	37.600	9.9339
3	CS4W030	24.340	6.4306
4	CS4W040	13.920	3.6777
5	CS4W050	10.860	2.8692
6	CS4W060	7.5200	1.9868
8	CS4W080	4.3400	1.1466
COPPER/BRONZE BRAZOLETS ON SCH 40 PIPE			
2-1/2	BR4B025	37.600	9.934
3	BR4B030	24.340	6.431
4	BR4B040	13.920	3.678
5	BR4B050	10.860	2.869
6	BR4B060	7.5200	1.987
8	BR4B080	4.3400	1.147
SCH 80 IRON SADDLES ON SCH 80 PIPE			
2	IR8S020	64.720	17.099
2-1/2	IR8S025	42.480	11.223
3	IR8S030	26.420	6.980
4	IR8S040	14.700	3.884
5	IR8S050	12.180	3.218
6	IR8S060	8.4400	2.230
8	IR8S080	4.9000	1.295
SCH 80 IRON SADDLE ON SCH 40 PIPE			
2	IR8S020	53.640	14.172
2-1/2	IR8S025	37.600	9.934
3	IR8S030	23.220	6.135
4	IR8S040	13.260	3.503
5	IR8S050	11.040	2.917
6	IR8S060	7.2400	1.913
8	IR8S080	4.4000	1.162

H-Dimensions

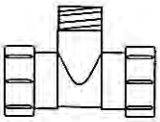
The plastic insert in Weldolet fittings MUST be removed during the welding process. When reinstalled, it is important that the insert be threaded to the proper height ("H" dimension).

Weldolet	"H" dimension	
part number	inches	mm
CS4W020	2.38	60.45
CS4W025	2.33	59.18
CS4W030	2.32	58.92
CS4W040	2.30	58.42
CS4W050	3.09	78.48
CS4W060	2.96	75.18
CS4W080	2.73	69.34



Weldolet	"H" dimension	
part number	inches	mm
CR4W020	2.38	60.45
CR4W025	2.33	59.18
CR4W030	2.32	58.92
CR4W040	2.30	58.42
CR4W050	3.09	78.48
CR4W060	2.96	75.18
CR4W080	2.73	69.34

K-Factors



PIPE SIZE	FITTING	2536/8512-XX	
		U.S. GAL	LITERS
POLYPROPYLENE FITTINGS (DIN/ISO AND BS AND ANSI)			
DN 15	PPMT005	952.87	251.75
DN 20	PPMT007	563.10	148.77
DN 25	PPMT010	291.60	77.042
DN 32	PPMT012	169.22	44.709
DN 40	PPMT015	103.90	27.450
DN 50	PPMT020	60.789	16.060
DN 65	PPMT025	41.498	10.964
DN 80	PPMT030	26.786	7.0769
DN 100	PPMT040	17.415	4.6011
DN 125	PPMT050	10.168	2.6864
DN 150	PPMT060	7.3119	1.9318
DN 200	PPMT080	3.9946	1.0554

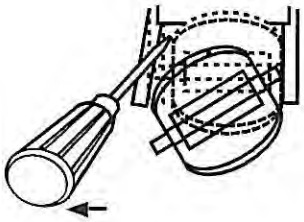
PIPE SIZE	FITTING	2536/8512-XX	
		U.S. GAL	LITERS
PVDF FITTINGS (DIN/ISO AND BS AND ANSI)			
DN 15	SFMT005	827.26	218.56
DN 20	SFMT007	489.87	129.42
DN 25	SFMT010	283.55	74.915
DN 32	SFMT012	158.59	41.899
DN 40	SFMT015	86.980	22.980
DN 50	SFMT020	50.385	13.312
DN 65	SFMT025	36.133	9.5465
DN 80	SFMT030	24.715	6.5297
DN 100	SFMT040	16.120	4.2589
DN 125	SFMT050	8.8624	2.3415
DN 150	SFMT060	6.4543	1.7052
DN 200	SFMT080	4.0720	1.0758
PVC FITTINGS (DIN/ISO) - EUROPE ONLY			
DN 15	PVMT005	972.37	256.90
DN 20	PVMT007	485.69	128.32
DN 25	PVMT010	297.27	78.540
DN 32	PVMT012	170.25	44.980
DN 40	PVMT015	103.71	27.400
DN 50	PVMT020	59.500	15.720
DN 65	PVMT025	34.973	9.2400
DN 80	PVMT030	24.981	6.6000
DN 100	PVMT040	16.275	4.3000
DN 150	PVMT060	8.1756	2.1600
DN 200	PVMT080	4.0878	1.0800

Maintenance and Cleaning

The 2537 requires very little maintenance.

- If the paddlewheel becomes fouled, it can be cleaned with mild detergents and a small brush.
- The electronics portion of the 2537 does not require maintenance or cleaning.

Rotor Replacement Procedure



1. To remove the rotor, insert a small screwdriver between the rotor and the ear of the sensor.
2. Twist the screwdriver blade to flex the ear outward enough to remove one end of the rotor and pin. DO NOT flex the ear any more than necessary! If it breaks, the sensor cannot be repaired.
3. Install the new rotor by inserting one tip of the pin into the hole, then flex the opposite ear back enough to slip rotor into place.

Ordering Information

Mfr. Part No.	Code	Description
2537 system for 0.5 in. to 4 in. pipes, with polypropylene body, Black PVDF rotor, Titanium pin, FPM O-rings		
3-2537-1C-P0	159 001 291	Pulse Divider via Dry-Contact Relay, Integral Mount
3-2537-2C-P0	159 001 292	Pulse Divider via Solid-State Relay, Integral Mount
3-2537-3C-P0	159 001 293	Flow Switch via Dry-Contact Relay, Integral Mount
3-2537-4C-P0	159 001 294	Flow Switch via Solid-State Relay, Integral Mount
3-2537-5C-P0	159 001 295	Digital (S^3L), Integral Mount
3-2537-6C-P0	159 001 296	4-20 mA, Integral Mount
2537 system for 5 in. to 8 in. pipes, with polypropylene body, Black PVDF rotor, Titanium pin, FPM O-rings		
3-2537-1C-P1	159 001 303	Pulse Divider via Dry-Contact Relay, Integral Mount
3-2537-2C-P1	159 001 304	Pulse Divider via Solid-State Relay, Integral Mount
3-2537-3C-P1	159 001 305	Flow Switch via Dry-Contact Relay, Integral Mount
3-2537-4C-P1	159 001 306	Flow Switch via Solid-State Relay, Integral Mount
3-2537-5C-P1	159 001 307	Digital (S^3L), Integral Mount
3-2537-6C-P1	159 001 308	4-20 mA, Integral Mount
2537 system for 0.5 in. to 4 in. pipes, with natural PVDF body, rotor and pin, FPM O-rings		
3-2537-1C-T0	159 001 315	Pulse Divider via Dry-Contact Relay, Integral Mount
3-2537-2C-T0	159 001 316	Pulse Divider via Solid-State Relay, Integral Mount
3-2537-3C-T0	159 001 317	Flow Switch via Dry-Contact Relay, Integral Mount
3-2537-4C-T0	159 001 318	Flow Switch via Solid-State Relay, Integral Mount
3-2537-5C-T0	159 001 319	Digital (S^3L), Integral Mount
3-2537-6C-T0	159 001 320	4-20 mA, Integral Mount

Accessories

Mfr. Part No.	Code	Description
3-2536.320-1	198 820 052	Rotor, PVDF Black
3-2536.320-2	159 000 272	Rotor, PVDF Natural
3-2536.320-3	159 000 273	Rotor, Tefzel®
3-2536.321	198 820 054	Rotor and Pin, PVDF Natural
3-2536.322-1	198 820 056	Sleeved Rotor, PVDF Black
3-2536.322-2	198 820 057	Sleeved Rotor, PVDF Natural
3-2536.322-3	198 820 058	Sleeved Rotor, Tefzel®
M1546-1	198 801 182	Rotor Pin, Titanium
M1546-2	198 801 183	Rotor Pin, Hastelloy-C
M1546-3	198 820 014	Rotor Pin, Tantalum
M1546-4	198 820 015	Rotor Pin, Stainless Steel
P51545	198 820 016	Rotor Pin, Ceramic
1220-0021	198 801 186	O-Ring, FPM
1224-0021	198 820 006	O-Ring, EPDM
1228-0021	198 820 007	O-Ring, FFPM
P31536	198 840 201	Sensor Plug, Polypro
P31536-2	159 000 649	Sensor Plug, PVDF
3-8050.396	159 000 617	RC Filter kit (for relay use)
3-9000.392-1	159 000 839	Liquid tight connector kit, NPT (1 piece)
3-9000.392-2	159 000 841	Liquid tight connector kit, PG13.5 (1 piece)
3-9000.392-3	159 001 430	Liquid-tight connector kit, dual-cable gland
7300-7524	159 000 687	24 VDC Power Supply 7.5 W, 300mA
7300-1524	159 000 688	24 VDC Power Supply 15 W, 600mA
7300-3024	159 000 689	24 VDC Power Supply 30 W, 1.3 A
7300-5024	159 000 690	24 VDC Power Supply 50 W, 2.1 A
7300-1024	159 000 691	24 VDC Power Supply 100 W, 4.2 A

+GF+

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For Worldwide Sales and Service, visit our website: www.gfsignet.com • Or call (in the U.S.): (800) 854-4090

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APPENDIX F: MAGMETER FLOW METER MANUAL

Signet 2551 Magmeter

English

3-2551.090 Rev G 10/08 English

	Topic:	Page
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5.	Hardware Configuration	4
6.	General Installation and Grounding Tips	5
7.	Wiring the Magmeter with 4-20 Loop	5
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Description

The Signet 2551 Magmeter is an insertion style magnetic flow sensor. The patented sensor design is available in a variety of corrosion-resistant materials to provide long-term reliability and minimal maintenance costs. Wetted material combinations include PP/316 SS, PVDF/SS, PVDF/Hastelloy-C, and PVDF/Titanium. The 2551 installs quickly and securely into a wide selection of flow fittings to deliver accurate flow measurement in pipe sizes ranging from DN15 to DN300 (½ in. to 12 in.).

Signet 2551 Magmeters are available with a frequency output or a 4 to 20 mA output. Signet's digital (S^3L) output is included with the Frequency output models for use with the Signet 8900 Multi-Parameter Controller, while the 4 to 20 mA output can be used for a direct input to a PLC, SCADA or telemetry system.

All 2551 Magmeters feature empty pipe detection and LED-assisted diagnostics. The Signet 3-0250 USB to Digital S^3L set-up tool is available to customize every performance feature in the 2551 to adapt it to the specific application requirements.

1. Quick Start Guide

This manual contains the general installation, wiring and calibration data for the Signet 2551-XX-11 Magmeter with Frequency or Serial data output, and for the Signet 2551-XX-12 Magmeter with Current output. The basic steps are outlined on this page.
See each referenced section for detailed information.

1. Configure the Hardware
2551-XX-11 ONLY: Position this Jumper to select digital (S^3L) output or Frequency output. (Not used for Current output version) Sec. 5 Pg. 4

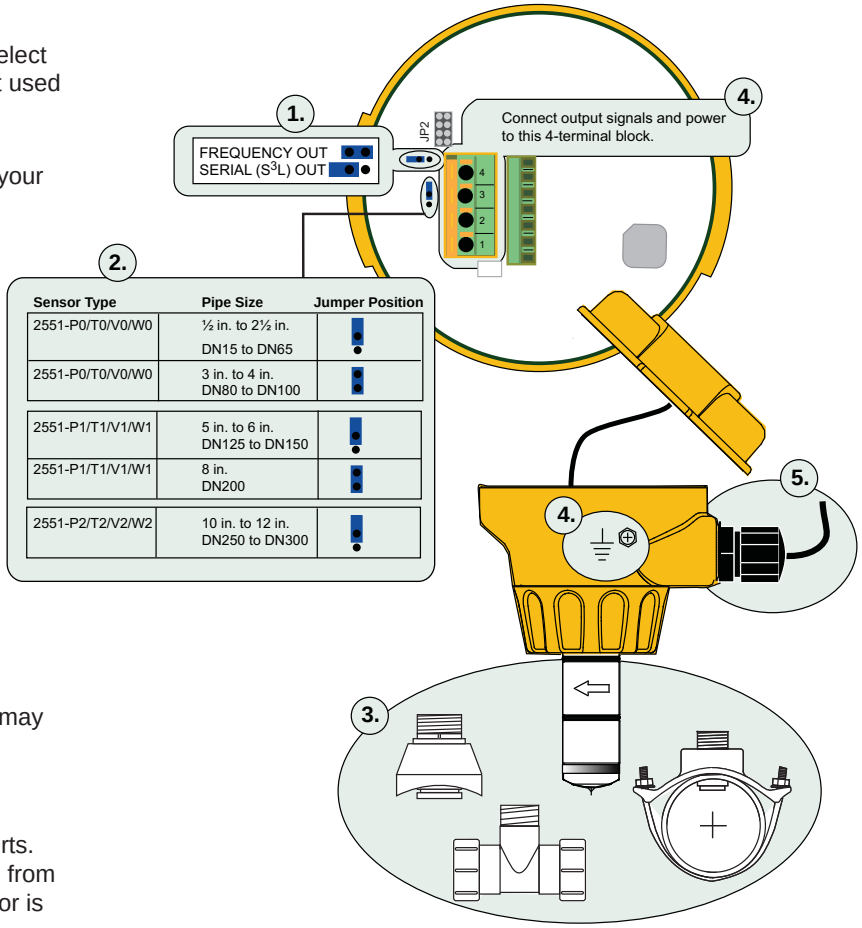
2. Position the PIPE SIZE Jumper according to your pipe size. Sec. 5 Pg. 4.

3. Install the Magmeter into the pipe.
Use Signet installation fittings ONLY.
The installation fitting is critical to Magmeter performance. Sec. 3 Pg. 3

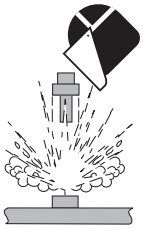
4. Connect POWER and OUTPUT wiring.
2551-XX-11 Frequency out: Sec. 8.1 Pg. 6
2551-XX-11 Serial data out: Sec. 8.2 Pg. 6
2551-XX-12 Current out wiring: Sec. 7 Pg. 5

GROUNDING
Without a good Earth Ground, the Magmeter may not operate efficiently. Sec. 6 Pg. 5

5. Route the wiring out through the two cable ports.
Use appropriate hardware to secure the 2551 from moisture intrusion. One Liquid Tight Connector is included. Sec. 5 Pg. 4



SAFETY INSTRUCTIONS
1. Depressurize and vent system prior to installation or removal.
2. Confirm chemical compatibility before use.
3. Do not exceed maximum temperature/pressure specifications.
4. Wear safety goggles or face shield during installation/service.
5. Do not alter product construction.
6. Disconnect power before attempting any service or wiring.



2. Specifications

General

Pipe size range: DN15 to DN 300 (0.5 in. to 12 in.)
Flow Range
- Minimum: 0.05 m/s (0.15 ft/s)
- Maximum: 10 m/s (33 ft/s)

Linearity: ±1% reading plus 0.01m/s (0.033 ft/s)
Repeatability: ±0.5% of reading @ 25°C (77°F)
Minimum Conductivity: 20 µS/cm

Wetted Materials:
- Sensor body and Electrodes and Grounding ring:
  - -P0, -P1, -P2: Polypropylene and 316L SS
  - -T0, -T1, -T2: PVDF and Titanium
  - -V0, -V1,-V2: PVDF and Hastelloy-C
  - -W0, -W1, -W2: PVDF and 316L SS
  - O-rings: FPM (standard)
    EPDM, FFPM (optional)

The user is responsible for determining the chemical suitability of these materials for a specific application.

- Case: PBT
- Display window: Polyamide

Electrical

Power Requirements
- 4 to 20 mA: 21.6 to 26.4 VDC, 22.1 mA max.
- Frequency: 5 to 26.4 VDC, 15 mA max.
- Digital (S^3L): 5 to 6.5 VDC, 15 mA max.

Reverse polarity and short circuit protected

Current output (4 to 20 mA):
- Loop Accuracy:
  32 µA max. error (25°C @ 24 VDC)
- Isolation: Low voltage < 48 VAC/DC from electrodes and auxilary power
- Maximum cable: 300 m (1000 ft.)
- Error condition: 22.1 mA
- Max. Loop Resistance: 300 Ω
- Compatible with PLC, PC or similar equipment

Frequency output:
- Max. Pull-up Voltage: 30 VDC
- Compatible with Signet 5075, 5500, 5600, 8550, 8900

Digital (S^3L) Output:
- Serial ASCII, TTL level 9600 bps
- Compatible with Signet 8900

Environmental Requirements

Storage Temperature: -20° to 70°C (-4° to 158°F)
Relative Humidity: 0 to 95% (non-condensing)
Operating Temperature:
- Ambient: -10° to 70°C (14° to 158°F)
- Media: 0° to 85°C (32° to 185°F)

Max. operating pressure:
- 10.3 bar @ 25°C (150 psi @ 77°F)
- 1.4 bar @ 85°C (20 psi @ 185°F)

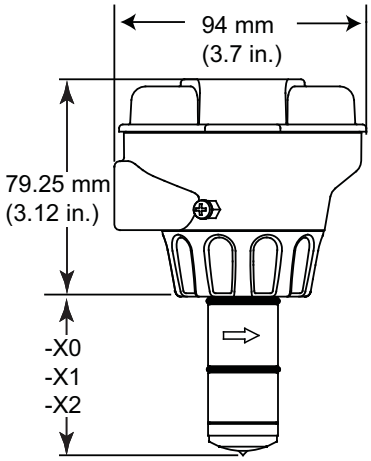
Standards and Approvals

CE
NEMA 4X / IP65 Enclosure (with cap installed)
EMC: EN55011: 1998 +A1:99+A2:02
Class B Emissions
EN61326: 1997 +A1:98+A2:01
EN61000-6-2:2001
Safety: EN61010-1:2001

U.S. Patent No. 7,055,396 B1

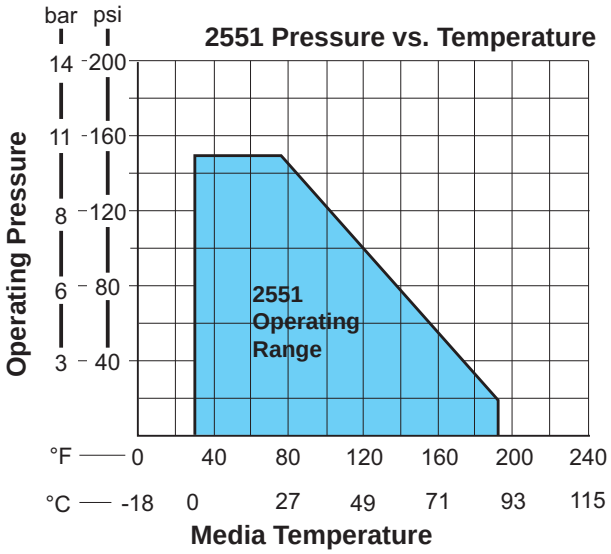
Chinese RoHS
For more information go to www.gfsignet.com

Dimensions



Pipe Range
1/2 to 4 in. -X0 = 58 mm (2.3 in.)
5 to 8 in. -X1 = 91 mm (3.6 in.)
10 to 12 in. -X2 = 167 mm (6.6 in.)

X = Sensor Body P, T, V, or W



3. Installation: Pipe fittings

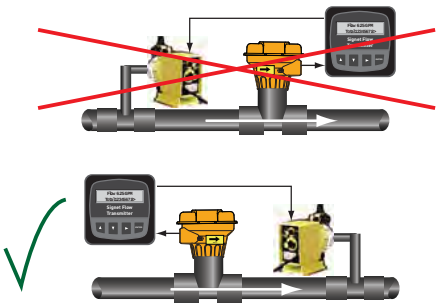
Georg Fischer offers a wide selection of installation fittings that control the position of the Magmeter electrodes in relation to the dimensions of the pipe. You will find a complete list of order numbers for installation fittings in the Calibration Tables on pages 7-10.

Type	Description
Plastic tees	• 0.5 to 4 inch versions • PVC or CPVC
PVC Glue-on Saddles	• Available in 10 and 12 inch sizes only • Cut 2-1/2 inch hole in pipe • Weld in place using solvent cement
PVC Saddles	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • 6 to 8 inch, cut 2-1/8 inch hole in pipe
PP Clamp-on Saddles	• Available in 10 and 12 inch sizes only • Cut 2-1/8 inch hole in pipe
Iron Strap-on saddles	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/8 inch hole in pipe

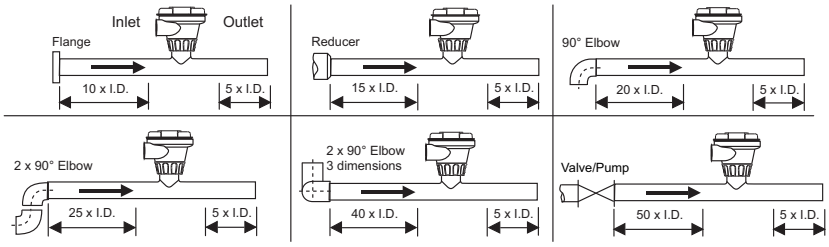
Type	Description
Iron, Carbon Steel, 316 SS Threaded tees	• 0.5 to 2 in. versions • Mounts on threaded pipe ends
Carbon steel & stainless steel Weld-on Weldolets	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/8 inch hole in pipe
Fiberglass tees & saddles: FPT FPS	• 1.5 in. to 8 in. PVDF insert • > 8 in. PVC insert
Metric Union tees	• For pipes from DN 15 to 50 mm • PP or PVDF

4. Selecting a Location

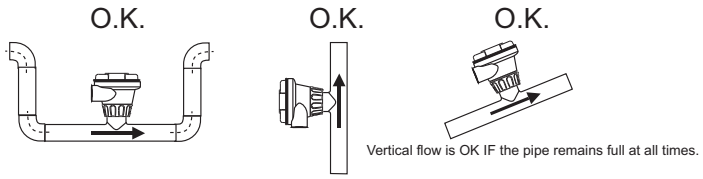
- The 2551 requires a full pipe and a fully developed turbulent flow profile for accurate measurement.
- If the piping system harbors air pockets or bubbles, take steps to locate the sensor so the air pockets will not contact the electrodes.
- In vertical installations, assemble the 2551 so the conduit ports are facing downward. This prevents condensation inside the conduit from being directed into the 2551 electronics housing.
- Chemical injection systems can temporarily alter the fluid conductivity and cause anomalies in the magmeter measurement.
  To avoid this problem, install the magmeter UPSTREAM of the injection point.



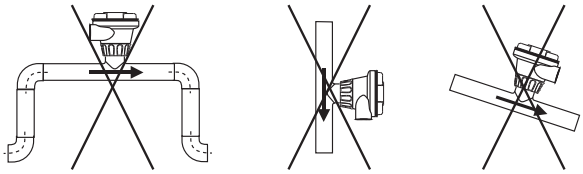
Select a location with sufficient distance of straight pipe immediately upstream of the sensor.



Locating the sensor in a trap or where the flow is upward helps to protect the sensor from exposure to air bubbles when the system is in operation.

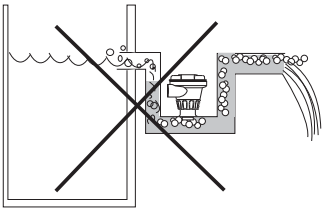


These configurations are not recommended because it is difficult to keep the pipe full.



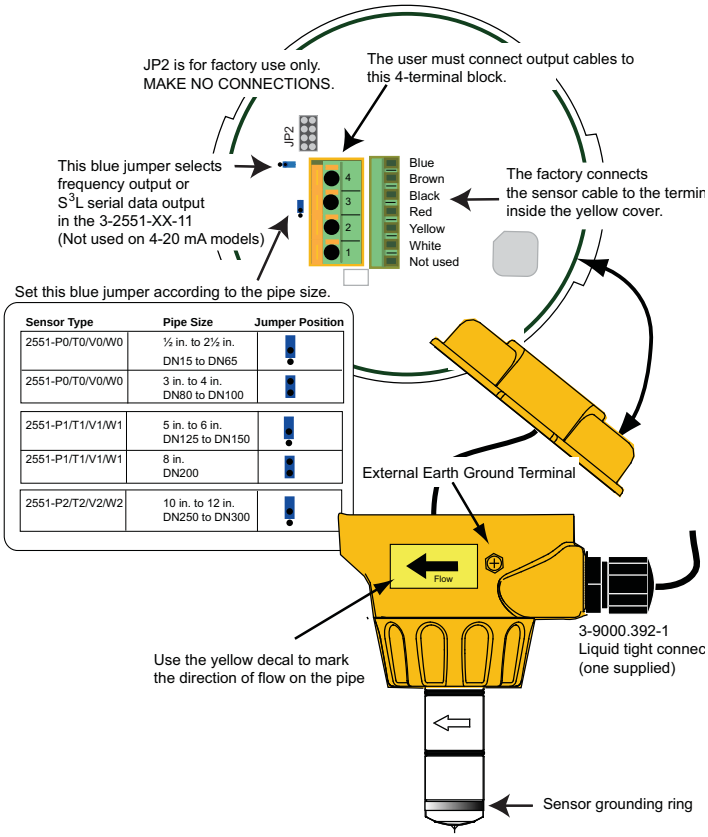
In a gravity-flow system, the tank must be designed so the level does not drop below the outlet.

This causes the pipe to draw air in from the tank. If air bubbles pass across the Magmeter electrodes, the output will become erratic.



5. Hardware Configuration

Whether using the 2551-XX-11 (frequency or digital S^3L output) or the 2551-XX-12 (with 4-20 mA output), the wiring terminals located on the inside of the yellow cover are identical. All of the connections from the Magmeter to external equipment (PLC, Datalogger, Chart Recorder, Flow meter, etc.) are made at the large 4-position terminal connector.
When the cover is removed the wiring from the sensor can be seen connected to the smaller terminal block. These connections should always remain connected to prevent inadvertent damage or miswiring.
The terminals on the 2551 Magmeter are designed for conductors from 16 AWG to 22 AWG.



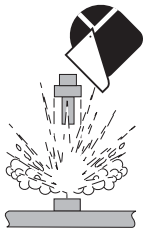
Sensor Type	Pipe Size	Jumper Position
2551-P0/T0/V0/W0	½ in. to 2½ in. DN15 to DN65	
2551-P0/T0/V0/W0	3 in. to 4 in. DN80 to DN100	
2551-P1/T1/V1/W1	5 in. to 6 in. DN125 to DN150	
2551-P1/T1/V1/W1	8 in. DN200	
2551-P2/T2/V2/W2	10 in. to 12 in. DN250 to DN300	

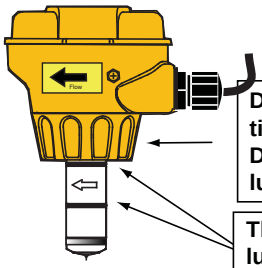
WARNING!
If the second conduit port is used, carefully drill the opening. (The plastic is too strong to be punched out.)
- Secure the Magmeter in a vise to prevent damage or injury.
- The plastic inside the port is very thin. Do not allow the drill to penetrate too deeply and damage the Magmeter wiring.

Important:

- The directional arrow on the sensor body MUST be pointed DOWNSTREAM for best performance.
- The FLOW arrow decal can be placed directly on the pipe to identify the direction of flow.
- Use a cable gland or a liquid tight connector to seal the cable ports from water intrusion.
- The yellow housing may be reversed to align the conduit ports as required.
- If the Magmeter is installed on a vertical pipe, the conduit ports should be turned to point downward. This will prevent condensation from being channeled into the enclosure.
- Use plumber's tape or a suitable sealant on cable ports.

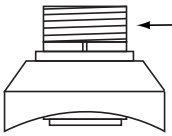
WARNING!





Do not use any tools to tighten the yellow retaining cap. DO NOT USE thread sealant or lubricants on retaining cap!

The O-rings can be lightly lubricated to facilitate insertion into the pipe fitting. DO NOT USE petroleum-based lubricants on O-rings!



DO NOT USE thread sealant or lubricants on the fitting threads.

FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN THE SENSOR BEING EJECTED FROM THE PIPE!

- **DO NOT USE ANY TOOLS ON THE RETAINING CAP. HAND TIGHTEN ONLY.**
- **THE O-RINGS CAN BE LIGHTLY LUBRICATED TO FACILITATE INSERTION INTO THE PIPE FITTING. DO NOT USE PETROLEUM-BASED LUBRICANTS!**
- **DO NOT USE THREAD SEALANT OR LUBRICANTS ON THE RETAINING CAP OR ON THE PLASTIC FITTING THREADS.**
- **IF LEAKING IS OBSERVED FROM THE RETAINING CAP, IT INDICATES DEFECTIVE OR WORN O-RINGS ON THE SENSOR. DO NOT ATTEMPT TO CORRECT BY FURTHER TIGHTENING.**

6. General Installation and Grounding Tips

Sensor conditioning

The Magmeter output signal may be unstable immediately after installation. Allowing the sensor to soak in a full pipe (or in any container of water) for 24 hours will stabilize the performance.

- Very low conductivity fluids may require a longer conditioning period. (The Magmeter may not operate properly in fluids where the conductivity is less than 20 µS/cm.)

Grounding

The 2551 Magmeter is unaffected by moderate levels of electrical noise. However, in some applications it may be necessary to ground portions of the system to eliminate electrical interference. The grounding requirements will vary with each installation.

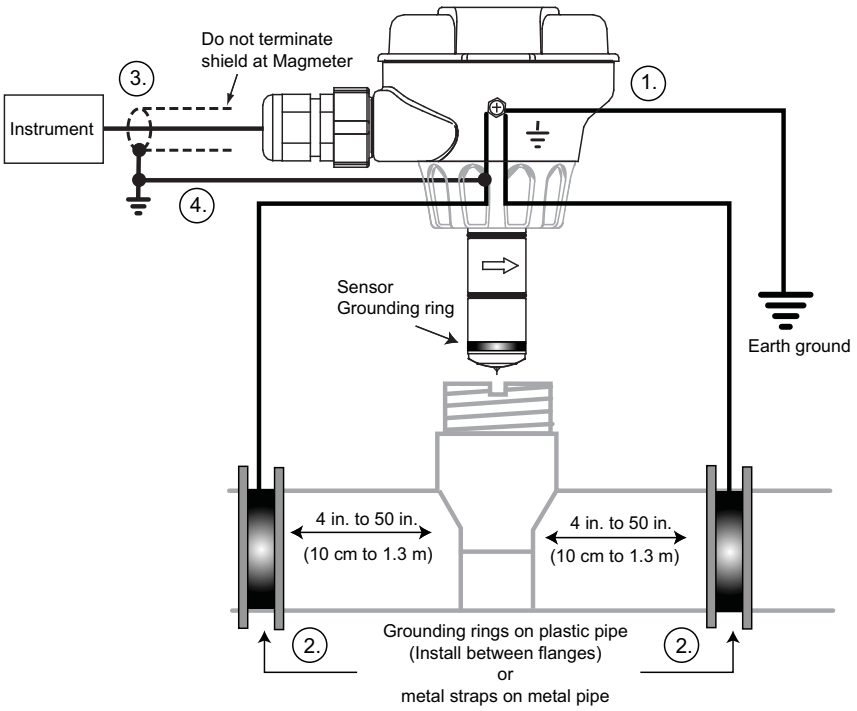
One or more of the following steps may be applied if the 2551 Magmeter is affected by electrical noise:

① The ground terminal on the outside of the yellow housing is connected internally to the grounding ring at the tip of the sensor. Connect a wire (14 AWG/2.08 mm^2 recommended) from this terminal directly to a local Earth ground.

② Install fluid grounding devices immediately upstream and downstream of the Magmeter. Connect the fluid grounds to the Earth ground terminal on the 2551.
Use flanged grounding rings or metal electrodes on plastic pipes, or metal clamps on metal pipes.
Fluid grounds must be in direct contact with the fluid, and as near to the Magmeter as possible.

③ The shield from the output cable must be terminated at the remote instrument ONLY. This shield must not be connected at both ends!

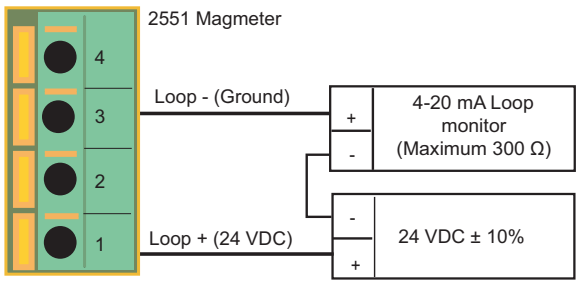
④ Connect an additional wire (minimum AWG 14/2.08 mm^2) from the remote instrument ground to the Magmeter ground terminal.



7. Wiring the 2551-XX-12 Magmeter with 4-20 mA Loop Output

The 2551-XX-12 Magmeter is a traditional 2-wire passive 4-20 mA loop transmitter.

- External loop power (24 VDC ±10%) is required. See Ordering Information for power supplies.
- **The maximum loop resistance the Magmeter can accomodate is 300 Ω.**
- All 2551-XX-12 Magmeters are shipped from the factory with the 4-20 mA output scaled for 0 to 5 m/s (0 to 16.4 ft/s). If this operating range is suitable, no adjustments are necessary.
- The Calibration Tables on pages 7-10 list the 20 mA setpoint for each installation fitting. Use this information to program the 4-20 mA range of the loop device (PLC, Datalogger, recorder, etc.)
- The 3-0250 USB to Digital (S3L) Configuration / Diagnostic Tool is required to change the operating range.

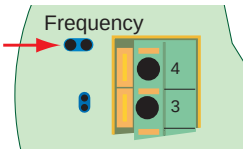


8. Wiring the 3-2551-11 with Frequency or Digital (S^3L) output

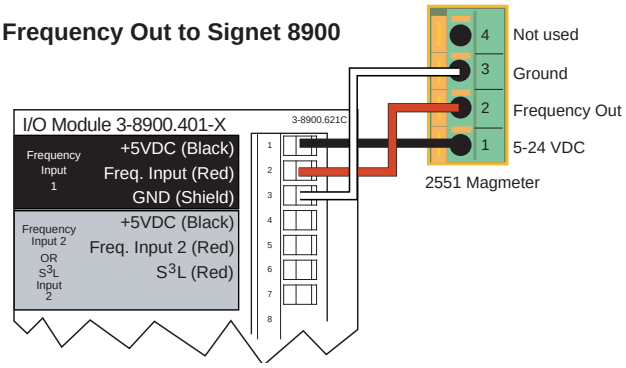
8.1 Wiring: Frequency output (Compatible with all POWERED Signet Flow instruments.)

- When the blue jumper illustrated here is placed over both pins, the 2551-XX-11 outputs an open collector frequency signal that can be connected to any powered Signet flow meter. (Models 5075, 5500, 5600, 8550, 8900.)
- 5 VDC power is provided to the 2551 Magmeter by all Signet flow instruments. No additional power is required.
- If connecting the 2551 Magmeter to a flow instrument from another manufacturer, 5 to 24 VDC power must be provided to the 2551. A 10 KΩ pull up resistor must also be connected between terminals 1 and 2.
- **The frequency output will be displayed as positive flow regardless of the flow direction.**

Blue Jumper ON = FREQ OUT

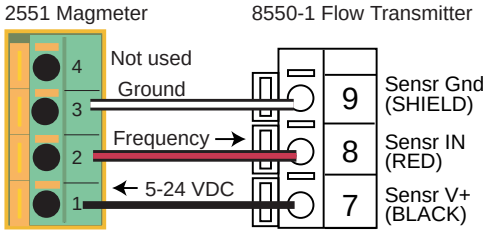


2551 Frequency Out to Signet 8900

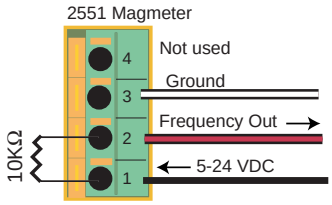


2551 Frequency Out to Signet 8550-1

AUX power MUST be connected on the 8550 to provide power to the 2551.



2551 Frequency Out to other Manufacturer's equipment

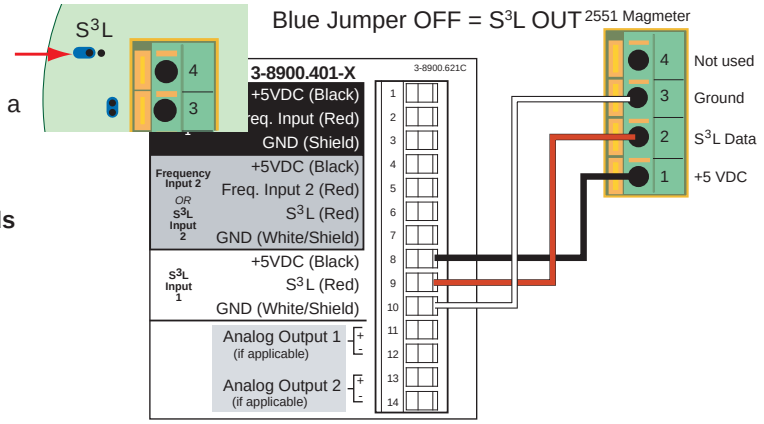


Install a pull-up resistor when connecting the 2551 Magmeter to other manufacturer's flowmeters.

8.2 Wiring: S^3L output (Compatible with 8900 Multi-Parameter Controller only)

- When the blue jumper illustrated here is removed (or placed over one pin for storage) the 2551-XX-11 outputs a digital (S^3L) signal compatible with the Signet 8900.
- The 2551 receives 5 VDC power from the 8900. No additional power is required.
- **The 8900 will display 0 (Zero) flow rate during periods of reverse flow.**
- The maximum cable length from the 2551 to the 8900 depends on the 8900 configuration. Refer to the 8900 manual for complete information.

Blue Jumper OFF = S^3L OUT



9. Calibration and Software Configuration

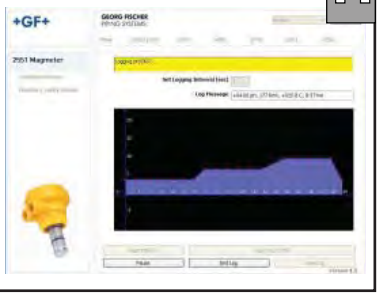
No calibration is necessary to begin using the 2551.
The application and performance settings are pre-set to meet the requirements of most applications.

The 2551 application and performance settings can be customized using the 3-0250 USB to Digital (S^3L) Configuration / Diagnostic Tool and software. A Windows PC is required to adjust the following parameters:

- **4 to 20 mA span**: Factory setting is 0 to 5 m/s. Can be customized to any range.
- **Noise Rejection Filter**: Factory set for 60 Hz. Can be changed to 50 Hz.
- **Low Flow Cutoff**: Factory setting is 0.05 m/s. Can be customized to any velocity.
- **Averaging Time**: Factory setting is 14 seconds Can be customized from 0.1 seconds to 100 seconds
- **Sensitivity**: Factory setting is 25% of full scale Can be customized to any % of full scale

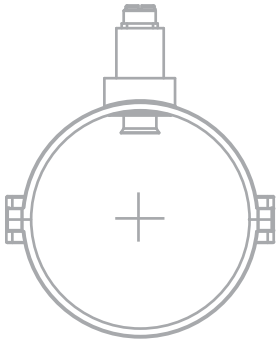
MONITOR/VERIFY SENSOR

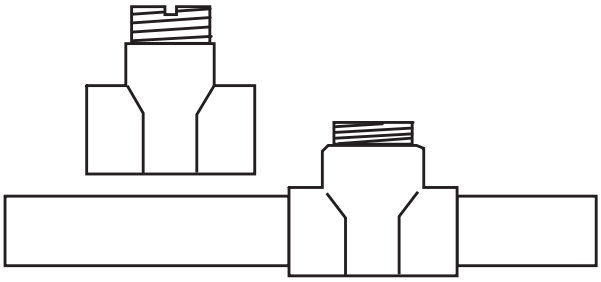
The **MONITOR/VERIFY SENSOR** function in the Signet 3-0250 Setup Tool software is very useful as a system troubleshooting tool.



10. Calibration Data: K-factors and Full Scale Current Values

Plastic Installation Fittings: PVC Tees and Saddles



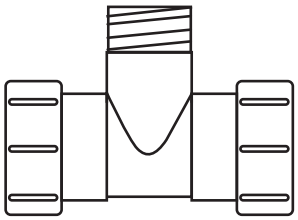


PIPE SIZE (IN.)	FITTING TYPE	K-Factor Gallons	K-Factor Liters	20 mA= in GPM	20 mA= in LPM
SCH 80 PVC TEES FOR SCH 80 PVC PIPE					
½	PV8T005	2289.37	604.85	13.1	49.6
¾	PV8T007	1430.41	377.92	20.97	79.38
1	PV8T010	876.86	231.67	34.21	129.5
1¼	PV8T012	447.06	118.11	67.1	253.99
1½	PV8T015	324.19	85.65	92.54	350.25
2	PV8T020	206.69	54.61	145.15	549.38
2½	PV8T025	131.46	34.73	228.2	863.74
3	PV8T030	82.52	21.80	363.55	1376.04
4	PV8T040	44.78	11.83	669.88	2535.49
SCH 80 PVC TEES FOR SCH 80 CPVC PIPE					
½	CPV8T005	2496.03	659.45	12.02	45.49
¾	CPV8T007	1381.48	364.99	21.72	82.19
1	CPV8T010	857.98	226.68	34.97	132.34
1¼	CPV8T012	445.17	117.61	67.39	255.07
1½	CPV8T015	325.56	86.01	92.15	348.78
SCH 80 PVC SADDLES FOR SCH 80 PVC PIPE					
2	PV8S020	193.83	51.21	154.77	585.81
2½	PV8S025	138.01	36.46	217.38	822.78
3	PV8S030	83.89	22.16	357.62	1353.60
4	PV8S040	40.88	10.80	733.88	2777.74
6	PV8S060	22.53	5.95	1331.85	5041.06
8	PV8S080	12.52	3.31	2395.41	9066.64
10	PV8S100	7.94	2.10	3778.75	14302.57
12	PV8S120	5.71	1.51	5256.69	19896.57
SCH 80 PVC SADDLES FOR SCH 40 PVC PIPE					
2	PV8S020	180.01	47.56	166.66	630.81
2½	PV8S025	123.72	32.69	242.49	917.82
3	PV8S030	75.81	20.03	395.71	1497.76
4	PV8S040	41.87	11.06	716.56	2712.19
6	PV8S060	19.71	5.21	1521.92	5760.46
8	PV8S080	11.73	3.10	2558.12	9682.50
10	PV8S100	7.43	1.96	4037.60	15282.3
12	PV8S120	5.23	1.38	5734.87	21706.48
POLYPROPYLENE CLAMP-ON SADDLES ON SCH 80 PP PIPE					
10	PPS100	7.94	2.10	3778.75	14302.57
12	PPS120	5.71	1.51	5256.69	19896.57
POLYPROPYLENE CLAMP-ON SADDLES ON SCH 40 PP PIPE					
10	PPS100	7.43	1.96	4037.60	15282.3
12	PPS120	5.23	1.38	5734.87	21706.48

10. Calibration Data: K-factors and Full Scale Current Values

Plastic Installation Fittings for Metric Pipes:

Polypropylene True Union Tees
PVDF True Union Tees
PVC True Union Tees

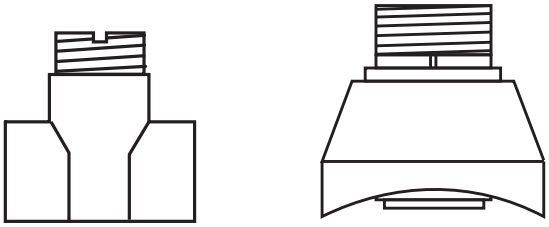


PIPE SIZE (Metric)	FITTING TYPE	K-Factor Gallons	K-Factor Liters	20 mA= in GPM	20 mA= in LPM
POLYPROPYLENE FITTINGS (DIN/ISO, BS, ANSI)					
DN15	PPMT005	2192.73	579.32	13.68	51.78
DN20	PPMT007	1327.81	350.81	22.59	85.52
DN25	PPMT010	737.16	194.76	40.70	154.04
DN32	PPMT012	453.46	119.81	66.16	250.41
DN40	PPMT015	275.03	72.66	109.08	412.86
DN50	PPMT020	164.17	43.35	182.74	691.66
PVDF FITTINGS (DIN/ISO, BS, ANSI)					
DN15	SFMT005	1946.49	514.26	15.41	58.34
DN20	SFMT007	1158.05	305.96	25.91	98.05
DN25	SFMT010	749.09	197.91	40.05	151.58
DN32	SFMT012	439.51	116.12	68.26	258.36
DN40	SFMT015	248.93	65.77	120.52	456.16
DN50	SFMT020	146.85	38.80	204.30	773.26
PVC FITTINGS (DIN/ISO, BS, ANSI)					
DN15	PVMT005	2067.76	546.30	14.51	54.91
DN20	PVMT007	1136.61	300.29	26.39	99.90
DN25	PVMT010	716.52	189.31	41.87	158.47
DN32	PVMT012	446.07	117.85	67.25	254.56
DN40	PVMT015	278.83	73.67	107.59	407.23
DN50	PVMT020	159.36	42.10	188.26	712.55

10. Calibration Data: K-factors and Full Scale Current Values

Metal Installation Fittings:

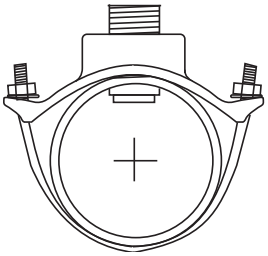
Carbon Steel Tees and Weld-o-Lets
Stainless Steel Tees and Weld-o-Lets
Galvanized Iron Tees



PIPE SIZE (IN.)	FITTING TYPE	K-Factor Gallons	K-Factor Liters	20 mA= in GPM	20 mA= in LPM
CARBON STEEL TEES ON SCH 40 PIPE					
½	CS4T005	1572.66	415.50	19.08	72.20
¾	CS4T007	1086.73	287.11	27.61	104.49
1	CS4T010	582.34	153.86	51.52	194.99
1¼	CS4T012	377.48	99.73	79.48	300.81
1½	CS4T015	267.79	70.75	112.03	424.02
2	CS4T020	167.85	44.35	178.73	676.48
STAINLESS STEEL TEES ON SCH 40 PIPE					
½	CR4T005	1601.26	423.05	18.74	70.91
¾	CR4T007	937.78	247.76	31.99	121.08
1	CR4T010	606.18	160.15	49.49	187.32
1¼	CR4T012	279.68	73.89	107.26	405.99
1½	CR4T015	147.65	39.01	203.19	769.06
2	CR4T020	111.90	29.56	268.09	1014.73
STAINLESS STEEL WELDOLETS ON SCH 40 PIPE					
2½	CR4W025	106.31	28.09	282.19	1068.10
3	CR4W030	72.27	19.09	415.12	1571.25
4	CR4W040	36.84	9.73	814.34	3082.28
5	CR4W050	29.28	7.73	1024.70	3878.50
6	CR4W060	20.29	5.36	1478.26	5595.21
8	CR4W080	11.73	3.10	2557.72	9680.96
10	CR4W100	7.45	1.97	4028.83	15249.13
12	CR4W120	5.24	1.39	5722.73	21660.53
CARBON STEEL WELDOLETS ON SCH 40 PIPE					
2½	CS4W025	105.70	27.93	283.82	1074.27
3	CS4W030	70.68	18.67	424.45	1606.56
4	CS4W040	36.38	9.61	824.65	3121.30
5	CS4W050	29.28	7.73	1024.70	3878.50
6	CS4W060	20.29	5.36	1478.26	5595.21
8	CS4W080	11.73	3.10	2557.72	9680.96
10	CS4W100	7.45	1.97	4028.83	15249.13
12	CS4W120	5.24	1.39	5722.73	21660.53
GALVANIZED IRON TEES ON SCH 40 PIPE					
1	IR4T010	558.50	147.56	53.71	203.31
1¼	IR4T012	334.45	88.36	89.70	339.51
1½	IR4T015	248.97	65.78	120.49	456.07
2	IR4T020	146.00	38.57	205.48	777.76

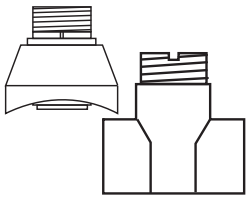
10. Calibration Data: K-factors and Full Scale Current Values

Metal Installation Fittings
Iron Saddles



PIPE SIZE (IN.)	FITTING TYPE	K-Factor Gallons	K-Factor Liters	20 mA= in GPM	20 mA= in LPM
SCH 80 IRON SADDLE ON SCH 80 PIPE					
2	IR8S020	194.85	51.48	153.96	582.75
2½	IR8S025	142.28	37.59	210.86	798.10
3	IR8S030	87.53	23.13	342.72	1297.20
4	IR8S040	40.62	10.73	738.58	2795.54
5	IR8S050	29.28	7.74	1024.43	3877.48
6	IR8S060	22.30	5.89	1345.58	5093.03
8	IR8S080	12.52	3.31	2395.41	9066.64
10	IR8S100	7.94	2.10	3778.75	14302.57
12	IR8S120	5.65	1.49	5311.45	20103.83
SCH 80 IRON SADDLE ON SCH 40 PIPE					
2	IR8S020	185.35	48.97	161.85	612.61
2½	IR8S025	127.47	33.68	235.36	890.83
3	IR8S030	76.62	20.24	391.54	1481.99
4	IR8S040	40.23	10.63	745.72	2822.57
5	IR8S050	27.32	7.22	1098.24	4156.83
6	IR8S060	19.71	5.21	1521.92	5760.46
8	IR8S080	11.61	3.07	2584.23	9781.30
10	IR8S100	7.36	1.94	4078.8	15438.2
12	IR8S120	5.18	1.37	5793.39	21927.98

Metal Installation Fittings:
Bronze and Copper Tees and Brazolets



PIPE SIZE (IN.)	FITTING TYPE	K-Factor Gallons	K-Factor Liters	20 mA= in GPM	20 mA= in LPM
BRONZE TEES ON SCH 40 PIPE					
1	BR4T010	582.34	153.86	51.52	194.99
1¼	BR4T012	330.54	87.33	90.76	343.53
1½	BR4T015	254.76	67.31	117.76	445.71
2	BR4T020	157.36	41.58	190.64	721.58
COPPER TEES FITTING ON COPPER PIPE SCH K					
½	CUKT005	2459.19	649.72	12.20	46.17
¾	CUKT007	1108.02	292.74	27.08	102.48
1	CUKT010	649.87	171.70	46.16	174.73
1¼	CUKT012	422.03	111.50	71.09	269.06
1½	CUKT015	281.43	74.35	106.60	403.47
2	CUKT020	136.02	35.94	220.55	834.78
COPPER TEES FITTING ON COPPER PIPE SCH L					
½	CUKT005	2406.30	635.75	12.47	47.19
¾	CUKT007	1174.77	310.37	25.54	96.66
1	CUKT010	672.28	177.62	44.62	168.90
1¼	CUKT012	402.84	106.43	74.47	281.87
1½	CUKT015	294.99	77.94	101.70	384.92
2	CUKT020	149.63	39.53	200.50	758.89
COPPER/BRONZE BRAZOLET ON SCH 40 PIPE					
2½	BR4B025	117.31	30.99	255.74	967.96
3	BR4B030	78.62	20.77	381.58	1444.28
4	BR4B040	45.13	11.92	664.77	2516.15
5	BR4B050	32.79	8.66	914.91	3462.95
6	BR4B060	22.73	6.01	1319.87	4995.72
8	BR4B080	13.14	3.47	2283.68	8643.71
10	BR4B100	8.34	2.20	3597.17	13615.29
12	BR4B120	5.87	1.55	5109.58	19339.76

11. Maintenance

The 2551 Magmeter requires very little maintenance. There are no user-serviceable components in the Magmeter.

- If the fluid contains deposits and solids that may coat the electrodes, a regular cleaning schedule is recommended.
- Do not use abrasive materials on the metal electrodes. Clean with soft cloth and mild detergent only.
- Use a cotton swab and mild detergent to remove deposits on the metal electrodes at the tip of the sensor.

11.1. Environmental Recommendations:

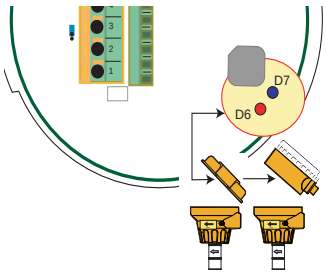
- When used properly, this product presents no inherent danger to the environment.
- Please follow local ordinances when disposing of this or any product with electronic components.

11.2 Troubleshooting

Symptom	Possible Cause	Possible Solution
• Frequency, Digital or Current output is erratic.	• Magmeter installed too close to upstream obstruction. • Electrodes coated with solids. • Electrodes exposed to air bubbles. • Electrical noise interference. • New sensor, metal surface not properly conditioned.	• Move the Magmeter upstream at least 10 pipe diameters from obstruction. • Clean the electrodes with soft cloth. Do not use abrasives. • Eliminate air bubbles in the pipe. • Remove the Magmeter and reinstall with the flow direction arrow on the sensor body pointed DOWNSTREAM. • Modify grounding as required to protect the Magmeter from interference. • Soak sensor overnight in fluid.
• Output is not 0 when flow is stopped.	• Electrode not adequately conditioned. • Electrical noise interference. • Vibration or other movement in pipe causes magmeter to detect flow. • Defective Magmeter	• Soak sensor overnight in fluid. • Modify grounding to protect the Magmeter from interference. • Set low flow cutoff higher. • Return to factory for service.
• 4-20 mA output is incorrect.	• Loop device not scaled same as Magmeter. • Range Jumper not placed correctly. • Defective Magmeter	• Use 3-0250 Setup tool to respan the Magmeter to match Loop device. • Respan Loop device to match Magmeter. • Set Range Jumper correctly. • Return to factory for service.
• Frequency output is inoperative • Digital (S^3L) output is inoperative. • Loop output is inoperative.	• 2551 is wrong model. • Blue jumper not in correct position. • Wiring is not correct. • Frequency input to other manufacturer's flow instrument does not have pull-up resistor.	• Frequency model is 3-2551-11. • Place blue jumper correctly. (Sec. 5 pg. 4) • Check wiring, make corrections. • Install 10kΩ resistor. (Sec 8.1, pg. 6)
• Output is 22.1 mA.	• Conductivity is less than 20 µS/cm. • Electronic component failure.	• Unsuitable application for Magmeter. Return to factory for service.

11.3 Troubleshooting with the RED and BLUE lights

No Lights:	The power is off or the sensor is not connected
Solid Blue:	The power is on but there is no flow in the pipe.
Blinking Blue:	Normal operation, blink rate is proportional to the flow rate.
Alternating Red-Blue:	Empty pipe indication (electrodes are not wet.)
Blinking Red:	System errors (Electrical noise interference)
Solid Red:	Instrument error (defective electronics component)



If the 2551 detects an Empty Pipe:

- Frequency output will be locked to 0 Hz if electrodes are not wet.
- Digital (S^3L) output will be locked to 0 if electrodes are not wet.
- 4-20 mA will be locked to 4 mA if electrodes are not wet.
- Blue and Red LED indicators on the magmeter circuit will blink alternately if electrodes are not wet.

If the 2551 detects REVERSE FLOW:

- Frequency out cannot distinguish reverse flow from forward flow. The output will be the absolute value.
- Digital (S^3L) output: Reverse flow results in 0 flow rate displayed on 8900
- 4-20 mA output can be spanned into negative flow range using the 3-0250 USB Setup Tool and software. (See section 9) (example: 4-20 mA = -100 to +100 GPM)

12. Ordering Information

Sensor Part No.					
3-2551					
	Sensor Body (Transducer) and electrodes/grounding ring materials - Choose one				
	-P	Polypropylene and 316L SS			
	-T	PVDF and Titanium			
	-V	PVDF and Hastelloy C			
	-W	PVDF and 316L SS			
		Pipe size - Choose one			
		0	DN15 to DN100 (½ to 4 in.)		
		1	DN125 to DN200 (5 to 8 in.)		
		2	DN250 to DN300 (10 to 12 in.)		
			Display Options - Choose One		
			-1	No Display	
				Output options - Choose One	
				1	Frequency, Digital (S^3L)
				2	4 to 20 mA output
3-2551	-P	0	-1	2	Example Part Number

Part Number	Code
3-2551-P0-11	159 001 105
3-2551-P0-12	159 001 110
3-2551-P1-11	159 001 106
3-2551-P1-12	159 001 111
3-2551-P2-11	159 001 107
3-2551-P2-12	159 001 112
3-2551-T0-11	159 001 108
3-2551-T0-12	159 001 113
3-2551-T1-11	159 001 109
3-2551-T1-12	159 001 114
3-2551-T2-11	159 001 448
3-2551-T2-12	159 001 449

Part Number	Code
3-2551-V0-11	159 001 257
3-2551-V0-12	159 001 259
3-2551-V1-11	159 001 258
3-2551-V1-12	159 001 260
3-2551-V2-11	159 001 450
3-2551-V2-12	159 001 451
3-2551-W0-11	150 001 230
3-2551-W0-12	159 001 231
3-2551-W1-11	159 001 232
3-2551-W1-12	159 001 233
3-2551-W2-11	159 001 452
3-2551-W2-12	159 001 453

Replacement parts and Accessories

Mfr. Part No.	Code	Description
1220-0021	198 801 186	O-ring, FPM
1224-0021	198 820 006	O-ring, EPDM
1228-0021	198 820 007	O-ring, FFPM
3-2551-11	159 001 215	Magmeter electronics, no display, frequency or digital (S^3L) output
3-2551-12	159 001 216	Magmeter electronics, no display, 4 to 20 mA output
3-2551-P0	159 001 211	PP/316L SS, DN15 to DN100 (½ to 4 in.) pipe
3-2551-P1	159 001 212	PP/316L SS, DN125 to DN200 (5 to 8 in.) pipe
3-2551-P2	159 001 444	PP/316L SS, DN250 to DN300 (10 to 12 in.) pipe
3-2551-T0	159 001 213	PVDF/Titanium, DN15 to DN100 (½ to 4 in.) pipe
3-2551-T1	159 001 214	PVDF/Titanium, DN125 to DN200 (5 to 8 in.) pipe
3-2551-T2	159 000 445	PVDF/Titanium, DN250 to DN300 (10 to 12 in.) pipe
3-2551-V0	159 001 376	PVDF/Hastelloy-C, DN15 to DN100 (½ to 4 in.) pipe
3-2551-V1	159 001 377	PVDF/Hastelloy-C, DN125 to DN200 (5 to 8 in.) pipe
3-2551-V2	159 000 446	PVDF/Hastelloy-C, DN250 to DN300 (10 to 12 in.) pipe
3-2551-W0	159 001 234	PVDF/316L SS, DN15 to DN100 (½ to 4 in.) pipe
3-2551-W1	159 001 235	PVDF/316L SS, DN125 to DN200 (5 to 8 in.) pipe
3-2551-W2	159 001 447	PVDF/316L SS, DN250 to DN300 (10 to 12 in.) pipe
7300-7524	159 000 687	24 VDC Power Supply 7.5 W, 300 mA
7300-1524	159 000 688	24 VDC Power Supply 15 W, 600 mA
7300-3024	159 000 689	24 VDC Power Supply 30 W, 1.3 A
7300-5024	159 000 690	24 VDC Power Supply 50 W, 2.1 A
7300-1024	159 000 691	24 VDC Power Supply 100 W, 4.2 A
3-0250	159 001 538	USB to Digital (S^3L) Configuration / Diagnostic Tool
3-9000.392-1	159 000 839	Liquid-tight connector kit, 1 set, ½ in. NPT

+GF+

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APPENDIX G: CHEMICAL METERING PUMP MANUAL

WALCHEM

An Iwaki America Company

EHE Series Metering Pumps

EHE Series
Electronic Metering Pump
Instruction Manual

Five Boynton Road Hopping Brook Park Holliston, MA 01746 USA

TEL: 508-429-1110 FAX: 508-429-7433 WEB: www.walchem.com

Notice

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P/N E00022.H1
Sep 2009

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Thank you for choosing a Walchem E Series metering pump. This instruction manual deals with the correct installation, operation, programming maintenance, and troubleshooting procedures for the EHE Series metering pumps. Please read through it carefully to ensure the optimum performance, safety and service of your pump.

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1.0 INTRODUCTION

1.1 Safety and Caution Notes

Always wear protective clothing, eye protection and gloves before working on or near a metering pump. Follow all recommendations of the supplier of the solution being pumped. Refer to the MSDS from the solution supplier for additional precautions.

Walchem EH Series metering pumps should NOT be installed where ambient temperatures exceed 122°F (50°C) or fall below 32°F (0°C), or where the pump or tubing are directly exposed to sunlight.

WARNING Risk of electrical shock! This pump is supplied with a grounding conductor and grounding-type attachment plug. To reduce the risk of electrical shock, be certain that it is connected only to a properly grounded, grounding type receptacle with ratings conforming to the data on the pump data plate. Prior to performing any maintenance on a pump, disconnect the pump from the electrical power source.

Plumbing Precautions

All tubing must be securely attached to the fittings prior to starting the pump (see Section 2.3). Only use Walchem tubing with your pump. Tubing should be shielded to prevent possible injury in case of rupture or damage. UV resistant tubing should be used if the tubing is exposed to UV light. Always adhere to local plumbing codes and requirements. Be sure that the installation does not constitute a cross connection. Walchem is not responsible for improper installations. Prior to performing any maintenance on a pump, depressurize the discharge tubing.

If you are pumping downhill or into little or no system pressure, a back pressure/anti-siphon device must be installed to prevent over-pumping. Contact your Walchem distributor for additional information.

Solution Compatibility

CAUTION! This pump has been tested by Underwriters Laboratories Inc. using water only. The suitability of this pump for use with liquids other than water is the responsibility of the user. For liquids other than water, select the best-suited liquid end material combination using a chemical compatibility chart or guidance from the solution supplier.

1.2 Principle of Operation

The E Series electronic metering pump consists of a pump unit, a drive unit, and a control unit. The drive unit is an electromagnetic solenoid. When the solenoid coil is energized by the control unit, the armature shaft moves forward due to the magnetic force of the solenoid. The shaft is attached to a PTFE faced diaphragm, which is part of the pump unit. The diaphragm is forced into the pump head cavity decreasing volume and increasing pressure which forces liquid in the pump head out through the discharge check valves. When the solenoid coil is de-energized, a spring returns the armature to its starting position. This action pulls the diaphragm out of the head cavity increasing volume and decreasing pressure. Atmospheric pressure then pushes liquid from the supply tank through the suction check valves to refill the pump head.

1.3 Specifications

EH	E36	E	1	-	PC	V
1	2	3	4		5	6

1 Pump Series

EHE Electronic metering pump with external Analog and pulse control or manual speed control (adjustable to 360 strokes per minute). Manually adjustable stroke length. (Turndown ratio 1800:1)

2 Capacity/Pressure Rating

Size	Output Capacity (GPH) min	Output Capacity (GPH) max	Output Capacity (mL/min) min	Output Capacity (mL/min) max	Output per stroke (mL) min	Output per stroke (mL) max	Maximum Pressure (PSI)	Maximum Pressure (MPa)	Conn. Size (in) Tubing O.D.
E31	0.0031	5.5	0.189	340	0.189	0.94	150	1.0	½
E36	0.0047	8.5	0.289	520	0.289	1.44	105	0.7	½
E46	0.0067	12.0	0.417	750	0.417	2.08	60	0.4	½
E56	0.0111	20.0	0.694	1250	0.694	3.47	30	0.2	½

3 Control Module

E For use on all EHE models, features analog and external pulse control with pulse divide and multiply capability.

4 Voltage

1 115VAC, 50/60 Hz
2 230VAC, 50/60 Hz

5 Liquid End

Liquid End Code	Pump Head & Fittings	Diaphragm*	Valve Balls	Valve Seat	Valve Seals	Gasket	Tubing
VC	PVC	PTFE	CE	FKM	FKM	PTFE	PE
VE	PVC	PTFE	CE	EPDM	EPDM	PTFE	PE
VF	PVC	PTFE	PTFE	EPDM	EPDM	PTFE	PE
PC	GFRPP	PTFE	CE	FKM	FKM	PTFE	PE
PE	GFRPP	PTFE	CE	EPDM	EPDM	PTFE	PE
FC	PVDF	PTFE	CE	PCTFE	PTFE	PTFE	PE
VM✞	M-PVC	PTFE	CE	FKM	PTFE	PTFE	PE

✞ E55 Model only * Bonded to EPDM

Materials of Construction

CE	Alumina ceramic	PCTFE	Polychlorotrifluoroethylene
EPDM	Ethylene propylene diene monomer	PE	Polyethylene
FKM	Fluoroelastomer	PTFE	Polytetrafluoroethylene
GFRPP	Glass fiber reinforced polypropylene	PVC	Polyvinylchloride (translucent)
M-PVC	Machined polyvinylchloride	PVDF	Polyvinylidenefluoride

6 Special Head Options

Blank Standard ½" tube connection with tube style injection & foot valves.
V Standard ½" tube connection with back pressure/anti-siphon valve, tube style injection & foot valves.
T ¾" NPT (male) pipe thread connection. No accessory valves.
P ¾" NPT (male) pipe thread connection with back pressure/anti-siphon valve.

Adjustment Range

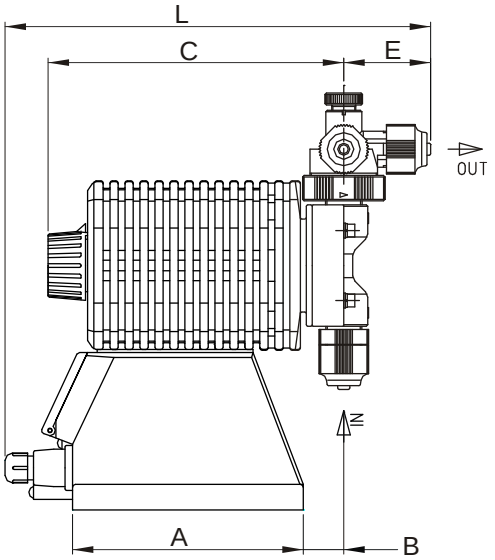
Stroke length adjustment range	20% to 100% Stroke Length
Frequency adjustment range	0 to 360 strokes per minute

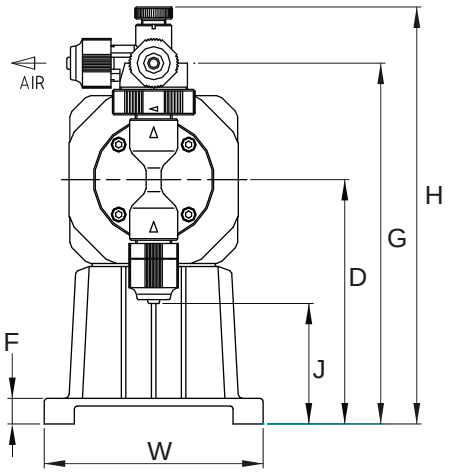
Operating Conditions

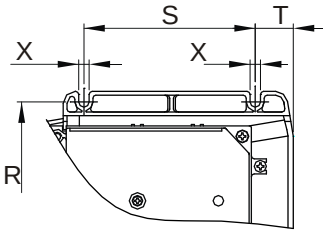
Ambient temperature	32 to 122°F (0 to 50°C)
Relative humidity	30 to 90% non-condensing
Liquid temperature	32 to 104°F (0 to 40°C) for PVC based Liquid Ends
	32 to 140°F (0 to 60°C) for PP or PVDF based Liquid Ends

1.4 Dimensions

PVC & GFRPP Models



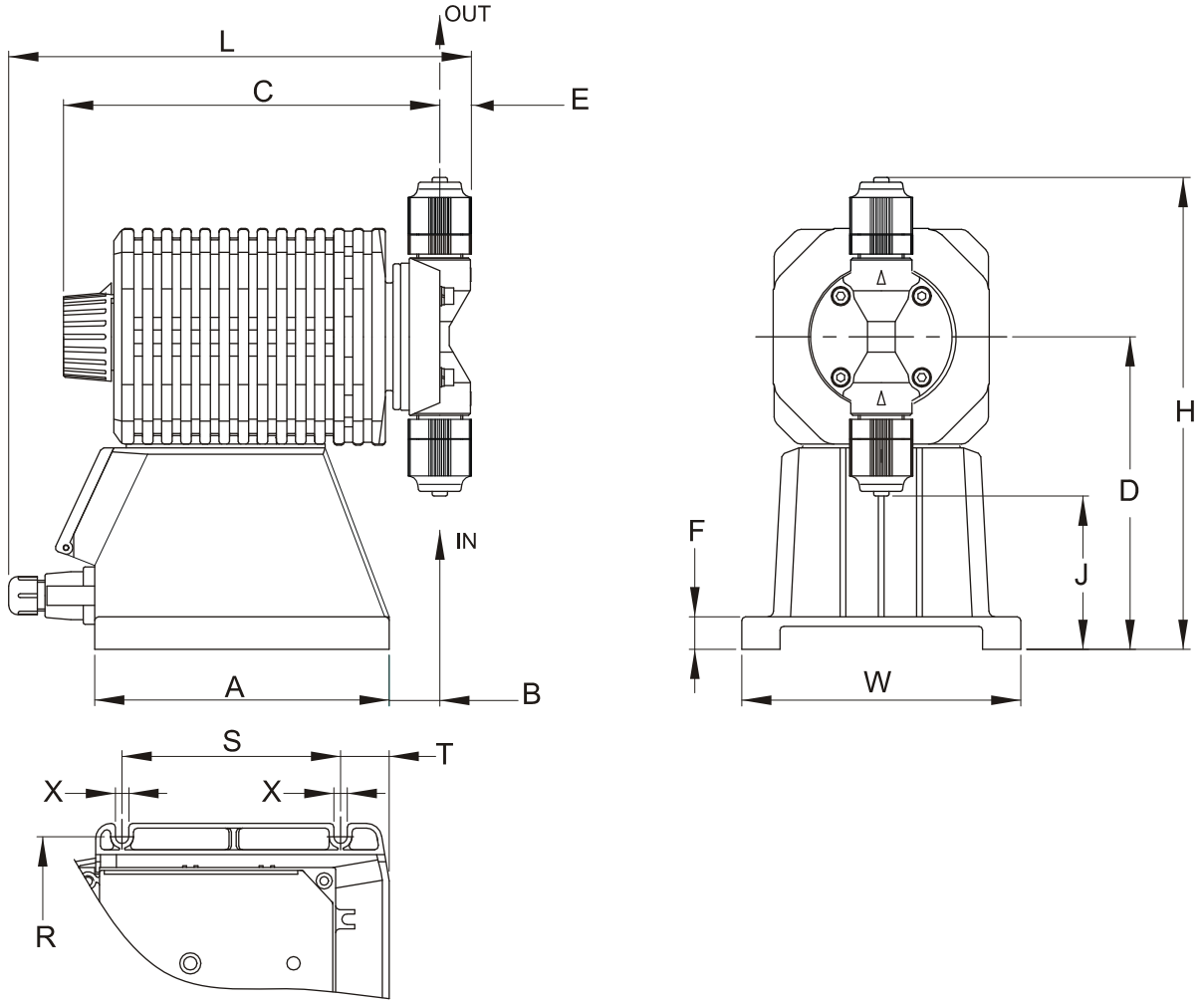




Model					A	B	C	D	E	F	G	H	J	L	W
EHE	31 36	E1 E2	-VC -PC -VE	-PE -VF	6.06	1.05	7.76	6.42	2.28	0.67	9.49	10.95	3.15	11.18	5.75
EHE	46	E1 E2	-VC -PC -VE	-PE -VF	6.06	1.14	7.83	6.42	2.28	0.67	9.86	11.34	2.80	11.25	5.75
EHE	56	E1 E2	-VC -PC -VE	-PE -VF	6.06	1.42	8.13	6.42	2.28	0.67	10.10	11.57	2.38	11.55	5.75
EHE	56	E1 E2	-VM		6.06	1.42	8.13	6.42	2.28	0.67	10.10	11.57	2.38	11.55	5.75

Mounting Dimensions	R	S	T	X
EHE all variations	5.20	4.50	1.00	0.28

FC Models



Model				A	B	C	D	E	F	H	J	L	W
EHE	31 36	E1 E2	-FC	6.06	1.05	7.76	6.42	0.65	0.67	9.69	3.15	9.53	5.75
EHE	46	E1 E2	-FC	6.06	1.14	7.83	6.42	0.75	0.67	10.00	2.80	9.72	5.75
EHE	56	E1 E2	-FC	6.06	1.42	8.13	6.42	0.85	0.67	10.45	2.38	10.12	5.75

Mounting Dimensions	R	S	T	X
EHE all variations	5.20	4.50	1.00	0.28

All dimensions in inches

2.0 INSTALLATION

2.1 Unpacking

Open the shipping carton and inspect contents for damage. If any items are missing or damaged contact your local distributor to arrange for replacement.

CAUTION

Pumps are pre-primed with water at the factory. If the application is not compatible with water, drain and dry before use. Be sure to remove caps from fittings before attaching tubing.

Head bolts may have loosened during storage or shipment. Be sure to check and tighten to 19 lb-in of torque, as necessary.

The electronics within the pump can be damaged by excessive surges in voltage. Do not install the pump near high-power electrical equipment that generates high surge voltages. Avoid branch circuits that also supply power to heavy or other equipment that could generate electrical interference. If necessary, install a surge suppression device (such as a varistor with a resistance greater than 2000A) or a noise-reducing transformer at the pump's power connection.

WARNING: Risk of electrical shock! *This pump is supplied with a grounding conductor and grounding-type attachment plug. To reduce the risk of electrical shock, be certain that it is connected only to a properly grounded, grounding type receptacle.*

2.2 Location

Choose a location for the pump that is clean, dry, vibration –free, close to an electrical outlet, and allows convenient access to stroke length control, frequency control, and tubing connections. Avoid areas where ambient temperature exceeds 122°F (50°C) or falls below 32°F (0°C), or where the pump or tubing would be exposed to direct sunlight.

This pump is cord connected and not intended for permanent mounting to a building structure. However, temporary mounting to stabilize the pump during operation may be necessary as long as tools are not required for the installation or removal of the pump.

Flooded suction (mounting the pump below the level of liquid in the supply tank) is strongly recommended, especially when pumping liquids that readily generate gas bubbles. Sodium hypochlorite and hydrogen peroxide are common examples of such liquids. (See Figure 1.)

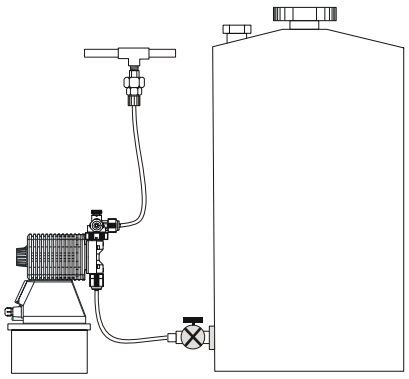


Figure 1
Flooded Suction

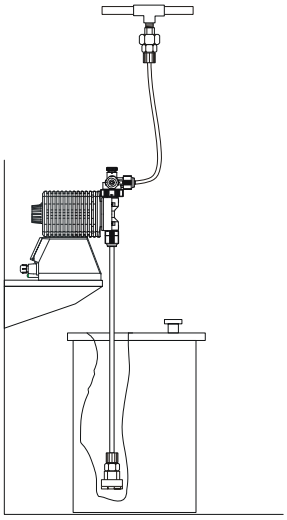


Figure 2
Shelf Mount
Suction Lift

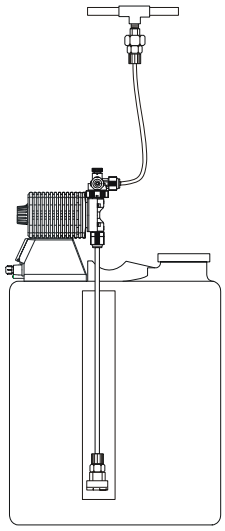


Figure 3
Tank Mount
Suction Lift

If flooded suction mounting is not possible, a shelf adjacent to (but not directly above) the supply tank often works well (see Figure 2). The supply tank or cover can also be used if it has provisions for mounting a pump (see Figure 3). In any case, the total suction lift should not exceed 5 ft (1.5m). For extremely gaseous liquids such as Sodium Hypochlorite or Hydrogen Peroxide, pulling from an external manifold will significantly reduce gas bubbles to the suction side of the pump. This installation will typically solve most priming issues associated with these gaseous liquids. See Figure 4 for reference.

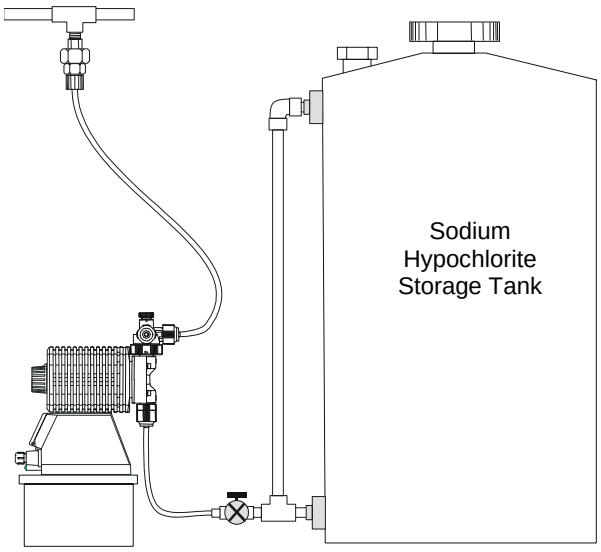


Figure 4
Flooded Suction for Gaseous Liquids

2.3 Supply Tubing

The supply tubing run should be as short as possible. For flooded suction mounting, install a shut-off valve with an appropriate tubing connector at the tank outlet. Cut a length of tubing from the coil supplied and install between the shut-off valve and the pump inlet fitting. For suction lift applications, install a foot valve on one end of suction tubing and cut the tubing to a length such that the foot valve hangs vertically about 1 in (25mm) above the bottom of the tank. Avoid any loops in the tubing run that could form a vapor trap. Running the tubing through a length of rigid pipe will help to keep tubing straight (see Figure 3). Total vertical suction lift should be no more than 5ft. (1.5m).

Attach tubing as shown in Figure 5. First slide the coupling nut, small end first, onto the tubing. Then slide on the clamp ring so that the rounded edges face the end of the tubing. Next push the tubing onto the tubing adapter fitting. (Tips: Place tubing adapter fitting on a flat surface such as a table top and press tubing down on top of it *all the way to the lip* of the tubing adapter fitting. If the tubing is stiff from cold, dip the tubing end in hot tap water for a few minutes so it will slide on and flare out more easily. Slide clamp ring down until it tightens over the adapter fitting. Then slide coupling nut down as far as it will go. Insert this arrangement into the suction valve housing. With one hand holding tubing and applying slight downward pressure, tighten the coupling nut until secure.

WARNING: All fittings and coupling nuts should be tightened by hand. If necessary, small pliers may be used to make it snug. DO NOT use excessive force or large wrenches.

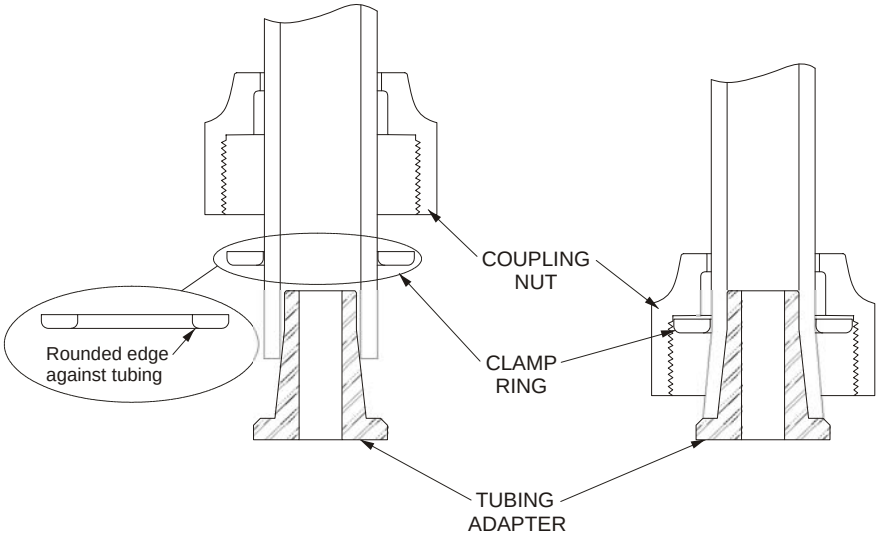


Figure 5 Tubing Connections

2.4 Discharge Tubing

Cut a length of tubing long enough to go from the pump to the application (injection) point. Additional tubing can be ordered from your distributor. Avoid sharp bends or kinks in the tubing and protect the tubing from sharp edges that could chafe or cut it. If applicable, install the injection valve in 1/2” NPT thread at the injection point and connect the discharge tubing to the injection valve. Attach the tubing as described above in Section 2.3, Figure 5.

Note: Most pump models have an air vent valve with two connections on the discharge side of the pump head. The connection marked 'OUT' is the discharge connection plumbed to the injection point. The connection marked 'AIR' is the vent connection and tubing should be routed from this point back to the chemical solution (supply) tank or drum. Refer to Section 1.4 drawing.

2.5 Installing Injection Check Valve

A fitting or tee with 1/2” NPTF threads and sufficient depth should be used to install the injection valve assembly. If required, trim off an amount of the extension tip until it fits your fitting or tee (see Figure 7). Attach the supplied tubing to the compression end: cut the tubing square, slide on the coupling nut, push the tubing to the bottom of the cone (use warm water to soften tubing as necessary), and hand tighten coupling nut.

The position of the injection check valve can be at any orientation as long as the spring is retained in the valve. DO NOT REMOVE THE SPRING. Be sure to check/replace the spring as needed.

CAUTION: Some chemicals may have reactions as they are injected into the main flow (ie. sulfuric acid may react with water causing excess heat). If that chemical is heavier than water, mount the injection valve as close as possible to vertical, injecting into the bottom of the pipe. This will keep the injection nozzle facing up and keep the heavier chemistry from draining into the pipe causing adverse reactions within the injection valve and pipe.

In addition to preventing backflow from pressurized lines, the injection valve will provide a limited amount of backpressure when pumping into open atmosphere type applications. However, the backpressure by the injection check valve is very low and can vary. Metering pump output is rated at maximum backpressure and, depending upon the application, may be higher if the back-pressure is lower than rated. Additionally, the valve does NOT act as an anti-siphon valve. If siphoning is a possibility, or if pumping downhill into open atmosphere (open tank), a separate backpressure/anti-siphon valve must be installed.

NOTE: Siphoning can also occur at the tip of the injection valve because of the high flow rate in the main pipe flowing past the small injection nozzle (venturi effect). In this case, an anti-siphon device must be installed to avoid over feeding or siphoning of chemistry into the line. Cutting the injector tip at an angle or to a different length will sometimes alleviate this problem.

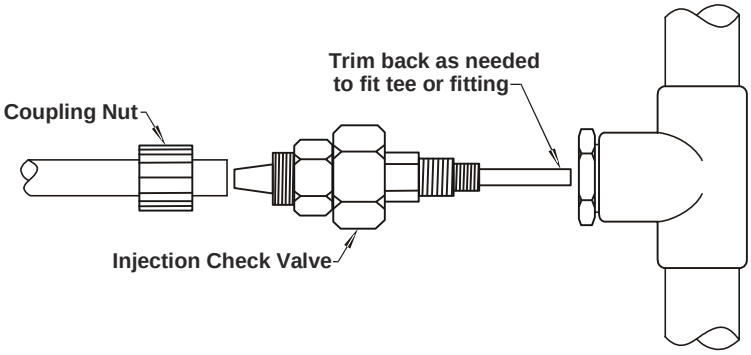


Figure 6
Injection Check Valve Installation

3.0 OPERATION

3.1 Priming

Install the pump as described in Section 2.0. With the pump plugged in but not pumping, set stroke length at 100% and frequency at 360 (use the ▲ or ▼ buttons as necessary to adjust the frequency). If the pump is equipped with a manual air vent valve, open the knob ½-1 turn; otherwise disconnect the discharge tubing from the injection valve. Push the **START/STOP** button to start the pump. *As soon as* liquid enters the discharge tubing at the pump head, push the **START/STOP** button again to stop the pump. Close the air vent valve and/or reconnect the discharge tubing to the injection valve.

If the pump does not self prime, remove the check valve housing on the discharge and suction sides to make sure the valve cartridges and gaskets are in correct positions (see Section 4.2). Remove and shake cartridges to make sure ball is loose inside. Wetting cartridges before re-installing will help in priming.

3.2 Adjustment

The pump will operate best with the stroke length at 100%. If less than full output is required, set the frequency to the desired percentage of maximum.

Example: Model EHE31E1-VC has maximum output of 5.5 GPH at 360spm and 100%SL.
Desired output is 4.0 GPH.
4.0 ÷ 5.5 = 0.73 or 73%. 73% of 360spm is 263spm.
Press the ▲ or ▼ buttons as necessary to set the frequency to 263spm.

If very low outputs are required, it will be necessary to also reduce the stroke length. (Minimum recommended stroke length is 20%.)

3.3 Calibration

If the application requires the pump to be calibrated, prime and adjust the pump per directions above. Then connect a calibration column to the suction side of the pump and re-prime the pump to eliminate any air.

Turn the pump on for one minute and read the amount of liquid pumped from the column. Adjust the frequency up or down as necessary and check the output again. When the desired output is reached, disconnect the calibration column and reconnect the suction tubing. (See Figure 7.)

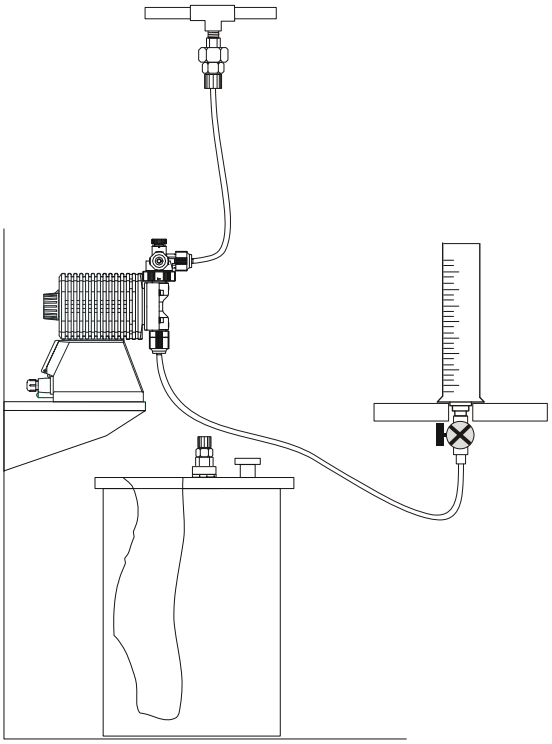
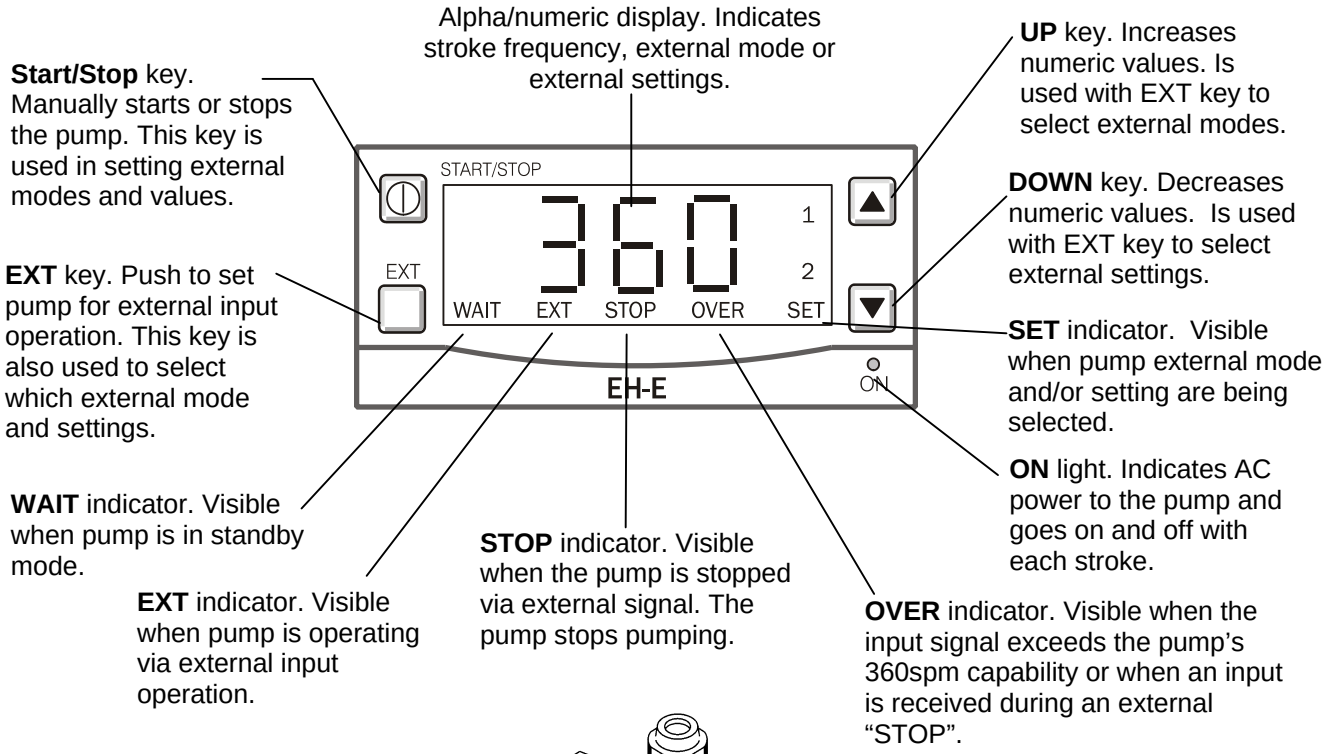


Figure 7
Pump Calibration

3.4 Control Unit Operation and Programming

The EHE Series metering pumps can be operated in either manual or external modes. The external mode can be controlled from a digital or analog external signal. An external stop function is available for remotely suspending operation of the pump and functions independent of the control mode.

Display/Keypad Overview



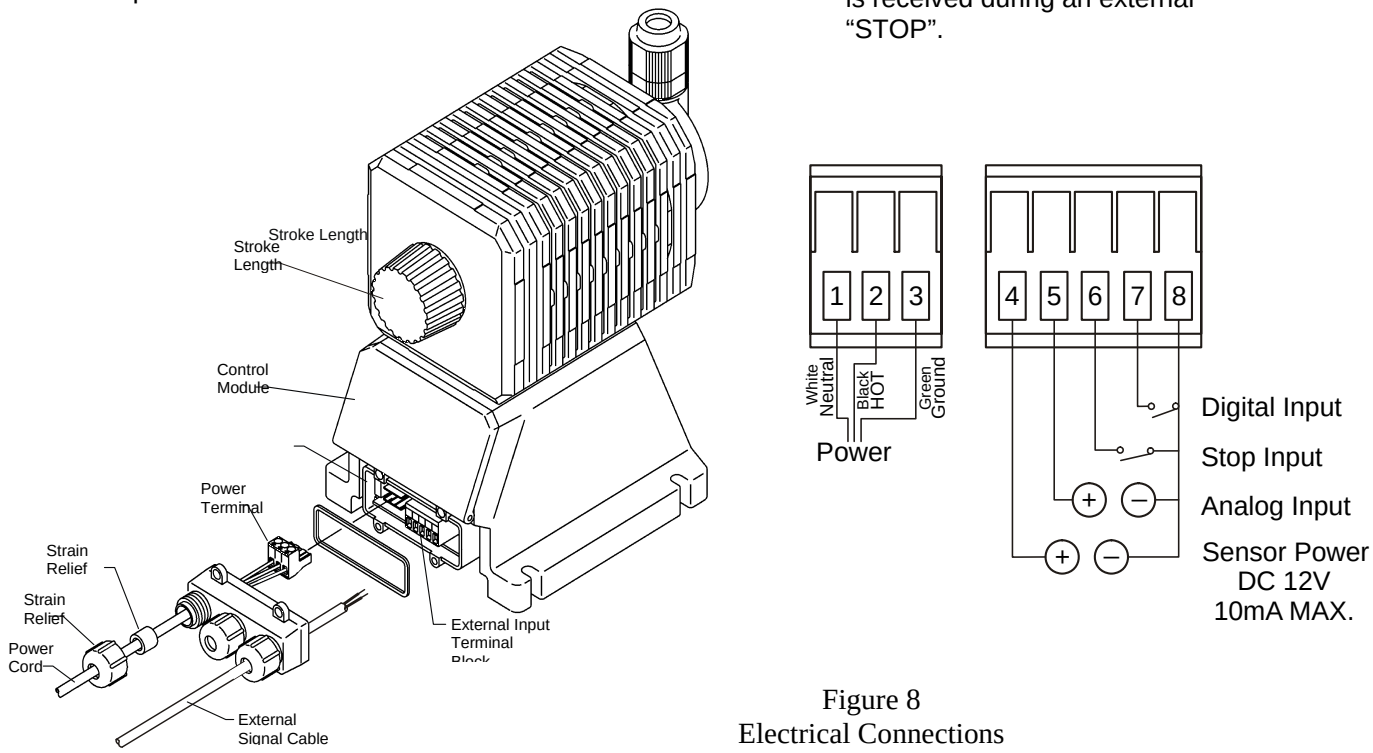
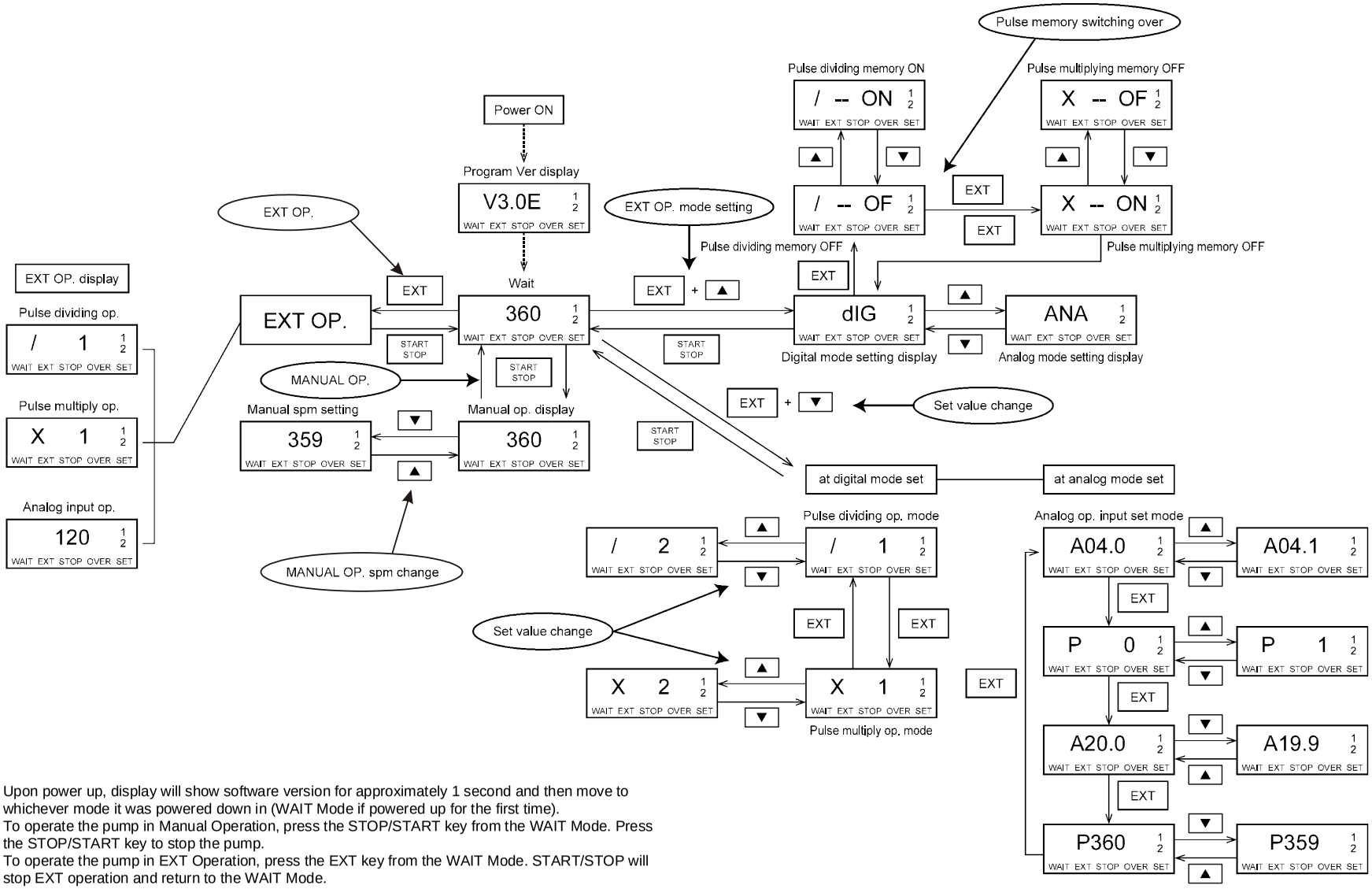


Figure 8
Electrical Connections

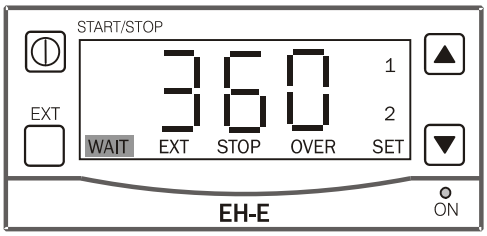


Notes:

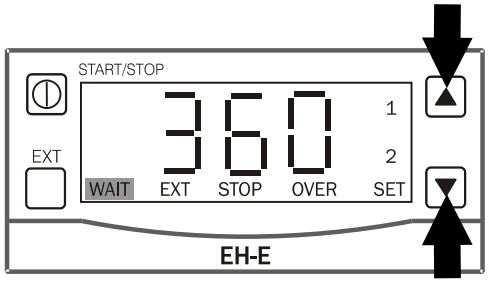
1. Upon power up, display will show software version for approximately 1 second and then move to whichever mode it was powered down in (WAIT Mode if powered up for the first time).
2. To operate the pump in Manual Operation, press the STOP/START key from the WAIT Mode. Press the STOP/START key to stop the pump.
3. To operate the pump in EXT Operation, press the EXT key from the WAIT Mode. START/STOP will stop EXT operation and return to the WAIT Mode.
4. To change input operation between Digital or Analog, press the EXT and ▲ keys simultaneously. Toggle between DIG or ANA with the ▲ or ▼ keys and select the desired control method by pressing with the STOP/START key. This will also exit this menu.
5. Input Pulse Memory can be turned on/off in the DIG mode. While selecting DIG in step 4, pressing the EXT key will move to this selection. On/Off is toggled with the ▲ or ▼ keys and the EXT key will switch between multiply and divide. Press the STOP/START key to return to the WAIT Mode.
6. To set the input operation values, press the EXT and ▼ keys simultaneously from the WAIT Mode. The values are changed with the ▲ or ▼ keys. The EXT key is used to toggle between MULT or DIV if set in DIG mode and will scroll through the (4) setpoints in ANA mode.

Manual Operation

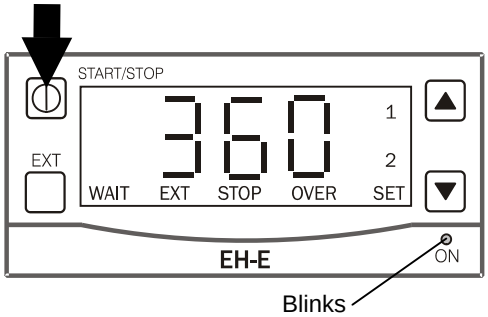
(1) Power ON
When power is applied to the pump, the green indicator above ON lights up, the display momentarily shows the software version ("Vx.xE"), and the controller goes to whatever mode the pump was in when power was disconnected. If being powered for the first time, the stroke rate is then displayed, the "WAIT" is lit, and pump is then in the Wait Mode.



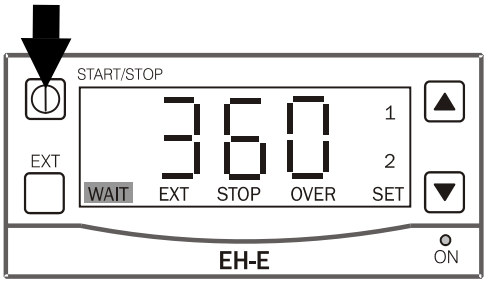
(2) The stroke rate (spm) can be changed by pressing the ▲ or ▼ keys in either the Wait Mode or during operation. Press the ▲to increase the stroke rate and the ▼ key to decrease the rate. Holding the keys down briefly will change the rate slowly, but holding them down for 3 seconds will change the rate rapidly. The default setting shipped from the factory is 360 spm.



(3) Pressing the STOP/START key will start pump operation. The WAIT backlight disappears and the green ON indicator blinks off with every stroke.



(4) Pressing the STOP/START key again will stop pump operation and the WAIT will be backlit as the pump enters the WAIT Mode.

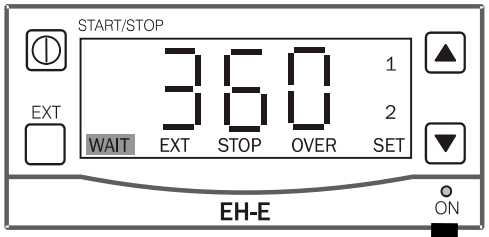


External Operation

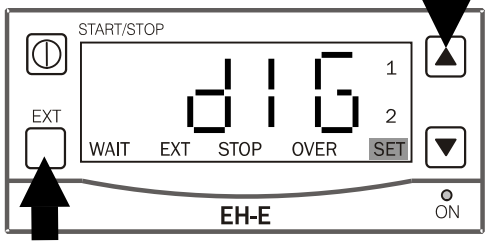
ANALOG INPUT OPERATION

In analog mode the pump will accept a milliamp signal and produce a pump speed proportional to the signal level received. The input resistance of the analog signal is 250Ω. The pump's response can be fine tuned by variable set points to meet system requirements.

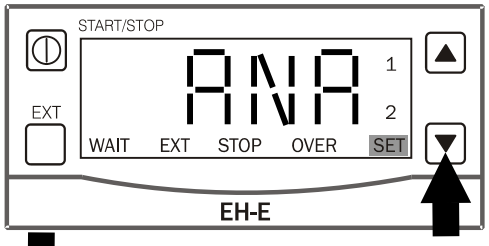
(1) Power ON
When power is applied to the pump, the green indicator above ON lights up, the display momentarily shows the software version ("Vx.xE"), and the controller goes to whatever mode the pump was in when power was disconnected. If being powered for the first time, the stroke rate is then displayed, the "WAIT" is lit, and pump is then in the Wait Mode.



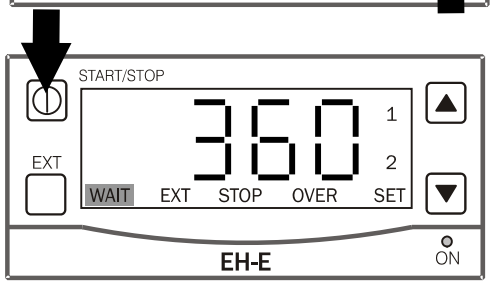
(2) Selecting the mode of EXT operation:
Press the EXT and the ▲ keys simultaneously. The WAIT backlight disappears, the SET backlight is lit, and the display shows "dIG" (if "ANA" is displayed, skip to step 3).



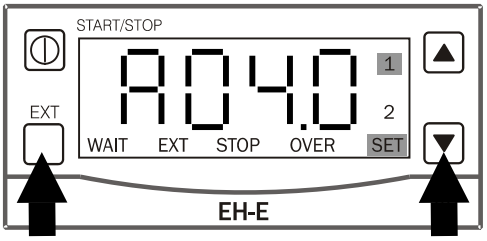
Change the mode by pressing the ▼ key. Every time the ▼ key is pressed, it toggles between the ANA and dIG modes. (Pump is shipped from the factory preset in the dIG mode)



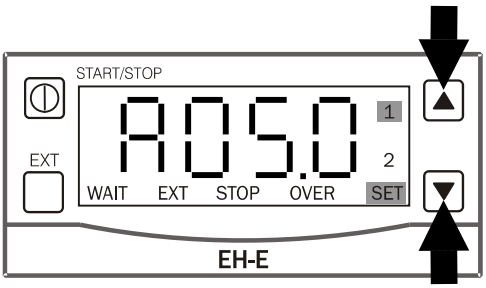
(3) Press the START/STOP key to confirm the Analog selection and return to the WAIT mode.



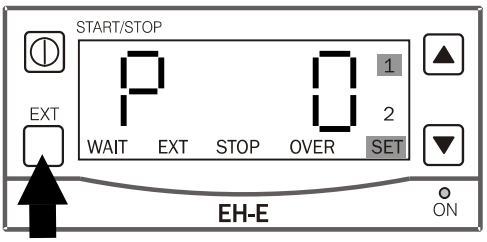
(4) Setting the Analog Input Set points:
(NOTE: Pump is pre-set at factory with the Analog set points set at 4.0mA = 0 SPM and 20.0mA = 360 SPM. If these are the desired set points, skip steps 4-12 and move to step 13.)
Press the EXT and ▼ keys simultaneously. The display will show the initial set point (default is A04.0) and the SET and 1 backlight will appear.



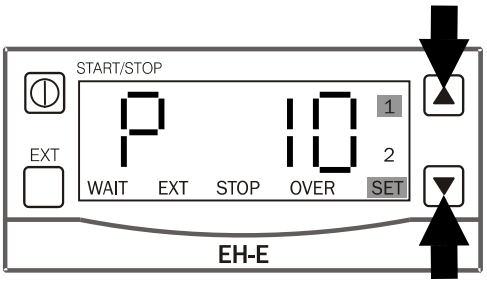
(5) Setting the Input Current (mA) of SET point 1:
Use the ▲ and ▼ keys to set the input current (mA) of SET point 1. The value will increase with the ▲ key and decrease with ▼ the key. The numerical value will change slowly by 0.1mA if the keys are pressed briefly, but will increment rapidly if they are held for more than 3 seconds.
The allowable range is 0.0-20.0mA and the default setting from the factory is 4.0mA.



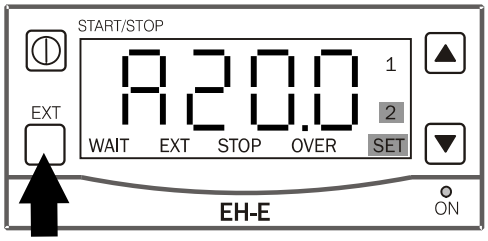
(6) Press the EXT key to confirm the current value of SET point 1 and move to the pump speed (SPM) setting of SET point 1. "P 0" will be the default setting (Pump speed=0spm) and the SET and 1 will remain backlit.



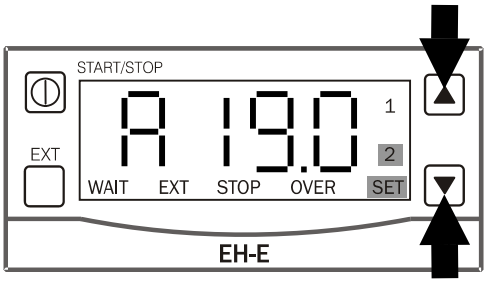
(7) Setting the Stroke Rate of SET point 1:
Set the stroke rate corresponding to the current setting of SET point 1 using the ▲ and ▼ keys.
The allowable range is 0-360 spm and the default setting from the factory is 0 spm.



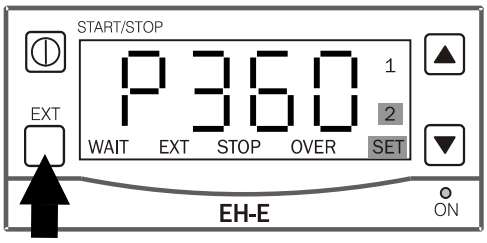
(8) Press the EXT key to confirm the pump speed value of SET point 1 and move to the Current Input setting of Set point 2. The backlight behind SET will remain, but the light behind 1 will go off and 2 will become backlit. The default display will show A20.0.



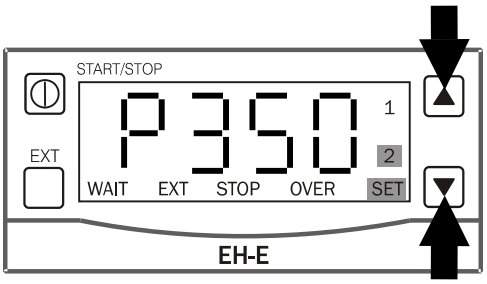
(9) Setting the Input Current (mA) of SET point 2:
Use the ▲ and ▼ keys to set the input current (mA) of SET point 2. Do NOT set the value equal to SET point 1 or an error (ERR1) will occur.
The allowable range is 0.0-20.0mA and the default setting from the factory is 20.0mA.



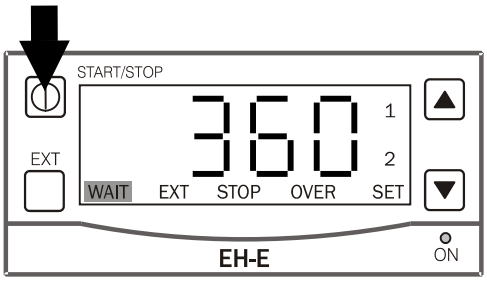
(10) Press the EXT key to confirm the current value of SET point 2 and move to the pump speed (SPM) setting of SET point 2. "P360" will be the default setting (Pump speed=360spm) and the SET and 2 will remain backlit.



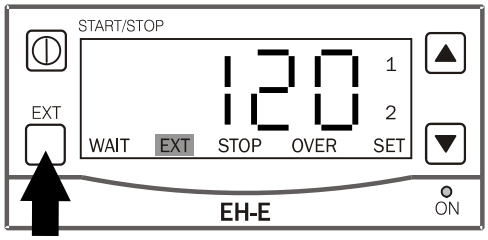
(11) Setting the Stroke Rate of SET point 2:
Set the stroke rate corresponding to the current setting of SET point 2 using the ▲ and ▼ keys.
The allowable range is 0-360 spm and the default setting from the factory is 360 spm.



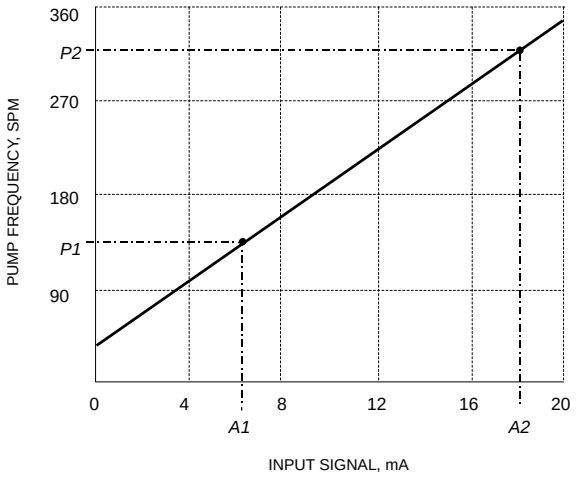
(12) Press the STOP/START key to confirm the pump speed value of SET point 2 and move back to the WAIT mode. (Pressing the EXT key will move back to setting the current value of SET point 1 – step #4. Press the STOP/START key anytime to exit and go to the WAIT mode)



(13) Press the EXT button to start EXT pump operation. The WAIT backlight will go out, EXT will become backlit, and the ON lamp will begin to blink with every stroke. The pump will operate at the speed corresponding to the incoming current (mA) signal.
To stop the pump, press the STOP/START key once and the pump will enter the WAIT mode.
Pressing the EXT again will restart the pump in EXT mode. (see wiring section to ensure the analog wiring is correct)



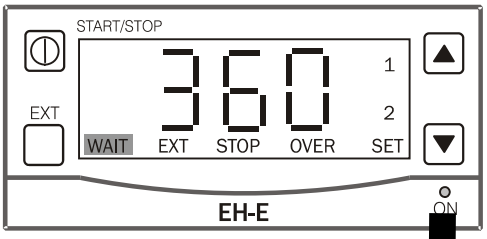
The pump speed will now be determined by the level of the milliamp signal as shown in the graph. The stroke length can be adjusted manually to set the volume pumped per stroke.



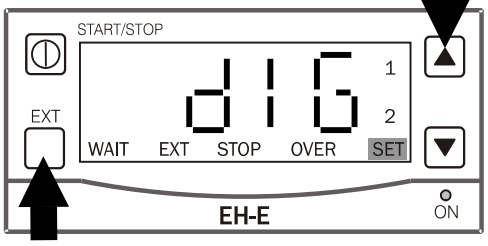
DIGITAL INPUT OPERATION

In digital mode, the pump can accept a non-powered (dry contact) pulse signal from a flowmeter or other similar instrument. The pump can be set to divide pulses by a factor of 1 to 999; or in multiply mode, 1 input pulse can produce 1 to 999 pump strokes. The minimum pulse width for input pulses is 10 mSec.

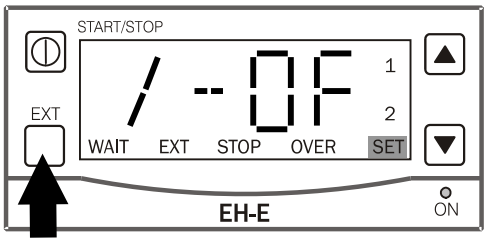
(1) Power ON
When power is applied to the pump, the green indicator above ON lights up, the display momentarily shows the software version ("Vx.xE"), and the controller goes to whatever mode the pump was in when power was disconnected. If being powered for the first time, the stroke rate is then displayed, the "WAIT" is lit, and pump is then in the Wait Mode.



(2) Selecting the mode of EXT operation:
Press the EXT and the ▲ keys simultaneously. The WAIT backlight disappears, the SET backlight is lit, and the display shows "dIG" or "ANA" (if "dIG" is displayed, skip to step 3). Change the mode by pressing the ▼ key. Every time the ▼ key is pressed, it toggles between the ANA and dIG modes. (Pump is shipped from the factory preset in the dIG mode)

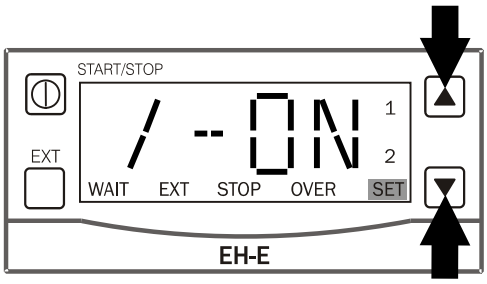


(3) Move to the Pulse Input Memory menu:
Press EXT while dIG is displayed and "/--OF" or "/--ON" will be displayed. "/--OF" is the default set at the factory as it is rarely needed or used.

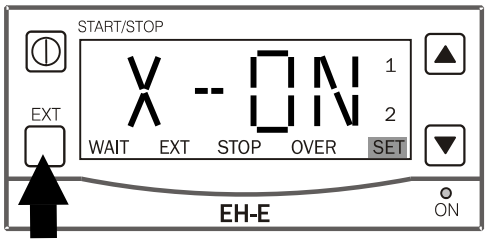


Pulse Input Memory: As digital pulses come into the pump – whether the pump will operate faster than the pulses (MULT) or at a fraction of the speed (DIV) – internal memory can be set to store these pulses if they come in too fast for the pump to keep up. Once the incoming pulses slow or stop, the pump will work off the excess pulses. The factory default settings are that the memory is OFF for the divide mode and ON for the multiply mode. A max. of 255 pulses can be stored.
NOTE! In the Multiply mode, stored pulses can cause the pump to run excessively after incoming pulses (usually indicating flow) have stopped. This could cause injection into a stagnant pipe.

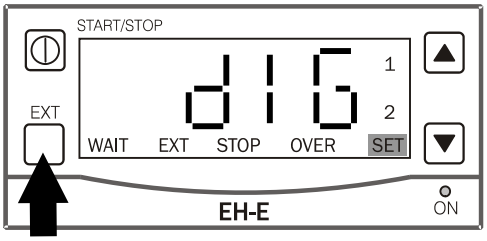
(4) Use the ▲ and ▼ keys to toggle the divide memory ON and OFF. These will change the display between "/--OF" and "/--ON".



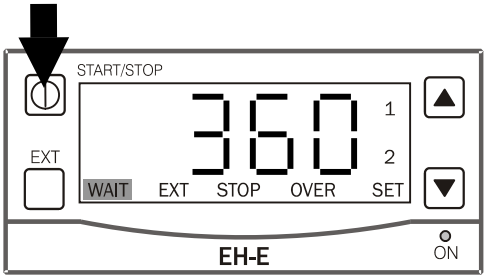
(5) Pressing the EXT key moves to the memory setting for the MULT mode. "X--ON" is the default setting. Pressing the ▲ and ▼ keys will toggle the display between "X--ON" and "X--OF".



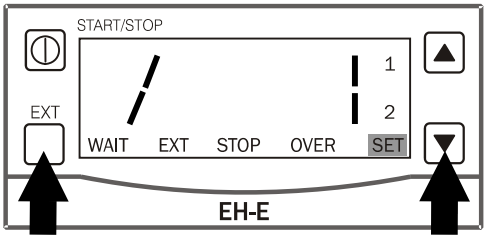
(6) Press the EXT key to enter the memory selections and return to the “dIG” set menu.



(7) Press the START/STOP key to confirm the Digital Operation selection and return to the WAIT mode. The SET backlight will go out and the WAIT light will illuminate.

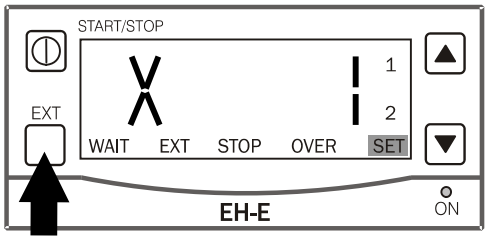


(8) Digital Input Selection:
(NOTE: Pump is pre-set at factory with both MULT or DIV set to 1. The default Digital mode is preset to DIV.)
Press the EXT and ▼ keys simultaneously. The display will show “/ 1” (Dividing mode) and the SET backlight will appear.

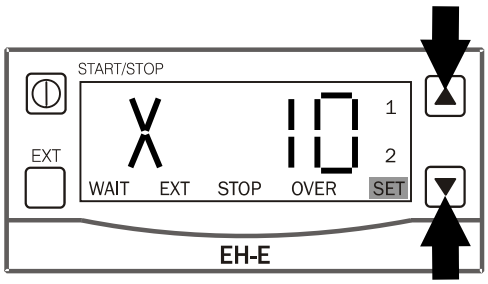


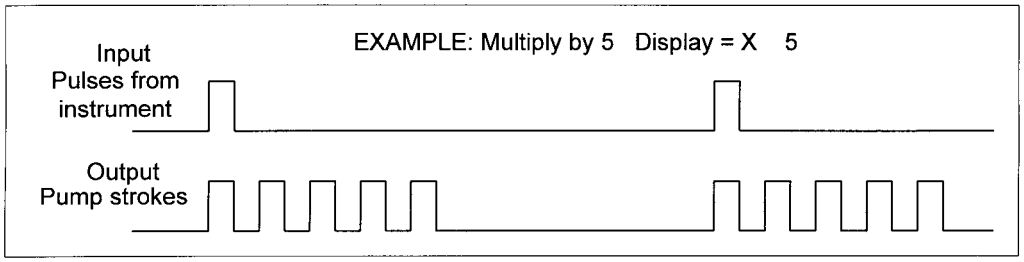
(9) Pressing the EXT key toggles the mode of operation between “/” (DIV) and “X” (MULT).

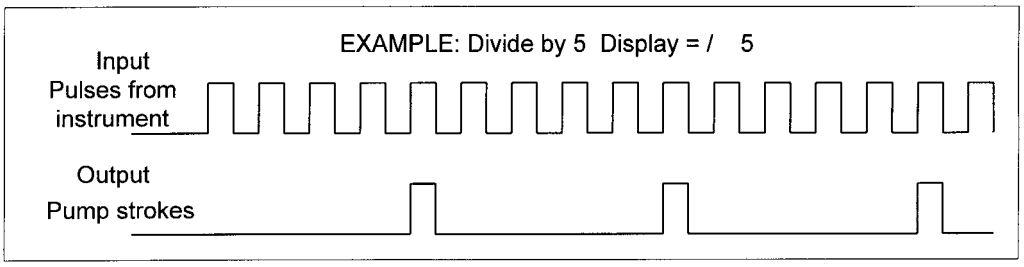
Once the desired mode of operation is displayed (“X 1” for MULT or “/ 1” for DIV), set the value needed to be multiplied or divided.



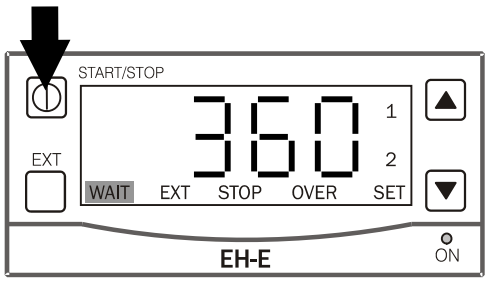
(10) Setting the Stroke Rate:
Set the desired multiplier or divider value using the ▲ and ▼ keys.
The allowable range is 1-999 and the default setting from the factory is 1.



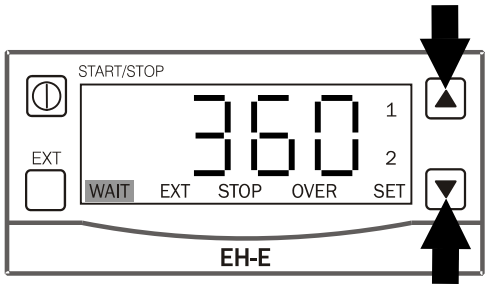




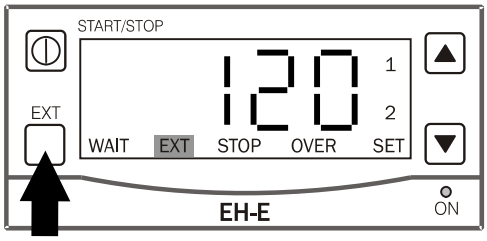
(11) Press the START/STOP key to confirm the operation mode and value settings. This will also return to the WAIT mode. The WAIT light will illuminate and the backlight behind SET will go out.



(12) IMPORTANT: Changing the pump speed in the WAIT (or MAN) mode using the ▲ and ▼ keys sets the MAX operating speed the pump will operate in the Digital mode (MULT). This can be used to help moderate the pump output and reduce slug feeding. For example, if the pump is set to multiply by 10 and a max of 3 input pulses/min are expected from a flowmeter, instead of having the pump stroke 10 times in 2 seconds for each input pulse (pump set at 360SPM), the speed can be reduced to 40 SPM and the pump will take 15 seconds to evenly pump in the 10 strokes – the pump will be operating 45 seconds out of 60 instead of 6 out of 60.

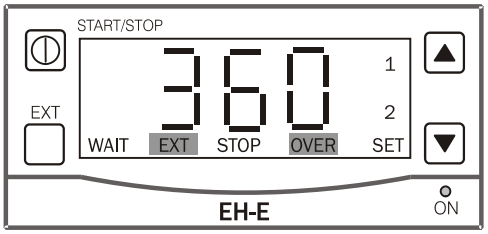


(13) Press the EXT button to start EXT pump operation. The WAIT backlight will go out, EXT will become backlit, and the ON lamp will blink with every stroke. The pump will operate at the speed corresponding to the MULT or DIV setting of the incoming pulses. To stop the pump, press the STOP/START key once and the pump will enter the WAIT mode.
Pressing the EXT again will restart the pump in EXT mode.
(see wiring section to ensure the digital input wiring is correct)

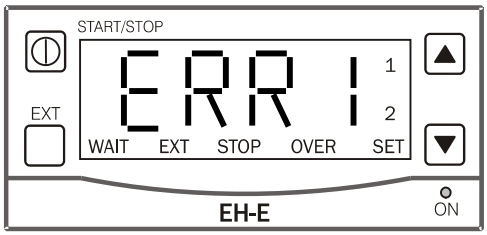


ALARM Indications

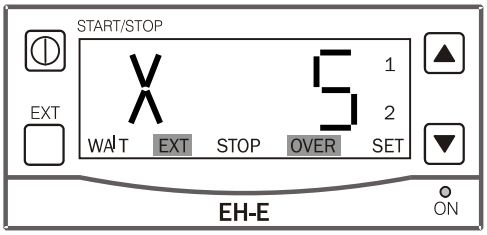
(1) In ANALOG Input Operation, if the incoming current matching 360SPM (typically, 20mA=360SPM) is exceeded, the OVER will become backlit. The pump will continue to operate at 360SPM during this condition.



(2) While programming the Analog Input Setpoints, if the same value (current or SPM) is set for both Setpoint 1 and 2, "ERR 1" will be displayed for 3 seconds. It will return to the programming menu so the setpoints can be corrected.



(3) In DIGITAL Input Operation (Multiply or Divide modes), if the incoming pulses come in either during operation or exceed the pump doing 360SPM, the OVER will be come backlit. If the Pulse Input Memory is on, the pump will store the extra pulses (max. of 255 incoming pulses) and work them off as it can to catch up.

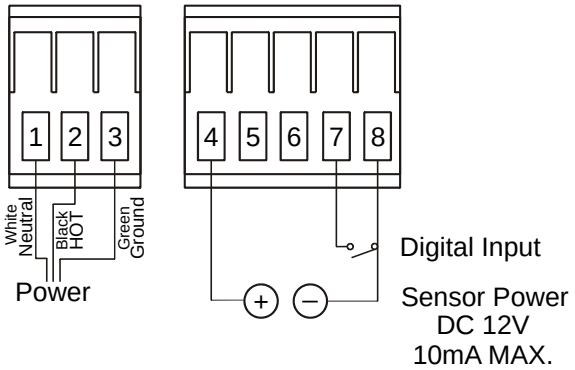


3.5 Input Wiring and Connections

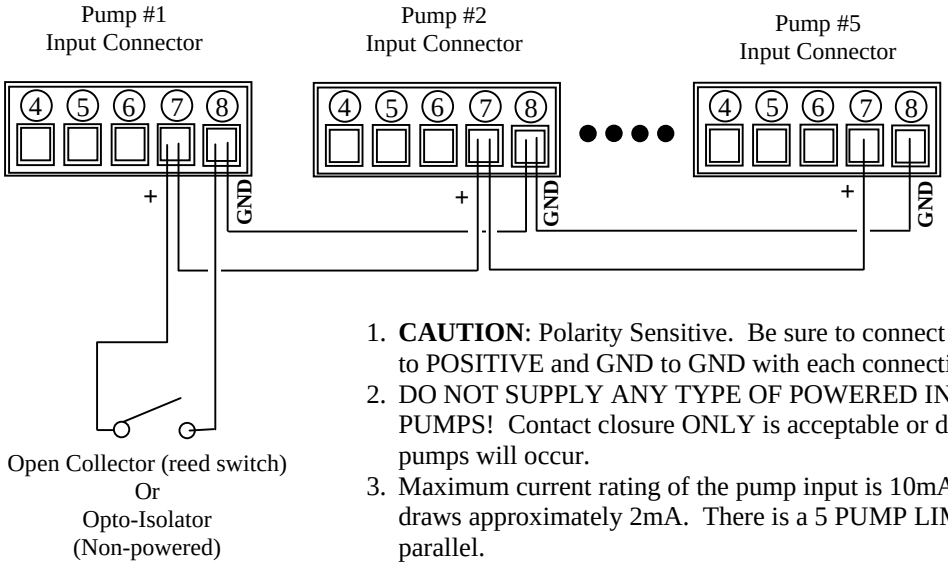
Digital Mode

Connecting a digital input device

Disconnect AC power to the pump. Remove the four screws from the terminal block cover and remove the cover. Remove the cord nut and bushing from the terminal block cover. Remove the terminal block from the connector. Slide the nut and bushing over the external control cable and insert the cable through the terminal block cover. Strip 1/4" insulation from conductors and connect the positive side to terminal 7 and the negative side to terminal 8. (See Figure 8 and the schematic, below.)



Connecting a digital input to multiple pumps in parallel



1. **CAUTION**: Polarity Sensitive. Be sure to connect the POSITIVE to POSITIVE and GND to GND with each connection.
2. DO NOT SUPPLY ANY TYPE OF POWERED INPUT TO THE PUMPS! Contact closure ONLY is acceptable or damage to the pumps will occur.
3. Maximum current rating of the pump input is 10mA. Each pump draws approximately 2mA. There is a 5 PUMP LIMIT of pumps in parallel.
4. Make sure the switching device can handle the maximum current in the system.

   Current = 2mA x # of Pumps

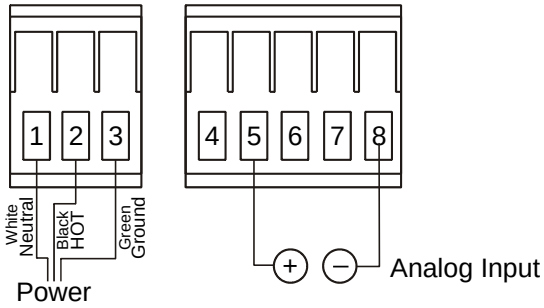
Sensor Power

The control circuit of the EHE series has the ability to provide 12 VDC at up to 10 mA to power a Hall effect sensor or similar device. Connect the sensor power leads to terminal 4 (positive) and terminal 8 (negative) of the terminal block.

Analog Mode

CAUTION: Open loop signal voltage must not exceed 25 VDC. If the signal voltage is greater than 25 VDC, power down the signal source prior to connection.

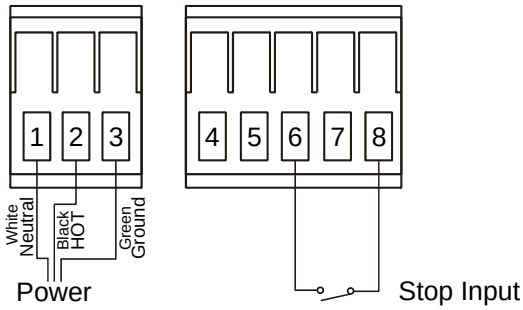
Connecting an analog signal device
Disconnect AC power to the pump. Remove the four screws from the terminal block cover and remove the cover. Remove the cord nut and bushing from the terminal block cover. Remove the terminal block from the connector. Slide the nut and bushing over the external control cable and insert the cable through the terminal block cover. Strip 1/4" insulation from conductors and connect the positive side to terminal 5 and the negative side to terminal 8. (See Figure 8 and the schematic to the right.)



STOP Function

The EHE series pump also includes a **STOP** function that allows an external signal to stop the operation of the pump.

A switch or solid-state device capable of switching 5 VDC at 2 mA can be connected to terminals 6 (positive) and 8 (negative) of the terminal block. Closing this circuit temporarily interrupts pump operation. Opening this circuit resumes pump operation. If the pump is operating in external digital mode, any pulses received while the pump is stopped will be saved (up to a maximum of 255). When pump operation resumes, saved pulses will allow the pump to "catch up" by producing the correct number of pump strokes that should have occurred while it was stopped. The 'Over' indicator will light up if the pump receives pulses while in the 'Stopped' condition (see Figure 8 and the schematic below).



3.6 AC Power Interruption

If AC power is interrupted, the pump will power up as shown below:

State preceding power OFF	State following power ON
WAIT	WAIT
Run Manual	Run manual
Run external	Run external
Set EXTernal mode	WAIT
Set EXTernal values	WAIT

4.0 MAINTENANCE

CAUTION: Before working on the pump, disconnect the power cord, depressurize the discharge tubing and drain or flush any residual liquid from the pump head and valves. Always wear protective gear when working around chemicals.

4.1 Diaphragm Replacement

Disconnect AC power to the pump and disconnect the suction tubing and discharge tubing. Remove the four head bolts with a 4mm hex wrench. Turn the stroke length knob fully counter-clockwise. Unscrew the diaphragm and remove its retainer (small disk behind the diaphragm). **CAUTION:** *There may be small brass spacers between the retainer and the armature shaft. These spacers need to be re-used when replacing the diaphragm.* Install the new retainer and diaphragm on the shaft. Turn the diaphragm clockwise until it bottoms on the shaft. Use Caution when handling the diaphragm – the PTFE surface can be damaged by tools, nails, or any sharp objects. Replace the pump head and tighten the head bolts to a torque of 19 lb-in (2.16 N-m).

4.2 Valve Replacement

Making sure the discharge side has been depressurized, remove the suction and discharge tubing. Remove the suction fitting, two valve cartridges*, o-ring and gasket(s). Install the new o-ring, gasket(s) and valve cartridges. Be sure both valve seats are in the same orientation. Refer to Figure 9 below. Tighten the suction fitting. Similarly remove and replace the discharge valve cartridges, o-ring and gasket(s).

*EHE46 and EHE56 series have one valve cartridge on the suction and discharge sides. Refer to Section 5.0 for exploded view drawing and parts list.

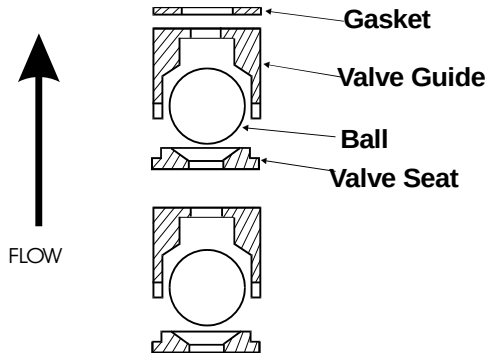


Figure 9 Valve Cartridge Orientation

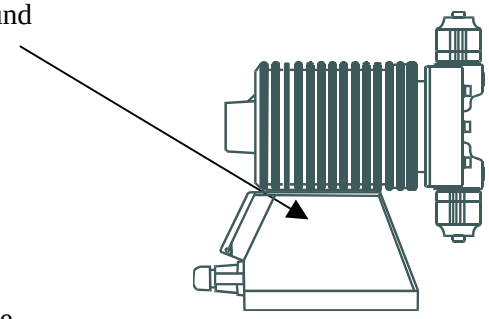
4.3 Tubing

Check ends of tubing for splits, cracks or thin spots. Examine the full length of tubing for damage due to chafing, abrasion, stress cracks, excessive temperature or exposure to ultraviolet light (direct sunlight or mercury vapor lamps). If any signs of deterioration exist, replace the entire length of tubing. It is a good idea to replace discharge tubing on a regular preventative maintenance schedule every 12 months.

5.0 EXPLODED VIEW AND PARTS GUIDE

5.1 How to order parts for your metering pump.

Have your catalog or model number ready. This is found on the silver label on the side of the pump.



From the exploded view drawing, identify the item number of the part(s) to be ordered.

The item numbers are listed and include part number, description and size/material information.

Contact your Walchem distributor for further assistance.

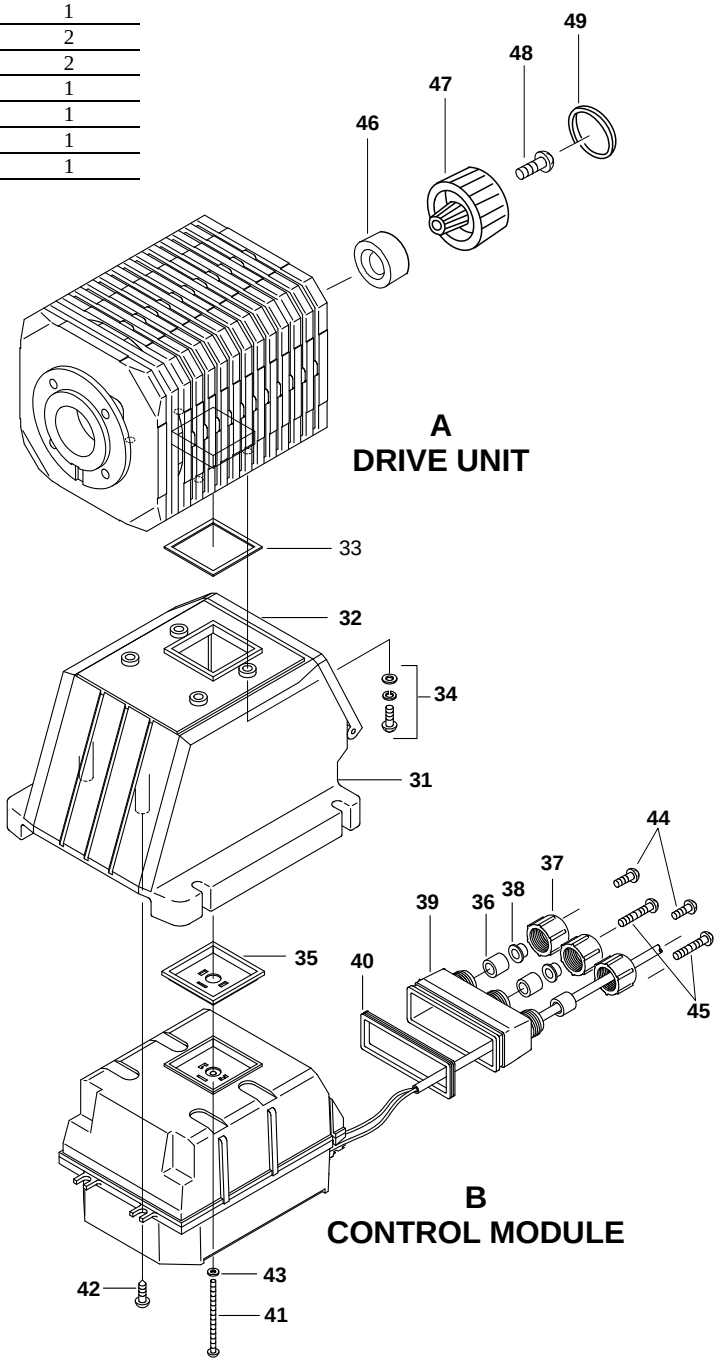
5.2 Accessories (Not shown)

Part No.	Description	Size	Liquid End Mtl
E90005	Valve, Injection 1/2	31, 36, 46	VC
E90006	Valve, Injection 1/2	31, 36, 46	VE, VF
E90007	Valve, Injection, 1/2	56	VC, VM
E90008	Valve, Injection, 1/2	56	VE, VF
E90009	Valve, Injection, 1/2	31, 36, 46	PC
E90010	Valve, Injection, 1/2	31, 36, 46	PE
E90011	Valve, Injection, 1/2	56	PC
E90012	Valve, Injection, 1/2	56	PE
E90022	Valve, Injection/Back Pressure, 1/2	31, 36, 46, 56	FC
E90068	Valve, Back Pressure/Anti-Siphon, 1/2	31, 36, 46, 56	VC, VE, VM, VF
E90069	Valve, Back Pressure/Anti-Siphon, 1/2	31, 36, 46, 56	PC, PE
E90018	Valve, Foot, 1/2	31, 36, 46, 56	PC
E90036	Valve, Foot, 1/2	31, 36, 46, 56	PE
E90037	Valve, Foot, 1/2	31, 36, 46, 56	VE
E90193	Valve, Foot, 1/2	31, 36, 46, 56	VF
E90275	Valve, Foot, 1/2	31, 36, 46, 56	FC
E00001-00	Tubing, 1/2 OD LLDPE per foot	31, 36, 46, 56	All
E00001	Tubing, 1/2 OD LLDPE, 20 FT	31, 36, 46, 56	All
E00001-50	Tubing, 1/2 OD LLDPE, 50 FT	31, 36, 46, 56	All
E00001-100	Tubing, 1/2 OD LLDPE, 100 FT	31, 36, 46, 56	All
E00001-250	Tubing, 1/2 OD LLDPE, 250 FT	31, 36, 46, 56	All
E00001-500	Tubing, 1/2 OD LLDPE, 500 FT	31, 36, 46, 56	All
E00071	Weight, Ceramic	31, 36, 46, 56	All
*E00030	Fitting (NPT Valve Housing) 1/2" NPT, PVC	31, 36	VC, VE, VF
*E00031	Fitting (NPT Valve Housing) 1/2" NPT, PP	31, 36	PC, PE
*E00032	Fitting (NPT Valve Housing) 1/2" NPT, PVDF	31, 36	FC
*E00033	Fitting (NPT Valve Housing) 3/4" NPT, PVC	31, 36	VC, VE, VF
*E00034	Fitting (NPT Valve Housing) 3/4" NPT, PP	31, 36	PC, PE
*E00035	Fitting (NPT Valve Housing) 3/4" NPT, PVDF	31, 36	FC
*E00036	Fitting (NPT Valve Housing) 3/4" NPT, PVC	46	VC, VE, VF
*E00037	Fitting (NPT Valve Housing) 3/4" NPT, PP	46	PC, PE
*E00038	Fitting (NPT Valve Housing) 3/4" NPT, PVDF	46	FC
*E00039	Fitting (NPT Valve Housing) 3/4" NPT, PVC	56	VC, VE, VM, VF
*E00040	Fitting (NPT Valve Housing) 3/4" NPT, PP	56	PC, PE
*E00041	Fitting (NPT Valve Housing) 3/4" NPT, PVDF	56	FC

* Fittings replace the Valve Housing (Item 3) and the complete Manual Air Vent Valve assembly (Item E) shown in exploded view.

5.3 Drive Control Components

Item	Part No.	Description	Qty
31	EH0700	Base, Pump, EHE	1
32	EH0697	Cover, Control Panel	1
33	EH1658	Gasket, EHE Pump Base	1
34	EH1071	Screw, M5 x 12, SS, PH	4
35	EH0696	Gasket, Terminal Block	1
36	EH0202	Grommet, Cord	3
37	EH0205	Nut, Strain Relief	3
38	EH0204	Cap, Strain Relief	2
39	EH0706	Box, Terminal, EHE	1
40	EH1036	Gasket, Terminal Box	1
41	EH0710	Screw, M3 x 50, SS, PH	1
42	EH0711	Screw, 5-10 SS PH Self Tap	2
43	EH0261	Gasket, M3 x 5 Bolt	1
44	EH1037	Screw, M3.5 x 10, SS, PH	2
45	EH1038	Screw, M3.5 x 25, SS, PH	2
46	EH0872	Gasket, Stroke Adjustment	1
47	EH0871	Knob, Stroke length Adj.	1
48	EH0873	Screw, M4 x 30 SS PH	1
49	EH0141	Cap, Stroke Length Adj Knob	1

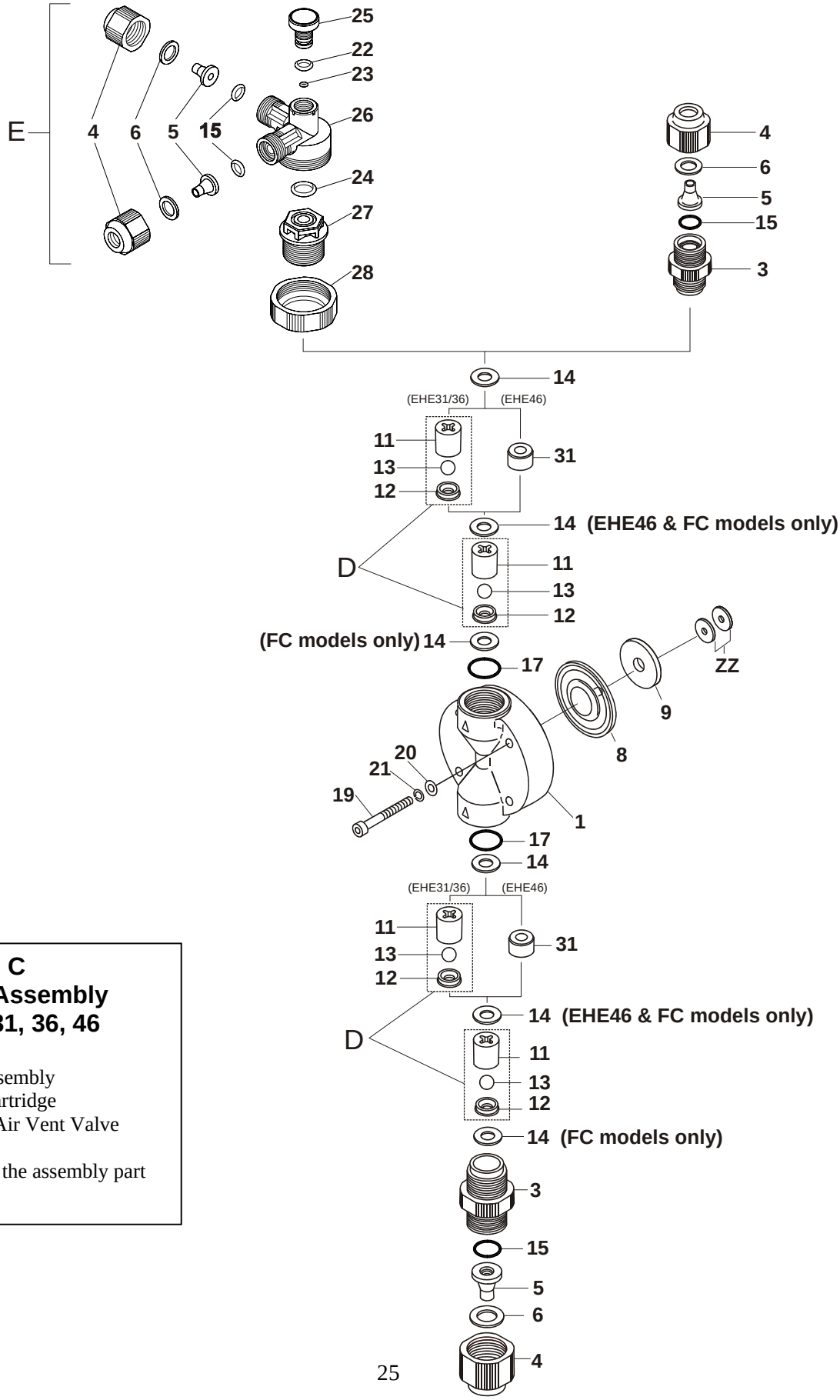


A Drive Unit

B Control Unit

See page 29 for the spare part assembly part numbers.

5.4 EHE31, 36, 46 Liquid End Exploded View



C
Head Assembly
EHE 31, 36, 46

C	Head Assembly
D	Valve Cartridge
E	Manual Air Vent Valve

See Page 29 for the assembly part numbers

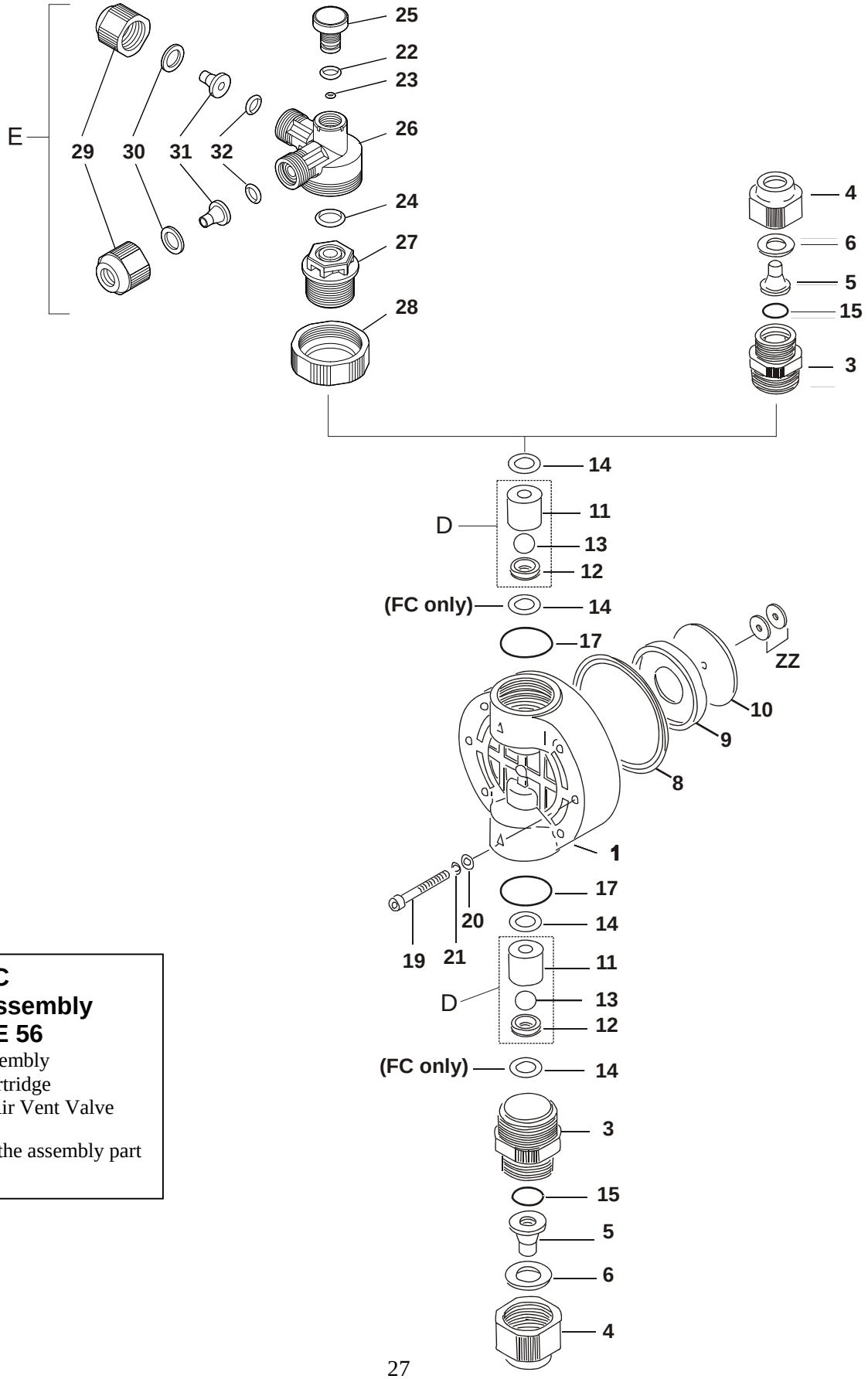
EHE31, 36, 46 Liquid End Parts List

Item	Part No	Description	Qty	Size	Liquid End Mtl
1	EH2101	Head, E31 PVC	1	31	VC, VE, VF
	EH2102	Head, E31 GFRPP	1	31	PC, PE
	EH2103	Head, E31 PVDF	1	31	FC
	EH1953	Head, E36 PVC	1	36	VC, VE, VF
	EH1962	Head, E36 GFRPP	1	36	PC, PE
	EH1967	Head, E36 PVDF	1	36	FC
	EH2109	Head, E46 PVC	1	46	VC, VE, VF
	EH2110	Head, E46 GFRPP	1	46	PC, PE
	EH2111	Head, E46 PVDF	1	46	FC
3	EH0619	Housing, Valve, ½ PVC	1	31,36	VC, VE, VF
	EH0675	Housing, Valve, ½ GFRPP	1	31,36	PC, PE
	EH0947	Housing, Valve, ½ PVDF	2	31,36	FC
	EH0640	Housing, Valve, ½ PVC	1	46	VC, VE, VF
	EH0679	Housing, Valve, ½ GFRPP	1	46	PC, PE
	EH0932	Housing, Valve, ½ PVDF	2	46	FC
4	EH0620	Nut, Coupling, ½ PVC	3	31,36,46	VC, VE, VF
	EH0676	Nut, Coupling, ½ GFRPP	3	31,36,46	PC, PE
	EH0933	Nut, Coupling, ½ PVDF	2	31,36,46	FC
5	EH0719	Adapter, ½, PVC	3	31,36,46	VC, VE, VF
	EH0734	Adapter, ½ GFRPP	3	31,36,46	PC, PE
	EH0938	Adapter, ½ PVDF	2	31,36,46	FC
6	EH0720	Clamp Ring, 1/2 SS	3(2)	31,36,46	All (FC)
*8	EH2105	Diaphragm, PTFE/EPDM	1	31	All
	EH2108	Diaphragm, PTFE/EPDM	1	36	All
	EH2113	Diaphragm, PTFE/EPDM	1	46	All
*9	EH0622	Retainer, Diaphragm	1	31	All
	EH0637	Retainer, Diaphragm	1	36	All
	EH0642	Retainer, Diaphragm	1	46	All
*11	EH0118	Guide, Valve 0.375 PVC	4	31,36	VC, VE,VF
	EH0332	Guide, Valve 0.375 GFRPP	4	31,36	PC, PE
	EH0352	Guide, Valve 0.375 PVDF	4	31,36	FC
	EH0643	Guide, Valve 0.500 PVC	2	46	VC, VE,VF
	EH0680	Guide, Valve 0.500 GFRPP	2	46	PC, PE
	EH0934	Guide, Valve 0.500 PVDF	2	46	FC
*12	EH0119	Seat, Valve 0.375 FKM	4	31, 36	VC, PC
	EH0623	Seat, Valve, 0.375 EPDM	4	31, 36	VE, PE, VF
	EH0593	Seat, Valve, 0.375 PCTFE	4	31, 36	FC
	EH0644	Seat, Valve, 0.500 FKM	2	46	VC, PC
	EH0645	Seat, Valve, 0.500 EPDM	2	46	VE, PE, VF
	EH0935	Seat, Valve, 0.500 PCTFE	2	46	FC
*13	EH0120	Ball, Valve, 0.375 CE	4	31, 36	VC, VE, PC, PE, FC
	E00062	Ball, Valve, 0.375, PTFE	4	31, 36	VF

Item	Part No	Description	Qty	Size	Liquid End Mtl
*13	EH0646	Ball, Valve, 0.500, CE	2	46	VC, VE, PC, PE, FC
	E00072	Ball, Valve, 0.500, PTFE	2	46	VF
*14	EH0121	Gasket, Valve, 0.375 PTFE	2	31, 36	VC, VE, PC, PE, VF
	EH0354	Gasket, Valve, 0.375 PTFE	6	31, 36	FC
	EH0648	Gasket, Valve, 0.500, PTFE	4	46	VC, VE, PC, PE, VF
	EH0936	Gasket, Valve, 0.500, PTFE	6	46	FC
*15	EH0028	O-Ring, P12 FKM	3	31,36,46	VC, PC
	EH0051	O-Ring, P12 EPDM	3	31,36,46	VE, PE, VF
	EH0939	Gasket, Adapter, PTFE	2	31,36,46	FC
*17	EH0122	O-Ring, P16 FKM	2	31, 36	VC, PC
	EH0127	O-Ring, P16 EPDM	2	31, 36	VE, PE, VF
	EH0650	O-Ring, 24 x 2.62, FKM	2	46	VC, PC
	EH0649	O-Ring, 24 x 2.62 EPDM	2	46	VE, PE, VF
	EH0355	Gasket, Housing, PTFE	2	31, 36	FC
	EH0941	Gasket, Housing, PTFE	2	46	FC
19	EH2106	Bolt, M5 x 40 316 SS	4/6	31,36,46	All
20	EH2011	Washer, M5 Flat, 316 SS	4/6	31,36,46	All
21	EH2012	Washer, M5 Lock, 316 SS	4/6	31,36,46	All
*22	EH0302	O-Ring, Knob, Seal	1	31,36,46	VC, PC
	EH0303	O-Ring, Knob, Seal	1	31,36,46	VE, PE, VF
*23	EH0300	O-Ring, Knob, Stop	1	31,36,46	VC, PC
	EH0301	O-Ring, Knob, Stop	1	30.35.45	VE, PE, VF
*24	EH1082	O-Ring, Fitting Seal	1	31, 36	VC, PC
	EH1084	O-Ring, Fitting Seal	1	31, 36	VE, PE, VF
	EH0122	O-Ring, Fitting Seal	1	46	VC, PC
	EH0127	O-Ring, Fitting Seal	1	46	VE, PE, VF
25	EH0299	Adjustment Knob	1	31,36,46	VC, VE, VF
	EH0321	Adjustment Knob	1	31,36,46	PC, PE
26	EH1662	Manual Air Vent Valve Body	1	31,36,46	VC, VE, VF
	EH1665	Manual Air Vent Valve Body	1	31,36,46	PC, PE
27	EH1078	Valve Housing MAVV	1	31, 36	VC, VE, VF
	EH1088	Valve Housing MAVV	1	31, 36	PC, PE
	EH1660	Valve Housing MAVV	1	46	VC, VE, VF
	EH1663	Valve Housing MAVV	1	46	PC, PE
28	EH1674	Lock Nut, MAVV	1	31, 36	VC, VE, VF
	EH1675	Lock Nut, MAVV	1	31, 36	PC, PE
	EH1661	Lock Nut, MAVV	1	46	VC, VE, VF
	EH1664	Lock Nut, MAVV	1	46	PC, PE
31	EH0653	Spacer, V.Housing, PVC	2	46	VC, VE, VF
	EH0683	Spacer, V.Housing, PP	2	46	PC, PE
	EH0940	Spacer, V.Housing, PVDF	2	46	FC
ZZ	---------	Brass Spacers	Drive specific/Re-use when replacing the diaphragm		

* Included in spare parts kit

5.4 EHE 56 Liquid End Exploded View



C
Head Assembly
EHE 56

C Head Assembly
D Valve Cartridge
E Manual Air Vent Valve

See page 29 for the assembly part numbers

EHE 56 Liquid End Parts List

Item	Part No	Description	Qty	Size	Liquid End Mtl
1	EH2114	Head, E56 PVC	1	56	VC, VE, VF
	EH2115	Head, E56 GFRPP	1	56	PC, PE
	EH2118	Head, E56 PVC Machined	1	56	VM
	EH2116	Head, E56 PVDF	1	56	FC
3	EH0656	Housing, Valve, E56, PVC	2	56	VC, VE, VM, VF
	EH0685	Housing, Valve, E56, GFRPP	2	56	PC, PE
	EH0916	Housing, Valve, ½ PVDF	2	56	FC
4	EH0657	Nut, Coupling, E56, PVC	2	56	VC, VE, VM, VF
	EH0686	Nut, Coupling, E56, GFRPP	2	56	PC, PE
	EH0917	Nut, Coupling, E56, PVDF	2	56	FC
5	EH0730	Adapter, E56, 1/2, PVC	2	56	VC, VE, VM, VF
	EH0735	Adapter, E56, 1/2, GFRPP	2	56	PC, PE
	EH0923	Adapter, E56, PVDF	2	56	FC
6	EH0731	Clamp Ring, E56, 1/2, SS	2	56	All
***8**	EH2119	Diaphragm, PTFE/EPDM	1	56	All
***9**	EH0660	Retainer, Secondary, PPS	1	56	All
***10**	EH0659	Retainer	1	56	All
***11**	EH0661	Guide, Valve, .625, PVC	2	56	VC, VE, VM, VF
	EH0718	Guide, Valve, .625, GFRPP	2	56	PC, PE
	EH0918	Guide, Valve, 0.625, PVDF	2	56	FC
***12**	EH0662	Seat, Valve, .625, FKM	2	56	VC, VM, PC
	EH0663	Seat, Valve, .625, EPDM	2	56	VE, PE, VF
	EH0920	Seat, Valve, 0.625, PCTFE	2	56	FC
***13**	EH0664	Ball, Valve, .625, CE	2	56	VC, VE, VM, PC, PE, FC
	E00073	Ball, Valve, .625, PTFE	2	56	VF
***14**	EH0666	Gasket, Valve, .625, PTFE	2	56	VC, VE, VM, PC, PE, VF
	EH0921	Gasket, Valve, 0.625 PTFE	4	56	FC
***15**	EH0122	O-Ring, P16 FKM	2	56	VC, VM, PC
	EH0127	O-Ring, P16 EPDM	2	56	VE, PE, VF
	EH0924	Gasket, Adapter, PTFE	2	56	FC
***17**	EH0667	O-Ring, 29.8 X 2.62, FKM	2	56	VC, VM, PC
	EH0668	O-Ring, 29.8 X 2.62, EPDM	2	56	VE, PE, VF
	EH0925	Gasket, Housing, PTFE	2	56	FC
19	EH2054	Bolt, M5 x 55 SHC, 316 SS	6	56	VC, VE, PC, PE, VF
	EH2121	Bolt, M5 x 75 SHC, 316 SS	6	56	VM
20	EH2011	Washer, M5 Flat, 316 SS	6	56	All
21	EH2012	Washer, M5 Lock, 316 SS	6	56	All
***22**	EH0302	O-Ring, Knob, Seal	1	56	VC, PC
	EH0303	O-Ring, Knob, Seal	1	56	VE, PE
***23**	EH0300	O-Ring, Knob, Stop	1	56	VC, PC
	EH0301	O-Ring, Knob, Stop	1	56	VE, PE
***24**	EH0122	O-Ring, Fitting Seal	1	56	VC, PC
	EH0127	O-Ring, Fitting Seal	1	56	VE, PE
25	EH0299	Adjustment Knob	1	56	VC, VE
	EH0321	Adjustment Knob	1	56	PC, PE
26	EH1662	Manual Air Vent Valve Body	1	56	VC, VE
	EH1665	Manual Air Vent Valve Body	1	56	PC, PE
27	EH1666	Valve Housing MAVV	1	56	VC, VE
	EH1667	Valve Housing MAVV	1	56	PC, PE
28	EH1661	Lock Nut, MAVV	1	56	VC, VE
	EH1664	Lock Nut, MAVV	1	56	PC, PE
29	EH0620	Coupling Nut	2	56	VC, VE
	EH0676	Coupling Nut	2	56	PC, PE
30	EH0720	Clamp Ring	2	56	VC, VE, PC, PE
31	EH0719	Adapter	2	56	VC, VE
	EH0734	Adapter	2	56	PC, PE
32	EH0028	O-Ring, Coupling Nut	2	56	VC, PC
	EH0051	O-Ring, Coupling Nut	2	56	PC, PE
ZZ	----------	Brass Spacers	Drive specific/ re-use when replacing diaphragm		

***** Included in spare parts kit

5.6 Assembly Part Numbers

Key letter from exploded view drawing, previous pages

A	Drive Unit
B	Control Module
C	Head Assembly
D	Valve Cartridge
E	Manual Air Vent Valve Assembly

E H E	36	E	1	–	V C
Series	Size	Control	Voltage		Liquid End

Pump Model	A Drive Unit Use P/N:	B Control Module Use P/N:	C Head Assembly Liquid End Code						
			VC	VE	VF	PC	PE	VM	FC
EHE31E1-	HE31-1	EHC-E11UPE (115V)	E31VC	E31VE	E31VF	E31PC	E31PE	-	E31FC
EHE31E2-	HE31-2	EHC-E23UPE (230V)							
EHE36E1-	HE36-1	EHC-E11UPE (115V)	E36VC	E36VE	E36VF	E36PC	E36PE	-	E36FC
EHE36E2-	HE36-2	EHC-E23UPE (230V)							
EHE46E1-	HE46-1	EHC-E11UPE (115V)	E46VC	E46VE	E46VF	E46PC	E46PE	-	E46FC
EHE46E2-	HE46-2	EHC-E23UPE (230V)							
EHE56E1-	HE56-1	EHC-E11UPE (115V)	E56VC	E56VE	E56VF	E56PC	E56PE	E56VM	E56FC
EHE56E2-	HE56-2	EHC-E23UPE (230V)							
D Valve Cartridge		31, 36	E90052	E90071	E90313	E90056	E90073	-	E90316
		46	E90074	E90075	E90314	E90077	E90078	-	E90317
		56	E90079	E90080	E90315	E90082	E90083	E90079	E90318
E Manual Air Vent Valve Assembly		31, 36	E90589	E90590	E90590	E90591	E90592	-	-
		46	E90366	E90367	E90367	E90368	E90369	-	-
		56	E90370	E90371	E90371	E90372	E90373	E90370	-

5.7 Spare Parts Kit

The spare parts kit number is the Head Assembly part number with '–PK' at the end. (E31VC-PK, E31VE-PK, E31PC-PK, etc.)

Spare parts kit includes: diaphragm, retainer(s), valve guides, valve seats, valve balls, valve gaskets, o-rings and a hex wrench (head bolts are not included) (see the exploded view drawings for detail of parts in the spare parts kits)

6.0 TROUBLESHOOTING

Caution: Before working on the pump disconnect the power cord, depressurize the discharge tubing and drain or flush any residual liquid from the pump head and valves.

Problem	Possible Cause	Corrective Action
Pump does not start	Faulty wiring	Correct wiring
	Improper voltage	Connect to proper voltage source
	Electronic control unit is damaged	Replace control unit (Contact distributor or factory)
Pump does not prime	Pump stroke length is too short	Operate pump with stroke length set at 100% until primed. Then set the stroke length as needed to obtain desired output.
	Air in suction tubing	Reroute suction tubing to eliminate air trap
	Valve gasket is missing	Install valve gasket
	Valve set assembly direction is wrong.	Reassemble valve set
	Pump is air locked	Prime pump per instructions
Output fluctuates	Suction or discharge valve is clogged with foreign matter	Disassemble, inspect, clean
	Air is trapped in pump	Prime pump per instructions
	Overfeeding	Install injection valve or back pressure valve. Check stroke length knob(@ 0%, pump should not pump)
	Diaphragm is damaged	Replace diaphragm
	Worn check valves	Replace valve cartridges
Liquid leaks	Fitting or coupling nut is loose	Tighten
	Pump head is loose	Tighten pump head bolts. Torque: 19 lb-in (2.16 N-m)
	Diaphragm is damaged	Replace diaphragm
	O-ring or valve gasket missing.	Install o-ring or valve gasket

7.0 SERVICE POLICY

The EHE Series electronic metering pumps have a 2-year warranty. Contact your Walchem distributor for service.

APPENDIX H: PNEUMATIC VALVE MANUAL

Pneumatic Actuators PA 40 – PA 70

Instruction Manual

GEORGE FISCHER +GF+

The technical data given are for general information purposes only. They imply no warranty of any kind. Please consult our General Terms and Conditions of Sale.

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1. Introduction

2. Technical Data for the Actuator
   2.1 The Actuator
   2.2 Torque Characteristics
   2.3 Torque in Relation to Control Pressure
   2.4 Direction of Rotation of the Actuator
   2.5 Actuator Dimensions

3. Valve Components

4. Setting the End Stops

5. Installation of Supplementary Components
   5.1 Auxiliary Switch Connections

6. Control Diagrams

7. Assembly of Actuator

8. Spare Parts List

1. Introduction

This instruction manual contains the technical data as well as instructions for installation, operation and maintenance of the pneumatic actuators PA 40 to PA 70 for the butterfly valve type 036 and the ball valve type 208.

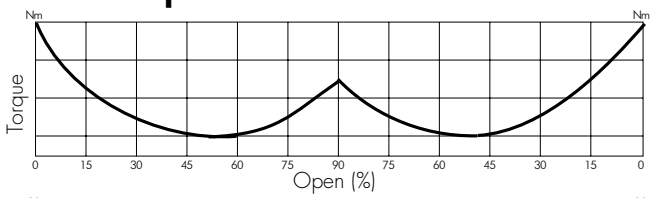
2. Technical Data

2.1 The Actuator

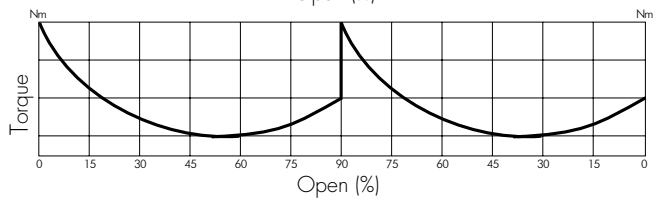
Control medium		Neutral, non-aggressive gases (preferably slightly oily compressed air)	
Control pressure		Single acting	Double acting
	min.	40.6 psi/2.8 bar	43.5 psi/3 bar
	max.	101.5 psi/7 bar	101.5psi/7 bar
Swept volume		PA 40: 15.256 in^3 PA 60: 61.023 in^3	PA 50: 30.512 in^3 PA 70: 122.046 in^3
Control connection		R 1/8" with Namur plate 1/4" NPT	
Control time		0.5 – 1 sec	
Control angle		90°	
Mode of operation		– Fail-safe close (FC) – Fail-safe open (FO) – Double acting (DA)	
Permissible operating temperature		14°F up to 176°F/–10°C up to 80°C	
Permissible humidity		0 – 100 %	
Position indicator		visual	
Housing material		Nickel plated (standard) Aluminium hard anodized (on request)	

2.2 Torque characteristics

Double acting



Single acting



Torques in Inch Pounds

Double acting

Type*		43.5 psi	58.1 psi	72.5 psi	81.2 psi	87 psi	101.5 psi
	0°	284	380	474	531	569	664
PA 40 DA	45°	142	189	237	266	284	332
	90°	213	284	356	398	427	498
	0°	569	758	948	1062	1138	1328
PA 50 DA	45°	284	380	474	531	569	664
	90°	427	569	712	797	853	996
	0°	1328	1517	1897	2124	2275	2655
PA 60 DA	45°	569	758	948	1062	1328	1328
	90°	853	1328	1422	1593	1707	1991
	0°	2275	3035	3793	4248	4552	5310
PA 70 DA	45°	1328	1517	1897	2124	2275	2655
	90°	1707	2275	2844	3186	3413	3983

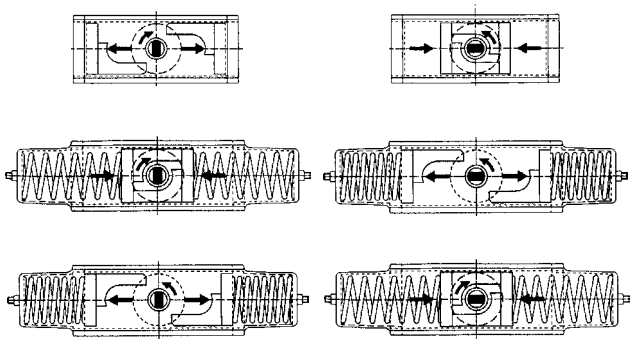
** Standard series, for reduced torques special springs are available*

Single acting

Type*		40.6 psi		60.9 psi		81.2 psi	
		spring	air	spring	air	spring	air
	0°	266	177	398	266	531	354
PA 40 FC/FO	45°	133	133	199	199	266	266
	90°	177	266	266	398	354	531
	0°	531	354	797	531	1062	708
PA 50 FC/FO	45°	266	266	398	398	531	531
	90°	354	531	531	797	708	1062
	0°	1062	708	1593	1062	2124	1416
PA 60 FC/FO	45°	531	531	797	797	1062	1062
	90°	708	1062	1062	1593	1416	2124
	0°	2124	1416	3186	2124	4248	2832
PA 70 FC/FO	45°	1062	1062	1593	1593	2124	2124
	90°	1416	2124	2124	3186	2832	4248

2.4 Direction of rotation of the actuator

Valve closes **Valve opens**

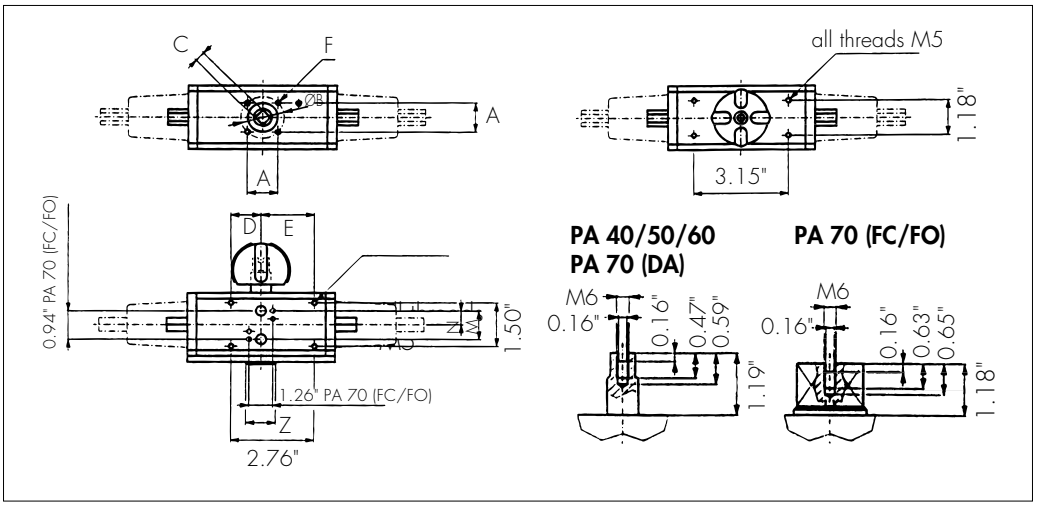


Double acting

Fail-safe close

Fail-safe open

2.5 Dimensions for Type PA 40/50/60/70 Pneumatic Actuators



Single acting (FC/FO)

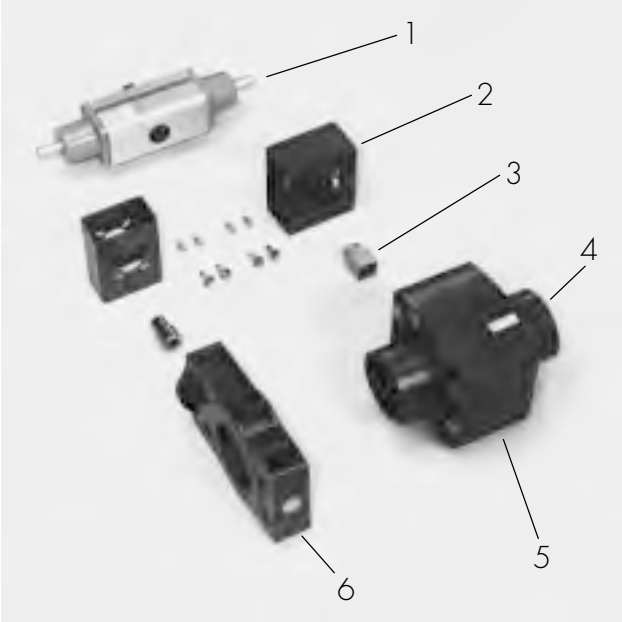
Actuator	A inch	B inch	C inch	D inch	E inch	F inch	M inch	N inch	Z inch
PA 40 FC/FO	1.39	1.97	0.55	1.38	1.38	M6	0.98	0.83	1.38
PA 50 FC/FO	1.95	2.76	0.67	1.38	1.38	M8	0.98	1.02	2.17
PA 60 FC/FO	3.11	4.02	0.87	1.38	1.38	M10	0.98	1.26	2.76
PA 70 FC/FO	3.48	4.92	1.06			M12			3.35

Double Acting (DA)

Actuator	A inch	B inch	C inch	D inch	E inch	F inch	M inch	N inch	Z inch
PA 40 DA	1.17	1.65	0.43	1.38	1.38	M5	0.81	0.71	1.18
PA 50 DA	1.39	1.97	0.55	1.38	1.38	M6	0.98	0.83	1.38
PA 60 DA	1.95	2.76	0.67	1.38	1.38	M8	0.98	1.02	2.17
PA 70 DA	3.11	4.02	0.87	1.38	1.38	M10	0.98	1.26	2.76

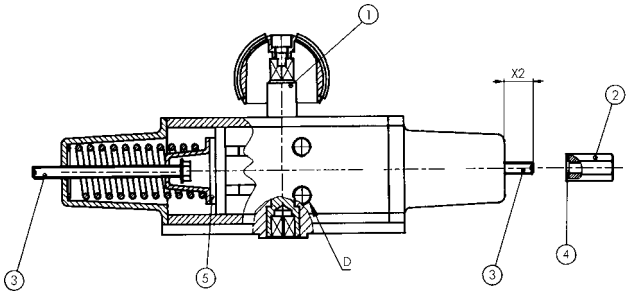
3. Valve Components

Butterfly valve Type 036
Ball valve Type 208



1 Actuator PA 40 – PA 70
2 Intermediate part with screws
3 Coupling piece
4 Valve body
5 Ball valve
6 Butterfly valve

4. Setting the End Stops



4.1 Stroke limiter 'close' position [spring closed or double acting] (max. 10°∢, 0–10°∢)

a) Unscrew the special nut (part 2).
b) Put compressed air in the bore 'D' (to open).
c) With a screwdriver, turn the screws (part 3) in a counterclockwise direction until the desired setting is reached.
d) Release the compressed air from the bore 'D' (for spring closed)
e) Check the setting and, if necessary, repeat the procedure from Step c).
f) Replace the special nut (part 2) and press the O-ring seals in the corresponding grooves (part 4).

4.2 Stroke limiter 'open' position (max. 10°∢, 90–80°∢)

a) Unscrew the special nut (part 2).
b) With a screwdriver, turn the screws (part 3) in a clockwise direction until the approx. setting is reached.
c) Put compressed air in the bore 'D' (to open) and check that the pistons (part 5) hit against the screws (part 3) and that the adjustment is correct for open position.
d) Replace the special nut (part 2) and press the O-ring seals in the corresponding grooves (part 4).

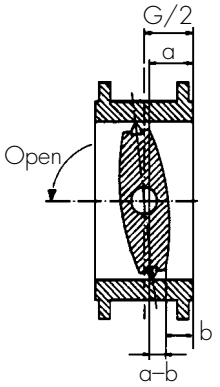
Note:
Regulating the stroke limiter for the two pistons can **only** be done in one direction (close or open)!

4.3 Setting the 'close' position of the butterfly valves

In the <close> position of the butterfly valve, the disc is not exactly vertical to the pipe axis. The deviation can be seen in the table below.

DN mm	d mm	a–b inch
65	75	.157
80	90	.157
100	110	.197
125	140	.197
150	160	.236
200	225	.236
250	280	.236

10" and 12" go to 90°



5. Installation of Supplementary Kits

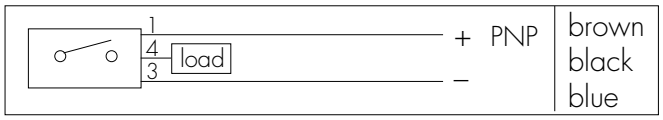
Accessories for Type PA 40/50/60/70 Pneumatic Actuators

Description		Technical Data	Part Number
2 auxiliary switches	mech.	250 VAC, 10 A	199.190.282
2 inductive switches with luminous diode	NPN	10...30 VDC, 0.1A	199.190.283
2 inductive switches with luminous diode	PNP	10...30 VDC, 0.1A	199.190.284
2 inductive switches	Namur	5...15 V	199.190.285
2 auxiliary switches	EExd	250 VAC/5 A	199.190.286
Namur mounting flange			199.190.281
Speed control			150.101.347
Pilot Valve Type PV 93 **for direct installation to actuator** Mode of operation: De-energized closed		200 – 230 V 50 – 60 Hz	199.190.263
		100 – 115 V 50 – 60 Hz	199.190.264
		24 V DC	199.190.265
		24 V/50 – 60 Hz	199.190.266
For assembly on multiple manifold Actuator with valve body		200 – 230 V 50 – 60 Hz	199.190.267
		100 – 115 V 50 – 60 Hz	199.190.268
		24 V DC	199.190.269
		24 V/50 – 60 Hz	199.190.270
Multiple manifold		for 4 valves for 6 valves for 8 valves	199.190.271 199.190.272 199.190.273
Blank plate			199.190.274
4-way pilot valve (solenoid) with speed control		115 VAC 230 VAC 24 VAC	199.190.303 199.190.302 199.190.304

5.1 Connecting Diagrams for Auxiliary Switches

inductive

199.190.278



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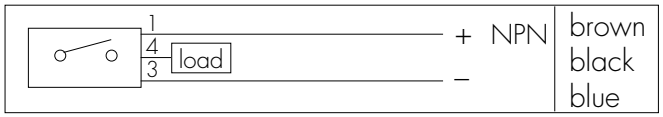

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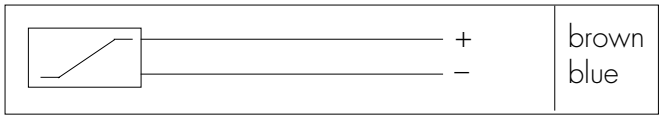

mechanical

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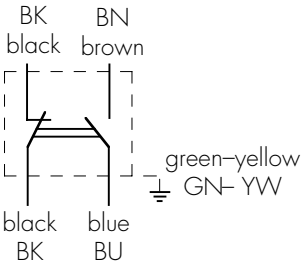


Actuator with mechanical auxiliary switch

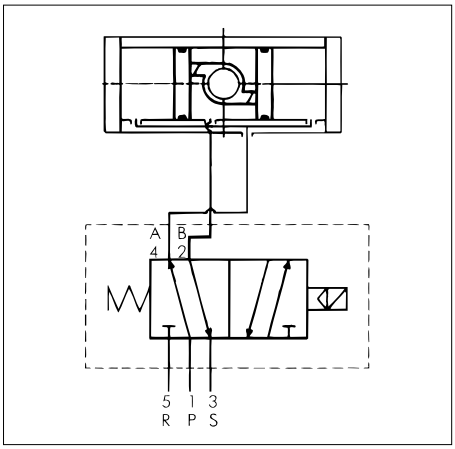
Actuator with pneumatic auxiliary switch

Actuator with pilot valve Type PV 93

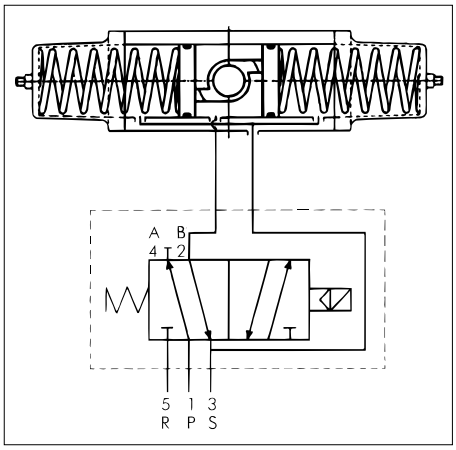
Actuator with auxiliary switches (NPN, PNP, Namur)

6. Control Diagrams

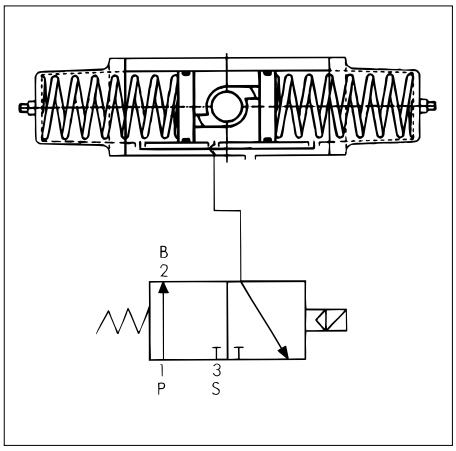
Double acting according to Namur 5/2-way



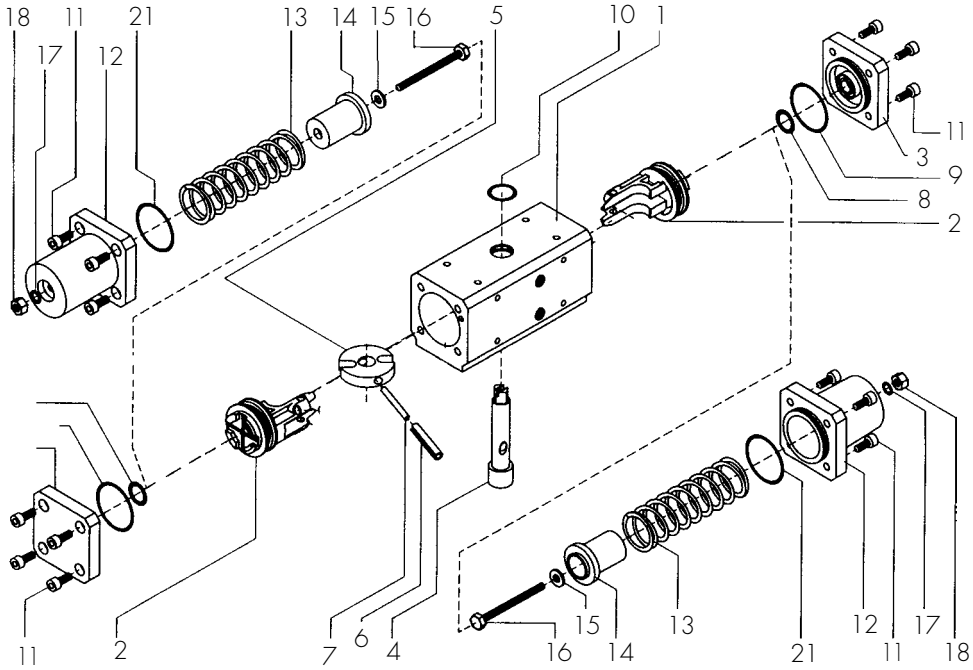
Single acting according to Namur 5/2-way



Single acting with valve 3/2-way



7. Assembly of the Actuator



Pos.	Part	Quantity for DA	Quantity for FC/FO	Material
1	Housing	1	1	Aluminum alloy
2	Piston	2	2	Aluminum alloy
3	Housing cover DA	2	–	Aluminum alloy
4	Piston shaft	1	1	Stainless steel
5	Drive wheel	1	1	Steel alloy
6	Outer pin sleeve	1	1	Steel alloy
7	Inner pin sleeve	1	1	Steel alloy
8	Piston damping O-ring	2	–	Nitrile rubber
9	Cover O-ring	2	2	Nitrile rubber
10	Housing O-ring	2	2	Nitrile rubber
11	Screw	8	8	Stainless steel
12	Spring cover FC/FO	–	2	Aluminum alloy
13	Spring	–	2	Steel alloy
14	Housing for springs	–	2	Aluminum alloy
15	Washer	–	2	Steel alloy
16	Compression screw	–	2	Steel alloy
17	O-ring	–	2	Nitrile rubber
18	Nut	–	2	Steel alloy

8. Spare Part Lists

Actuators and Intermediate Parts

for Type 208

Inch size	d mm	DN mm	Single acting Actuator	Single acting Intermediate part	Double acting Actuator	Double acting Intermediate part
2½	75	65	PA 40 FC/FO 198 800 728	198 000 236	PA 40 DA 198 800 732	198 000 237
3	90	80	PA 50 FC/FO 198 800 729	198 000 238	PA 50 DA 198 800 733	198 000 239
4	110	100		198 000 240		198 000 241
6	160	150		198 000 240		198 000 241

for Type 036

Inch size	d mm	DN mm	Single acting Actuator	Single acting Intermediate part	Double acting Actuator	Double acting Intermediate part
2½	75	65	PA 40 FC/FO 198 800 728	198 000 220	PA 40 DA 198 800 732	198 000 221
3	90	80		198 000 222		198 000 223
4	110	100	PA 50 FC/FO 198 800 729	198 000 224	PA 50 DA 198 800 733	198 000 225
5	140	125		198 000 226		198 000 227
6	160	150	PA 60 FC/FO 198 800 730	198 000 228	PA 60 DA 198 800 734	198 000 229
8	225	200		198 000 230		198 000 231
10	280	250	PA 70 FC/FO 198 800 731	198 000 232	PA 70 DA 198 800 735	198 000 233

Butterfly valve with short shaft

Inch size	d mm	DN mm	PVC EPDM	PVC FPM	PP EPDM	PP FPM	PVDF FPM
2½	75	65	161 367 045	161 367 065	167 367 045	167 367 065	175 367 065
3	90	80	161 367 046	161 367 066	167 367 046	167 367 066	175 367 066
4	110	100	161 367 047	161 367 067	167 367 047	167 367 067	175 367 067
5	140	125	161 367 048	161 367 068	167 367 048	167 367 068	175 367 068
6	160	150	161 367 049	161 367 069	167 367 049	167 367 069	175 367 069
8	225	200	161 367 050	161 367 070	167 367 050	167 367 070	175 367 070
10	280	250	161 367 051	161 367 071	–	–	–

GEORGE FISCHER +GF+

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www.us.piping.georgefischer.com

APPENDIX I: AIR COMPRESSOR MANUAL

Questions? See us on the World Wide Web at www.dewalt.com

INSTRUCTION MANUAL
GUIDE D'UTILISATION
MANUAL DE INSTRUCCIONES

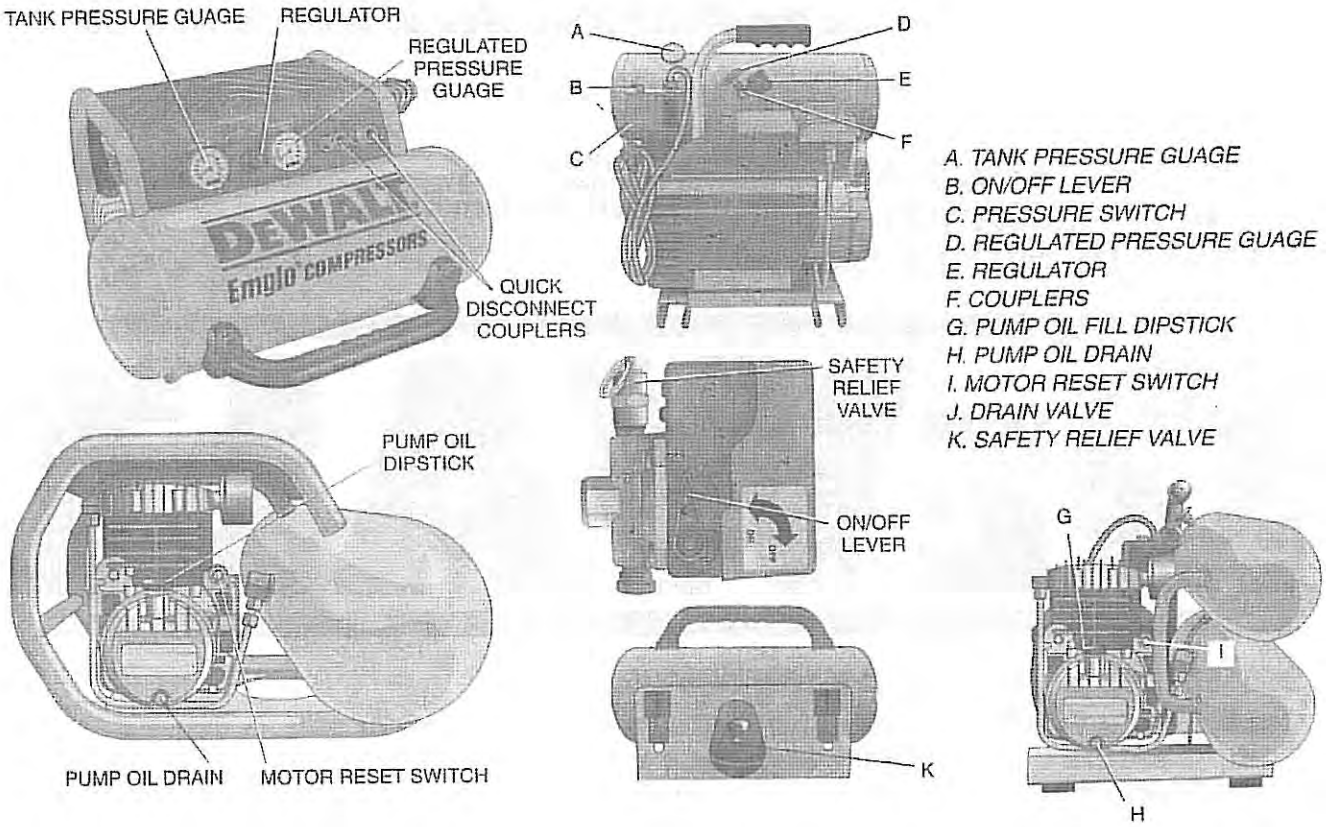
INSTRUCTIVO DE OPERACIÓN, CENTROS DE SERVICIO Y PÓLIZA DE GARANTÍA. **ADVERTENCIA:** LÉASE ESTE INSTRUCTIVO ANTES DE USAR EL PRODUCTO.

DEWALT®

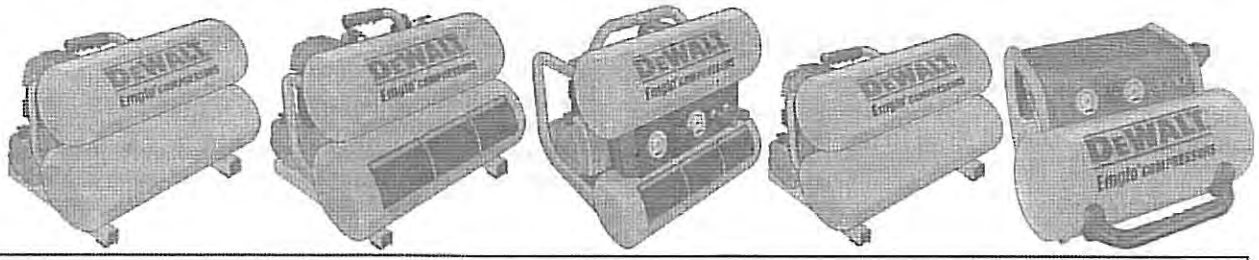
D55150, D55151, D55152, D55153, D55155

Contractor's Electric 4 Gallon Hand Carry Air Compressor
Compresseurs d'air portatifs électriques de 4 gallons de classe entrepreneur
Compresor de aire portátil elèctrico de 4 galones para contratistas

DEWALT Industrial Tool Co., 701 East Joppa Road, Baltimore, MD 21286 (AUG03) Form No. 5135175-01
Copyright © 2003 DEWALT The following are trademarks for one or more DEWALT power tools: the yellow and black color scheme; the "D" shaped air intake grill; the array of pyramids on the handgrip; the kit box configuration; and the array of lozenge-shaped humps on the surface of the tool.



A. TANK PRESSURE GUAGE
B. ON/OFF LEVER
C. PRESSURE SWITCH
D. REGULATED PRESSURE GUAGE
E. REGULATOR
F. COUPLERS
G. PUMP OIL FILL DIPSTICK
H. PUMP OIL DRAIN
I. MOTOR RESET SWITCH
J. DRAIN VALVE
K. SAFETY RELIEF VALVE



SPECIFICATIONS

MODEL	D55150	D55151	D55152	D55153	D55155
WEIGHT	57 lbs.	53 lbs.	65 lbs.	56 lbs.	61 lbs.
HEIGHT	16.75 in.	16.75 in.	16.0 in.	16.75 in.	12.5 in.
WIDTH	18.0 in.	18.0 in.	18.0 in.	18.0 in.	21.75 in.
LENGTH	15.0 in.	15.0 in.	18.0 in.	15.0 in.	21.75 in.
MOTOR	1 HP,120 V. 12 A. 60 Hz. 1725 RPM	2 HP, 120 V. 14 A. 60 Hz. 3450 RPM	2.75 HP, 120 V. 14 A. 60 Hz. 3450 RPM	2.75 HP, 120 V. 15 A. 60 Hz. 3450 RPM	2.75 HP, 120 V. 15 A. 60 Hz. 3450 RPM
PUMP OIL	4 oz.	6 oz.	12 oz.	4 oz.	4 oz.
CFM/PSI	4.0@40 3.4@60 2.8@90 2.6@100	4.8@40 4.4@60 3.8@90 3.6@100	5.1@40 4.6@60 4.0@90 3.8@100	5.4@40 5.1@60 4.6@90 4.5@100	5.4@40 5.1@60 4.6@90 4.5@100

IF YOU HAVE ANY QUESTIONS OR COMMENTS ABOUT THIS OR ANY DEWALT TOOL, CALL US TOLL FREE AT 1-800-4-DEWALT (1-800-433-9258).

⚠ ***WARNING! Read and understand all instructions before operating this compressor.*** *Failure to follow all instructions listed below may result in electric shock, fire and/or serious personal injury.*

English

SAVE THESE INSTRUCTIONS

Safety Instructions

⚠ ***WARNING:*** *Some dust created by this product contains chemicals known to State of California to cause cancer, birth defects or other reproductive harm. Some examples of these chemicals are:*

- *compounds in fertilizers*
- *compounds in insecticides, herbicides and pesticides*
- *arsenic and chromium from chemically treated lumber*

To reduce your exposure to these chemicals, wear approved safety equipment such as dust masks that are specially designed to filter out microscopic particles.

⚠ ***WARNING:*** *Use of this product will expose you to chemicals known to the State of California to cause cancer, birth defects and other reproductive harm.* ***Avoid inhaling vapors and dust, and wash hands after using.***

⚠ ***WARNING:*** *This product contains chemicals, including lead, known to the State of California to cause cancer, and birth defects or other reproductive harm.* ***Wash hands after handling.***

The user of the air compressor must understand these instructions. Each person operating the air compressor must be of sound mind and body and must not be under the influence of any substance which might impair vision, dexterity, or judgement.

AIR TANK

The tank on your Air Compressor is designed and may be UM coded (for units with tanks greater than 6 inch diameter) according to ASME Section VIII, Div. 1 rules. All pressure vessels must be inspected once every two years. To find your state pressure vessel inspector, look under the Division of Labor and Industries in the government section of a phone book or call 1-800-4DEWALT for assistance.

The following conditions could lead to a weakening of the tank, and result in a violent tank explosion:

1. ***Failure to properly drain condensed water from the tank, causing rust and thinning of the steel tank.*** *Drain tank daily or after each use. If tank develops a leak, replace it immediately with a new tank or new compressor outfit.*
2. ***Modifications or attempted repairs to the compressor tank.*** *Never drill into, weld, or make any modifications to the tank or its attachments.*
3. ***Modifications of the pressure switch, safety valve, or any other components that control tank pressure.*** *The tank is designed to withstand specific operating pressures. Never make adjustments or substitute parts to alter the factory set operating pressures.*

ATTACHMENTS & ACCESSORIES

Exceeding the pressure rating of air tools, spray guns, air operated accessories, tires and other inflatables can cause them to explode or fly apart, resulting in serious injury. Follow the equipment manufacturers recommendation and never exceed the maximum allowable pressure rating of attachments. Never use the compressor to inflate small, low-pressure objects such as children's toys, footballs, basketballs, etc..

RISK OF EXPLOSION OR FIRE

It is normal for electrical contacts within the motor and pressure switch to spark. Always operate the compressor in a well-ventilated area free of combustible materials, gasoline or solvent vapors. If electrical sparks from compressor come into contact with flammable vapors, they may ignite, causing fire or explosion. When spraying flammable materials, locate compressor at least 20 feet upwind from spray area. An additional length of hose may be required.

Store flammable materials in a secure location away from the compressor.

Restricting any of the compressor ventilation openings will cause serious overheating and could cause fire. Never place objects against or on top of compressor. Operate the compressor in an open area at least 3 feet away from any wall or obstruction that would restrict the flow of fresh air to the ventilation openings.

RISK OF ELECTRICAL SHOCK

Your air compressor is powered by electricity. If it is not used properly it could cause electric shock. Never operate the compressor outdoors when it is raining or in wet conditions.

Never operate compressor with guards or protective covers that are damaged or removed. Repairs by anyone other than qualified personnel can result in serous injury or death by electrocution. Any electrical wiring or repairs required on this product should be performed by authorized service center personnel in accordance with national and local electrical codes.

GROUNDING INSTRUCTIONS

In the event of a malfunction or breakdown, grounding provides a path of least resistance for electric current to reduce the risk of electric shock. This tool is equipped with an electric cord having an equipment-grounding conductor and grounding plug. The plug must be plugged into a matching outlet that is properly installed and grounded in accordance with all local codes and ordinances. Do not modify plug provided: if it will not fit the outlet, have the proper outlet installed by a qualified electrician.

Improper connection of the equipment-grounding conductor can result in a risk of electric shock. The conductor with insulation having an outer surface that is green with or without yellow stripes is the equipment-grounding conductor. If repair or replacement of the electric cord or plug is necessary do not connect the equipment-grounding conductor to a live terminal.

If the grounding instructions are not completely understood or if in doubt as to whether the tool is properly grounded, check with a qualified electrician or service personnel.

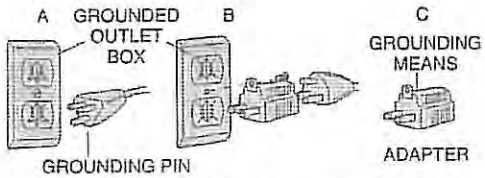
Use only 3-wire extension cords that have 3-prong grounding plugs and 3-pole receptacles to avoid overheating.

REPAIR OR REPLACE DAMAGED OR WORN CORDS IMMEDIATELY.

THE USE OF A GFCI OUTLET IS RECOMMENDED AND MAY BE REQUIRED IN CERTAIN AREAS.

Grounded tools intended for use on a supply circuit having a nominal rating less than 150 volts: This tool is intended for use on a circuit that has an outlet that looks like the one illustrated in Figure A. The tool has a grounding plug that looks like the plug illustrated in Figure A. A temporary adapter, which looks like the adapter illustrated in Figures B and C, may be used to connect this plug to a 2-pole receptacle as shown in Figure B if a properly grounded outlet is not available. The temporary adapter should be used only until a properly grounded outlet can be installed by a qualified electrician, The green-colored rigid ear, lug, and the like, extending from the

English



adapter must be connected to a permanent ground such as a properly grounded outlet box.

The adapter (C) is not for use in Canada.

DEWALT does not recommend the use of extension cords. This can create power loss and overheating of the motor. Use an additional air hose rather than an extension cord. If use of an extension cord is unavoidable, it should be plugged into a GFCI found in circuit boxes or protected receptacles. When using an extension cord, observe the following.

Extension Cord Chart			
1 Hp Motor Rating	Length of Cord in Feet		
	25'	50'	100'
12 amp, 115V	14 Ga.	12 Ga.	10 Ga.
2 Hp Motor Rating	Length of Cord in Feet		
	25'	50'	100'
15 amp, 115V	14 Ga.	12 Ga.	8 Ga.

RISK FROM FLYING OBJECTS

The compressed air stream can cause soft tissue damage to exposed skin and can propel dirt, chips, loose particles and small objects at high speed, resulting in serious injury. Always wear ANSI Z28.1 approved safety glasses with side shields when using the compressor. Never direct air stream at people or animals. Use only OSHA approved air blow guns.

RISK TO BREATHING

The compressed air from your compressor is not safe for breathing! The air stream may contain carbon monoxide, toxic vapors or solid particles. Never inhale air from the compressor either directly or from a breathing device connected to the compressor.

Sprayed materials such as paint, paint solvents, paint remover, insecticides, weed killers, etc. contain harmful vapors and poisons. **NOTE:** Operate air compressor only in a well ventilated area. Read and follow the safety instructions provided on the label or safety data sheets for the material you are spraying. Use a NIOSH/MSHA approved respirator designed for use with specific application.

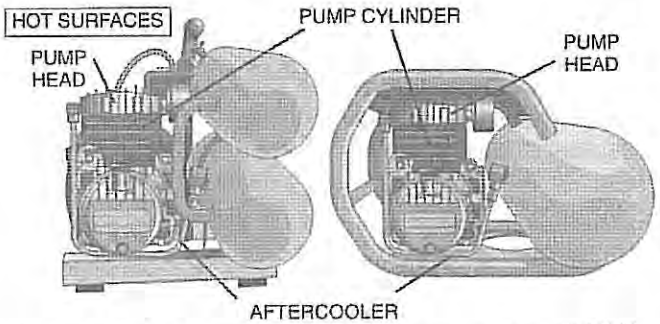
RISK FROM MOVING PARTS

The compressor cycles automatically when the pressure switch is in the ON/AUTO position. Always turn off the compressor, bleed pressure from the air hose and tank, and disconnect from power source before performing maintenance or attaching tools and accessories.

Keep your hair, clothing, and gloves away from moving parts. Loose clothes, jewelry, or long hair can be caught in moving parts. Air vents may cover moving parts and should be avoided as well. Do not remove the protective covers from this product. Never operate compressor with guards or protective covers that are damaged or removed. Never stand on the compressor.

RISK OF BURNS

Touching exposed metal such as the compressor head or aftercooler can result in serious burns. Never touch any exposed metal parts on compressor during or immediately after operation. Compressor



will remain hot for several minutes after operation. Do not move the compressor while it is running. Hot motor parts could cause burns contributing to the dropping of the compressor, damaging the compressor and/or injuring the operator.

RISK FROM NOISE

⚠ ***CAUTION:*** *Wear appropriate personal hearing protection during use. Under some conditions and duration of use, noise from this product may contribute to hearing loss.*

Introduction

Congratulations on the purchase of your new DEWALT Air Compressor! You can be assured that this tool has been constructed with the highest level of precision and accuracy. Each component has been rigorously tested by technicians to ensure the quality, endurance and performance of this air compressor.

By reading the following simple safety, installation, operation, maintenance and troubleshooting steps described in this manual, you will receive years of trouble-free operation. The manufacturer reserves the right to make changes in price, color, materials, equipment specifications, or models at any time without notice.

Inspection of Compressor

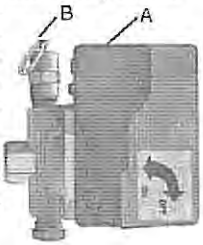
Inspect for signs of obvious or concealed freight damage. Report any damage to the delivering freight carrier immediately. Be sure that all damaged parts are replaced and any mechanical problems are corrected prior to the operation of the air compressor. The air compressor serial number is located on the shroud of the compressor. Please write the serial number in the space provided in the service section for future reference.

⚠ ***WARNING:*** *When using electric tools, basic safety precautions should always be followed to reduce risk of fire, electric shock, and personal injury.*

DEWALT Air Compressor Features

PRESSURE SWITCH

This switch (A) is used to start or stop the air compressor. Moving the switch to the ON position will provide automatic power to the pressure switch which will allow the motor to start when the air tank pressure is below the factory set cut-in pressure. When in the ON (AUTO) position, the pressure switch stops the compressor from charging air when the air tank pressure reaches the factory set cut-out pressure limit. For ease of starting, this switch also has a pressure release valve located on the side of the switch designed to automatically release compressed air from the air compressor pump head and its discharge line when the air compressor reaches the cut-out pressure limit or is shut off. Moving the switch to the OFF position will open the pressure switch contacts and stop the air compressor.

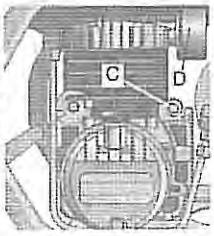


English

SAFETY RELIEF VALVE
This valve (B) is designed to prevent system failures by relieving pressure from the system when the compressed air reaches a predetermined level. The valve is preset by the manufacturer and must not be modified in any way.

AIR TANK DRAIN VALVE
The drain valve is used to remove moisture from the air tank after the air compressor is shut off.

MOTOR THERMAL OVERLOAD
The electric motor has a manual thermal overload protector (C). If the motor overheats for any reason, the thermal overload will cut off power, thus preventing the motor from being damaged. Turn the pressure switch to the OFF position and wait until the motor cools before pressing the thermal overload button.



AIR INTAKE FILTER
This filter (D) is designed to clean air entering the pump. To ensure the pump continually receives a clean, cool, and dry air supply this filter must always be clean and the filter intake must be free from obstructions.

TANK PRESSURE GAGE
The tank pressure gage indicates air pressure in the air tank.

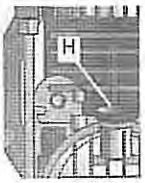
REGULATED PRESSURE GAGE
The regulated pressure gage indicates the air pressure available at the outlet side of the regulator. This pressure is controlled by the regulator and is always less than or equal to the air tank pressure.

PRESSURE REGULATOR
The regulator knob controls the air pressure coming from the air tank.

OIL DIPSTICK
The dipstick (H) will indicate the amount of oil in the pump. Oil level should be checked on a daily basis to ensure that it does not exceed the maximum notch or fall below the minimum notch on the dipstick.

Common Procedures

CHECKING COMPRESSOR PUMP OIL LEVEL
⚠ ***WARNING:*** *Aftercooler, pump head, and surrounding parts are very hot. Do not touch. (see Hot Surfaces on page 4).*



1. Ensure that the unit is off.
2. Locate unit on a flat horizontal surface.
3. Remove dipstick (H) from oil fill port.
4. Look for visual signs of contaminants (water, dirt, etc.) in oil on dipstick.
5. Wipe oil off of the dipstick.
6. Reinsert the dipstick fully into the oil fill port for a few seconds to allow oil to collect on dipstick.
7. Remove the oil dipstick to read oil level. Oil should not exceed top raised line (MAX) on dipstick. If oil is below lower mark (MIN), add DEWALT synthetic oil and follow steps 5 through 7.

CHECKING SAFETY RELIEF VALVE OPERATION
⚠ ***WARNING:*** *Aftercooler, pump head, and surrounding parts are very hot. Do not touch (see Hot Surfaces on page 4).*

1. Ensure that the unit is off.
2. Ensure that the tank is empty by looking at tank pressure gage. Drain the tanks if necessary.
3. Grasp the wire ring on the safety valve.
4. Pull and release the ring a few times to ensure that the plunger moves in and out. Replace the safety valve if plunger does not

move or is difficult to move.

CHECKING AIR FILTER ELEMENT
⚠ ***WARNING:*** *Aftercooler, pump head, and surrounding parts are very hot. Do not touch (see Hot Surfaces on page 4).*

1. Ensure that the unit is off.
2. Allow the unit to cool.
3. Unscrew the filter from pump head by turning counter clockwise.
4. Separate the filter body into two halves.
5. If the element needs cleaning blow out with air. Replace air filter assembly if unsure whether element can be cleaned sufficiently.
6. Reconnect the filter body.
7. Screw the filter into pump head by turning clockwise until the filter is hand tight.

TURNING THE UNIT ON
Follow the pre-start and start-up procedures in the operating procedure section.

TURNING THE UNIT OFF
Follow the shut-down procedures in the operating procedures section.

ADJUSTING THE REGULATOR
1. Pull the regulator knob out. (For D55155 compressor)
2. Turn the knob clockwise to increase regulated pressure and counter clockwise to decrease regulated pressure.
3. When desired pressure is shown on the regulated pressure gage, push the knob in to lock it. (For D55155 compressor)

INSTALLING HOSES
⚠ ***WARNING:*** *Firmly grasp the hose when installing or disconnecting to prevent hose whip.*

Ensure that the regulated pressure gage reads 0 PSI.

2. Grasp the hose at the coupler.
3. Pull back the collar on the female quick-connect coupler located on the compressor.
4. Push the male connector into the female connector.
5. Release the female connector.
6. Grasp hose and pull to ensure couplers are seated.
7. Adjust regulator to desired pressure.

DISCONNECTING HOSES
⚠ ***WARNING:*** *Firmly grasp the hose when installing or disconnecting to prevent hose whip.*

1. Ensure that the regulated pressure gage reads 0 PSI.
2. Grasp the hose at the coupler.
3. Pull back the collar on female quick-connect coupler located on the compressor.
4. Pull the male connector out of the female connector.
5. Release the female connector.

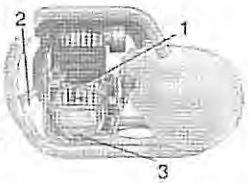
DRAINING THE TANK
⚠ ***WARNING:*** *The tank contains high pressure air. Keep the outlet of drain away from face and other body parts. Use safety glasses when draining because debris can be kicked up into face. Use ear protection because air flow noise is loud when draining.*

NOTE: All compressed air systems generate condensate that accumulates in any drain point (e.g. tanks, filter, aftercoolers, dryers). This condensate contains lubricating oil and/or substances which may be regulated and must be disposed of in accordance with local, state, and federal laws and regulations.

1. Ensure that the ON/OFF switch is in the OFF position.
2. Move the compressor into an inclined position so that the drain valve(s) are at the lowest point This will assist in removing moisture, dirt, etc. from the tanks.

English

3. Place a suitable container under the drain to catch discharge.
4. Open the valve from below, keeping hands away from hot components.
5. Slowly rotate the lever or turn knob counter clockwise to gradually bleed air from tank.
6. When tank is at 10 PSI, rotate the lever or knob to the fully open position.
7. Close the drain valve when finished.



Preparation For Use

INITIAL SET-UP

Read all safety instructions before setting-up air compressor.

1. Remove oil plug.
2. Pour DEWALT synthetic oil into crankcase (See Specifications).

⚠ ***WARNING: THE COMPRESSOR IS SHIPPED WITHOUT OIL IN THE CRANKCASE. ADD OIL.***

3. Insert dipstick.
4. Close air tank drain valve.

⚠ ***CAUTION:*** *Do not operate without lubricant or with inadequate lubricant. DEWALT is not responsible for compressor failure caused by inadequate lubrication.*

Compatibility

Air tools and accessories that are operated with the compressor must be compatible with petroleum based products. If you suspect that a material is not compatible with petroleum products, use an air line filter for removal of moisture and oil vapor in compressed air. **NOTE:** Always use an air line filter to remove moisture and oil vapor when spraying paint.

Location

⚠ ***CAUTION:*** *In order to avoid damaging the air compressor, do not allow the unit to be tilted more than 10° from the normal horizontal position when operating.*

All hand carry compressors should be run with the rubber feet resting on a horizontal, flat surface.

Place the air compressor at least 3 feet away from obstacles that may prevent proper ventilation. Keep the compressor away from areas that have dirt and/or volatile fumes in the atmosphere. These impurities may clog the intake filter and valves, causing inefficient operation.

NOTE: The D55155 single tank air compressor is designed to be carried in the vertical orientation but will right itself in the proper horizontal position when placed on a flat surface.

HUMID AREAS

In frequently humid areas, moisture may form in the bare pump and produce sludge in the lubricant, causing running parts to wear out prematurely. Excessive moisture is especially likely to occur if the unit is located in an unheated area that is subject to large temperature changes. Two signs of excessive humidity are external condensation on the bare pump when it cools down and a "milky" appearance in compressor lubricant. You may be able to prevent moisture from forming in the bare pump by increasing ventilation or operating for longer intervals.

ELECTRICAL

Refer to the safety instructions before using unit. Observe extension cord safety instructions if necessary. Always shut off the air compressor switch before removing the plug from the outlet.

NOISE CONSIDERATIONS

Consult local officials for information regarding acceptable noise

levels in your area. To reduce excessive noise, use vibration mounts or silencers, relocate the unit or construct total enclosures or baffle walls. Contact a DEWALT service center or call 1-800-4DEWALT for assistance.

TRANSPORTING

When transporting the compressor in a vehicle, trailer, etc., ensure that the tanks are drained and the unit is secured. Use care when driving to avoid tipping the unit over in the vehicle. Damage can occur to the compressor or surrounding items if the compressor is tipped.

MOVING

When moving the compressor, grasp the handle grip and carry the compressor as close to your body as possible.

⚠ ***WARNING:*** *Ensure proper footing and use caution when carrying compressor to avoid a loss of balance.*

Air Inlet Filter

⚠ **CAUTION:** Do not operate without the air inlet filter.

General Requirements

The piping, fittings, receiver tank, etc. must be certified safe for at least the maximum working pressure of the unit. Use hard welded or threaded steel or copper pipes, cast iron fittings and hoses that are certified safe for the unit's discharge pressure and temperature. Use pipe thread sealant on all threads and tighten joints thoroughly to prevent air leaks. **DO NOT USE PVC PLASTIC.**

CONDENSATE DISCHARGE PIPING

To install a condensate discharge line, use piping at least one size larger than the connection. Connect the piping so that it is secured tightly and is routed to a suitable drain point. Use as short and direct a pipe as possible. Condensate must be disposed of in accordance with local, state, and federal laws and regulations.

NOTE: All compressed air systems generate condensate that accumulates in any drain point (e.g. tanks, filter, aftercoolers and dryers). This condensate contains lubricating oil and/or substances which may be regulated and must be disposed of in accordance with local, state, and federal laws and regulations.

Operating Procedures

PRE-START CHECKLIST

1. Ensure that the ON/OFF lever switch is in the OFF position.
2. Ensure that the tank is drained so that moisture, dirt, etc. can be eliminated.
3. Ensure that the tank pressure gage reads 0 PSI.
4. Ensure that the safety and drain valves are functioning properly.
5. Ensure that the drain valve is closed.
6. Check the oil level in the pump.

NOTE: The air compressor is shipped without oil in crankcase. Add oil before using.

7. Ensure that all guards and covers are in place and securely mounted. Ensure that all labels are legible. Do not use the compressor until all these items have been verified.

START-UP

1. Ensure that the ON/OFF lever on the pressure switch is in the OFF position.
2. Pull out and turn the regulator knob counterclockwise until it is fully closed. Push in to lock. The regulated pressure gage should read 0 PSI.
3. Plug the power cord into a grounded outlet.
4. Move the ON/OFF lever to the ON position. Allow the compressor to reach cut-out pressure limit. This pressure will cause the compressor to shut down automatically.

NOTE: When the compressor is started and the tank is empty, an air noise will be heard. This noise is normal as the cold start valves are allowing air to escape from the air compressor lines. This noise will also be heard when the unit shuts off because the unloader valve, located in the pressure switch, is purging air from the lines.

5. Attach the hose and accessory.
6. Adjust the regulator to the desired setting.

NOTE: If any unusual noise or vibration is noticed, stop the compressor and refer to the troubleshooting section.

Shut-down

NOTE: NEVER stop the air compressor by unplugging it from the power source. This could result in damage to the unit.

1. Move the ON/OFF lever to the OFF position.

NOTE: If finished using compressor, follow steps 2 - 7 below.

2. Unplug the cord from the outlet.
3. Turn the regulator knob counterclockwise until it is fully closed. Ensure that the regulated pressure gage reads 0 PSI.
3. Remove the hose and accessory.
4. Drain the air tanks.
5. Allow the compressor to cool down.
6. Wipe compressor clean and store in a safe, non-freezing area.

Maintenance

The following procedures must be followed when maintenance or service is performed on the air compressor.

1. Turn off the compressor.
2. Disconnect cord from electrical outlet.
3. Drain tanks.
4. Allow the compressor to cool down before starting service.

NOTE: All compressed air systems contain maintenance parts (e.g. lubricating oil, filters, separators) which are periodically replaced. These used parts may be, or may contain, substances that are regulated and must be disposed of in accordance with local, state, and federal laws and regulations.

NOTE: Take note of the positions and locations of parts during disassembly to make reassembly easier. The assembly sequences and parts illustrated may differ for your particular unit.

NOTE: Any service operations not included in this section should be performed by authorized service personnel.

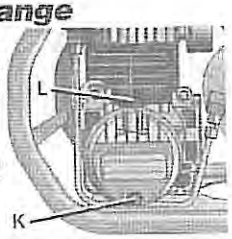
Maintenance Chart

Procedure	Day	Week	Month	200 Hrs.
Check pump oil level	X			
Oil leak inspection	X			
Drain condensation in air tank(s)	X			
Check for unusual noise/vibration	X			
Check for air leaks**	X			
Inspect air filter		X		
Clean exterior of compressor		X		
Check safety relief valve			X	
Change pump oil *				X
Replace air filter				X

** The pump oil must be changed after the first 20 hours of operation. Thereafter, every 200 hours or once a year, whichever comes first. In harsh environments, maintenance must be performed on an accelerated schedule. Always use DEWALT synthetic oil.*

*** To check for air leaks apply a solution of soapy water around joints. While the compressor is reaching the pressure cut-out limit and after the pump cuts out, look for air bubbles around the joints.*

Compressor Pump Oil Change



NOTE: Pump oil contains substances that are regulated and must be disposed of in accordance with local, state, and federal laws and regulations.

⚠ ***WARNING :*** *Aftercooler, pump head, and surrounding parts are very hot. Do not touch (see Hot Surfaces on page 4).*

1. Ensure that the unit is off.
2. Allow the unit to cool.
3. Place a suitable container under the drain plug (K).
4. Remove the oil dipstick (L) from crankcase.
5. Remove the oil drain plug.
6. Allow ample time for all the oil to drain out. (Tilting the compressor towards the drain plug assists draining.)
7. Reinstall the oil drain plug.
8. Fill the pump with DEWALT synthetic compressor oil (See Specifications).
9. Reinstall the oil dipstick.

Accessories

Recommended accessories for use with your tool are available for purchase from your local dealer or authorized service center. If you need assistance in locating any accessory for your tool, contact: DEWALT Industrial Tool Co., 701 East Joppa Road, Baltimore,MD 21286 or call 1-800-4-DEWALT.

⚠ ***CAUTION:*** *The use of any other accessory not recommended or use with this tool could be hazardous.*

SERVICE

Please have the following information available for all service calls:

Model Number _____

Serial Number _____

Date and Place of Purchase _____

Repairs

To assure product SAFETY and RELIABILITY, repairs, maintenance and adjustment should be performed by authorized service centers or other qualified service organizations, always using identical replacement parts.

Full One Year Warranty

DEWALT heavy duty industrial tools are warranted for one year from date of purchase. We will repair, without charge, any defects due to faulty materials or workmanship. For warranty repair information, call 1-800-4-DEWALT. This warranty does not apply to accessories or damage caused where repairs have been made or attempted by others. This warranty gives you specific legal rights and you may have other rights which vary in certain states or provinces.

FREE WARNING LABEL REPLACEMENT: If your warning labels become illegible or are missing, call 1-800-4-DEWALT for a free replacement.

English

TROUBLESHOOTING GUIDE

This section provides a list of the more frequently encountered malfunctions, their causes and corrective actions. The operator or maintenance personnel can perform some corrective actions, and others may require the assistance of a qualified DEWALT technician or your dealer.

Problem	Code
Compressor does not start or restart	16,17,18,19,20,36
Unit does not or is slow to come up to speed	3,8,11,12,14,15,20,21,22,24,25,31
Air compressor not making enough air	1,3,7,8,9,10,11,21,24,25,28,29
Insufficient pressure at air tool or accessory	1,3,7,8,9,10,11,21,24,25,27,28,29
High oil consumption	2,6,9,10,11,12,15,30,32
Unit runs excessively hot	1,2,4,5,10,11,12,13,15,19,30
Excessive starting and stopping	7,20,21,24,25,29
Excessive noise during operation	2,3,4,5,8,9,10,11,12,15,25,29,30,31
Moisture in discharge air	34,35
Moisture in crankcase or "milky" appearance in petroleum lubricant or rusting in cylinders	6,7,9,10,15,25,26,33,35
Oil in discharge air (oil pumping)	2,6,8,9,10,11,15,31,32
Oil leaking from shaft seal	12
Safety relief valve "pops"	22,23
Air leaks at pump	24,25
Air leaks at fittings	25
Air leaks from tank	26
Abnormal piston ring or cylinder wear	2,4,5,6,9,10,11,13

Code	*Possible Cause*	*Possible Solution*
1.	Clogged or dirty inlet and/or discharge line filter.	Clean or replace air inlet and/or discharge line filter.
2.	Lubricant viscosity too low.	Drain existing lubricant and refill with DEWALT Synthetic lubricant.
3	Lubricant viscosity too high.	Drain existing lubricant and refill with DEWALT Synthetic lubricant.
4.	Lubricant level too low.	Add lubricant to crankcase to proper level.
5.	Detergent type lubricant being used.	Drain existing lubricant and refill with DEWALT Synthetic lubricant.
6.	Extremely light duty cycles.	Run unit for longer duty cycles.
7.	Air leaks in air discharge piping.	Check tubing and connections.
8.	Compressor pump check valve is loose, broken, or has carbon buildup.	Inspect valve. Clean or replace as required.
9.	Carbon build up on top of compressor pump piston.	Clean piston. Repair or replace as required.
10	Piston rings damaged or worn (broken, rough, or scratched). Excessive end gap or side clearance. Piston rings not seated, stuck in grooves, or end gaps not staggered.	Install new rings.
11	Cylinder or piston scratched, worn, or scored.	Repair or replace as required.
12	Worn connecting rod, piston pin, or crankpin bearings.	Inspect all. Repair or replace as required..
13	Crankshaft seal worn or crankshaft scored.	Replace seal or crankshaft assembly.
14	Extremely dusty atmosphere.	Install more effective filtration or relocate the compressor.
15	Ambient temperature too low.	Relocate compressor to warmer environment. Ensure that DEWALT Synthetic oil is in crankcase.
16	Worn cylinder finish.	Deglaze cylinder with 180 grit flex-hone
17	Power cord not plugged in.	Plug cord into grounded outlet.
18	Pressure switch is in OFF position.	Move switch to ON/AUTO position.
19	Motor thermal overload switch has tripped.	Turn the compressor off, wait until motor is cool, then press motor thermal overload button (located on motor) firmly until a click is heard.
20	Fuse blown or circuit has tripped.	Replace fuse or reset circuit breaker. Check for proper fuse. Use only "Fusetron" type T fuses. Check for low voltage conditions. Disconnect any other electrical appliances from circuit or operate the compressor on its own branch circuit.
21	Wrong gage wire or length of extension cord.	If possible, eliminate extension cord. Check the chart on page 7 for proper gage wire and cord length.

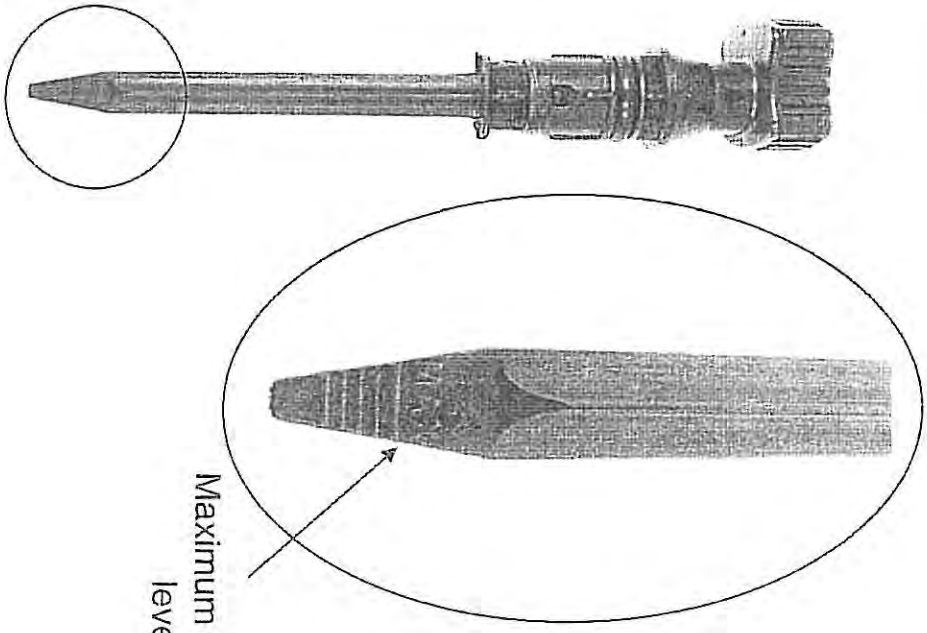
English

English

Code	Possible Cause	Possible Solution
22	Tank air pressure exceeds pressure switch "cut-in" setting.	Set pressure switch in the "Auto" position. The motor will automatically start when air tank pressure drops below "cut-in" pressure.
23	Pressure relief valve on pressure switch has not unloaded pump head pressure.	Drain tanks. If problem persists, contact DEWALT customer service at 1-800-4-DEWALT.
24	Defective motor, motor capacitor, or pressure switch.	Contact DEWALT Customer Service at 1-800-4-DEWALT.
25	Pressure switch does not shut off motor when air compressor reaches "cut-out" pressure.	Move the pressure switch to the OFF position. If the motor does not shut off, unplug the air compressor. If the electrical contacts are welded together, replace the pressure switch.
26	Air compressor is not large enough for air required.	Check accessory air requirement. If higher than the CFM or pressure supply of the air compressor, then larger air compressor is required.
27	Defective pressure switch.	Replace the pressure switch.
28	Defective safety relief valve.	Operate safety relief valve manually by pulling on test ring. If it still leaks, replace the safety relief valve.
29	Excessive air tank pressure.	Defective pressure switch. Replace the pressure switch.
30	Defective gaskets.	Replace and torque head bolts to 6 to 7 ft lbs.
31	Fittings not tight enough.	**Warning**: Drain air before lightening. Tighten fittings so air can not be heard escaping. Check joint with soap solution. Do not overtighten
32	Defective or rusted air tank	Air tank must be replaced. Do not attempt to repair air tank.
33	Pressure regulator knob not turned to high enough pressure or defective pressure regulator.	Adjust pressure regulator knob to proper setting or replace.
34	Hose or hose connections are too small or too long.	Replace with larger hose or connectors.
35	Possible defective reed valve.	Remove pump head and inspect valve plate and reed valve. Clear or replace valves as required.
36	Air compressor on uneven surface.	Do not incline the air compressor more than 10° in any direction while running.
37	Crankcase overfilled with oil.	Drain oil. Refill to proper level with DEWALT synthetic oil.
38	Plugged oil dipstick vent.	Clean dipstick vent.
39	Water in oil due to condensation.	Drain oil. Refill to proper level with DEWALT synthetic oil.
40	Condensation in air tank caused by high level of atmospheric humidity.	Drain air tank after every use. Drain air tank more often in humid weather and use an air line filter.
41	Compressor located in damp or humid location.	Relocate the compressor.

D55151 Oil Fill Instructions

Fill motor with 6 ounces of oil maximum. See MAX oil mark on dipstick.



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D55151 Oil Fill Instruction sheet

APPENDIX J: CENTRIFIGAL PUMP MANUAL

Centrifugal Pumps: Basic Concepts of Operation, Maintenance, and Troubleshooting (Part- I)

Introduction

The operating manual of any centrifugal pump often starts with a general statement, "Your centrifugal pump will give you completely trouble free and satisfactory service only on the condition that it is installed and operated with due care and is properly maintained."

Despite all the care in operation and maintenance, engineers often face the statement "the pump has failed i.e. it can no longer be kept in service". Inability to deliver the desired flow and head is just one of the most common conditions for taking a pump out of service. There are other many conditions in which a pump, despite suffering no loss in flow or head, is considered to have failed and has to be pulled out of service as soon as possible. These include seal related problems (leakages, loss of flushing, cooling, quenching systems, etc), pump and motor bearings related problems (loss of lubrication, cooling, contamination of oil, abnormal noise, etc), leakages from pump casing, very high noise and vibration levels, or driver (motor or turbine) related problems.

The list of pump failure conditions mentioned above is neither exhaustive nor are the conditions mutually exclusive. Often the root causes of failure are the same but the symptoms are different. A little care when first symptoms of a problem appear can save the pumps from permanent failures. Thus the most important task in such situations is to find out whether the pump has failed mechanically or if there is some process deficiency, or both. Many times when the pumps are sent to the workshop, the maintenance people do not find anything wrong on disassembling it. Thus the decision to pull a pump out of service for maintenance / repair should be made after a detailed analysis of the symptoms and root causes of the pump failure. Also, in case of any mechanical failure or physical damage of pump internals, the operating engineer should be able to relate the failure to the process unit's operating problems.

Any operating engineer, who typically has a chemical engineering background and who desires to protect his pumps from frequent failures must develop not only a good understanding of the process but also thorough knowledge of the mechanics of the pump. Effective troubleshooting requires an ability to observe changes in performance over time, and in the event of a failure, the capacity to thoroughly investigate the cause of the failure and take measures to prevent the problem from re-occurring.

The fact of the matter is that there are three types of problems mostly encountered with centrifugal pumps:

design errors

poor operation

poor maintenance practices

The present article is being presented in three parts, covering all aspects of operation, maintenance, and troubleshooting of centrifugal pumps. The article has been written keeping in mind the level and interests of students and the beginners in operation. Any comments or queries are most welcome.

Working Mechanism of a Centrifugal Pump

A centrifugal pump is one of the simplest pieces of equipment in any process plant. Its purpose is to convert energy of a prime mover (a electric motor or turbine) first into velocity or kinetic energy and then into pressure energy of a fluid that is being pumped. The energy changes occur by virtue of two main parts of the pump, the impeller and the volute or diffuser. The impeller is the rotating part that converts driver energy into the kinetic energy. The volute or diffuser is the stationary part that converts the kinetic energy into pressure energy.

Note: All of the forms of energy involved in a liquid flow system are expressed in terms of feet of liquid i.e. head.

Generation of Centrifugal Force

The process liquid enters the suction nozzle and then into eye (center) of a revolving device known as an impeller. When the impeller rotates, it spins the liquid sitting in the cavities between the vanes outward and provides centrifugal acceleration. As liquid leaves the eye of the impeller a low-pressure area is created causing more liquid to flow toward the inlet. Because the impeller blades are curved, the fluid is pushed in a tangential and radial direction by the centrifugal force. This force acting inside the pump is the same one that keeps water inside a bucket that is rotating at the end of a string. Figure A.01 below depicts a side cross-section of a centrifugal pump indicating the movement of the liquid.

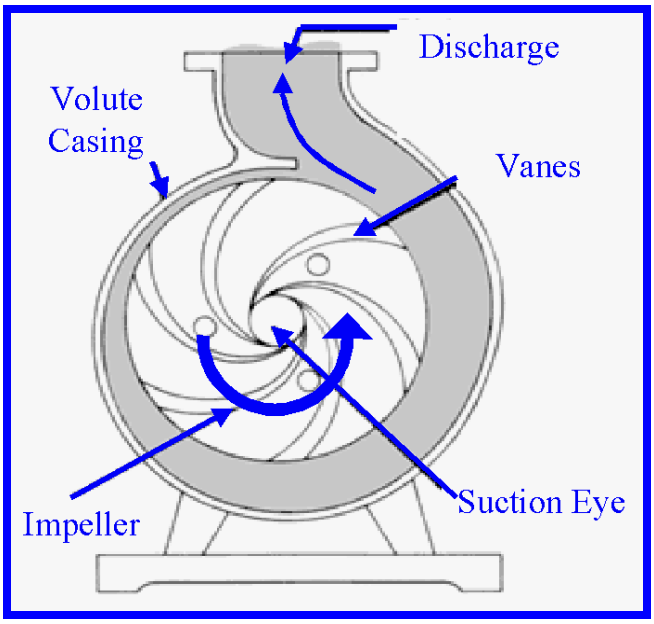

Figure A.01: Liquid flow path inside a centrifugal pump

Conversion of Kinetic Energy to Pressure Energy

The key idea is that the energy created by the centrifugal force is *kinetic energy*. The amount of energy given to the liquid is proportional to the *velocity* at the edge or vane tip of the impeller. The faster the impeller revolves or the bigger the impeller is, then the higher will be the velocity of the liquid at the vane tip and the greater the energy imparted to the liquid.

This kinetic energy of a liquid coming out of an impeller is harnessed by creating a *resistance* to the flow. The first resistance is created by the pump volute (casing) that catches the liquid and slows it down. In the discharge nozzle, the liquid further decelerates and its velocity is converted to pressure according to Bernoulli's principle.

Therefore, the head (pressure in terms of height of liquid) developed is approximately equal to the velocity energy at the periphery of the impeller expressed by the following well-known formula:

$$H = \frac{v^2}{2g}$$

where

- H = Total head developed in feet.
- v = Velocity at periphery of impeller in ft/sec.
- g = Acceleration due to gravity - 32.2 feet/Sec^2

A handy formula for peripheral velocity is:

$$v = \frac{N \times D}{229}$$

where

- v = Velocity at periphery of impeller in ft/sec.
- N = The impeller RPM (revolutions per minute)
- D = Impeller diameter in inches

This head can also be calculated from the readings on the pressure gauges attached to the suction and discharge lines.

One fact that must always be remembered: A pump does not create pressure, it only provides flow. Pressure is a just an indication of the amount of resistance to flow.

Pump curves relate flow rate and pressure (head) developed by the pump at different impeller sizes and rotational speeds. The centrifugal pump operation should conform to the pump curves supplied by the manufacturer. In order to read and understand the pump curves, it is very important to develop a clear understanding of the terms used in the curves. This topic will be covered later.

General Components of Centrifugal Pumps

A centrifugal pump has two main components:

I. A rotating component comprised of an impeller and a shaft

II. A stationary component comprised of a casing, casing cover, and bearings.

The general components, both stationary and rotary, are depicted in Figure B.01. The main components are discussed in brief below. Figure B.02 shows these parts on a photograph of a pump in the field.

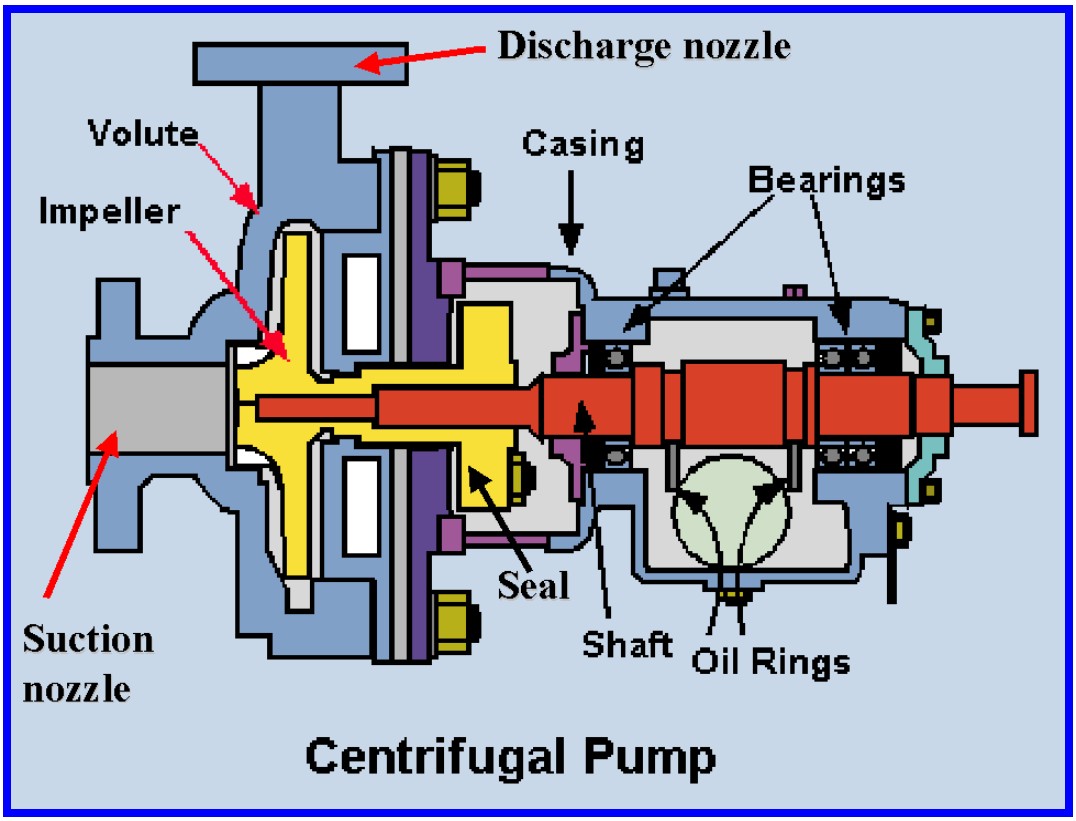

Figure B.01: General components of Centrifugal Pump

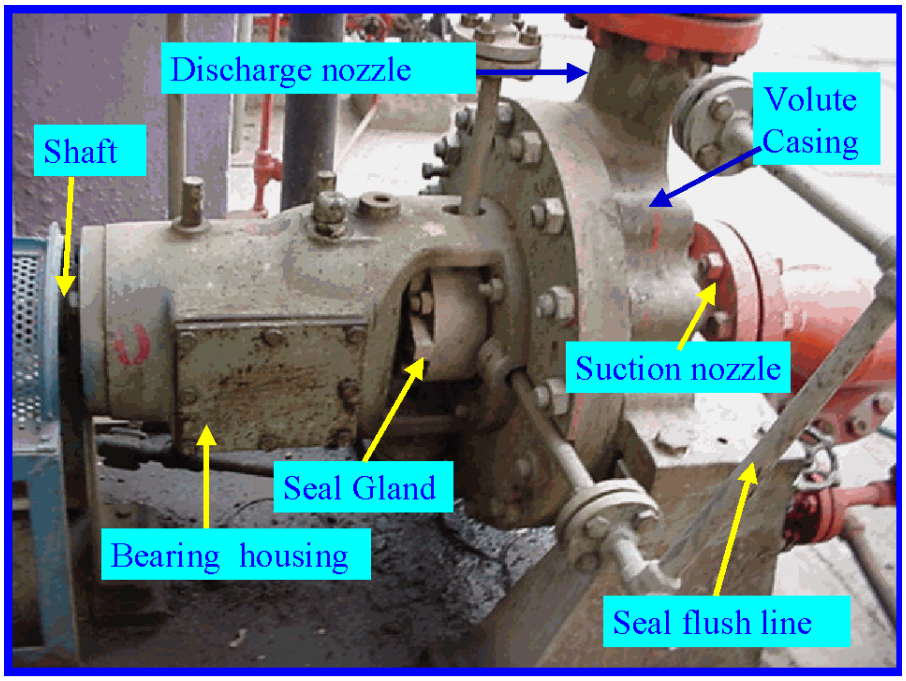

Figure B.02: General components of a Centrifugal Pump

Stationary Components

Casing

Casings are generally of two types: volute and circular. The impellers are fitted inside the casings.

1. ***Volute casings*** build a higher head; *circular casings* are used for low head and high capacity.
   - A *volute* is a curved funnel increasing in area to the discharge port as shown in Figure B.03. As the area of the cross-section increases, the volute reduces the speed of the liquid and increases the pressure of the liquid.

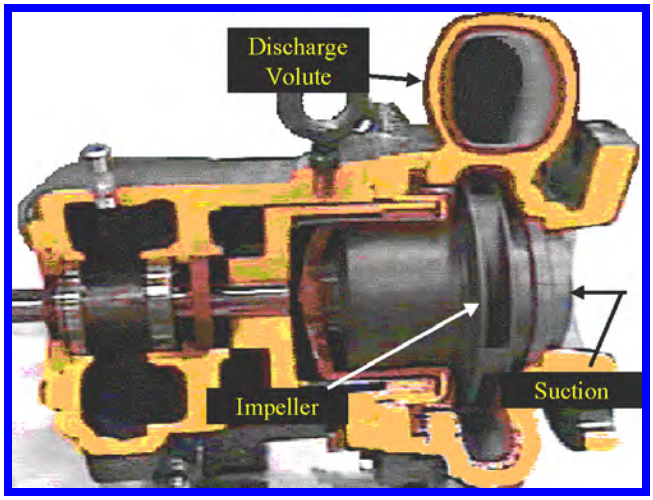

Figure B.03: Cut-away of a pump showing volute casing

- One of the *main purposes of a volute casing* is to help balance the hydraulic pressure on the shaft of the pump. However, this occurs best at the manufacturer's recommended capacity. Running volute-style pumps at a lower capacity than the manufacturer recommends can put lateral stress on the shaft of the pump, increasing wear-and-tear on the seals and bearings, and on the shaft itself. Double-volute casings are used when the radial thrusts become significant at reduced capacities.

2. **Circular casing** have stationary diffusion vanes surrounding the impeller periphery that convert velocity energy to pressure energy. Conventionally, the diffusers are applied to multi-stage pumps.

- The casings can be designed either as solid casings or split casings. **Solid casing** implies a design in which the entire casing including the discharge nozzle is all contained in one casting or fabricated piece. A **split casing** implies two or more parts are fastened together. When the casing parts are divided by horizontal plane, the casing is described as horizontally split or axially split casing. When the split is in a vertical plane perpendicular to the rotation axis, the casing is described as vertically split or radially split casing. Casing Wear rings act as the seal between the casing and the impeller.

Figure B.04: Solid Casing

Suction and Discharge Nozzle

The suction and discharge nozzles are part of the casings itself. They commonly have the following configurations.

1. *End suction/Top discharge* **(Figure B.05)** - The suction nozzle is located at the end of, and concentric to, the shaft while the discharge nozzle is located at the top of the case perpendicular to the shaft. This pump is always of an overhung type and typically has lower NPSHr because the liquid feeds directly into the impeller eye.

2. *Top suction Top discharge nozzle* **(Figure B.05)** -The suction and discharge nozzles are located at the top of the case perpendicular to the shaft. This pump can either be an overhung type or between-bearing type but is always a radially split case pump.

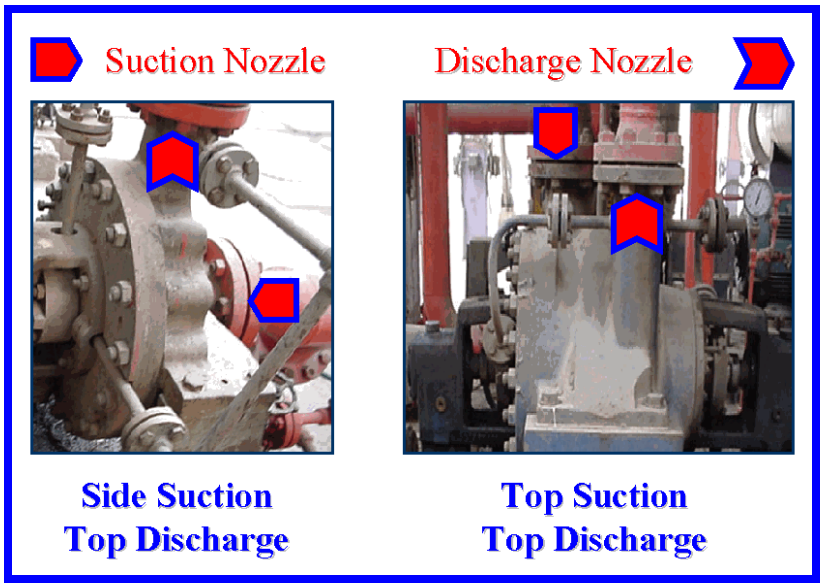

Figure B.05: Suction and Discharge Nozzle Locations

3. *Side suction / Side discharge nozzles* - The suction and discharge nozzles are located at the sides of the case perpendicular to the shaft. This pump can have either an axially or radially split case type.

Seal Chamber and Stuffing Box

Seal chamber and Stuffing box both refer to a chamber, either integral with or separate from the pump case housing that forms the region between the shaft and casing where sealing media are installed. When the sealing is achieved by means of a mechanical seal, the chamber is commonly referred to as a Seal Chamber. When the sealing is achieved by means of packing, the chamber is referred to as a Stuffing Box. Both the seal chamber and the stuffing box have the primary function of protecting the pump against leakage at the point where the shaft passes out through the pump pressure casing. When the pressure at the bottom of the chamber is below atmospheric, it prevents air leakage into the pump. When the pressure is above atmospheric, the chambers prevent liquid leakage out of the pump. The seal chambers and stuffing boxes are also provided with cooling or heating arrangement for proper temperature control. Figure B.06 below depicts an externally mounted seal chamber and its parts.

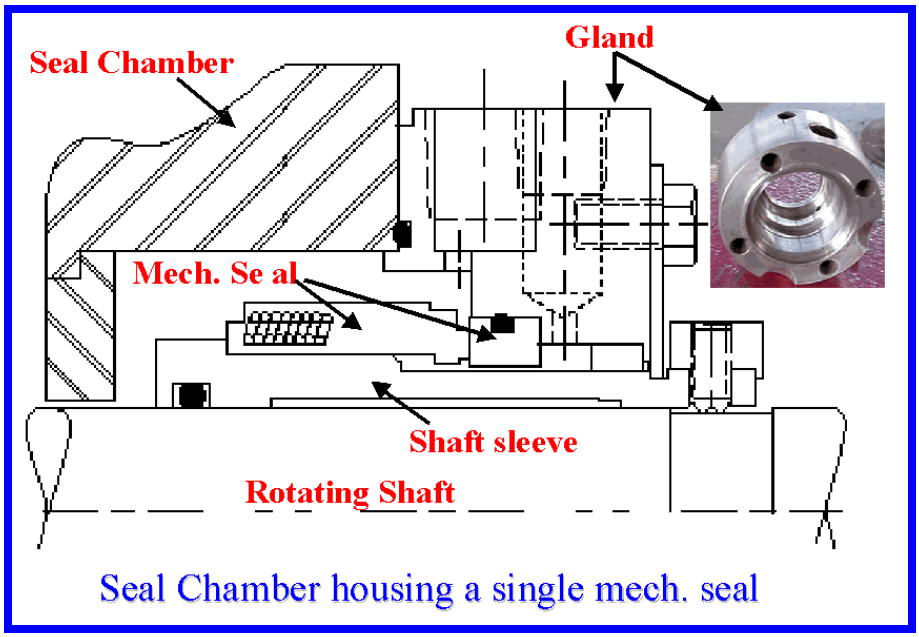

Figure B.06: Parts of a simple Seal Chamber

- **Gland:** The gland is a very important part of the seal chamber or the stuffing box. It gives the packings or the mechanical seal the desired fit on the shaft sleeve. It can be easily adjusted in axial direction. The gland comprises of the seal flush, quench, cooling, drain, and vent connection ports as per the standard codes like API 682.
- **Throat Bushing:** The bottom or inside end of the chamber is provided with a stationary device called throat bushing that forms a restrictive close clearance around the sleeve (or shaft) between the seal and the impeller.
- **Throttle bushing** refers to a device that forms a restrictive close clearance around the sleeve (or shaft) at the outboard end of a mechanical seal gland.
- **Internal circulating device** refers to device located in the seal chamber to circulate seal chamber fluid through a cooler or barrier/buffer fluid reservoir. Usually it is referred to as a pumping ring.
- **Mechanical Seal:** The features of a mechanical seal will be discussed in Part-II of the article.

Bearing housing

The bearing housing encloses the bearings mounted on the shaft. The bearings keep the shaft or rotor in correct alignment with the stationary parts under the action of radial and transverse loads. The bearing house also includes an oil reservoir for lubrication, constant level oiler, jacket for cooling by circulating cooling water.

Rotating Components

1. Impeller

The impeller is the main rotating part that provides the centrifugal acceleration to the fluid. They are often classified in many ways.

- Based on major direction of flow in reference to the axis of rotation
  - Radial flow
  - Axial flow
  - Mixed flow
- Based on suction type
  - Single-suction: Liquid inlet on one side.
  - Double-suction: Liquid inlet to the impeller symmetrically from both sides.
- Based on mechanical construction **(Figure B.07**)
  - Closed: Shrouds or sidewall enclosing the vanes.
  - Open: No shrouds or wall to enclose the vanes.
  - Semi-open or vortex type.

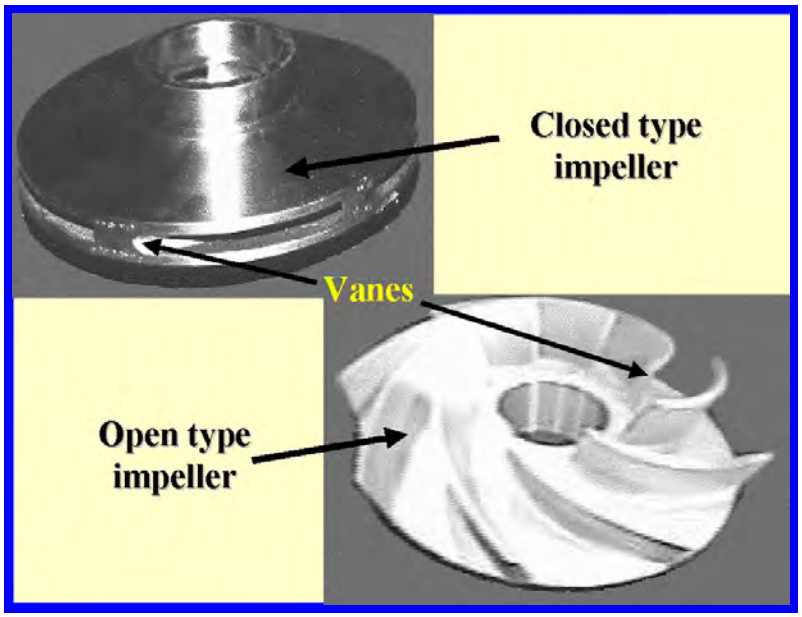

Figure B.07: Impeller types

Closed impellers require wear rings and these wear rings present another maintenance problem. Open and semi-open impellers are less likely to clog, but need manual adjustment to the volute or back-plate to get the proper impeller setting and prevent internal re-circulation. Vortex pump impellers are great for solids and "stringy" materials but they are up to 50% less efficient than conventional designs. The number of impellers determines the number of stages of the pump. A single stage pump has one impeller only and is best for low head service. A two-stage pump has two impellers in series for medium head service. A multi-stage pump has three or more impellers in series for high head service.

- Wear rings: Wear ring provides an easily and economically renewable leakage joint between the impeller and the casing. clearance becomes too large the pump efficiency will be lowered causing heat and vibration problems. Most manufacturers require that you disassemble the pump to check the wear ring clearance and replace the rings when this clearance doubles.

2. Shaft

   The basic purpose of a centrifugal pump shaft is to transmit the torques encountered when starting and during operation while supporting the impeller and other rotating parts. It must do this job with a deflection less than the minimum clearance between the rotating and stationary parts.

- Shaft Sleeve (**Figure B.08**): Pump shafts are usually protected from erosion, corrosion, and wear at the seal chambers, leakage joints, internal bearings, and in the waterways by renewable sleeves. Unless otherwise specified, a shaft sleeve of wear, corrosion, and erosion-resistant material shall be provided to protect the shaft. The sleeve shall be sealed at one end. The shaft sleeve assembly shall extend beyond the outer face of the seal gland plate. (Leakage between the shaft and the sleeve should not be confused with leakage through the mechanical seal).

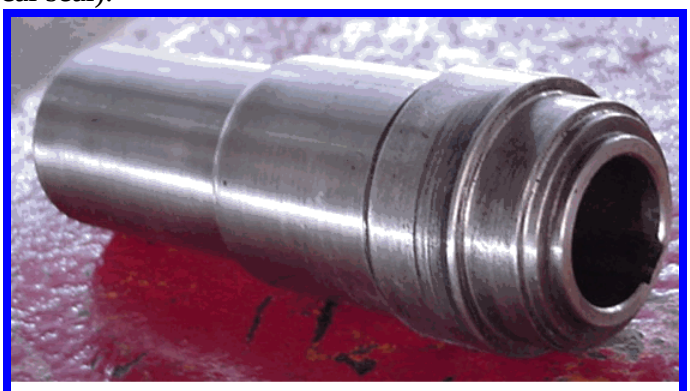

Figure B.08: A view of a shaft sleeve

- Coupling: Couplings can compensate for axial growth of the shaft and transmit torque to the impeller. Shaft couplings can be broadly classified into two groups: rigid and flexible. Rigid couplings are used in applications where there is absolutely no possibility or room for any misalignment. Flexible shaft couplings are more prone to selection, installation and maintenance errors. Flexible shaft couplings can be divided into two basic groups: elastomeric and non-elastomeric

  - Elastomeric couplings use either rubber or polymer elements to achieve flexibility. These elements can either be in shear or in compression. Tire and rubber sleeve designs are elastomer in shear couplings; jaw and pin and bushing designs are elastomer in compression couplings.

  - Non-elastomeric couplings use metallic elements to obtain flexibility. These can be one of two types: lubricated or non-lubricated. Lubricated designs accommodate misalignment by the sliding action of their components, hence the need for lubrication. The non-lubricated designs accommodate

misalignment through flexing. Gear, grid and chain couplings are examples of non-elastomeric, lubricated couplings. Disc and diaphragm couplings are non-elastomeric and non-lubricated.

Auxiliary Components

Auxiliary components generally include the following piping systems for the following services:

- Seal flushing , cooling , quenching systems
- Seal drains and vents
- Bearing lubrication , cooling systems
- Seal chamber or stuffing box cooling, heating systems
- Pump pedestal cooling systems

Auxiliary piping systems include tubing, piping, isolating valves, control valves, relief valves, temperature gauges and thermocouples, pressure gauges, sight flow indicators, orifices, seal flush coolers, dual seal barrier/buffer fluid reservoirs, and all related vents and drains.

All auxiliary components shall comply with the requirements as per standard codes like API 610 (refinery services), API 682 (shaft sealing systems) etc.

Definition of Important Terms

The key performance parameters of centrifugal pumps are capacity, head, BHP (Brake horse power), BEP (Best efficiency point) and specific speed. The pump curves provide the operating window within which these parameters can be varied for satisfactory pump operation. The following parameters or terms are discussed in detail in this section.

Capacity

Head

- Significance of using Head instead of Pressure
- Pressure to Head Conversion formula
- Static Suction Head, $\mathbf{h_S}$
- Static Discharge Head, $\mathbf{h_d}$
- Friction Head, **hf**

- Vapor pressure Head, **hvp**
- Pressure Head, **hp**
- Velocity Head, **hv**
- Total Suction Head $\mathbf{H_S}$
- Total Discharge Head $\mathbf{H_d}$
- Total Differential Head $\mathbf{H_T}$

NPSH

- Net Positive Suction Head Required **NPSHr**
- Net Positive Suction Head Available **NPSHa**

Power (Brake Horse Power, B.H.P) and Efficiency (Best Efficiency Point, B.E.P)
Specific Speed (Ns)
Affinity Laws

Capacity

Capacity means the flow rate with which liquid is moved or pushed by the pump to the desired point in the process. It is commonly measured in either gallons per minute (gpm) or cubic meters per hour (m^3/hr). The capacity usually changes with the changes in operation of the process. For example, a boiler feed pump is an application that needs a constant pressure with varying capacities to meet a changing steam demand.

The capacity depends on a number of factors like:

Process liquid characteristics i.e. density, viscosity
Size of the pump and its inlet and outlet sections
Impeller size
Impeller rotational speed RPM
Size and shape of cavities between the vanes
Pump suction and discharge temperature and pressure conditions

For a pump with a particular impeller running at a certain speed in a liquid, the only items on the list above that can change the amount flowing through the pump are the pressures at the pump inlet and outlet. The effect on the flow through a pump by changing the outlet pressures is graphed on a pump curve.

As liquids are essentially incompressible, the capacity is directly related with the velocity of flow in the suction pipe. This relationship is as follows:

$$Q = 449 \times V \times A$$

where

- Q = Capacity in gallons per minute (GPM).
- V = Velocity of flow in ft/sec.
- A = Area of pipe in ft^2

Head

Significance of using the ***"head"*** term instead of the ***"pressure"*** term

The pressure at any point in a liquid can be thought of as being caused by a vertical column of the liquid due to its weight. The height of this column is called the static head and is expressed in terms of feet of liquid.

The same *head* term is used to measure the kinetic energy created by the pump. In other words, head is a measurement of the height of a liquid column that the pump could create from the kinetic energy imparted to the liquid. Imagine a pipe shooting a jet of water straight up into the air, the height the water goes up would be the head.

The head is not equivalent to pressure. Head is a term that has units of a length or feet and pressure has units of force per unit area or pound per square inch. **The main reason for using head instead of pressure** to measure a centrifugal pump's energy is that the pressure from a pump will change if the specific gravity (weight) of the liquid changes, but the head will not change. Since any given centrifugal pump can move a lot of different fluids, with different specific gravities, it is simpler to discuss the pump's head and forget about the pressure.

A given pump with a given impeller diameter and speed will raise a liquid to a certain height regardless of the weight of the liquid.

So a centrifugal pump's performance on any Newtonian fluid, whether it's heavy (sulfuric acid) or light (gasoline) is described by using the term 'head'. The pump performance curves are mostly described in terms of head.

Pressure to Head Conversion formula

The static head corresponding to any specific pressure is dependent upon the weight of the liquid according to the following formula:

$$\text{Head (ft)} = \frac{\text{Pressure (psi)} \times 2.31}{\text{Specific Gravity}}$$

Newtonian liquids have specific gravities typically ranging from 0.5 (light, like light hydrocarbons) to 1.8 (heavy, like concentrated sulfuric acid). Water is a benchmark, having a specific gravity of 1.0.

This formula helps in converting pump gauge pressures to head for reading the pump curves. The various head terms are discussed below.

Note: The Subscripts **'s'** refers to suction conditions and **'d'** refers to discharge conditions.

- Static Suction Head, $\mathbf{h_S}$
- Static Discharge Head, $\mathbf{h_d}$
- Friction Head, **hf**
- Vapor pressure Head, **hvp**
- Pressure Head, **hp**
- Velocity Head, **hv**
- Total Suction Head $\mathbf{H_S}$
- Total Discharge Head $\mathbf{H_d}$
- Total Differential Head $\mathbf{H_T}$
- Net Positive Suction Head Required **NPSHr**
- Net Positive Suction Head Available **NPSHa**

Static Suction Head (**h_S**) : Head resulting from elevation of the liquid relative to the pump center line. If the liquid level is above pump centerline, **h_S** is positive. If the liquid level is below pump centerline, **h_S** is negative. Negative **h_S** condition is commonly denoted as a "suction lift" condition

Static Discharge Head (**h_d**): It is the vertical distance in feet between the pump centerline and the point of free discharge or the surface of the liquid in the discharge tank.

Friction Head (**hf**): The head required to overcome the resistance to flow in the pipe and fittings. It is dependent upon the size, condition and type of pipe, number and type of pipefittings, flow rate, and nature of the liquid.

Vapor Pressure Head (**hvp**): Vapor pressure is the pressure at which a liquid and its vapor co-exist in equilibrium at a given temperature. The vapor pressure of liquid can be obtained from vapor pressure tables. When the vapor pressure is converted to head, it is referred to as vapor pressure head, **hvp**. The value of **hvp** of a liquid increases with the rising temperature and in effect, opposes the pressure on the liquid surface, the positive force that tends to cause liquid flow into the pump suction i.e. it reduces the suction pressure head.

Pressure Head (**hp**)*:* Pressure Head must be considered when a pumping system either begins or terminates in a tank which is under some pressure other than atmospheric. The pressure in such a tank must first be converted to feet of liquid. Denoted as **hp**, pressure head refers to absolute pressure on the surface of the liquid reservoir supplying the pump suction, converted to feet of head. If the system is open, **hp** equals atmospheric pressure head.

Velocity Head (**hv**): Refers to the energy of a liquid as a result of its motion at some velocity **'v'**. It is the equivalent head in feet through which the water would have to fall to acquire the same velocity, or in other words, the head necessary to accelerate the water. The velocity head is usually insignificant and can be ignored in most high head systems. However, it can be a large factor and must be considered in low head systems.

Total Suction Head (**H_S**): The suction reservoir pressure head (**hp_S**) plus the static suction head (**h_S**) plus the velocity head at the pump suction flange (h_{VS}) minus the friction head in the suction line (**hf_S**).

$$H_S = hp_S + h_S + hv_S - hf_S$$

The total suction head is the reading of the gauge on the suction flange, converted to feet of liquid.

Total Discharge Head (**H_d**): The discharge reservoir pressure head (**hp_d**) plus static discharge head (**h_d**) plus the velocity head at the pump discharge flange (**hv_d**) plus the total friction head in the discharge line (**hf_d**).

$$H_d = hp_d + h_d + hv_d + hf_d$$

The total discharge head is the reading of a gauge at the discharge flange, converted to feet of liquid.

Total Differential Head (**H_T**): It is the total discharge head minus the total suction head or

$$H_T = H_d + H_S \text{ (with a suction lift)}$$
$$H_T = H_d - H_S \text{ (with a suction head)}$$

NPSH

When discussing centrifugal pumps, the two most important head terms are NPSHr and NPSHa.

Net Positive Suction Head Required, NPSHr

NPSH is one of the most widely used and least understood terms associated with pumps. Understanding the significance of NPSH is very much essential during installation as well as operation of the pumps.

Pumps can pump only liquids, not vapors

The satisfactory operation of a pump requires that vaporization of the liquid being pumped does not occur at any condition of operation. This is so desired because when a liquid vaporizes its volume increases very much. For example, 1 ft^3 of water at room temperature becomes 1700 ft^3 of vapor at the same temperature. This makes it clear that if we are to pump a fluid effectively, it must be kept always in the liquid form.

Rise in temperature and fall in pressure induces vaporization

The vaporization begins when the vapor pressure of the liquid at the operating temperature equals the external system pressure, which, in an open system is always equal to atmospheric pressure. Any decrease in external pressure or rise in operating temperature can induce vaporization and the pump stops pumping. Thus, the pump always needs to have a sufficient amount of suction head present to prevent this vaporization at the lowest pressure point in the pump.

NPSH as a measure to prevent liquid vaporization

The manufacturer usually tests the pump with water at different capacities, created by throttling the suction side. When the first signs of vaporization induced cavitation occur, the suction pressure is noted (the term cavitation is discussed in detail later). This pressure is converted into the head. This head number is published on the pump curve and is referred as the "net positive suction head required (NPSHr) or sometimes in short as the NPSH. **Thus the Net Positive Suction Head (NPSH) is the total head at the suction flange of the pump less the vapor pressure converted to fluid column height of the liquid.**

NPSHr is a function of pump design

NPSH required is a function of the pump design and is determined based on actual pump test by the vendor. As the liquid passes from the pump suction to the eye of the impeller, the velocity increases and the pressure decreases. There are also pressure losses due to shock and turbulence as the liquid strikes the impeller. The centrifugal force of the impeller vanes further increases the velocity and decreases the pressure of the liquid. The NPSH required is the positive head in feet absolute required at the pump suction to overcome these pressure drops in the pump and maintain the majority of the liquid above its vapor pressure.

The NPSH is always positive since it is expressed in terms of absolute fluid column height. The term "Net" refers to the actual pressure head at the pump suction flange and not the static suction head.

NPSHr increases as capacity increases

The NPSH required varies with speed and capacity within any particular pump. The NPSH required increase as the capacity is increasing because the velocity of the liquid is increasing, and as anytime the velocity of a liquid goes up, the pressure or head comes down. Pump manufacturer's curves normally provide this information. The NPSH is independent of the fluid density as are all head terms. **Note:** It is to be noted that the net positive suction head required (NPSHr) number shown on the pump curves is for fresh water at 20°C and not for the fluid or combinations of fluids being pumped.

Net Positive Suction Head available, NPSHa

NPSHa is a function of system design

Net Positive Suction Head Available is a function of the system in which the pump operates. It is the excess pressure of the liquid in feet absolute over its vapor pressure as it arrives at the pump suction, to be sure that the pump selected does not cavitate. It is calculated based on system or process conditions.

NPSHa calculation

The formula for calculating the NPSHa is stated below:

$$NPSHa_S = hp_S + h_S - hvp_S - hf_S$$

- hp_S - Pressure Head i.e Barometric Pressure of the suction vessel converted to Head
- h_S - Static suction Head i.e.the vertical distance between the eye of the first stage impeller centerline and the suction liquid level.
- hvp_S - Vapor pressure Head i.e. vapor pressure of liquid at its max. pumping temperature converted to Head
- hf_S - Friction Head i.e. friction and entrance pressure losses on the suction side converted to Head

Note:

1. It is important to correct for the specific gravity of the liquid and to convert all terms to units of "feet **absolute**" in using the formula.
2. Any discussion of NPSH or cavitation is only concerned about the suction side of the pump. There is almost always plenty of pressure on the discharge side of the pump to prevent the fluid from vaporizing.

NPSHa in a nutshell

In a nutshell, NPSH available is defined as:

NPSHa = Pressure head + Static head - Vapor pressure head of your product – Friction head loss in the piping, valves and fittings.

"All terms in feet absolute"

In an existing system, the NPSHa can also be approximated by a gauge on the pump suction using the formula:

$$\mathbf{NPSHa = hp_S - hvp_S \ ? \ hg_S + hv_S}$$

- ✍ $\mathbf{hp_S}$ = Barometric pressure in feet absolute.
- ✍ $\mathbf{hvp_S}$ = Vapor pressure of the liquid at maximum pumping temperature, in feet absolute.
- ✍ $\mathbf{hg_S}$ = Gauge reading at the pump suction expressed in feet (plus if above atmospheric, minus if below atmospheric) corrected to the pump centerline.
- ✍ $\mathbf{hv_S}$ = Velocity head in the suction pipe at the gauge connection, expressed in feet.

Significance of NPSHr and NPSHa

The NPSH available must always be greater than the NPSH required for the pump to operate properly. It is normal practice to have at least 2 to 3 feet of extra NPSH available at the suction flange to avoid any problems at the duty point.

Power and Efficiency

Brake Horse Power (BHP)

The work performed by a pump is a function of the total head and the weight of the liquid pumped in a given time period.

Pump input or brake horsepower (BHP) is the actual horsepower delivered to the pump shaft.

Pump output or hydraulic or water horsepower (WHP) is the liquid horsepower delivered by the pump. These two terms are defined by the following formulas.

$$BHP = \frac{Q \times H_T \times Sp.Gr.}{3960 \times Eff.}$$

where

- Q = Capacity in gallons per minute (GPM).
- H_T = Total Differential Head ,ft
- $Sp.Gr.$ = Specific Gravity of the liquid
- $Eff.$ = Pump efficiency , %

$$WHP = \frac{Q \times H_T \times Sp.Gr.}{3960}$$

where

- Q = Capacity in gallons per minute (GPM).
- H_T = Total Differential Head ,ft
- $Sp.Gr.$ = Specific Gravity of the liquid

The constant 3960 is obtained by dividing the number or foot-pounds for one horsepower (33,000) by the weight of one gallon of water (8.33 pounds).

BHP can also be read from the pump curves at any flow rate. Pump curves are based on a specific gravity of 1.0. Other liquids' specific gravity must be considered.

The brake horsepower or input to a pump is greater than the hydraulic horsepower or output due to the mechanical and hydraulic losses incurred in the pump.

Therefore the pump efficiency is the ratio of these two values.

$$\text{Pump Efficiency } (Eff.) = \frac{WHP}{BHP}$$

Best Efficiency Point (BEP)

The H, NPSHr, efficiency, and BHP all vary with flow rate, Q. **Best Efficiency Point (BEP)** is the capacity at maximum impeller diameter at which the efficiency is highest. All points to the right or left of BEP have a lower efficiency.

Significance of BEP

BEP as a measure of optimum energy conversion

When sizing and selecting centrifugal pumps for a given application the pump efficiency at design should be taken into consideration. The efficiency of centrifugal pumps is stated as a percentage and represents a unit of measure describing the change of centrifugal force (expressed as the velocity of the fluid) into pressure energy. The B.E.P. (best efficiency point) is the area on the curve where the change of velocity energy into pressure energy at a given gallon per minute is optimum; in essence, the point where the pump is most efficient.

BEP as a measure of mechanically stable operation

The impeller is subject to non-symmetrical forces when operating to the right or left of the BEP. These forces manifest themselves in many mechanically unstable conditions like vibration, excessive hydraulic thrust, temperature rise, and erosion and separation cavitation. Thus the operation of a centrifugal pump should not be outside the furthest left or right efficiency curves published by the manufacturer. Performance in these areas induces premature bearing and mechanical seal failures due to shaft deflection, and an increase in temperature of the process fluid in the pump casing causing seizure of close tolerance parts and cavitation.

BEP as an important parameter in calculations

BEP is an important parameter in that many parametric calculations such as specific speed, suction specific speed, hydrodynamic size, viscosity correction, head rise to shut-off, etc. are based on capacity at BEP. Many users prefer that pumps operate within 80% to 110% of BEP for optimum performance.

Specific Speed

Specific speed as a measure of the geometric similarity of pumps

Specific speed (N_s) is a non-dimensional design index that identifies the geometric similarity of pumps. It is used to classify pump impellers as to their type and proportions. Pumps of the same Ns but of different size are considered to be geometrically similar, one pump being a size-factor of the other.

Specific speed Calculation

The following formula is used to determine specific speed:

$$Ns = \frac{N \times Q^{0.5}}{H^{0.75}}$$

where

- Q = Capacity at best efficiency point (BEP) at maximum impeller diameter,GPM
- H = Head per stage at BEP at maximum impeller diameter ,ft
- N = Pump speed, RPM

As per the above formula, it is defined as the speed in revolutions per minute at which a geometrically similar impeller would operate if it were of such a size as to deliver one gallon per minute flow against one-foot head.

The understanding of this definition is of design engineering significance only, however, and specific speed should be thought of only as an index used to predict certain pump characteristics.

Specific speed as a measure of the shape or class of the impellers

The specific speed determines the general shape or class of the impellers. As the specific speed increases, the ratio of the impeller outlet diameter, D2, to the inlet or eye diameter, D1, decreases. This ratio becomes 1.0 for a true axial flow impeller. *Radial flow impellers* develop head principally through centrifugal force. Radial impellers are generally low flow high head designs. Pumps of higher specific speeds develop head partly by centrifugal force and partly by axial force. A higher specific speed indicates a pump design with head generation more by axial forces and less by centrifugal forces. An axial flow or propeller pump with a specific speed of 10,000 or greater generates its head exclusively through axial forces. Axial flow impellers are high flow low head designs.

Specific speed identifies the approximate acceptable ratio of the impeller eye diameter (D1) to the impeller maximum diameter (D2) in designing a good impeller.

Ns: 500 to 5000; D1/D2 > 1.5 - radial flow pump
Ns: 5000 to 10000; D1/D2 < 1.5 - mixed flow pump
Ns: 10000 to 15000; D1/D2 = 1 - axial flow pump

Specific speed is also used in designing a new pump by size-factoring a smaller pump of the same specific speed. The performance and construction of the smaller pump are used to predict the performance and model the construction of the new pump.

Suction specific speed (Nss)

Suction specific speed (Nss) is a dimensionless number or index that defines the suction characteristics of a pump. It is calculated from the same formula as Ns by substituting H by NPSHr.

In multi-stage pump the NPSHr is based on the first stage impeller NPSHR.

Specific speed as a measure of the safe operating range

Nss is commonly used as a basis for estimating the safe operating range of capacity for a pump. The higher the Nss is, the narrower is its safe operating range from its BEP. The numbers range between 3,000 and 20,000. Most users prefer that their pumps have Nss in the range of 8000 to 11000 for optimum and trouble-free operation.

The Affinity Laws

The Affinity Laws are mathematical expressions that define changes in pump capacity, head, and BHP when a change is made to pump speed, impeller diameter, or both. According to *Affinity Laws*:

Capacity, Q changes in direct proportion to impeller diameter **D** ratio, or to speed **N** ratio:

$$Q_2 = Q_1 \times [D_2/D_1]$$
$$Q_2 = Q_1 \times [N_2/N_1]$$

Head, H changes in direct proportion to the square of impeller diameter **D** ratio, or the square of speed **N** ratio:

$$H_2 = H_1 \times [D_2/D_1]^2$$
$$H_2 = H_1 \times [N_2/N_1]^2$$

BHP changes in direct proportion to the cube of impeller diameter ratio, or the cube of speed ratio:

$$BHP_2 = BHP_1 \times [D_2/D_1]^3$$
$$BHP_2 = BHP_1 \times [N_2/N_1]^3$$

Where the subscript: 1 refers to initial condition, 2 refer to new condition

If changes are made to both impeller diameter and pump speed the equations can be combined to:

$$Q_2 = Q_1 \times [(D_2 x N_2)/(D_1 x N_1)]$$

$$H_2 = H_1 \times [(D_2 x N_2)/(D_1 x N_1)]^2$$

$$BHP_2 = BHP_1 \times [(D_2 x N_2)/(D_1 x N_1)]^3$$

This equation is used to hand-calculate the impeller trim diameter from a given pump performance curve at a bigger diameter.

The Affinity Laws are valid only under conditions of constant efficiency.

Understanding Centrifugal Pump Performance Curves

The capacity and pressure needs of any system can be defined with the help of a graph called a ***system curve***. Similarly the capacity *vs.* pressure variation graph for a particular pump defines its characteristic ***pump performance curve***.

The pump suppliers try to match the system curve supplied by the user with a pump curve that satisfies these needs as closely as possible. A pumping system operates where the pump curve and the system resistance curve intersect. The intersection of the two curves defines the operating point of both pump and process. However, it is impossible for one operating point to meet all desired operating conditions. For example, when the discharge valve is throttled, the system resistance curve shift left and so does the operating point.

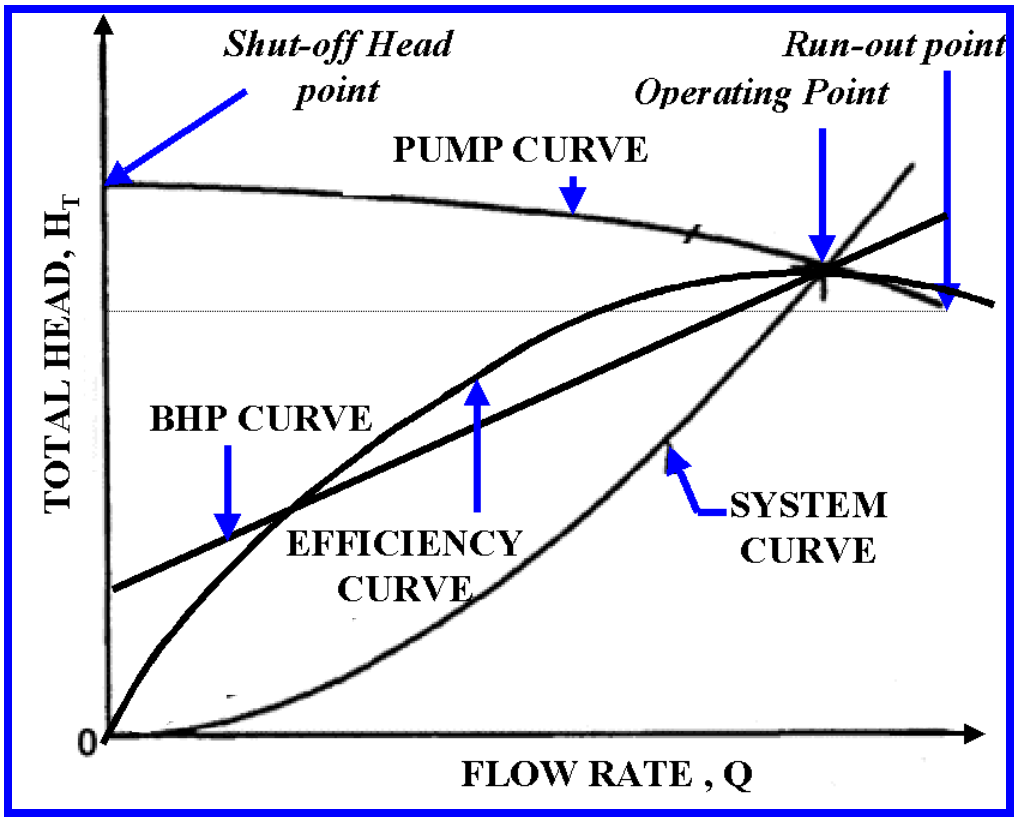

Figure D.01: Typical system and pump performance curves

Developing a system curve

The *system resistance or system head curve* is the change in flow with respect to head of the system. **It must be developed by the user based upon the conditions of service.** These include physical layout, process conditions, and fluid characteristics. It represents the relationship between flow and hydraulic losses in a system in a graphic form and, since friction losses vary as a square of the flow rate, the system curve is parabolic in shape. Hydraulic losses in piping systems are composed of pipe friction losses, valves, elbows and other fittings, entrance and exit losses, and losses from changes in pipe size by enlargement or reduction in diameter.

Developing a Pump performance Curve

A pump's performance is shown in its characteristics performance *curve* where its capacity i.e. flow rate is plotted against its developed head. The pump performance curve also shows its efficiency (BEP), required input power (in BHP), NPSHr, speed (in RPM), and other information such as pump size and type, impeller size, etc. This curve is plotted for a constant speed (rpm) and a given impeller diameter (or series of diameters). **It is generated by tests performed by the pump manufacturer.** Pump curves are based on a specific gravity of 1.0. Other specific gravities must be considered by the user.

Normal Operating Range

A typical performance curve (Figure D.01) is a plot of Total Head vs. Flow rate for a specific impeller diameter. The plot starts at zero flow. The head at this point corresponds to the shut-off head point of the pump. The curve then decreases to a point where the flow is maximum and the head minimum. This point is sometimes called the run-out point. The pump curve is relatively flat and the head decreases gradually as the flow increases. This pattern is common for radial flow pumps. Beyond the run-out point, the pump cannot operate. The pump's range of operation is from the shut-off head point to the run-out point. Trying to run a pump off the right end of the curve will result in pump cavitation and eventually destroy the pump.

In a nutshell, by plotting the system head curve and pump curve together, you can determine:

1. Where the pump will operate on its curve?

2. What changes will occur if the system head curve or the pump performance curve changes?

Two Basic Requirements for Trouble-Free Operation of Centrifugal Pumps

Centrifugal pumps are the ultimate in simplicity. In general there are two basic requirements that have to be met at all the times for a trouble free operation and longer service life of centrifugal pumps.

The **first** requirement is that no cavitation of the pump occurs throughout the broad operating range and the **second** requirement is that a certain minimum continuous flow is always maintained during operation.

A clear understanding of the concept of cavitation, its symptoms, its causes, and its consequences is very much essential in effective analyses and troubleshooting of the cavitation problem.

Just like there are many forms of cavitation, each demanding a unique solution, there are a number of unfavorable conditions which may occur separately or simultaneously when the pump is operated at reduced flows. Some include:

- Cases of heavy leakages from the casing, seal, and stuffing box
- Deflection and shearing of shafts
- Seizure of pump internals
- Close tolerances erosion
- Separation cavitation
- Product quality degradation
- Excessive hydraulic thrust
- Premature bearing failures

Each condition may dictate a different minimum flow low requirement. The final decision on recommended minimum flow is taken after careful "techno-economical" analysis by both the pump user and the manufacturer.

The consequences of prolonged conditions of cavitation and low flow operation can be disastrous for both the pump and the process. Such failures in hydrocarbon services have often caused damaging fires resulting in loss of machine, production, and worst of all, human life.

Thus, such situations must be avoided at all cost whether involving modifications in the pump and its piping or altering the operating conditions. Proper selection and sizing of pump and its associated piping can not only eliminate the chances of cavitation and low flow operation but also significantly decrease their harmful effects.

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Centrifugal Pumps: Basic Concepts of Operation, Maintenance, and Troubleshooting (Part- II, Understanding Cavitation)

Introduction

In Part I of the article, two basic requirements for trouble free operation and longer service life of centrifugal pumps are mentioned in brief.

1. PREVENT CAVITATION
   Cavitation of the pump should not occur throughout its operating capacity range.

2. MINIMIZE LOW FLOW OPERATION
   Continuous operation of centrifugal pumps at low flows i.e. reduced capacities, leads to a number of unfavorable conditions. These include reduced motor efficiency, excessive radial thrusts, excessive temperature rise in the pumping fluid, internal re-circulation, etc. A certain minimum continuous flow (MCF) should be maintained during the pump operation.

Operating a pump under the condition of cavitation for even a short period of time an have damaging consequences for both the equipment and the process. Operating a pump at low flow conditions for an extended duration may also have damaging consequences for the equipment.

The condition of cavitation is essentially an indication of an abnormality in the pump suction system, whereas the condition of low flow indicates an abnormality in the entire pumping system or process. The two conditions are also interlinked such that a low flow situation can also induce cavitation.

The concept of cavitation is explored in detail under following topics:

1. Meaning of the term 'cavitation' in the context of centrifugal pumps.
2. Important definitions: Static pressure, Dynamic pressure, Total pressure, Static pressure head, Velocity Head, Vapor pressure.
3. Mechanism of cavitation.
4. General symptoms of cavitation and its effects on pump performance and pump parts.
5. Types of cavitation:
   a. Vaporous cavitation
      i. Classic cavitation
      ii. Internal re-circulation cavitation
   b. Gaseous cavitation
      i. Air ingestion induced cavitation
6. Methods to prevent cavitation.

The topics 1 to 4 are covered in detail in this part of the article. The topics 5 to 6 shall be explored in next part of the article.

Readers of Part I showed keen interest and appreciation about the approach in which the topic of Centrifugal Pumps has been discussed. The same enthusiasm, response and feedback are solicited from the readers.

Concept of Cavitation

Cavitation is a common occurrence but is the least understood of all pumping problems. Cavitation means different things to different people. Some say when a pump makes a rattling or knocking sound along with vibrations, it is cavitating. Some call it slippage as the pump discharge pressure slips and flow becomes erratic. When cavitating, the pump not only fails to serve its basic purpose of pumping the liquid but also may experience internal damage, leakage from the seal and casing, bearing failure, etc.

In summary, cavitation is an abnormal condition that can result in loss of production, equipment damage and worst of all, personnel injury.

The plant engineer's job is to quickly detect the signs of cavitation, correctly identify the type and cause of the cavitation and eliminate it. A good understanding of the concept is the key to troubleshooting any cavitation related pumping problem.

The concept of cavitation is explored under the following topics:

1. Meaning of the term 'cavitation' in the context of centrifugal pumps.
2. Important definitions: Static pressure, Dynamic pressure, Total pressure, Static pressure head, Velocity Head, Vapor pressure.
3. Mechanism of cavitation.
4. General symptoms of cavitation and its effects on pump performance and pump parts.
5. Types of cavitation:
    a. Vaporous cavitation
        i. Classic cavitation
        ii. Internal re-circulation cavitation
    b. Gaseous cavitation
        i. Air ingestion induced cavitation
6. Methods to prevent cavitation

1. Meaning of the term 'cavitation' in the context of centrifugal pumps

The term 'cavitation' comes from the Latin word cavus, which means a hollow space or a cavity. Webster's Dictionary defines the word 'cavitation' as the rapid formation and collapse of cavities in a flowing liquid in regions of very low pressure.

In any discussion on centrifugal pumps various terms like vapor pockets, gas pockets, holes, bubbles, etc. are used in place of the term cavities. These are one and the same thing and need not be confused. The term bubble shall be used hereafter in the discussion.

In the context of centrifugal pumps, the term cavitation implies a dynamic process of formation of bubbles inside the liquid, their growth and subsequent collapse as the liquid flows through the pump.

Generally, the bubbles that form inside the liquid are of two types: Vapor bubbles or Gas bubbles.

1. Vapor bubbles are formed due to the vaporisation of a process liquid that is being pumped. The cavitation condition induced by formation and collapse of vapor bubbles is commonly referred to as Vaporous Cavitation.
2. Gas bubbles are formed due to the presence of dissolved gases in the liquid that is being pumped (generally air but may be any gas in the system). The cavitation condition induced by the formation and collapse of gas bubbles is commonly referred to as Gaseous Cavitation.

Both types of bubbles are formed at a point inside the pump where the local static pressure is less than the vapor pressure of the liquid (vaporous cavitation) or saturation pressure of the gas (gaseous cavitation).

Vaporous cavitation is the most common form of cavitation found in process plants. Generally it occurs due to insufficiency of the available NPSH or internal recirculation phenomenon. It generally manifests itself in the form of reduced pump performance, excessive noise and vibrations and wear of pump parts. The extent of the cavitation damage can range from a relatively minor amount of pitting after years of service to catastrophic failure in a relatively short period of time.

Gaseous cavitation occurs when any gas (most commonly air) enters a centrifugal pump along with liquid. A centrifugal pump can handle air in the range of ½ % by volume. If the amount of air is increased to 6%, the pump starts cavitating. The cavitation condition

is also referred to as Air binding. It seldom causes damage to the impeller or casing. The main effect of gaseous cavitation is loss of capacity.

The different types of cavitation, their specific symptoms and specific corrective actions shall be explored in the next part of the article. However, in order to clearly identify the type of cavitation, let us first understand the mechanism of cavitation, i.e. how cavitation occurs. Unless otherwise specified, the term cavitation shall refer to vaporous cavitation.

2. Important Definitions: *To enable a clear understanding of mechanism of cavitation, definitions of following important terms are explored.*

- *Static pressure,*
- *Dynamic pressure,*
- *Total pressure,*
- *Static pressure head,*
- *Velocity head, and*
- *Vapor pressure.*

Static Pressure, p_s

The static pressure in a fluid stream is the normal force per unit area on a solid boundary moving with the fluid. It describes the difference between the pressure inside and outside a system, disregarding any motion in the system. For instance, when referring to an air duct, static pressure is the difference between the pressure inside the duct and outside the duct, disregarding any airflow inside the duct. In energy terms, the static pressure is a measure of the potential energy of the fluid.

Dynamic pressure, p_d

A moving fluid stream exerts a pressure higher than the static pressure due to the kinetic energy ($\frac{1}{2} mv^2$) of the fluid. This additional pressure is defined as the dynamic pressure. The dynamic pressure can be measured by converting the kinetic energy of the fluid stream into the potential energy. In other words, it is pressure that would exist in a fluid stream that has been decelerated from its velocity 'v' to 'zero' velocity.

Total pressure, p_t

The sum of static pressure and dynamic pressure is defined as the total pressure. It is a measure of total energy of the moving fluid stream. i.e. both potential and kinetic energy.

Relation between p_s, p_d & p_t

In an incompressible flow, the relation between static, dynamic and total pressures can be found out using a simple device called Pitot tube (named after Henri Pitot in 1732) shown in Figure 1.

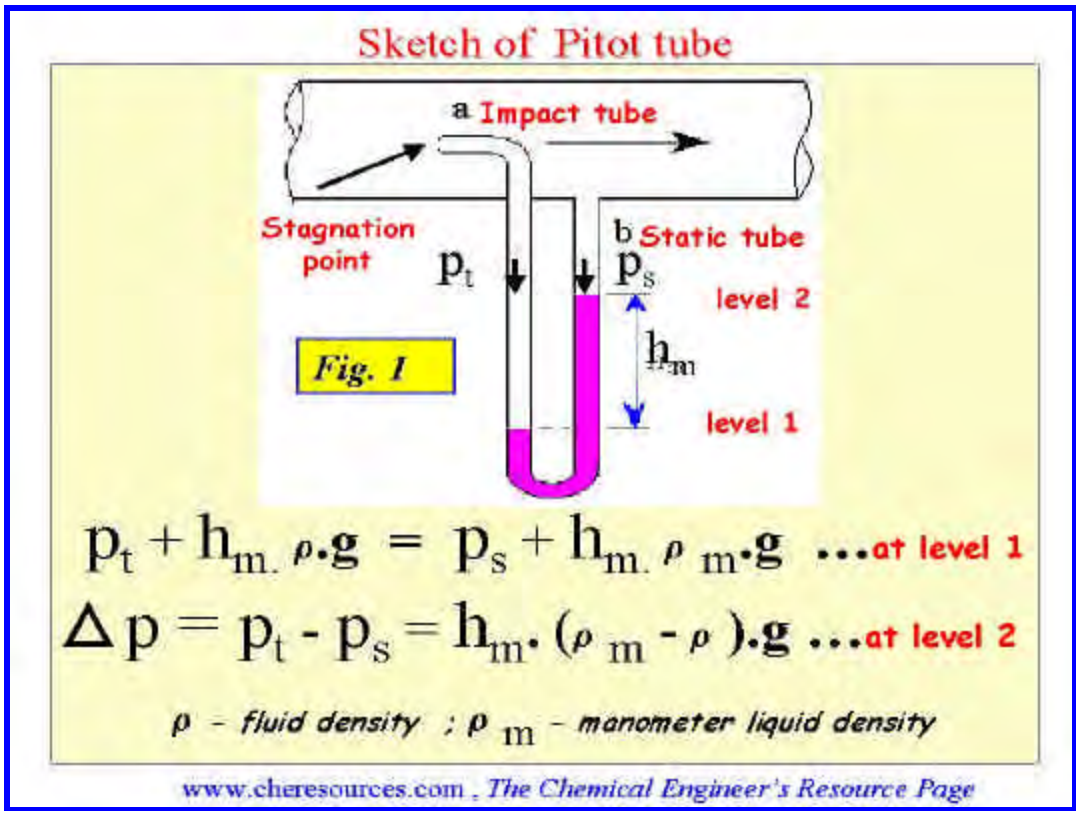

Figure 1: A Simple Sketch of a Pilot Tube

The Pitot tube has two tubes:

1. *Static tube* (b): The opening of the static tube is parallel to the direction of flow. It measures the static pressure, since there is no velocity component perpendicular to its opening.

2. *Impact tube* (a): The opening of the impact tube is perpendicular to the flow direction. The point at the entrance of the impact tube is called as the stagnation point .At this point the kinetic energy of the fluid is converted to the potential energy. Thus, the impact tube measures the total pressure (also referred to as stagnation pressure) i.e. both static pressure and dynamic pressure (also referred to as impact pressure).

The two tubes are connected to the legs of a manometer or equivalent device for measuring pressure.

The relation between p_s, p_d *and* p_t *can be derived by applying a simple energy balance.*

Energy balance equation

Potential energy + Kinetic energy = total energy (constant)

As mentioned earlier, in the case of a fluid or gas the potential energy is represented by the static pressure and the kinetic energy by dynamic pressure. The kinetic energy is a function of the motion of the fluid, and of course it's mass. It is generally more convenient to use the density of the fluid (r) as the mass representation.

$$\therefore \qquad K.E = p_d = \tfrac{1}{2} m v^2 = \tfrac{1}{2} r v^2$$

The corresponding pressure balance equation is

static pressure + dynamic pressure = total pressure

$$\left(p_s + \rho \times \frac{V^2}{2}\right) = p_t$$

In place of the pressure terms as used above, it is more appropriate to speak of the energy during pumping as the energy per unit weight of the liquid pumped and the units of energy expressed this way are foot-pounds per pound (Newton-meters per Newton) or just feet (meters) i.e. the units of head. Thus the energy of the liquid at a given point in flow stream can be expressed in terms of head of liquid in feet.

The pressure term can be converted to head term by division with the factor 'r **g**'. For unit inter-conversions the factor 'r g/g_c' should be used in place of 'r **g**'.

Static pressure head

The head corresponding to the static pressure is called as the static pressure head.

$$\textbf{Static pressure head} = p_s / r\, g$$

Velocity head

The head corresponding to dynamic pressure is called the velocity head.

$$\textbf{Velocity head} = p_d / r\ g = (r\ v^2 / 2) / r\ g = v^2/2g$$

From the reading h_m, of the manometer velocity of flow can be calculated and thus velocity head can be calculated. The pressure difference, dP ($p_t - p_s$) indicated by the manometer is the dynamic pressure.

$$dP = h_m (r_m - r)\, g = r\ v^2 /2$$
$$\textbf{Velocity head} = dP / r\ g = h_m (r_m - r) / r$$

Vapor pressure, p_v

Vapor pressure is the pressure required to keep a liquid in a liquid state. If the pressure applied to the surface of the liquid is not enough to keep the molecules pretty close together, the molecules will be free to separate and roam around as a gas or vapor. The vapor pressure is dependent upon the temperature of the liquid. Higher the temperature, higher will be the vapor pressure.

3. Mechanism of Cavitation

The phenomenon of cavitation is a stepwise process as shown in Figure 2.

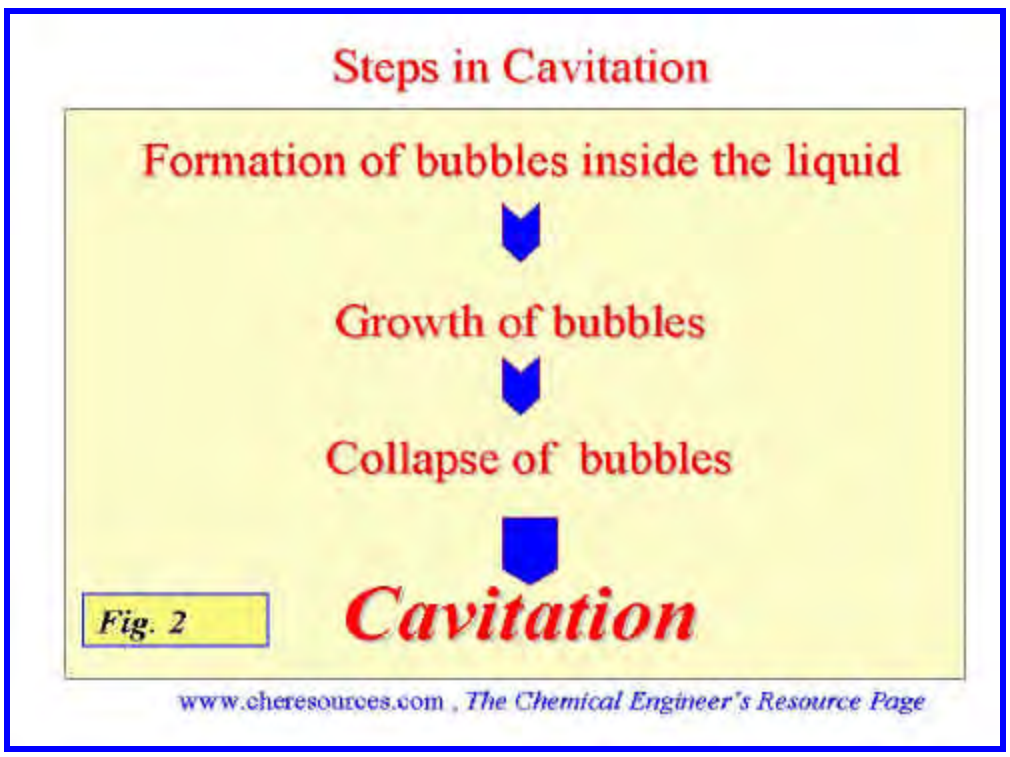

Figure 2: Phenomenon of Cavitation

Step One*, Formation of bubbles inside the liquid being pumped.*

The bubbles form inside the liquid when it vaporises i.e. phase change from liquid to vapor. *But how does vaporization of the liquid occur during a pumping operation?*

Vaporization of any liquid inside a closed container can occur if either pressure on the liquid surface decreases such that it becomes equal to or less than the liquid vapor pressure at the operating temperature, or the temperature of the liquid rises, raising the vapor pressure such that it becomes equal to or greater than the operating pressure at the liquid surface. For example, if water at room temperature (about 77 ^{o}F) is kept in a closed container and the system pressure is reduced to its vapor pressure (about 0.52 psia), the water quickly changes to a vapor. Also, if the operating pressure is to remain constant at about 0.52 psia and the temperature is allowed to rise above 77 ^{o}F, then the water quickly changes to a vapor.

Just like in a closed container, vaporization of the liquid can occur in centrifugal pumps when the local static pressure reduces below that of the vapor pressure of the liquid at the pumping temperature.

NOTE: The vaporisation accomplished by addition of heat or the reduction of static pressure without dynamic action of the liquid is excluded from the definition of cavitation. For the purposes of this article, only pressure variations that cause cavitation shall be explored. Temperature changes must be considered only when dealing with systems that introduce or remove heat from the fluid being pumped.

To understand vaporization, two important points to remember are:

1. We consider only the static pressure and not the total pressure when determining if the system pressure is less than or greater than the liquid vapor pressure. The total pressure is the sum of the static pressure and dynamic pressure (due to velocity).
2. The terms pressure and head have different meanings and they should not be confused. As a convention in this article, the term "pressure" shall be used to understand the concept of cavitation whereas the term "head" shall be used in equations.

<u>Thus, the key concept is - vapor bubbles form due to vaporization of the liquid being pumped when the local static pressure at any point inside the pump becomes equal to or less than the vapor pressure of the liquid at the pumping temperature.</u>

How does pressure reduction occur in a pump system?

The reduction in local static pressure at any point inside the pump can occur under two conditions:

1. The actual pressure drop in the external suction system is greater than that considered during design. As a result, the pressure available at pump suction is not sufficiently high enough to overcome the design pressure drop inside the pump.
2. The actual pressure drop inside the pump is greater than that considered during the pump design.

The mechanism of pressure reduction in the external and internal suction system of a pump system is explored next.

- *Pressure reduction in the external suction system of the pump*

A simple sketch of a pump 'external suction system' is shown in Figure 3.

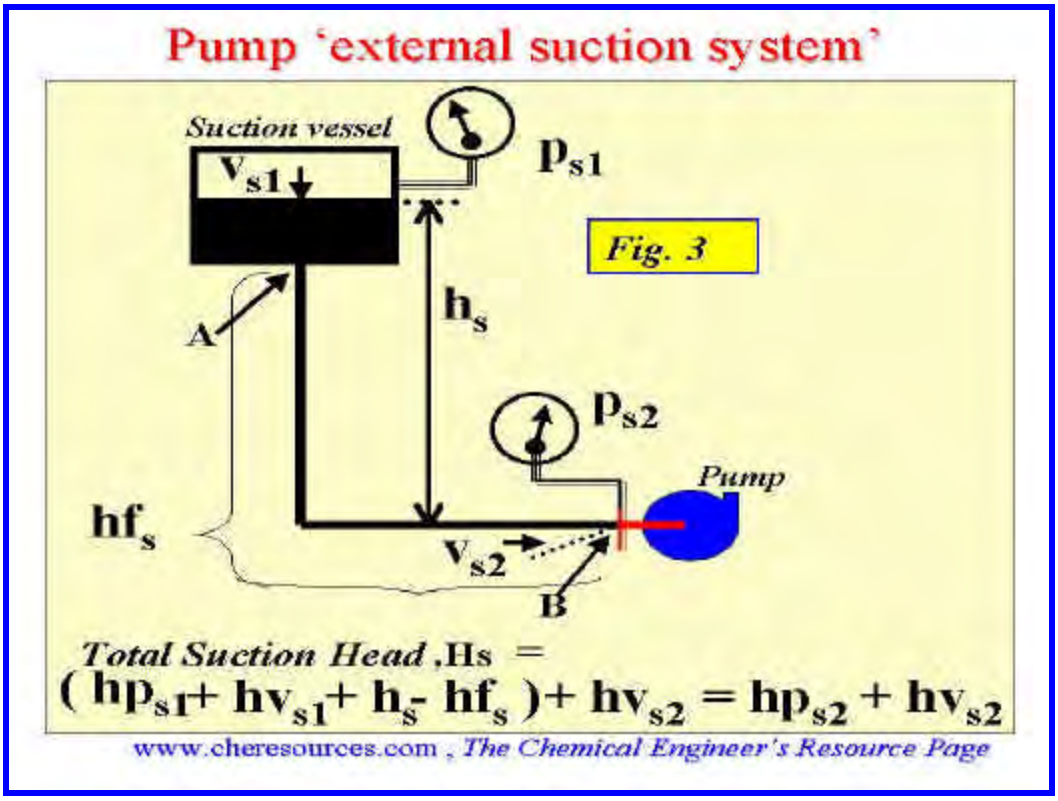

Figure 3: External Suction System

Nomenclature used for Figure 3

- ρ - Liquid density in lb_m / ft^3
- G - Acceleration due to gravity in ft / s^2
- Psn - p refers to local static pressure (absolute). Subscript s refers to suction and subscript n refers to the point of measurement. The pressure at any point can be converted to the head term by division with the factor - *r* g
- p_{s1} - Static pressure (absolute) of the suction vessel in psia
- hp_{s1} - Static pressure head i.e. absolute static pressure on the liquid surface in the suction vessel, converted to feet of head (p_{s1}/ *r* g/g_c). If the system is open, hp_{s1} equals the atmospheric pressure head.
- v_{s1} - Liquid velocity on the surface in the suction vessel in ft/s
- hv_{s1} - Velocity head i.e. the energy of a liquid as a result of its motion at some velocity 'v_{s1}'. (v^2_{s1} / 2g). It is the equivalent head in feet through which the liquid would have to fall to acquire the same velocity, or the head necessary to accelerate the liquid to velocity v_{s1}. In a large suction vessel, the velocity head is practically zero and is typically ignored in calculations.
- h_s - Static suction head. . . . i.e. head resulting from elevation of the liquid relative to the pump centerline. If the liquid level is above pump centerline, h_S is positive. If the liquid level is below pump centerline, h_S is negative. A negative h_S condition is commonly referred to as "suction lift".
- hf_s - Friction head i.e. the head required to overcome the resistance to flow in the pipe, valves and fittings between points A and B, inclusive of the entrance losses at the point of connection of suction piping to the suction vessel (point A in Figure 1). The friction head is dependent upon the size, condition and type of pipe, number and type of fittings, valves, flow rate and the nature of the liquid. The friction head varies as the square of the average velocity of the flowing fluid.
- p_{s2} - Absolute static pressure at the suction flange in psia
- hp_{s2} - Static pressure head at the suction flange i.e. absolute pressure of the liquid at the suction flange, converted to feet of head - p_{s2} / ρ g/g_c
- v_{s2} - Velocity of the moving liquid at the suction flange in ft/s. The pump suction piping is sized such that the velocity at the suction remains low.
- hv_{s2} - Velocity head at suction flange i.e. the energy of a liquid as a result of its motion at average velocity 'v_{s2}' equal to v^2_{s2} / 2g.
- p_v - Absolute vapor pressure of the liquid at operating temperature in psia.
- hp_v - Vapor Pressure head i.e. absolute vapor pressure converted to feet of head (p_v / ρ. g/g_c).
- H_s - Total Suction Head available at the suction flange in ft.

Note: As pressure is measured in absolute, total head is also in absolute.

The pump takes suction from a vessel having a certain liquid level. The vessel can be pressurised (as shown in the Figure 3) or can be at atmospheric pressure or under vacuum.

Calculation of the Total Suction Head, $\mathbf{H_s}$

The external suction system of the pump provides a certain amount of head at the suction flange. This is referred to as Total Suction Head (TSH), H_s.

TSH can be calculated by application of the energy balance. The incompressible liquid can have energy in the form of velocity, pressure or elevation. Energy in various forms is either added to or subtracted from the liquid as it passes through the suction piping. The head term in feet (or meters) is used as an expression of the energy of the liquid at any given point in the flow stream.

As shown in Figure 3, the total suction head, H_s, available at the suction flange is given by the equation,

$$\mathbf{H_s = hp_{s1} + hv_{s1} + h_s - hf_s + hv_{s2}} \qquad \textbf{(1)}$$

For an existing system, Hs can also be calculated from the pressure gauge reading at pump suction flange,

$$\mathbf{H_s = hp_{s2} + hv_{s2}} \qquad \textbf{(2)}$$

Equations 1 and 2 above include the velocity head terms hv_{s1} and hv_{s2}, respectively.

A word about the velocity head term:

There is a lot of confusion as to whether the velocity head terms should be added or subtracted in the head calculations. To avoid any confusion remember the following:

- Just like a static tube of Pitot, a pressure gauge can measure only the static pressure at the point of connection. It does not measure the dynamic pressure as the opening of the gauge impulse pipe is parallel to the direction of flow and there is no velocity component perpendicular to its opening.

In Figure 4 below, flow through a pipe of varying cross section area is shown.

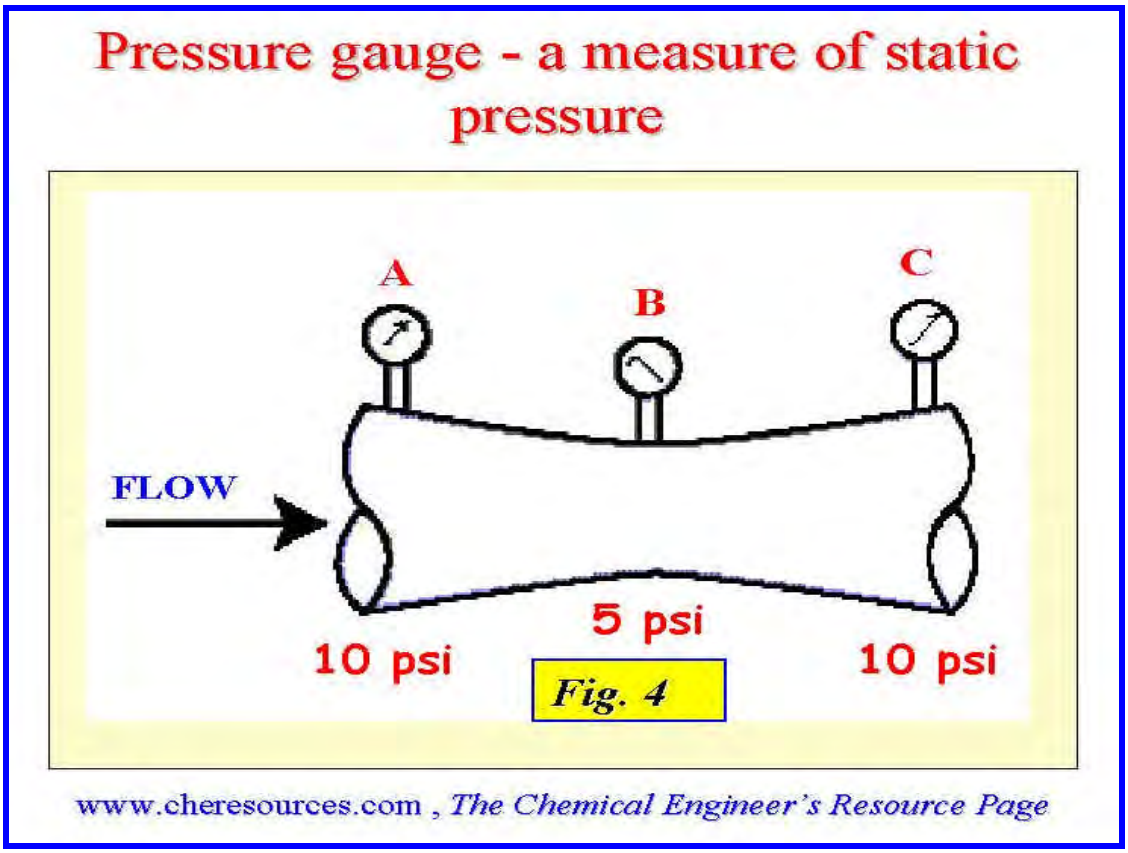

Figure 4: Measuring Static Pressure

As the cross section at point B reduces, the velocity of flow increases. The rise in kinetic energy happens at the expense of potential energy. Assuming that there are no friction losses, the total energy (sum of potential energy and kinetic energy) of fluid at point A, B and C remains constant. The pressure gauges at point A, B and C measure only the potential energy i.e. the static pressures at respective points. The drop in static pressure from 10 psi (point A) to 5 psi (point B) occurs owing to rise the dynamic pressure by 5 psi i.e. increase in velocity at point B. However the gauge at point B records only the static pressure. The velocity decreases from point B to C and the static pressure is recovered again to 10 psi.

- At a particular point of flow, the total pressure is the sum of the static pressure and the dynamic pressure.

Thus, theoretically, the velocity head terms must always be added and not subtracted, in calculating Total Suction Head (TSH), H_s.

However, practically speaking, the value of these terms is not significant in comparison to the other terms in the equation.

- hv_{s1}: In industrial scale suction vessels, the value of hv_{s1} is practically zero and it can be safely ignored.
- hv_{s2}: It is good piping design practice to reduce the friction losses and prevent unnecessary flow turbulence by sizing the suction pipes for fluid velocities in the three to five feet per second range only. The velocity head corresponding to a velocity of 5 ft/s at the suction flange is only about 0.4 ft. Thus, for all practical purposes, in high head systems the velocity head at the suction flange is not significant and can be safely ignored. Only in low head systems does the factor need to be considered.

Therefore, neglecting the velocity head terms, Equations 1 and 2 simplify to:

$$\mathbf{H_s = hp_{s1} + h_s - hf_s} \qquad \textbf{(3)}$$

$$\mathbf{H_s = hp_{s2}} \qquad \textbf{(4)}$$

Two important inferences can be drawn from the above equations:

- The pressure reduction in the external suction system is primarily due to frictional loss in the suction piping (Equation 3).
- For all practical purposes, the total head at the suction flange is the static pressure head at the suction flange (Equation 4).

Therefore the pump's external suction system should be designed such that the static pressure available at the suction flange is always positive and higher than the vapor pressure of the liquid at the pumping temperature.

∴ For no vaporization at pump suction flange,

$$\mathbf{(p_{s2} > p_v) \text{ or } (p_{s2} - p_v) \text{ or } (hp_{s2} - hp_v) > 0} \qquad \textbf{(5)}$$

As the liquid enters the pump, there is a further reduction in the static pressure. If the value of p_{s2} is not sufficiently higher than p_v, at some point inside the pump the static pressure can reduce to the value of p_v. In pumping terminology, the head difference term corresponding to Equation 5 ($hp_{s2} - hp_v$) is called the Net Positive Suction Head or NPSH. The NPSH term shall be explored in detail in the next part of the article. For now, the readers should focus only on how the static pressure within the pump may be reduced to a value lower than that of the liquid vapor pressure.

- *Pressure reduction in the internal suction system of the pump*

The pressure of the fluid at the suction flange is further reduced inside the internal suction system of the pump.

Flow path of fluid inside the pump

The internal suction system is comprised of the pump's suction nozzle and impeller. Figures 5 and 6 depict the internal parts in detail. A closer look at the graphic is a must in understanding the mechanism of pressure drop inside the pump.

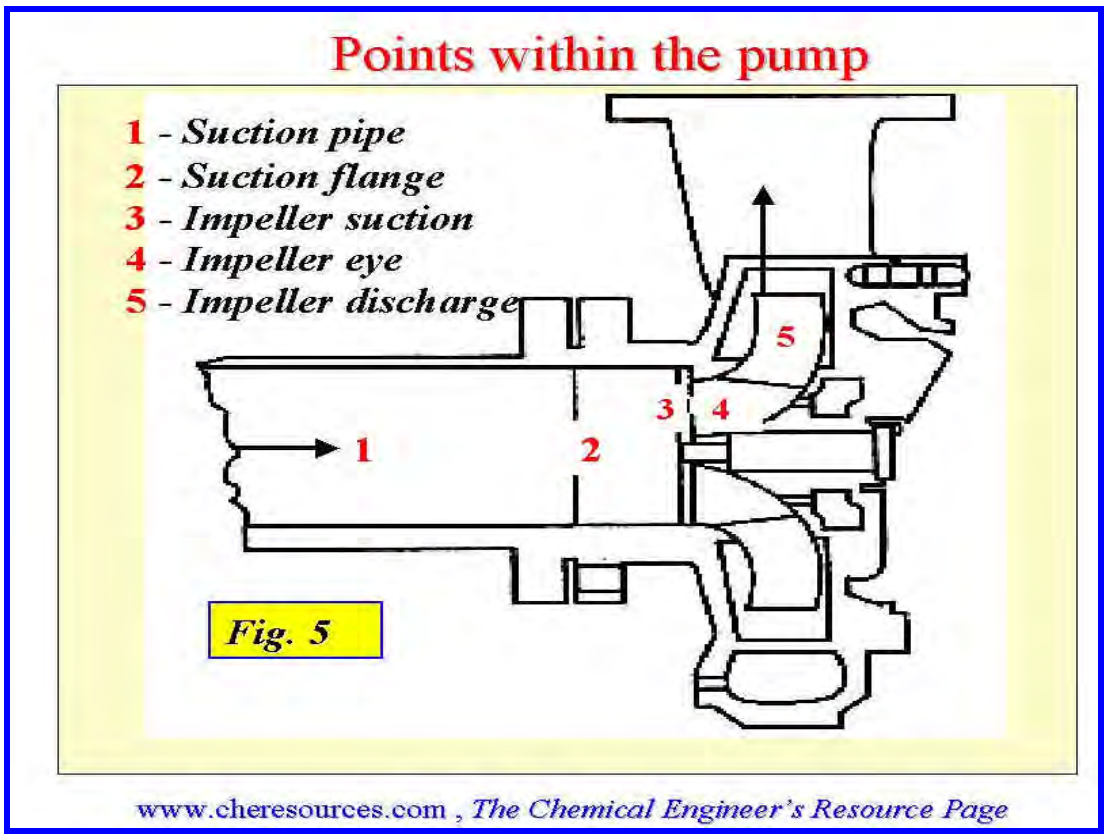

Figure 5: Internal Pump Locations

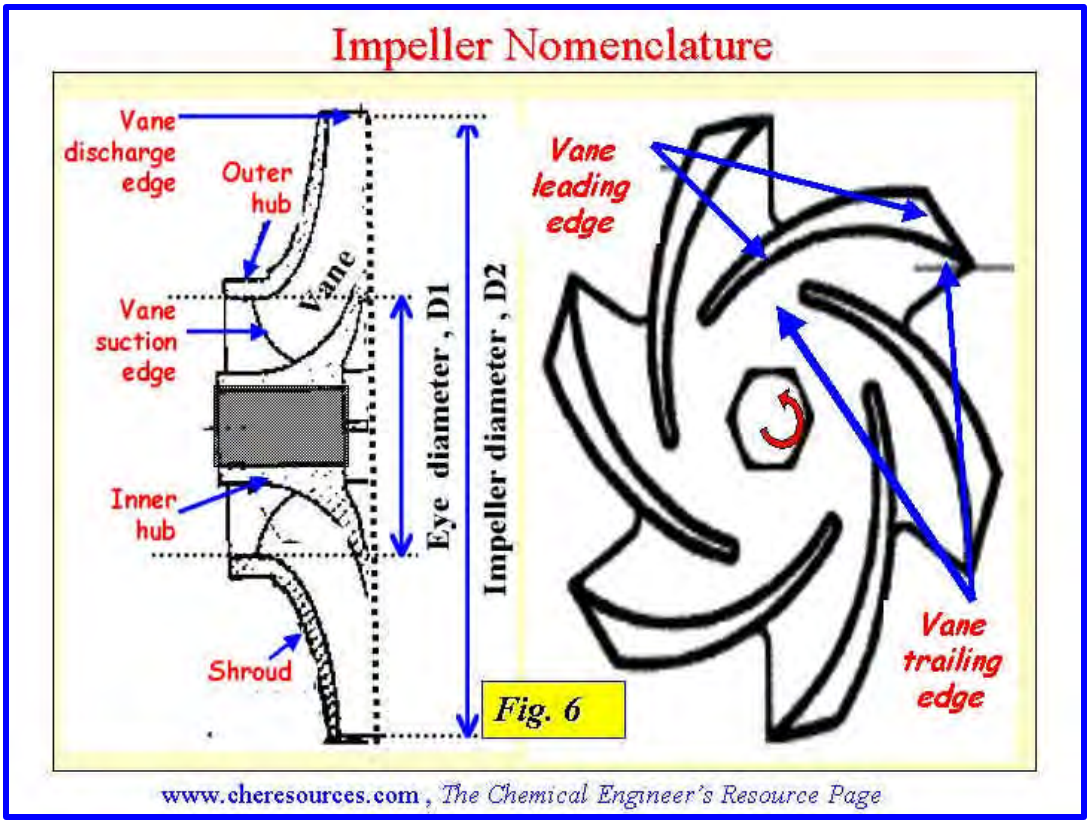

Figure 6: Impeller Nomenclature

In Figure 7, it can be seen that the passage from the suction flange (point 2) to the impeller suction zone (point 3) and to the impeller eye (point 4) acts like a venturi i.e. there is gradual reduction in the cross-section area.

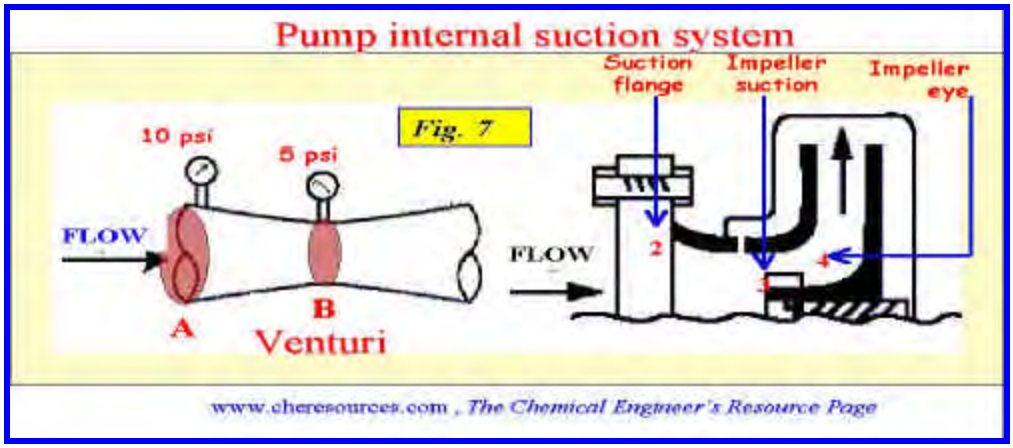

Figure 7: Pump Internal Suction System

In the impeller, the point of minimum radius (r_{eye}) with reference to pump centerline is referred to as the "eye" of the impeller (Figure 8).

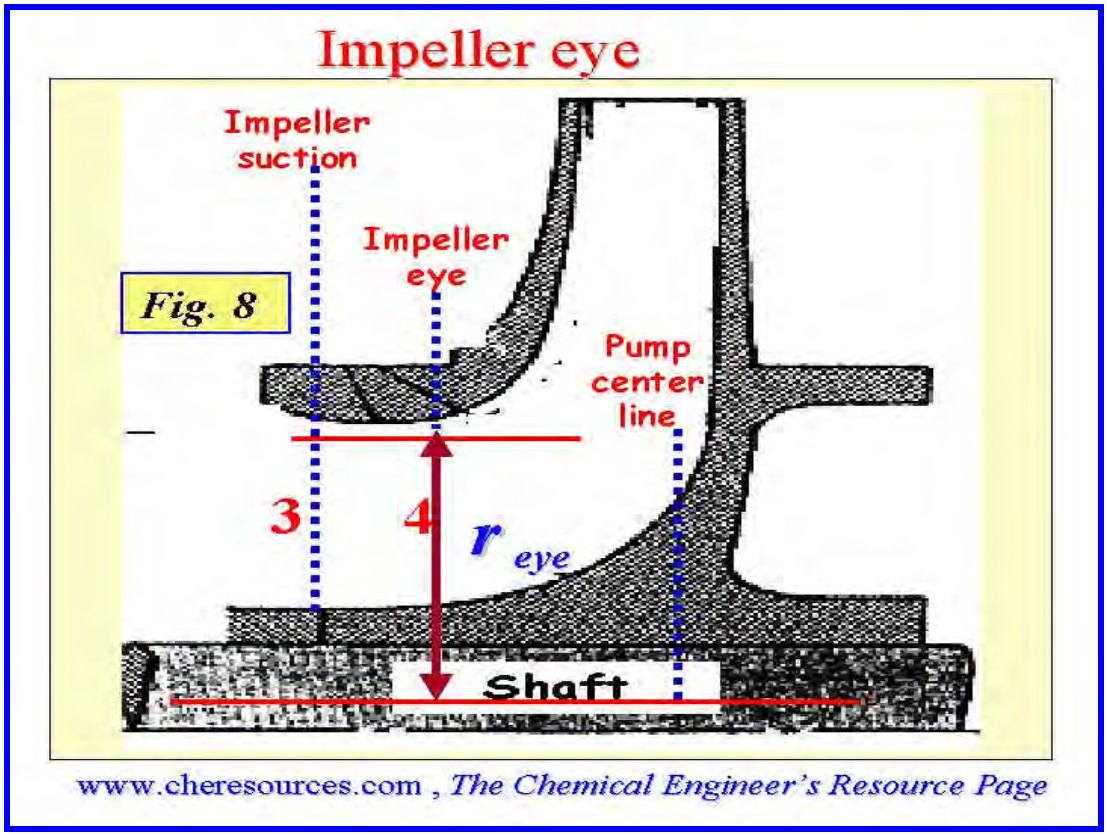

Figure 8: Impeller Eye

How pressure reduction occurs as the fluid flows inside the pump?

According to Bernoulli's principle, when a constant amount of liquid moves through a path of decreasing cross-section area (as in a venturi), the velocity increases and the static pressure decreases. In other words, total system energy i.e. sum of the potential and kinetic energy, remains constant in a flowing system (neglecting friction). The gain in velocity occurs at the expense of pressure. At the point of minimum cross-section, the velocity is at a maximum and the static pressure is at a minimum.

The pressure at the suction flange, p_{s2} (Point 2) decreases as the liquid flows from the suction flange, through the suction nozzle and into the impeller eye. This decrease in pressure occurs not only due to the venturi effect but also due to the friction in the inlet passage. However, the pressure drop due to friction between the suction nozzle and the impeller eye is comparatively small for most pumps. However the pressure reduction due

APPENDIX K: SAND FILTER AND CONTROLS

ULTRA 116(i) AUTOMATIC FILTER CONTROLLER

OPERATOR / OWNER MANUAL

REV – 03/01/2007

Yardney Water Management Systems, Inc.
6666 Box Springs Blvd., Riverside, CA U.S.A.
Phone: (951) 656-67l6 or (800) 854-4788 ●Fax (951) 656-3867
Website: www.yardneyfilters.com ● Email: sales@yardneyfilters.com

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PAGE 9 PRESSURE DIFFERENTIAL OVERRIDE

Yardney
Yardney Water Management Systems, Inc.
6666 Box Springs Blvd., Riverside, CA U.S.A.
Phone: (951) 656-67l6 or (800) 854-4788 ●Fax (951) 656-3867
Website: www.yardneyfilters.com ● Email: sales@yardneyfilters.com

FEATURES:

Thank you for purchasing the Yardney "Ultra" 116 Automatic Filter Controller. Listed below are some important features you should be aware of before you begin programming. Details on how to implement these features are described on the following pages.

- Operational with AC, 12VDC or 12 VDC Battery power.
- Selectable 24 VAC or 12 VDC Solenoid Output Voltage. 12 VDC can be selected as either Continuous or Pulse Output
- Four (4) station base unit expandable to 16 stations with 4-station Plug-In Modules
- Stations can be enabled or disabled by the 4-position dip switches located on the rear of the front panel and on each Plug-In Modules and can be enabled in any combination. (Example: Enabled Stations- 2,5,9 and 15)
- Capability of operating up to two valves per station plus a master valve.
- Periodic Flush and Delay Time Controls
- Actuation from a Pressure Differential (PD) Switch
- Re-settable flush cycle counter
- Manual start and advance function
- Manual stop function
- Elapsed time count since last flush cycle
- Outdoor lockable case (weatherproof NEMA 4X case option available)
- English / Spanish Controls

Yardney Water Management Systems, Inc.
6666 Box Springs Blvd., Riverside, CA U.S.A.
Phone: (951) 656-67l6 or (800) 854-4788 ●Fax (951) 656-3867
Website: www.yardneyfilters.com ● Email: sales@yardneyfilters.com

ELECTRICAL HOOK-UP:

1. To connect wires from power source to controller, follow instructions in A or B below.

A. 110 VAC Power Source

1.) Screw a ½" condulet (customer supplied) to the threaded transformer nipple at bottom of enclosure feeding the transformer leads into condulet.

2.) Install and secure rigid conduit or armored cable as may be required by local electrical codes to condulet routing wires from 110 VAC source into condulet

3.) Connect one wire from power source to black transformer lead and the other to the white transformer lead using approved wire nuts.

4.) To ground controller, connect green transformer lead to grounding wire. Grounding can also be achieved by securing metal conduit to the ½" condulet or by loosening the green screw at the bottom of the case, placing a grounding wire between the head of the screw and the case, and then re-tightening the screw.

B. 12 VDC Power Source

1.) Remove transformer from enclosure by first unscrewing locking nut from threaded nipple that protrudes through opening in bottom of enclosure. Transformer can then be removed from wiring compartment that is accessed by removing the lower panel.

2.) Route two wires from power source through the smallest opening in the bottom of the enclosure using conduit or armored cable as may bee required by local electrical codes.

WARNING: Do not use an alternator as a direct power source. Connecting the wires directly to an alternator or voltage regulator may cause sever damage to the controller and will void the warranty. Always connect the D/C power feed from the D/C battery to the controller.

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3.) Connect wires to battery terminals located to the left of the main terminal strip, taking care to connect positive wire to positive terminal and negative wire to negative terminal.
4.) Controller should be grounded by a.) Securing metal conduit to case or b.) by loosening the green screw at the bottom of the enclosure, slipping a grounding wire between the head of the screw and the enclosure and then re-tightening the screw.

2. Route station wires from solenoid valves through the largest opening in bottom of case. One wire is routed from each valve to the corresponding numbered station terminal. One common wire is connected in parallel with each valve and then to the "COMMON" Terminal.
3. If the master valve is used, connect one wire to the terminal marked "M" and the other to the "COMMON" Terminal.
4. Connect the wires from the Pressure Differential (PD) Switch to the terminals marked "PD" with the black wire connecting to the left terminal (under "P") and the white wire connecting to the right terminal (under "D").

ELECTRICAL INFORMATION

The Model 116 is designed to operate on either AC or 12 VDC power.

AC POWER:	**Input:**	120 VAC or optional 240 VAC, 50 or 60 Hz.
	Output:	Selectable 24 VAC or 12 VDC (continuous or pulse operation). 3 amps maximum output current.
DC POWER:	**Input:**	12 VDC
	Output:	12 VDC (either continuous or pulse operation) CAUTION: Continuous operation on Battery Power Source is allowed, but can drain your battery.
	Power Consumption:	20 milliamps drain on the battery when operating in Pulse mode. 46 milliamps is consumed when a Display Function Switch is depressed. Three (3) amps maximum on continuous output operation are consumed.

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REAR PANEL CONTROLS and SET-UP:

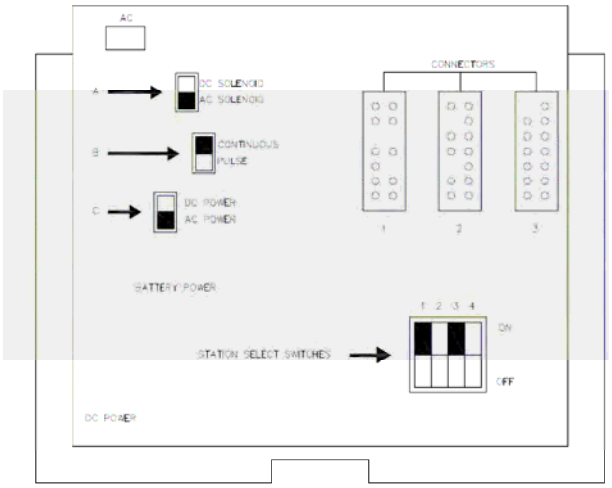
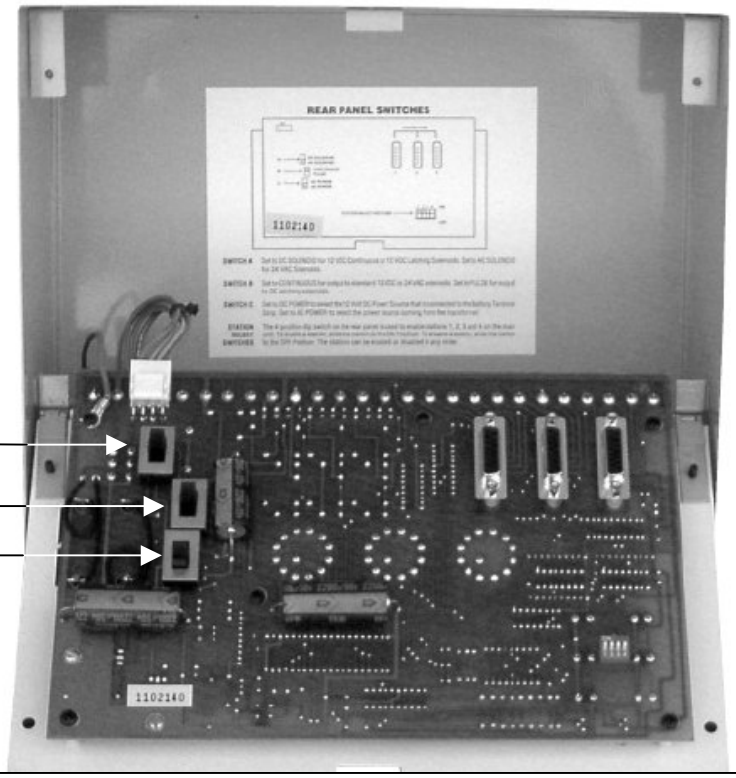


FIGURE 1



POWER SELECT SWITCHES

These switches, located on the rear panel, are to be set by the user at the time of installation to meet input and output power requirements of the system. To gain access to rear panel, first remove bottom panel, then remove upper screws on top panel and swing downward. The switches are identified in the diagram above.

Switch A — Set to **DC SOLENOID** for 12 VDC Continuous or 12 VDC latching Solenoids. Set to **AC SOLENOID** for 24 VAC Solenoids

Switch B — Set to **CONTINUOUS** for output to standard 123 VDC or 24 VAC solenoids. Set to **PULSE** for output to 12 VDC latching solenoids.

Switch C — Set to **D/C POWER** to select the 12 Volt DC Power Source that is connected to the Battery Terminal Strip. Set to **AC POWER** to select the power source coming from the transformer.

*******NOTE*******

With regard to the processor used in the Ultra 116/116i (After 3/07)

If the solenoid switches are set to ***A/C*** and ***PULSE***, (an invalid setting) the circuit breaker will pop. No damage will occur, but the condition must be corrected before the system will operate properly.

STATION SELECT SWITCHES

The 4-position dipswitch on the rear panel is used to enable stations 1, 2, 3 and 4 on the main unit. To enable a station, slide the switch to the ON position. To disable a station, slide the switch to the OFF position. The stations can be enabled or disabled in any order

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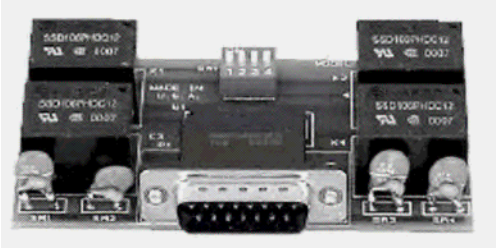
PLUG-IN MODULE:

4-STATION PLUG-IN MODULES

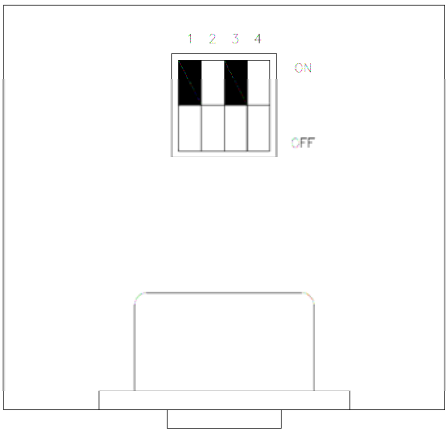


The number of stations can be increased from 4 to 16 in 4 station increments with modules that plug into the rear of the panel. The modules are interchangeable and can be inserted into any module position. Insert a module into connector:
#1 to add stations 5 through 8
#2 to add stations 9 through 12
#3 to add stations 13 through 16

A 4-position dipswitch is located on each module. It is used to enable (ON) or disable (OFF) each of the added stations. Dipswitch positions are numbered 1 through 4 and they correspond to the added stations in ascending order. For example, on a module plugged into connector #2, position 1 corresponds to station 9; position 2 corresponds to station 10, etc.

Enable the stations to be included In the flush cycle by setting to ON The corresponding dip switch positions.

Secure the module in place by using the 4-40 screws on the module plug.



INSTALLATION INSTRUCTIONS

MOUNTING THE CONTROLLER:
The controller is mounted in an outdoor, rain-tight, rust resistant and dust-proof box. To gain access to mounting holes at the rear of the case, first remove the lower access panel. Next, remove the upper screws of the top panel and swing the panel downward. If additional support is desired, a third fastener can be added through a lower hole in the rear of the case.

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PROGRAMMING

TIME CONTROL SETTINGS Rotate the knob to desired setting for each of the following controls:

Periodic Flush: Period between flush cycles (Hours). If this knob is set to OFF, Flush cycles will occur only when activated by the pressure differential switch or by pressing the "MANUAL START" button. If the Periodic Switch is rotated during a Periodic Cycle Interval, the Periodic Time will restart at the beginning of the Periodic Interval.

Flush Duration: Duration of flush for each station (seconds).

Delay: Pause between stations after each flush (seconds).

ON/OFF SWITCH: Set switch to the OFF position to suspend operation. When the switch is returned to ON, three operations will take place.

1.) If the controller is in the Pulse Mode, each station enabled will be pulsed to the Off Position.
2.) The Cycle Count will be reset to zero
3.) Operation will resume at the beginning of a Periodic Cycle.

DISPLAY & LEDS: The display and LED's are used to view information on the current status of the system. The display and LED's will be enabled when the push button switches are depressed. The Display will show "PD" when the Pressure Differential Switch is closed.

PUSH BUTTON SWITCHES: The Push Button Switches are used to display the status of the controller and to perform manual star, advance and stop operations.

Display: Depressing this switch will show the status of the controller. The controller will be in either the Periodic Flush or Delay cycle. One of the three LED's will be lit, indicating which cycle is in process. The number appearing on the display indicates the following:

(CONTINUED ON THE NEXT PAGE)

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PROGRAMMING (CONTINUED)

Periodic Mode: Percent of Periodic Flush interval that has elapsed since the last Flush Cycle. For example, if the Periodic Flush is set at 2 hours, and 75 appears on the display, then 75% of the 2 hours (1 ½ hours) has elapsed since the last flush.

Flush Mode: Station is in progress.

Delay Mode: Station has just completed.

Manual Start: Pressing and holding this switch down for 2 seconds will advance the controller from one cycle to the next. Keeping the switch depressed will allow continuous station advancement every 2 seconds. The Display and LED's will light indicating the controller status.

Manual Stop: Pressing and holding this switch down for 2 seconds will reset the controller to the beginning of the Periodic Mode. If the controller is in the Pulse Mode, each station enabled will also be Pulsed Off in sequence.

Count: Depressing this switch will display a count of the number of Flush cycles (up to 99, the count will start over at 0 if exceeded) since the controller was turned on or since the last manual reset of the count. The count will increment every time a Flush cycle starts. This is initiated by one of the following:

1) Manual Start Operation
2) PD Switch Closure
3) Normal Flush Start

Clear: Depressing the Clear Pushbutton along with the Count Pushbutton will clear the count.

PRESSURE DIFFERENTIAL OVERRIDE

The controller will automatically initiate a Flush Cycle if the "PD" Switch is closed for 30 seconds. During this time, the display will show "Pd"

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OPERATION & INSTALLATION INSTRUCTIONS
INDUSTRIAL IN-LINE FILTRATION SYSTEMS (MULTIPLE TANK)
READ THIS MANUAL TWICE BEFORE INSTALLATION!

GENERAL:

The Yardney **Sand Media Filtration Systems** are designed to remove suspended solids from industrial plant water efficiently and economically.

Water flows, under pressure, through the inlet port of the three-way valve, into the filter vessel and through the deflector assembly to be evenly distributed over the filter media bed. The filter media removes suspended solids and clean water passes through the under-drain to the vessel outlet. Minimum suggested operating of the filter system is 30 PSI.

The filtration mode continues until a sufficient amount of solids have been collected to create a 10 lb. pressure drop across the filter bed. At this time, the filters will be automatically backwashed. During the backwash mode of operation, the three-way valve changes flow direction, shutting off the inlet water to the filter being backwashed. Clean filtered water from the other filters is then processed in the opposite flow direction creating the backwash condition. The water flows in this upward direction lifting and expanding the media, allowing it to release the collected contaminant. The contaminant is then carried away with this backwash water.

1. RECEIVING INSTRUCTIONS

Upon receipt of the filter system, inspect for any visible damage, missing parts, etc. If any damage is noted, advise the freight carrier and Yardney Water Management Systems at once. A damage claim should be filed with the freight company as soon as possible to avoid any unnecessary delays in settlement of the damage claim or installation of the filter system.

2. INSTALLATION

With a few exceptions, Yardney Filter Systems are shipped completely assembled and mounted on a structural steel skid. The larger systems, IL-4824-5 & 6 and IL-5436-5 & 6 are shipped on two (2) separate skids and require minor assembly.

All filter systems must be installed on a level surface that will support the equipment. It is recommended that 1/4" tolerance be the maximum allowed out of level condition. A concrete base with grouting and/or shims under the structural members is generally the best method to obtain the levelness required. The grouting and/or shims should be kept to a minimum for best results.

A minimum of 48" service walkway should be maintained around the filter system to allow for media loading and system servicing.

2. INSTALLATION (CONT.)

The inlet and outlet manifolds are supplied with either a flange or groove ends (for use with groove type couplings). In either case, line connections to the filter system should be the same size as those supplied with the system.

The inlet and outlet manifolds are supplied as standard with fusion epoxy lining and modifications to the manifolds that require welding, cutting, excessive heat, etc., should be avoided as this will burn the epoxy lining.

The backwash line piping is connected to the backwash restrictor valve on the backwash manifold. The backwash line piping should discharge into a floor drain or sump and should not be connected directly to a pressurized drain line.

If it is necessary to run the backwash piping a long distance to a drain, allowance should be made in the size and drainage of pipe to handle total backwash flow without any restriction.

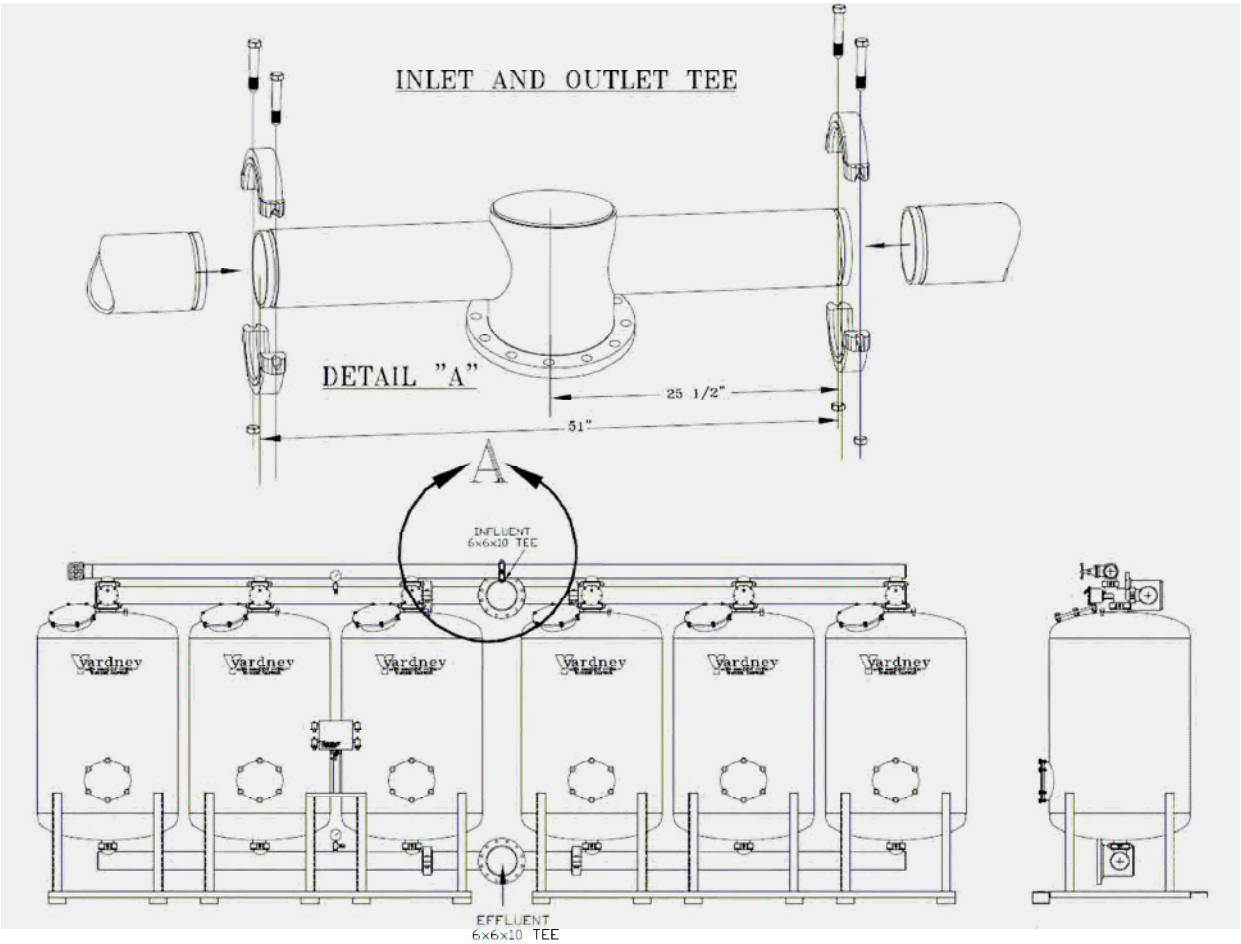
Specific sizes for backwash piping are shown in the chart below.

	BACKWASH FLOW (PER FILTER)	MINIMUM PIPE SIZE
IL-1824	26 GPM	1 1/2”
IL-2424	47 GPM	2”
IL-3024	75 GPM	2”
IL-3624	107 GPM	4”
IL-4824	189 GPM	4”
IL-5424	239 GPM	4”

Restriction of backwash flow from filters to the drain will have an adverse effect on the overall backwashing capability and could lead to inadequate cleaning of the filter during the backwash cycle.

OPERATION & INSTALLATION INSTRUCTIONS
INDUSTRIAL IN-LINE FILTRATION SYSTEMS (MULTIPLE TANK)
READ THIS MANUAL TWICE BEFORE INSTALLATION!

NOTE: Yardney Multi-Media Filter Systems that are supplied on two separate skids require the installation of the inlet and outlet tee and connecting the backwash line prior to connecting to your process. Refer to the illustration below.



3. SAND MEDIA FILTRATION MEDIA LOADING

The sand media filtration system consists of one grade of crushed rock gravel pack and one grade of silica sand media. The quantity of media, type of media and loading sequence can be found in the Filter Tank Loading Table on Page 5.

The media depths should be marked on the outside of the vessel prior to media installation. These depth lines need not be continuous, but must be sufficient to indicate the media levels to installers.

Based upon prior experience, it has been determined that one of the most efficient methods for installation of media is by the use of air conveying equipment. The use of this method is acceptable with one stipulation; the velocity of the air conveyed media must be low enough to avoid a sandblasting effect. The internal lining on the vessel will not stand up to high velocities of air conveyed media. If air-conveying equipment is not available, the media should be installed by hand loading of media bags.

THE CRUSHED ROCK MUST BE THOROUGHLY WASHED PRIOR TO LOADING INTO THE FILTER. FAILURE TO WASH THE CRUSHED ROCK COULD LEAD TO COMPROMISED FILTER PERFORMANCE AND A FOULED UNDERDRAIN.

NOTE: Installers should wear appropriate dust masks when working inside the vessel during media installation and should comply with confined space regulations.

Once the crushed rock has been installed and packed around the collection laterals, it should be raked moderately level. The succeeding layers of media should now be installed.

Remove all foreign material from the filter vessel. Clean all sealing surfaces of the manway. Chipping of the vessel lining may occur unless the sealing surfaces are free of sand, grit, etc. Close the manway.

REFER TO PAGE 5 FOR MEDIA REQUIREMENTS.

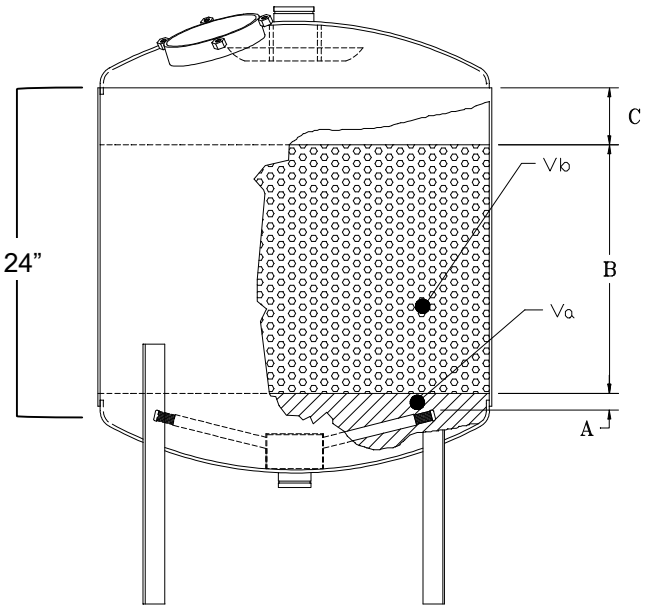
OPERATION & INSTALLATION INSTRUCTIONS

INDUSTRIAL IN-LINE FILTRATION SYSTEMS (MULTIPLE TANK)

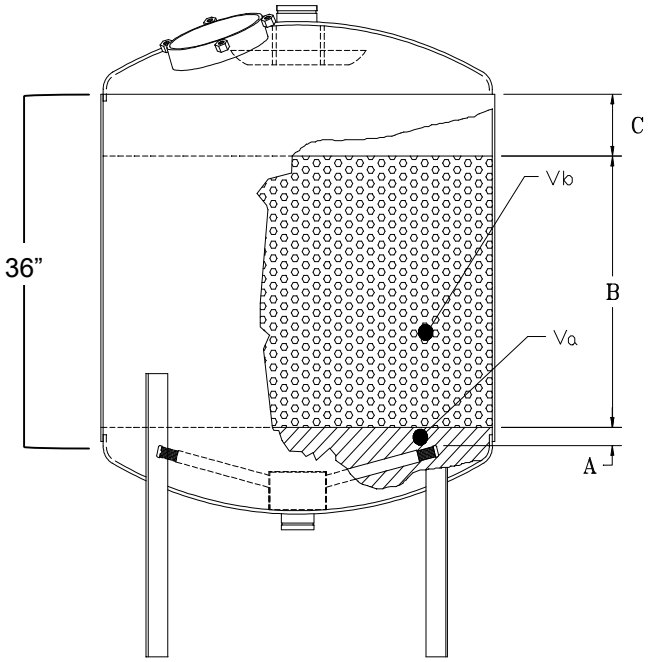
READ THIS MANUAL TWICE BEFORE INSTALLATION!

FILTER TANK LOADING TABLE

24” Deep Tank Sideshell



36” Deep Tank Sideshell



24" DEEP BED SIDESHELL

FILTER DIAMETER (INCHES)	1/2" TO 3/4" CRUSHED ROCK		MEDIA		C
	A (INCHES)	Va (CUBIC FT.)	B (INCHES)	Vb (CUBIC FT.)	INCHES
18	2	1.0	17.0	2.5	3
24	2	1.5	17.5	4.5	3
30	2	2.5	17.5	10.0	3
36	2	4.0	17.0	10.0	3
48	2	7.0	20.0	21.0	3

36" DEEP BED SIDESHELL

FILTER DIAMETER (INCHES)	1/2" TO 3/4" CRUSHED ROCK		MEDIA		C
	A (INCHES)	Va (CUBIC FT.)	B (INCHES)	Vb (CUBIC FT.)	INCHES
18	2	1.0	29.0	4.5	3
24	2	1.5	29.5	7.5	3
30	2	2.5	29.5	12.0	3
36	2	4.0	29.0	17.0	3
48	2	7.0	32.0	33.5	C

NOTE: ALL DIMENSIONS AND VOLUMES ARE APPROXIMATE

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4. INITIAL MEDIA CLEANSING

Despite cleaning of the media prior to packaging, a certain amount of "fines" will be present in the media supplied. Serious operational problems could result if these "fines" remain in the filter during operation. Thus, it is necessary to clean the media prior to operating the filter system.

In order to accomplish this the filter should be filled with water. This water should be as clean as possible. The media should now soak for 6 - 12 hours.

The media should be backwashed after the soaking period using the sequence designed for this filter system as outlined on Page 11. It is recommended that the backwash operation be performed using the manual mode of operation. By using the manual mode the operator will become familiar with the filter system and will also be able to spot any potential operational problems prior to actual automatic operation of the filter system. The filter should be cleaned until such time as the backwash water becomes clear. Filling a glass container with the water as it exits the filter can make a quick check of the backwash water. The container should not have any sedimentation at the bottom after the water has settled.

Refer to Page 11 for backwash instructions used for this procedure.

5. ROUTINE MEDIA CLEANINGTHROUGH AUTOMATIC BACKWASHING

The filter media should be backwashed on a routine basis. The length of the filtering cycle between cleaning sequences is dependent upon the application. Typical filtering cycles are in the 12-24 hour range, however, some applications allow for a much longer cycle; in some cases, shorter cycles.

The condition that determines the length of the filtering cycle before the backwashing is required is the media bed differential pressure. The differential pressure may be determined by reading the influent and effluent pressure gauges. Subtract the effluent pressure gauge reading from the influent pressure gauge reading. The difference is the media bed differential pressure. The filter system should be cleaned when the differential pressure reaches approximately 10 PSID -- more than the clean filter pressure differential.

It is recommended that a filter be cleaned at least once a day regardless of the application or differential pressure. The cleaning sequence of a filter system varies from one step (for simple systems) to as many as 20 steps (for more complex systems). If the filter system is comprised of several filters, the number of filters would multiply the cleaning sequence steps. However, regardless of the complexity of the cleaning sequence, reversing the water flow inside the filter vessel cleans all filters.

5. ROUTINE MEDIA CLEANING THROUGH BACKWASHING (CONT'D)

In a simple cleaning sequence, valve manipulation will occur in one step. While in a complex cleaning sequence, the valve manipulation will occur over a period of several minutes and several valve sequences. In the case of the multiple unit filter system, a slight delay between stations is recommended to minimize water surges within the filter system

6. OPERATION SEQUENCE

Regardless of the number of filter tanks, the operational sequence for each unit is identical, therefore; only one sequence example is explained (Standard 3-way valve sequence).

On Line - The Influent/backwash valve open to the influent position, the online timer controls the duration.
(Time between flushes is set as required.)

Backwash- Influent is closed; the backwash is open to the backwash position. The backwash timer controls the duration. Initial setting should be approximately 3 minutes.

7. CLEANING CYCLE CONTROLLER SETTINGS

Refer to separate manual for operation of the automatic backwash controller.

Various types of controllers may be supplied with filter systems to control the duration of the various steps in the backwash cleaning cycle sequence. As a general rule, timer settings are recommendations only. The settings that should be observed for proper filter system start-up are as follows:

Backwash Duration	180 seconds
Delay between filter vessels	10 seconds
D/P Delay	30 seconds

All other timer settings should be determined on-site based upon dirt load, etc. (with regard to adjustable valves)

8. INITIATION OF THE CLEANING SEQUENCE

The cleaning sequence may be initiated by one of the following initiation events: the filter cycle timer, the pressure differential override or the manual override. Generally, the filter cycle timer is the primary initiation source, while the pressure and manual override are secondary initiation sources. In all cases, the automatic controls will accept the first initiation signal. Any subsequent signals will not have any effect on the controls until such time as the cleaning sequence has been completed. Each of the cleaning initiation sources is explained individually below.

9. FILTER CYCLE TIMER

The filter cycle timer is generally referred to as the periodic start timer. When the timer reaches its elapsed time setting, a signal is sent to the controlling component to begin a cleaning sequence.

As stated above, this timer is generally the primary initiation source and its set time should be adjusted as required so that it remains the primary source.

10. AUTOMATED MODE

The filter system may be cleaned in either of two modes, automated or manual. With the automatic controls in the automated mode, the filter system is capable of completely unattended operation. However, if the case arises, the system may be operated manually to initiate the back-flush sequence.

11. FILTER CYCLE LENGTH

The filter cycle time is the period of elapsed time between cleaning of the filters(s). The periodic start timer controls this period of time.

The optimum cycle length is critical to the proper and efficient operation of the filter system. If the cycle length is too long, the filter media will become excessively dirty, resulting in pressure differential initiated backwash sequences. On the other hand, an insufficient cycle length will result in too frequent backwashes and inefficient use of the filter. Due to these factors, the cycle length must be determined on site under actual operating conditions.

The filter cycle controlled by the periodic flush timer should be adjusted as stated above until the optimum cycle length has been determined. In some applications the cycle length will vary depending upon actual operating conditions, such as the time of year, the amounts of solids in the influent water, etc.

12. BACKWASH VALVE AIR SUPPLY

The filters are designed to use industrial air pressure for backwash valve actuation. A pressure regulator and gauge assembly should be used prior to connecting the air supply to the solenoid valves. Once the system has been put on-line the air supply can be regulated for proper backwash valve opening. The backwash valves should open into the backwash position with minimal noise and hammer.

The air supply requirement varies with the size of the filters and the pressure at which the filters will operate. The IL 36", IL 48", and IL 54" require the air supply to the backwash valves to be at least 75% of the system operation pressure.

The air supply required to operate the valves on the IL 18", IL 24" and IL 30" is approximately one-half of the system's operating pressure. In all cases, the air supply to the regulator should exceed the air supply requirements for the backwash valves.

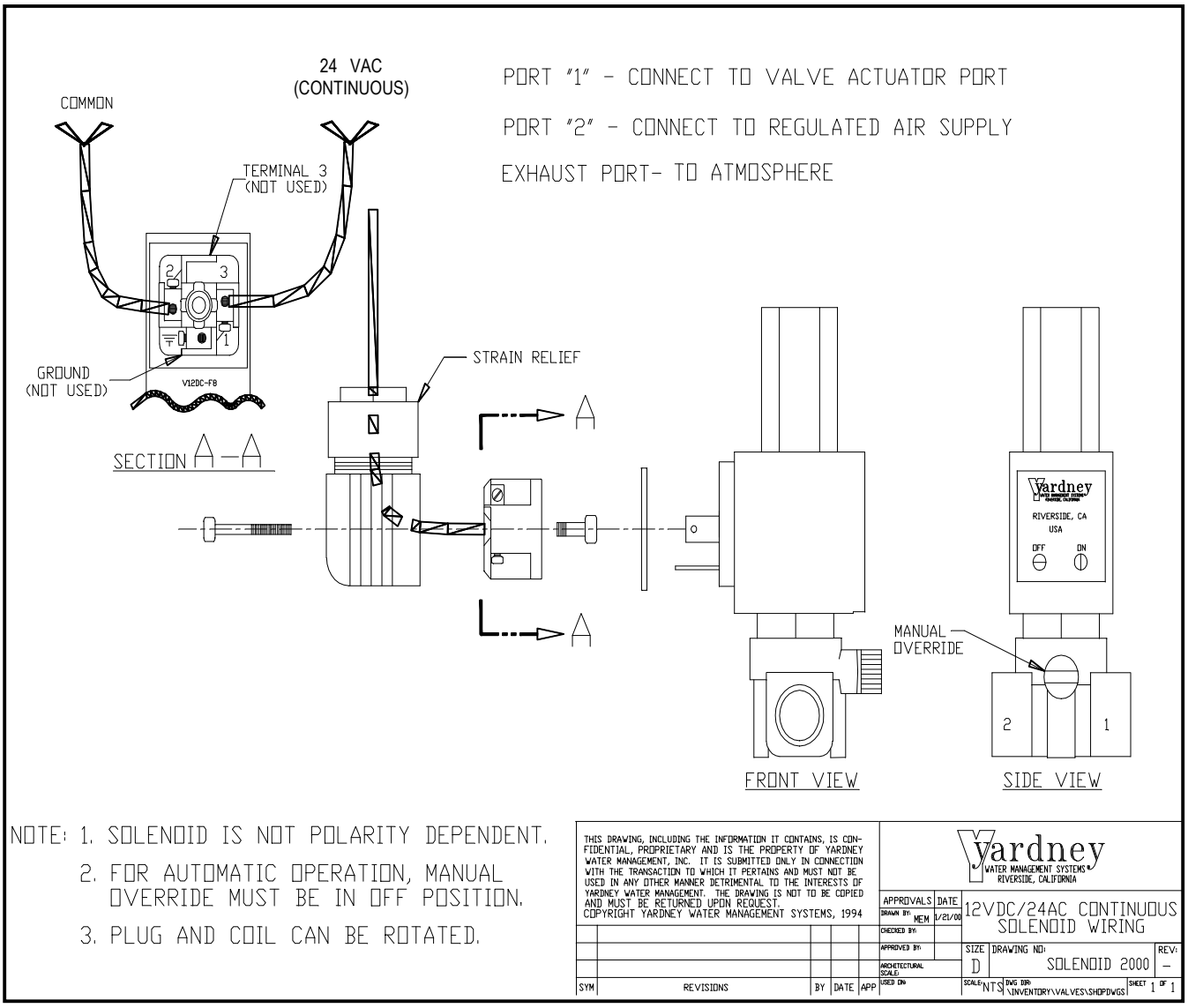
The air supply is routed through a 24 VAC normally closed solenoid valve. One solenoid valve is supplied for each backwash valve.

The solenoids are mounted on the backwash control box and pre-wired at the factory.

On the larger systems, IL-4824-5&6 through IL-4836-5&6, it will be necessary to install the supply tubing from the solenoid valves to the backwash valves. The tubing is pre-cut and numbered to correspond with the respective backwash valve.

The solenoid valves are supplied with manual override. In the event the electrical supply to the backwash controller is interrupted, the filters can be backwashed by using the manual operator. Turning the thumb screw located on the base of the solenoid valve to the "ON" position will change the position of the solenoid plunger, thus allowing air pressure to open the backwash valve. The filter can now be backwashed.

To terminate the backwash, the manual operator should be turned to the "OFF" position.



NOTE: 1. SOLENOID IS NOT POLARITY DEPENDENT.
2. FOR AUTOMATIC OPERATION, MANUAL OVERRIDE MUST BE IN OFF POSITION.
3. PLUG AND COIL CAN BE ROTATED.

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SYM	REVISIONS	BY	DATE	APP

Yardney WATER MANAGEMENT SYSTEMS RIVERSIDE, CALIFORNIA

APPROVALS		DATE
DRAWN BY:	MEM	1/21/00
CHECKED BY:		
APPROVED BY:		
ARCHITECTURAL SCALE:		
USED ON:		

12VDC/24AC CONTINUOUS SOLENOID WIRING

SIZE	DRAWING NO:	REV:
D	SOLENOID 2000	–

SCALE: NTS DWG DIR: \INVENTORY\VALVES\SHOPDWGS SHEET 1 OF 1

13. SYSTEM START-UP

The following start-up sequence can be used for the starting up of both automatic and manual backwash filter systems. In the event that the filter system is supplied with manual backwash valves, then the manual backwash valve operator supplied with the system must be used for opening and closing the backwash valves.

NOTE: First time start-up should be done with caution. All air must be purged out of all lines and filters. Valves and pumps must be opened slowly to prevent damage to filters and related equipment.

1. Start the system in the manual mode with the controller in the "OFF" position and with the backwash restriction valve in the 1/4 open position. Introduce water into the filter system, filling lines and tanks slowly.

2. When approximately 10 PSI is reached, turn manual override knob on solenoid on tank #1 to the "ON" position for 1 to 2 minutes. Turn tank #1 "OFF" and repeat the procedure on tank #2, etc -- this is done to purge entrapped air from the tanks.

3. When 50% of the system pressure is attained, repeat the manual flush cycle to again purge the entrapped air.

4. When 100% of the system pressure is reached, or after 15 minutes of operation, repeat the flush cycle allowing 3 minutes flush per tank.

5. With the manual override knob in the "OFF" position, turn the flush controller "ON." Set 180 seconds on the flush duration of the controller and 0 seconds on the delay time. Push manual start button and the system should go through an automatic flush cycle.

6. Set the pressure differential switch pointer/contact to 10 PSI over the clean filter pressure differential. (Example: Clean filter pressure differential of 5 PSI + 10 PSI = 15 PSI pressure differential switch setting.)

7. The automatic controller should be set so that the frequency of filter backwashing corresponds with the build up of pressure drop to the established dirty filter pressure differential set point. Establishing the time frequency of flush may require several days of monitoring to determine the proper setting. (Example: If it takes 6 hours of operation to reach the dirty filter pressure switch setting of 15 PSI, the backwash frequency should be set at 6 hours on the controller).

13. SYSTEM START-UP (CONT.)

8. The backwash restrictor valve adjustment - A critical factor to successful media filtration operation!!!

a) Open the backwash restrictor control valve approximately 25%. (1 to 1-1/2 turns depending upon valve brand.)
b) Be sure that all air is purged from each tank by partially opening and closing each tank flush valve.
c) Before proceeding with backwash adjustments, the pump must be run long enough to fill the entire system at the designed operating pressure and flow.
d) Using the manual override on the solenoid valve, manually initiate a flush on one tank. This changes that tank from the filtering mode to backwash. (See page 10)
e) By the use of a screen, your hand, or a sampling device, monitor the contents of the backwash water.
f) Gradually open the backwash restrictor valve until a small amount of filter media appears in the backwash water.
g) When media begins to show in the backwash water, close the backwash flow control valve until the water is essentially clear of media. A trace of media is acceptable since it is desirable that the lighter granules (fines) in the media bed be allowed to wash out. After completing the above adjustments, all tanks should be backwashed extensively (3 to 5 minutes each) to remove contaminants and fine material usually found in newly installed media.

IMPORTANT NOTE:

1. If at a later time, you make any significant changes in pressure or flow, the above adjustments should be rechecked.
2. We recommend backwashing at 10 PSI above clean filter pressure differential.

14. OPERATION OF THE AUTOMATIC CONTROLS

This Yardney Sand-Media Filter is equipped with a Yardney Ultra 116i solid-state controller. The controller requires 115 VAC power input to the controller and provides 24 VAC output to activate standard 24 VAC solenoids on the filter valves. (Instructions for the Yardney Ultra 116 controller are included inside the locked controller box.)

1. Power Switch:	Turns controller unit on or off.
2. Periodic Flush Dial:	Sets the amount of time between normal flushing cycles.
3. Flush Dial:	Sets the amount of time in seconds the filter solenoid valve will be activated or the length of flush at each filter valve station.
4. Dwell Time Dial:	Sets the delay time between the closing of one filter valve and the opening of the other valve.

(Continued on page 13)

14. OPERATION OF THE AUTOMATIC CONTROLS (CONT'D)

5. Pressure differential switch will override the timer and initiate a flush. This will set the interval hour count to zero.

15. INITIAL SETTINGS FOR THE AUTOMATIC CONTROLS

15.1

Periodic Flush: During start-up, the filters should be backflushed every two hours. After observing how quickly the filters load up, the interval between backflush can be increased to as long as once every 24 hours depending on the amount of contaminant accumulation. We recommend backflushing when the filter shows a 10-PSI (net of clean filter differential pressure) pressure differential between the inlet and outlet pressure gauges.

15.2

Flush Duration - Seconds Setting: During start-up and initial operation, the backflush duration should be set for 2-1/2 - 3 minutes. The minimum backwash duration should be set at 2 minutes.

15.3

Delay - Seconds Setting: The dwell should be adjusted to allow an overlapping of the backwash valves. The next valve in sequence should start to open a few seconds before the preceding valve closes. If the valve shuts off completely prior to the opening of the next valve, water hammer may occur.

16. PRESSURE DIFFERENTIAL

A pressure differential switch is connected electrically to the controller terminals marked "P.D." When the pressure drop reaches the setting set on this gauge, the switch will override the "periodic hour" setting and initiate a flush cycle. This is to protect the system from loading up with particulate prior to the setting for periodic backwash set on the controller. A flush cycle initiated by the pressure differential switch is treated like a regular flush cycle and will zero the elapsed time elapsed so that the correct periodic flush setting will initiate the next flush cycle.

EXAMPLE: If the interval setting is for 12 hours and the P.D. switch initiates a flush cycle 6 hours into this setting, the next scheduled flush cycle will be 12 hours later. This eliminates doubling-up backflush events.

OPERATING TROUBLESHOOTING GUIDE

A. POOR FILTRATION

DESCRIPTION	SOLUTION
1. Wrong media.	1. Addition of correct media or media replacement.
2. High-pressure differential forcing contaminants.	2. More frequent back flushes and/or readjustment of the backwash control valve.
3. Filter media low causing contaminants to pass through.	3. Addition of media to the correct level.

B. CONSTANT HIGH PRESSURE DIFFERENTIAL

DESCRIPTION	SOLUTION
1. Filter media low causing inadequate backflush.	1. Addition of media to correct level.
2. Filter sealed over -- not enough water available through filter for backflush.	2. Removal of covers and removal of the top layer of dirt from filter media. Replace covers and flush tanks for short intervals until clean. Readjust the backflush flow control valve.
3. Insufficient backflush flow.	3. **Readjust the backflush control valve. (Section 13:8 on page 12 System Start-Up)**.

C. BACKWASH VALVE LEAKAGE CAUSE

DESCRIPTION	SOLUTION
1. Obstruction in the valve seat area.	1. Remove obstruction.
2. Valve seat element worn.	2. Replace.

D. AIR HAMMER

DESCRIPTION	SOLUTION
1. Backflush line causing vacuum.	1. Install a vacuum breaker on the backwash manifold.

E. FREQUENCY OF BACKFLUSH INCREASING

DESCRIPTION	SOLUTION
1. Improper backflush flow rate or improper duration of backflush.	1. Increase backflush flow rate and/or the length of backflush time. (Reference Section 14 Page 12 - "Auto Controls")
2. Low filter bed.	2. Addition of media to the correct level.
3. Dirtier water.	3. Greater filter capacity required.

RECOMMENDED SPARE PARTS

		Part Number
1.	**Electrical**	
	Solenoid valve 24 VAC	166002460
	Pressure differential switch 0 – 20 PSI	166070020
2.	**Gauges**	
	0-100 PSI glycerin filled, SS body	144025100
3.	**Valves**	
	Urethane seal 342C valve	136070300
	For filter size IL-24, 30	
	Urethane seal 434D valve	136070400
	For filter size IL-36, 48, 54	
	O-rings (2 per valve) 342C and 454D	141006087
	Back-up rings (4 per valve) 342C, 454D	141090063
	Diaphragm (1 per valve) 342C	136090354
	Diaphragm (1 per valve) 454D	136090454
4.	**Gaskets for Grooved Couplings**	
	2" for filter size IL-24	108560200
	3" for filter size IL-18, 24, 30	108560300
	4" for filter size IL-24, 30, 36, 48, 54	108560400
	5" for filter size IL-36, 48, 54	108560500
	6" for filter size IL-48, 54	108560600
5.	**Lid Gaskets**	
	Side Manway -- 9-3/4" x 7-3/4"	142023036
	For filter size IL-24, 30	
	Side Manway -- 14-1/4"OD	140031114
	For filter size IL-36, 48, 54	
	Top Manway -- 7-5/16" x 5-1/8"	142022400
	For filter size IL-24	
	Top Manway -- 9-3/4" x 7-3/4"	142023036
	For filter size IL-30, 36	
	Top Manway -- 14-1/4" OD	140031114
	For filter size IL-48, 54	
6.	**Filtration Media**	
	1/2" - 3/4" crushed rock	148055075
	.47 mm crushed Silica Sand	148020047

Other medias are available as may be required. Consult the factory.

MEDIA FILTER PREVENTATIVE MAINTENANCE SCHEDULE

The following is a schedule for start-up and operational preventative maintenance. The format is a simple one that can be adapted to all forms of filtration and even to other industrial equipment. The chart should be located in an accessible, but protected, location on the filter pad. The responsible individual should be instructed to date and sign the respective block after each task is performed.

	Seasonal start up	Seasonal shut down	Daily	Weekly	Bi-Monthly	Monthly	Quarterly
Check media depth		x					x
Inspect all poly line connections.	x						
Inspect elec.con. & control box seals.		x					x
Lubricate backwash valves.	x						x
Inspect inner valve components (seals, diaphram & shaft.)		x					
Check coupling gaskets for leaks.	x			x			
Check system pressure diff.	x		x				
Adjust backwash flow rate.	x						x
Check flowmeter to assure proper flow rate.	x			x			
Mon.duration of flush cycle.	x				x		
Evaluate seasonal water quality fluctuations						x	
Service down stream strainer		x					x
Chlorine shock treatment.	x						x

TROUBLE SHOOTING MEDIA FILTERS

PROBLEM: POOR FILTRATION

Probable Cause	Solution
1. Excessive flow through filters, causing coning of media and/or forcing contaminants through filter to outlet.	1. Reduce flow rate or add filter unit(s). See manufacturer for recommended flow range.
2. Air in filter(s) causing disruption of media bed.	2. Install auto or manual air bleed device.
3. Incorrect media in filtration system.	3. Replace with proper media. See manufacturer for recommended media.
4. Excessively high pressure forcing contaminates through filters.	4. Readjust backwash control valve and timers.
5. Insufficient depth of media, which allows contaminates to pass through system.	5. Add media to achieve proper depth.

PROBLEM: CONSISTENTLY HIGH PRESSURE DIFFERENTIAL

Probable Cause	Solution
1. Filter sealed over with contaminates restricting backwash flow.	1. Open tanks and skim away any excess or caked contaminates from the media sand beds surface. Return tanks to normal service.Backwash each tank until backwash flow runs clean.
2. Insufficient backwash flow.	2. Readjust backwash flow or partially close effluent valve.
3. Filter media low causing inadequate backwash.	3. Addition of media to correct level.

PROBLEM: MEDIA SAND APPEARS DOWNSTREAM

Probable Cause	Solution
1. Incorrect media sand (i.e. too fine).	1. Replace with proper media sand. See manufacturers recommendations.
2. Broken or damaged underdrain.	2. Repair or replace.

PROBLEM: BACKWASH VALVE(S) LEAK

Probable Cause	Solution
1. Obstruction in valve seat.	1. Remove obstruction.
2. Rubber seating disk is worn or damaged.	2. Replace seat disk.
3. Diaphragm damaged (leaking from port of diaphragm chamber at rear of valve).	3. Replace diaphragm.
4. Pinched or worn O-Ring.	4. Replace O-Ring and lubricate shaft.

PROBLEM: WATER HAMMER

Probable Cause	Solution
1. Air in tanks.	1. Bleed off trapped air. See startup instructions. Check also for leaks in pump suction line. An air bleed at filter inlet may also help.
2. Long backwash line causing vacuum.	2. Install vacuum breaker on backwash line.

PROBLEM: INCREASING FREQUENCY OF BACKWASH CYCLE

Probable Cause	Solution
1. Backwash flow or duration is not adequate to flush filter tanks of all contaminates.	1. Readjust backwash flow and/or increase duration of backwash cycle.
2. Insufficient media depth.	2. Add media to achieve proper depth.
3. Increased concentration of contaminants in water supply. (Note: May only be a seasonal problem.)	3. Add extra filter tank(s) to system or reduce flow rate.

PROBLEM: AUTOMATIC BACKWASH FAILS TO CYCLE

Probable Cause	Solution
1. Controller power off, blown fuse or circuit breaker tripped.	1. Turn power on. Be sure wiring is connected. Reset circuit breaker or install new fuse.
2. Improper setting on differential pressure switch.	2. Inspect seal for signs of tampering.
3. Solenoid(s) malfunctioning.	3. Check connections. Clean ports. Check filter/screen on water/air feed assembly for damage screen and clean or replace if necessary.
4. Loss of sufficient system pressure to actuate valve(s).	4. Check automation for pressure leaks. Also, inspect filter/screen on water/air feed assembly for damage. Clean or replace if necessary.

FILTER UNDERDRAIN OBSTRUCTION OR PLUGGAGE

Infrequent flushing, the lack of chemical treatment, an improperly set backwash restrictor valve or operating the filters outside of recommended flow range are the four most common causes of media filter underdrain blockage. All four of these situations, either singularly or in combination, will result in contaminates reaching the filter underdrain. Evidence of underdrain blockage can be seen by monitoring the pressure gauges. If the pressure differential does not return to 2-6 PSI after a flush cycle there is a possibility of underdrain contamination.

First, the cause of the blockage must be determined and rectified (i.e. reset backwash restrictor valve, increase frequency of flushing, adjust flow rate to comply with manufacturer's recommendation or install chlorine injection equipment.) If the cause of the blockage has been identified and corrected, and the pressure differential does not return to 2-6 PSI after backflushing, more severe steps will have to be taken to clear the underdrain. If organic contaminates are suspected, a chlorine shock treatment may be necessary.

CHLORINE SHOCK TREATMENT FOR SAND MEDIA FILTERS

Step 1 Remove manway lids and fill each tank with water up to the top weld seam. It is not necessary to remove the sand. Make sure the effluent valve is closed so water will be held in the filter tank.

Step 2 Add 10 to 20 ounces of 12% pool chlorine per square foot of filtration area to each vessel. If unavailable, an equivalent amount of chlorine bleach is an acceptable alternative.

Step 3 Allow to stand for 12 hours. **BEWARE OF CHLORINE FUMES.**

Step 4 Secure manway lids, open field valve and initiate a backflush cycle. Flush each vessel for approximately 3 minutes and repeat full sequence several times.

NOTE: One or two shock treatments will usually be enough to unplug an underdrain that is contaminated with organics. Consult the manufacturer if a high pressure differential persists.

SAFETY NOTE: Always wear eye protection, gloves and protective clothing whenever handling any chemicals. A safety water rinse station should also be available to rinse off any chemicals which may come into contact with filter personnel. Do not mix chemicals in this procedure and always induce chemicals into a water filled filter tank.

Yardney
WATER MANAGEMENT SYSTEMS, INC.

- INDUSTRIAL
- PRESSURIZED
- IN-LINE

SAND MEDIA FILTRATION SYSTEMS

Yardney high rate automatic backwashing **Sand Media** filters are designed for general-purpose water filtration. These permanent media, automatic backwashing filters will remove organic and/or inorganic suspended solids down to 20 microns in size. Through the use of automatically controlled backwashing, the filter will operate "on line" for extended periods of time prior to the short backwashing cycle. Automatic filter operation is monitored on both elapsed time as well as pressure differential. When the controller "calls" for a backwash as a result of pressure differential or elapsed time, the backwashing function utilizes a portion of the clean filtered water produced by the system to clean the media. Single tank systems utilize unfiltered water for backwashing. Optional external backwash water sourcing systems are available for both single and multiple tank systems.

- EXCELLENT FOR SUSPENDED SOLIDS REMOVAL DOWN TO 20 MICRONS
- UNITS SHIPPED COMPLETELY ASSEMBLED ON STRUCTURAL SKIDS
- 3M SCOTCHKOTE 134 FUSION BONDED EPOXY LININGS
- 24" AND 36" DEEP SAND MEDIA TANK SHELLS AVAILABLE
- AUTOMATIC BACKWASH VALVES IN CAST IRON, STAINLESS TRIM – AIR OR WATER POWERED
- SOLID STATE CONTROLS (W/ AN INTEGRAL ADJUSTABLE PRESSURE DIFFERENTIAL SYSTEM)
- FLANGED OR GROOVED OPTIONS AVAILABLE FOR INLET AND OUTLET CONNECTIONS
- REMOVEABLE TYPE 304 STAINLESS UNDER-DRAIN
- IDEAL FOR RAW WATER FILTRATION OR PRETREATMENT FOR BAGS CARTRIDGES, OR R.O. SYSTEMS
- EASY INSTALLATION AND START-UP
- ASME CODE STAMP AVAILABLE (OPTIONAL)
- NEMA 4X CONTROL HOUSINGS ARE AVAILABLE (OPTIONAL)
- FILTERED WATER BACKWASH ON MULTIPLE TANK SYSTEMS

Yardney Water Management Systems, Inc.
6666 Box Springs Blvd. ● Riverside, CA 92507-0736 U.S.A.
Phone: (951) 656-6716 or (800) 854-4788 ● Fax: (951) 656-3867
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LIT- ILDATA-005 - 1206

Yardney
WATER MANAGEMENT SYSTEMS, INC.

INDUSTRIAL IN-LINE PRESSURIZED SAND MEDIA FILTRATION SYSTEMS

ENGINEERING & SIZING DATA FOR SINGLE & MULTIPLE TANK SYSTEMS
IN-LINE SAND MEDIA FILTRATION SYSTEMS – 24" SIDE SHELL TANKS
DESIGNED FOR GENERAL FILTRATION APPLICATIONS
FOR REMOVAL OF SUSPENDED SOLIDS DOWN TO **20 MICRONS** IN SIZE

	Service Flow rates									Approximate Shipping Weight Lbs.			Approximate Space Requirement		
Model Number	Normal Flow Range GPM	Peak Flow Rate GPM	Total Filtration Area (Sq. Ft.)	Dia. X Side Shell (Inches)	Sand Media Cu. Ft.	Back-Wash GPM	Inlet/Outlet Size	Back-Wash Line Size	Standard Maximum Working Pressure	Equip.	Media	Approximate Operating Weight Lbs.	Length	Width	Height
IL-1824-1A	18-26	35	1.75	18 X 24	2.5	26	2"	2"	100 PSI	245	450	750	2' 10"	2' 0"	4' 6"
IL-1824-2A	35-53	70	3.50	18 X 24	5.0	26	3"	2"	100 PSI	460	725	1450	3' 5"	1' 10"	5' 0"
IL-1824-3A	53-79	105	5.25	18 X 24	7.5	26	3"	2"	100 PSI	670	1100	2250	5' 3"	1' 10"	5' 0"
IL-2424-1A	32-47	63	3.15	24 X 24	4.5	47	2"	2"	100 PSI	320	650	1200	3' 1"	2' 5"	5' 0"
IL-2424-2A	63-95	126	6.30	24 X 24	9.0	47	3"	2"	100 PSI	590	1200	2300	4' 5"	2' 4"	5' 6"
IL-2424-3A	95-142	189	9.45	24 X 24	13.5	47	3"	2"	100 PSI	860	1850	3400	6' 9"	2' 4"	5' 6"
IL-3024-1A	49-74	98	4.91	30 X 24	7.0	74	3"	3"	100 PSI	500	1000	1850	4' 8"	2' 10"	5' 6"
IL-3024-2A	98-147	196	9.82	30 X 24	14.0	74	4"	2"	100 PSI	820	1925	3500	5' 5"	2' 9"	5' 8"
IL-3024-3A	147-221	295	14.73	30 X 24	21.0	74	4"	2"	100 PSI	1160	2850	5200	8' 3"	2' 9"	5' 8"
IL-3624-1A	71-107	142	7.10	36 X 24	10.0	107	3"	3"	100 PSI	625	1450	2650	4' 8"	3' 3"	5' 10"
IL-3624-2A	142-213	284	14.20	36 X 24	20.0	107	4"	4"	100 PSI	1060	2825	5050	6' 5"	3' 3"	6' 3"
IL-3624-3A	213-320	426	21.30	36 X 24	30.0	107	4"	4"	100 PSI	1720	4200	7000	9' 9"	3' 3"	6' 3"
IL-4824-1A	126-189	252	12.60	48 X 24	21.0	189	4"	4"	80 PSI	880	3100	4400	5' 7"	4' 3"	6' 10"
IL-4824-2A	252-378	504	25.20	48 X 24	42.0	189	6"	4"	80 PSI	1780	5625	8850	8' 5"	4' 3"	7' 2"
IL-4824-3A	378-567	756	37.80	48 X 24	63.0	189	6"	4"	80 PSI	2590	8400	13,150	12' 9"	4' 3"	7' 2"
IL-4824-4A	504-756	1008	50.40	48 X 24	84.0	189	8"	4"	80 PSI	3920	11,250	18,000	17' 1"	4' 5"	7' 4"
IL-4824-5A	630-945	1260	63.00	48 X 24	105.0	189	10"	4"	80 PSI	4525	14,025	22,150	22' 2"	4' 3"	7' 2"
IL-4824-6A	756-1134	1512	75.60	48 X 24	126.0	189	10"	4"	80 PSI	5350	16,800	26,500	26' 6"	4' 3"	7' 2"
IL-5424-1A	159-238	318	15.9	54 X 24	23.0	239	4"	4"	80 PSI						
IL-5424-2A	318-476	636	31.8	54 X 24	46.0	239	6"	4"	80 PSI						
IL-5424-3A	477-714	954	47.7	54 X 24	69.0	239	6"	4"	80 PSI						
IL-5424-4A	636-952	1272	63.6	54 X 24	92.0	239	8"	4"	80 PSI						
IL-5424-5A	795-1190	1590	79.5	54 X 24	115.0	239	10"	4"	80 PSI						
IL-5424-6A	954-1428	1908	95.4	54 X 24	138.0	239	10"	4"	80 PSI						

Single Tank Models I.D. – 1A Multiple Tank Models I.D. – 2A, 3A, 4A, 5A, 6A

Standard Systems Include:

- Filtered water backwash on multi-tank systems
- All interior surfaces fusion epoxy coated w/ 3M Scotchkote 134
- Advanced solid-state automation with elapsed timer and pressure differential control
- Skid mounted on structural steel skid
- Liquid-filled stainless steel pressure gauges
- Grooved coupling in/out standard (flanged available – consult factory
- Automatic diaphragm operated non-corrosive brass or cast iron valves
- Systems provided with interconnecting piping
- Removable 304 stainless steel cross-flow underdrain standard
- ASME code stamped available – consult factory
- Filtration media is included in system definition and pricing.

STANDARD MEDIA SPECIFICATIONS:

Filtration Media: Various Grades Of Crushed Silica (Depending upon desired water quality)

Gravel Pack: ½" X ¾" crushed rock

NOTE: Media shipping weight includes gravel pack.

NOTE: Consult factory for requirements of higher working pressure.

"Excellence In Filtration For A Better World"

Yardney Water Management Systems, Inc.
6666 Box Springs Blvd. ● Riverside, CA 92507-0736 U.S.A.
Phone: (951) 656-6716 or (800) 854-4788 ● Fax: (951) 656-3867
Website: www.yardneyfilters.com ● Email: sales@yardneyfilters.com
LIT- ILDATA-005 - 1206

Attachment D

ATS Monitoring Sampling & Reporting Plan

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

6301 Angelo Court #9, Loomis, CA 95650 | Phone: 916-652-9745 | Fax: 916-652-9705 | www.ats-env.com

Sample Collection

Influent and Effluent grab samples will be collected from influent and effluent ports of the ATS. To maintain sample integrity and prevent cross-contamination, the following precautions will be used:

- Wear clean nitrile gloves.
- Do not allow sample container to come into contact with any other material than the water sample.
- Discard sample bottles or lids that have been dropped or come into contact with any other material.
- Do not leave cooler lid open for extended periods of time.
- Do not touch the exposed end of the sampling tube (if used).
- Do not allow rain water to drip from rain gear or other surfaces into sample bottles.
- Do not eat, drink or smoke while collecting samples.
- Do not sneeze or cough in the direction of a open sample container.
- Minimize the exposure of sunlight to the sample containers.
- Decontaminate sampling equipment prior to use.

Immediately following collection, sample bottles including field blanks will be capped, labeled, documented on a Chain of Custody (COC) form provided by the analytical laboratory, sealed in a plastic bag, placed in an ice-chilled cooler, at as near to 4ºC as possible, and delivered to the laboratory within 24 hours.

All sampling containers will be pre-labeled prior to initiating the sampling event. The sample containers will be preserved as required, filled and capped. Containers will be placed in a cooler immediately after sampling and held until delivery to a state certified laboratory.

Documentation

The following procedures will be used during sample collection and handling. Recordkeeping includes the following:

- Field logs for documenting time and place
- Sample labels to identify individual samples
- Chain of Custody record forms for documenting possession and transfer of sample – includes laboratory analysis request data for specific analysis.

All data on sample bottle ID labels and COC forms should be recorded using waterproof ink. If errors are made on labels or a COC form, the correction shall be made by lining through the error and entering the correct information. All corrections should be initialed and dated with no erroneous information obliterated.

At the time of sampling, the Sample ID will be logged on a COC form, which will accompany the sample to the laboratory. Laboratory personnel will accept the samples by signing the COC form. Identification will be attached to each sample bottle. The following identification matrix will be utilized for this project:

SSS - PN - L

SSS=Sample Designator
PN = Project Name
L=Location (Influent/Effluent)

Example: 001- FD – E

The label shall also include:

- Date and Time of collection
- Analysis Requested
- Preservative (if used)
- Initials of person collecting sample
- Additional comments, remarks or notations

Sampling Supplies and Equipment

An adequate supply of materials should be kept onsite at all times.

- Nitrile Gloves
- Sample Bottles
- Sample Bottle Lids
- Distilled Water
- Soap
- Paper Towels
- Coolers
- Pens

Monitoring Forms

Handheld meters shall be used as described in the O&M Manual. This information will be recorded using the following

Form # CWCASOS01
Rev Date: 10/6/2010

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

SYSTEM OPERATION SUMMARY

Project Title: _____ Project #: _____

Project Location: _____ Date: _____

	PRE-TREAT FLOW TOTALIZER		INFLUENT FLOW TOTALIZER		EFFLUENT FLOW TOTALIZER	
	Gallons	Time	Gallons	Time	Gallons	Time
Start						
Finish						
Total Volume						

Generator Hours	Start:	Finish:	Total:

Residual Chitosan Test: **#of Tests_____** **#Passed_____** **Failed:_____**

First Shift	**Second Shift**	**Third Shift**
Technician Name	Technician Name	Technician Name
Technician Signature	Technician Signature	Technician Signature

Form # CWCASMF01
Rev Date: 10/6/2010

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

SYSTEM MONITORING FORM

Project Title: _____ _____

Project Location: _____ _____

TIME	BF/R/D	FLOW Influent/Effluent	pH Influent/Effluent	NTU Influent/Effluent	Pressures Influent/Effluent	Intials
		/	/	/	/	
		/	/	/	/	
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BF= Back Flush R=Recirculation D=Discharge
*Indicates verification of in-line meters:required once per day

First Shift	Second Shift	Third Shift
Technician Name	Technician Name	Technician Name
Technician Signature	Technician Signature	Technician Signature

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

POLYMER INJECTION CALIBRATION/BENCH SCALE TREATABILITY

Project Title _____ Project #: _____

Project Location: _____ Date: _____

BENCH SCALE TREATABILITY

	Sample ID	Time	Volume	Turbidity (NTU)	pH	Adjusted pH	Conductivity (µS/cm)
Sample 1							
Sample 2							

Sample 1			Floc Size Guide	Sample 2		
Estimated Dose Rate (ppm)**	Floc Size	Settling Time	0 - No Reaction 1 - Pin Floc 2 - Medium Floc 3 - Large Floc	Estimated Dose Rate (ppm)**	Floc Size	Settling Time
			**1 drop of 1.5%=0.75ppm			
			**ppm = (ml/min)x3.97 / flow GPM			

Pretreat Pump

Time	Flow (GPM)	Chitosan Delivery (ml/min)	Dose Rate (ppm) *	Initials

Sand Filter Pump

Time	Flow (GPM)	Chitosan Delivery (ml/min)	Dose Rate (ppm) *	Initials

First Shift	Second Shift	Third Shift
Technician Name	Technician Name	Technician Name
Technician Signature	Technician Signature	Technician Signature

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

POLYMER INJECTION CALIBRATION/BENCH SCALE TREATABILITY

Project Title: _____ Project Number: _____

Project Location: _____ Date: _____

pH Meter Model: Oakton pH 6		
pH Standard	Initial Reading	Calibrated Reading
4.01		
7.00		
10.00		

Conductivity Meter Model: Hanna Dist III	
Conductivity Standard	1413.00
Initial Reading	
Calibrated Reading	

Turbidity Meter Model: Hach 2100P		
Turbidity Standard	Initial Reading	Calibrated Reading
<0.1		
20		
100		
80		

Influent Meter pH Meter Model: +GF+ Signet			Effluent Meter pH Meter Model +GF+ Signet:		
pH Standard	Initial Reading	Calibrated Reading	ph Standard	Initial Reading	Calibrated Reading

Pretreat Turbidity Meter Model: Microtol			Influent Turbidity Meter Model: Microtol			Effluent Turbidity Meter Model: Microtol		
Turbidity Standard	Initial Reading	Calibrated Reading	Turbidity Standard	Initial Reading	Calibrated Reading	Turbidity Standard	Initial Reading	Calibrated Reading
1000			1000			1000		
10			10			10		
0.02			0.02			0.02		

First Shift	Second Shift	Third Shift
Technician Name	Technician Name	Technician Name
Technician Signature	Technician Signature	Technician Signature

Form # CWCARST01
Rev Date: July,2009

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

RESIDUAL CHITOSAN FORM

Project Title: _____ Project Number: _____

Project Location: _____ Date: _____

	Sample Time	Turbidity (NTU)	Specific Conductivity (µS/cm)	pH	Adjusted pH	Chitosan Dose Rate (ppm)	Result (Positive/ Negative)	Result Time	Pass/Fail
Analysis									
Matrix Spike									

	Sample Time	Turbidity (NTU)	Specific Conductivity (µS/cm)	pH	Adjusted pH	Chitosan Dose Rate (ppm)	Result (Positive/ Negative)	Result Time	Pass/Fail
Analysis									
Matrix Spike									

	Sample Time	Turbidity (NTU)	Specific Conductivity (µS/cm)	pH	Adjusted pH	Chitosan Dose Rate (ppm)	Result (Positive/ Negative)	Result Time	Pass/Fail
Analysis									
Matrix Spike									

	Sample Time	Turbidity (NTU)	Specific Conductivity (µS/cm)	pH	Adjusted pH	Chitosan Dose Rate (ppm)	Result (Positive/ Negative)	Result Time	Pass/Fail
Analysis									
Matrix Spike									

First Shift	Second Shift	Third Shift
_____	_____	_____
Technician Name	Technician Name	Technician Name
_____	_____	_____
Technician Signature	Technician Signature	Technician Signature

Form# CWCASSOS
Rev Date: 10/6/10

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

SUPPLEMENTAL SYSTEM OPERATION SUMMARY

Project Title: _____ Project #: _____

Project Location: _____ Date: _____

Operator's Log:

First Shift	Second Shift	Third Shift
Technician Name	Technician Name	Technician Name
Technician Signature	Technician Signature	Technician Signature

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

DAILY DISCHARGE TOTAL & PROJECT DISCHARGE TOTAL

Project Title: _____ Project #: _____

Project Location: _____ Date: _____

DATE	DAILY TOTAL	PROJECT TOTAL UP TO DATE	TECHNCIANS INITIALS

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

RECEIVING WATERS

Project Title: _____ Project #: _____

Project Location: _____ Date: _____

Pre-Operation Sample	Upstream	Downstream	Notes
Sample Location			
Sample Time			
Turbidity (NTU)			
pH (Standard Units)			
Temperature			
Specific Conductance (µS/cm)			
Maxium Discharge Limit (NTU)*			

Operation Sample	Upstream	Downstream	Notes
Sample Location			
Sample Time			
Turbidity (NTU)			
pH (Standard Units)			
Temperature			
Specific Conductance (µS/cm)			
Maxium Discharge Limit (NTU)*			

** Unless superseded and/or specified otherwise by another permit, discharge limits are established from the excerpt below, referenced in RESOLUTION NO. R5-2007-0136, AMENDMENT TO THE WATER QUALITY CONTROL PLAN (BASIN PLAN) FOR THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD, CENTRAL VALLEY REGION, FOURTH EDITION Revised August 2006 (with Approved Amendments), THE SACRAMENTO RIVER BASIN AND THE SAN JOAQUIN RIVER BASIN.*

Turbidity:

Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:

- *Where natural turbidity is less than 1 Nephelometric Turbidity Unit (NTU), controllable factors shall not cause downstream turbidity to exceed 2 NTUs.*
- *Where natural turbidity is between 1 and 5 NTUs, increases shall not exceed 1 NTU.*
- *Where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20 percent.*
- *Where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs.*
- *Where natural turbidity is greater than 100 NTUs, increases shall not exceed 10 percent.*

pH:

The pH shall not be depressed below 6.5 nor raised above 8.5 standard units.

_____ _____

Technician Name Technician Signature

Attachment E

ATS Health and Safety Plan

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

6301 Angelo Court #9, Loomis, CA 95650 | Phone: 916-652-9745 | Fax: 916-652-9705 | www.ats-env.com

Rocklin Crossing
Stormwater Active Treatment System (ATS)Operations

Health & Safety Plan

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

6301 Angelo Court #9, Loomis, CA 95650 | Phone: 916-652-9745 | Fax: 916-652-9705 | www.ats-env.com

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1.0 INTRODUCTION

When Active Treatment Systems, Inc. (ATS) mobilizes, operates, maintains, demobilizes or has a working presence at the ATS site, this HASP is in effect for its employees. It is intended that this HASP be a subset of the master HASP covering the entire project.

2.0 SCOPE OF WORK

Active Treatment Systems, Inc. (ATS) will provide interconnecting conveyance plumbing, pumps, filters, chemical injection pumps, monitoring & system controls, and coagulant for the purpose of storm water treatment at the Rocklin Crossing Project. The aforementioned equipment will be utilized to process and treat storm water for discharge.

3.0 SITE LOCATION

The ATS unit is located within the Rocklin Crossing Project which is located off of Sierra College Blvd & Croftwood Dr., Rocklin CA located in Placer County. (Figure 1).

Figure 1

3.1 ACCESS ROUTES

Access to the Rocklin Crossing Project is by Sierra College Blvd. You can access the site directly off of Sierra College Blvd. by taking 80 West to Sierra College then head south. The site access is just south of the Hwy 80 overpass.

3.1.1 Rocklin Crossing Project

Access into the Rocklin Crossing Project is provided by Sierra College Blvd. (Figure 2).

3.1.2 ATS Stormwater ATS

Access to the treatment system location inside the project site is accomplished by traveling along Sierra College Blvd. and turning east on Croftwood Dr. The ATS is located directly along Croftwood Dr. as you first enter the property (Figure 2).

Figure 2

4.0 SITE AUTHORITIES, ROLES & RESPONSIBILITIES

4.1 Company Safety Officer (CSO)

Jason Hills has been designated as the Company Safety Officer (CSO) for the Storm Water ATS Operations at the Rocklin Crossing Project.

The Company Safety Officer will be responsible for ensuring the HASP is complied with at all times or that responsibility is delegated to a suitably trained and competent CSO Substitute. Compliance with the information provided in this HASP is mandatory for all ATS personnel involved in active field work at the Site. <u>These field personnel must be familiar with the details and implications presented in this document</u>.

4.1.1 CSO Responsibilities

- Developing, implementing, monitoring, and reviewing the HASP regularly during the project.
- Ensuring that appropriate personal protective equipment and monitoring equipment is available and properly utilized by on-site ATS personnel.
- Establishing that ATS personnel are aware of the provisions of this plan, are instructed of work practices necessary to ensure safety, and are familiar with planned procedures for dealing with emergencies.
- Ensuring that ATS personnel are aware of the potential hazards associated with site operations.
- Monitoring the safety performance of ATS personnel to see that the required work practices are employed.
- Correcting ATS work practices or conditions that may result in injury or exposure to hazardous substances
- Ensuring that all equipment is installed and/or operated in a manner which minimizes HSSE hazards and risks
- Halting site operations and supporting those who choose to halt operations on their own, if necessary in the event of an emergency or to correct unsafe work practices
- Reporting and investigating safety and environmental incidents for the duration of the project
- Provide resources necessary for a safe working environment
- Maintain communications with the client
- Conduct daily safety meetings.
- Evaluate hazards
- Provide ongoing review of the protection level needs as project work is performed, and inform the PM of the need to upgrade/downgrade protection levels as appropriate
- Manage emergency situations, as necessary
- Investigate incidents
- Maintain safety records
- Prepare incident reports
- Modify the Site Health and Safety Plan as required based on incidents and findings regarding work practices.

4.2 Storm Water Advanced Treatment System (ATS) Operator

The following personnel have been designated as ATS Operators.

- Patrick Sparks
- Vernon Slater
- Kyle Dixon
- Jason Hills
- Shane Kiley

- Wendell Sawyer
- Tim Breitkreutz
- Ryan Lahargoue
- Doug Parry
- Katie Sasser

The ATS Operator will be responsible for ensuring that ATS Operations proceed in accordance with the Site HSSE requirements.

4.3 ATS Project Manager

Patrick Sparks has been designated as the Project Manager (PM) for the ATS Storm Water ATS Treatment Operations at the Rocklin Crossing Project.

5.0 EMERGENCY RESPONSE PLAN

It Is ATS's policy to evacuate personnel from areas involved in emergency response where immediate risk to life or health is present, and to summon outside assistance from agencies with personnel trained to deal with the specific emergency. This includes hazardous material emergencies. This Emergency Response Plan provides basic response information for potential emergencies for all personnel while working on-Site.

5.1 Notification Numbers

ATS Compliance Services of California (ATS)		
Name	**Title**	**Number**
ATS Office	-	(916) 652-9745
Patrick Sparks	Project Manager	(916) 437-8541
Vernon Slater	Project Scientist	(916) 437-8100
Jason Hills	Project Manager	(916) 437-8710
Kyle Dixon	Operations Manager	(916) 437-8693
Shane Kiley	Project Manager	(916) 437-8625
Wendell Sawyer	President	(916) 417-6697

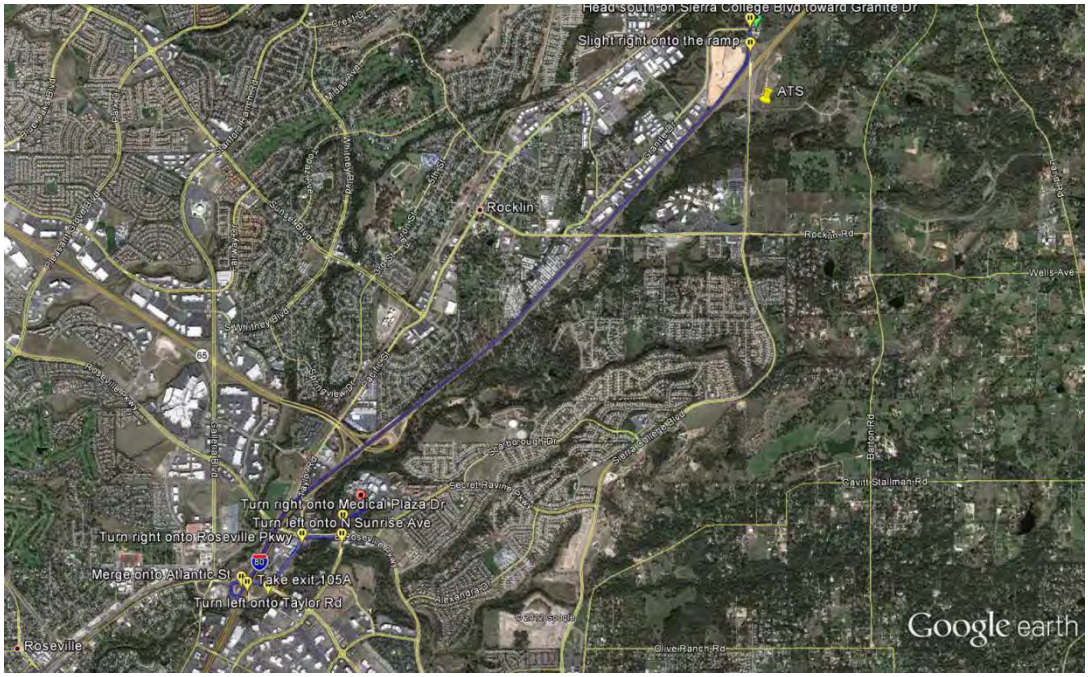
SD Deacon & Other			
Name	**Title**	**Company**	**Number**

5.2 Hospital Route Directions & Map

5.2.1 Sutter Medical Center –Roseville Directions

Head West onto Hwy 80 and go 4.5 miles and exit Eureka Rd. toward Taylor Rd. Merge onto Atlantic and turn left onto Taylor Rd, make a right onto Roseville Pkwy, make your 1st right onto Sunrise Blvd, and take your first right on Medical Plaza Dr.

Sutter Medical Center
3 Medical Plaza Dr.
Roseville, CA
916-773-7977



5.3 Incident Case Management

All job-related accidents and injuries will be reported as follows:

- Report Immediately. Personnel will report **ALL** on-the-job accidents, illnesses, or near misses to the CSO immediately.
- Obtain Medical Treatment. Personnel should immediately obtain any necessary medical treatment. If treatment requires more than basic first-aid care then the injured employee will be transported to a care facility designated in Section 4.2
- Record Accident Information. Interview injured workers and witnesses. Document the scene and gather necessary evidence. Personnel and their CSO will complete an ATS

Incident Investigation Report Form (Section 16.3), as well as any necessary documentation required by the Site HSSE Officer.

- Investigate the Accident. The ATS CSO, Site HSSE Officer, or other designated individual, will investigate the nature of the accident or incident and gather all pertinent information associated with the accident.
- Determine the cause of the accident. ATS personnel and the Site HSSE Officer will determine the causes of the accident and provide recommendations as to how to prevent a recurrence of the accident or incident.
- Record findings. ATS personnel and the Site HSSE Officer will record the findings as well as the corrective actions taken.

5.4 Security Arrangements/Instructions

Only those individuals authorized to visit the Active Treatment System (ATS), or those designated to operate the system or to provide support are allowed to be in or around the ATS area. This will prevent those individuals who are not specifically trained for the hazards and operations of the ATS from putting themselves and the centrifuge operators at risk.

When operations permit, authorized individuals may enter the ATS area under the direct supervision of the Company Safety Officer, or delegated competent substitute. In addition, a safety orientation may be required before access is allowed.

6.0 INSPECTIONS, EVALUATION, & JOB HAZARD ASSESSMENT (JHA)

Periodic inspections, evaluations and procedures for correction and control provide a method of identifying existing or potential hazards in the workplace, and eliminating or controlling them. Hazard Assessment and control is the heart of ATS's effective Health and Safety Plan.

6.1 Inspections & Evaluation

Periodic inspections to identify and evaluate workplace hazards shall be performed by the following competent observer(s) in the following areas of our workplace:

Competent Observer	Area
Wendell Sawyer Jason T. Hills Shane Kiley Kyle Dixon Patrick Sparks Vernon Slater	On-Site Projects

Periodic inspections are performed according to the following schedule:

- Weekly
- When we initially established our HASP
- When new substances, processes, procedures or equipment which present potential new hazards are introduced into our workplace
- When new, previously unidentified hazards are recognized
- When occupational injuries and illnesses occur
- When we hire and/or reassign permanent or intermittent workers to processes, operations, or tasks for which a hazard evaluation has not been previously conducted; and
- Whenever workplace conditions warrant an inspection.

Periodic inspections consist of identification and evaluation of workplace hazards utilizing applicable sections of the attached Hazard Assessment Checklist and any other effective methods to identify and evaluate workplace hazards.

6.2 Job Hazard Assessment

ATS has performed a job safety analysis of work performed in water treatment operations, at project sites. Recognized potential hazards include chemical exposure, fire hazards, biological hazards, physical hazards, electrical hazards, heat and cold, noise, and confined-space entry. Each anticipated hazard category that may present potential for personnel exposure is briefly discussed in the following section.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Driving/Vehicle Traffic	1) Accidents 2) Injuries from collision 3) Crushing 4) Loss of vehicle Control	1) Employ safe driving practices; wear seatbelts, obey traffic right of way. 2) Haul road – left hand traffic; locate and obey traffic flagger

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Lifting Heavy Objects	1) Injuries from lifting heavy and/or awkward supplies and equipment	1) Use extreme care when lifting 2) Use sound lifting techniques 3) Recruit extra assistance when necessary 4) Employ lifting aids when necessary

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Ladder use	1) Injury from falls	1) Use proper ladders free of defect; maintain 3 points of contact at all times; secure proper footing under ladder; recruit assistance whenever necessary to secure ladder and for handling of tools/materials.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Working at heights on tanks. • Climbing ladders • Standing, walking, working on tank platform	1) Injury from falling objects 2) Injury from falls	1) Be aware of surroundings; wear hard hat at all times; communicate with other personnel nearby. 2) Ensure proper guards/rails are in place, secure, and free of defects; ensure tank deck platform is secure and free of defects.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Cutting (Reciprocal Saw)	1) Injuries from reciprocal saw use	1) Use appropriate PPE (gloves, eye safety glasses) 2) Recruit help whenever necessary. 3) First aid kits are on site.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Open Water – Lake or Basins	1) Drowning	1) Place retrieval equipment and life other flotation devices in proximity to open water

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Handling Large Pipe	1) Hand & finger injuries from pinching and crushing	1) Use appropriate PPE (gloves). 2) Conduct all work in a slow and controlled manner whenever possible. 3) Recruit help whenever necessary. 4) Block/support elevated pipe whenever possible.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Sun Exposure	1) Dehydration 2) Sun Stroke 3) Sunburn	1) Have water Onsite for all employees 2) Drink adequate amounts of water 3) Take breaks in the shade 4) Wear sunscreen

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Driving Vehicles/Road and driving hazards including vehicle traffic (contractor vehicle traffic including slow moving water trucks, p/u trucks, heavy equipment, delivery trucks), wildlife, uneven roads, narrow roads, changing weather conditions affecting roads (rain, snow, wind, ice)	1) Injuries from collision, crushing, loss of vehicle control	1) Employ safe driving practices 2) Inspect vehicle for defects/deficiencies (brakes, tire pressure, tire conditions) 3) Wear seatbelt 4) Follow speed limits 5) Maintain Vigilance for changing road conditions and hazards 6) Defensive driving

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Chemical Exposure	1) Exposure	1) Review corresponding MSDS 2) Wear all appropriate PPE and first aid procedures

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Heavy Equipment	1) Injuries from crushing or contact	1) Designate equipment work areas 2) Listen for backup alarms 3) Maintain eye contact with operator 4) Maintain awareness of surroundings.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Slippery surfaces around job site basin areas, including surrounding lining, treatment containers	1) Injuries from slips and falls 2) Potential of falling into basin or pond 3) Shifting pond liner material during pond filling.	1) Maintain Vigilance 2) Exercise Care 3) Immediately cleanup liquid spills 4) Use extreme caution near edges of pond or basin.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Open Tanks; tank ladders	1) Drowning 2) Falls	1) Use extreme caution on top of tanks and climbing tank ladders 2) Inspect tanks, ladders, platforms for defect and report deficiencies.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Unstable slopes, slides, erosion; pond banks collapse	1) Injuries from engulfment 2) Injuries from contact from rocks and material 3) Falls	1) Maintain vigilance. 2) Maintain awareness of changing conditions of slopes and weather

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Uneven, unstable, or rough terrain	1) Injuries from tripping and falls.	1) Identify and remove tripping hazards. 2) Level the uneven ground 3) Use extreme caution near edges of work pad areas, road, and other areas with drop offs present.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Thunderstorms/lightning	1) Sudden thunderstorms and lightning	1) Maintain awareness of changing weather conditions 2) For prolonged period of lighting, move away from steel containers and seek shelter in vehicles for grounding

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Electrical Currents	1) Injuries from electrical shock	1) Maintain vigilance 2) Practice safe work practices 3) Ensure that lockout/tag out procedures are followed and circuits are de-energized before performing work. 4) Ensure only trained and designated staff are performing electrical work.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Diesel Fuel	1) Exposure 2) Spill and Contamination	1) Wear appropriate PPE 9 at all times 2) Maintain vigilance 3) Practice safe work practices 4) Use containment equipment and material when necessary (sorbent socks, pads, containment catches), or in case of a spill.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Handling Dry Ice	1) Suffocation 2) Cryogenic burns	1) Wear appropriate PPE at all times. 2) Maintain vigilance. 3) Practice safe work practices. 4) Use heavy glove, dry ice tongs, plastic scoop or shovel. 5) Containers of solid Carbon Dioxide should be stored upright and be firmly secured to prevent falling or being knocked over 6) Containers should be vented, to prevent the build-up of Carbon Dioxide gas. 7) Containers should be thermally insulated and kept at the lowest possible temperature to maintain the soli and avoid generation of Carbon Dioxide gas. 8) Storage containers and equipment used with Carbon Dioxide should not be located in sub-surface or enclosed areas. 9) Storage of dry ice should never occur in a gas-tight container.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Delivery and off loading of equipment	1) Struck by 2) Caught between 3) Loss of control while unloading 4) Equipment in unsafe condition 5) Lifting/rigging for offloading	1) Maintain awareness of all suspended loads and surrounding moving equipment. Equipment not required for unloading should remain outside the unloading area. Never position yourself under a suspended load. 2) Maintain awareness; do not position yourself between fixed and moving objects. 3) Unload in a designated area where level and secure footing is provided. Secure truck and trailer from movement during unloading operation. 4) Ensure equipment was inspected prior to loading. 5) Ensure lifting equipment is suited for task and weights to be handled. Rigging gear is in good condition and properly sized for load.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
Elements • Cold • Slippery Surfaces	1) Exposure to cold 2) Slips	1) Wear appropriate clothing, while maintaining high visibility PPE requirements. 2) Be aware of surroundings.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
General ATS Equipment Area • Walking • Inspecting • Opening and entering control unit.	1) Slips, trips, falls 2) Head injury from overhead structures 3) Cuts, scrapes	1) Be aware of surroundings, buried pipe, trip hazards, ensure unused materials are neatly organized, and placed in appropriate areas; follow general housekeeping rules and guidelines. 2) Wear appropriate PPE – hard hat; be aware of surroundings and overhead structures 3) Wear appropriate PPE – hard hat, gloves (when appropriate); be aware of surroundings and overhead structures.

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

JOB HAZARD ANALYSIS (JHA)

HAZARD IDENTIFICATION	INJURY/EXPOSURE	CONTROL MEASURES
	1)	

6.2.1 JHA COMPLIANCE AGREEMENT

INSTRUCTIONS: This form is to be completed and signed by each person to work on the project site and provided to client Safety Supervisor for copies (if required) and returned to the ATS HASP binder.

Project Name:	Rocklin Crossing
Project Number:	12SDD1
JHA Date:	

I have read and understood the contents of this Job Hazard Assessment and agree to act responsibly to ensure the safety of myself and others. I understand that it is in my best interest to see that site operations are conducted in the safest manner possible; therefore, I will be alert to site health, safety, and environmental conditions at all times.

Name	Signature	Company	Date
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10			
11.			
12.			

6.3 HAZARD CORRECTION PROCEDURES

HAZARD CORRECTION

Unsafe or unhealthy work conditions, practices, or procedures shall be corrected in a timely manner based on the severity of the hazards. Hazards shall be corrected according to the following procedures:

- When observed or discovered
- When an imminent hazard exists which cannot be immediately abated without endangering employee(s) and/or property, ATS will remove all exposed workers from the area except those necessary to correct the existing condition. Workers necessary to correct the hazardous condition shall be provided with the necessary protection
- All such actions taken and dates they are completed shall be documented on the appropriate forms.

Safety meetings will be held on-site and daily to review HASP topics, and discuss and report safety hazard concerns by supervisors and personnel.

To ensure that all personnel are involved in the hazard correction process, all personnel are encouraged to report any hazard concern either in writing via a company hazard report form **(below**) or verbally to their supervisor or to any individual with whom they feel comfortable. Personnel wishing to remain anonymous are informed that their signature is not required on the written form and also that a suggestion box is provided in the workshop or office.

Hazard Assessment and Correction Record

Reference Info - #:_____**Follow Up Inspection Needed:** YES ☐ NO ☐

Location: _____

Date of Inspection: _____

Person(s) Conducting Inspection: _____

Start Date of Corrective Action: _____ **End Date of Corrective Action**: _____

Person(s) Conducting Corrective Action: _____

Reason for Inspection/Action: Initial Site Hazard Assessment ☐ Safety Suggestion ☐ Report of Accident/Incident ☐ Supplemental Assessment/Other ☐ Please Explain: _____

_____

Unsafe Condition/Work Practice/Hazard (Use back for extra space or sketch/diagram)**:**

_____

_____

_____

Corrective Action Taken: _____

_____

ATS Personnel and/or other Persons Observed (Optional):_____

_____

Overall Assessment Grade (Optional) **Circle:**

5 – Excellent 4 – Good 3 – Average 2 – Poor 1 – Unsatisfactory

Notes: _____

_____

_____

Additional Info/Sketch/Diagram on Back of Page? YES ☐ NO ☐

Signature: _____ Date**:** _____

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7.0 CONSTITUENT OF CONCERN OF EXPOSURE ANALYSIS

The following identifies several constituents of concern at the Rocklin Crossing Project:

Recognized potential constituents of concern include the following:

- Coagulant Polymer
- PVC Primer
- PVC Glue
- Pipe Thread Sealant (Pipe Dope)

7.1 Coagulant Polymer

The following Coagulant Polymers may be used in the sludge de-watering operation:

- ChitoVan Stormwater Flocculent HV (1.5%)

Site Level D PPE is required to handle the aforementioned flocculent polymers. In addition, Nitrile gloves must be worn.

The MSDS for each Coagulant Polymer is located in Section 15.0. Personnel must read the MSDS before handling the polymer. The MSDS will provide information pertaining to toxicity, first aid measures, spill response measures, chemical properties, health concerns, etc.

7.2 PVC Primer

PVC Primer may be used to make plumbing connections. Site Level D PPE is required when handling PVC Primer. In addition, Nitrile gloves must be worn.

The MSDS for PVC Primer is located in Section 15.0. Personnel must read the MSDS before handling PVC Primer. The MSDS will provide information pertaining to toxicity, first aid measures, spill response measures, chemical properties, health concerns, etc.

7.3 PVC Glue

PVC Glue may be used to make plumbing connections. Site Level D PPE is required when handling PVC Gluer. In addition, Nitrile gloves must be worn.

The MSDS for PVC Glue is located in Section 15.0. Personnel must read the MSDS before handling PVC Glue. The MSDS will provide information pertaining to toxicity, first aid measures, spill response measures, chemical properties, health concerns, etc.

7.4 Pipe Thread Sealant (Pipe Dope)

Pipe Dope may be used to make plumbing connections. Site Level D PPE is required when handling Pipe Dope. In addition, Nitrile gloves must be worn.

The MSDS for Pipe Dope is located in Section 15.0. Personnel must read the MSDS before handling Pipe Dope. The MSDS will provide information pertaining to toxicity, first aid measures, spill response measures, chemical properties, health concerns, etc.

8.0 MINIMUM PERSONAL PROTECTIVE EQUIPMENT

8.1 Site Minimum PPE Requirements

For Storm Water ATS Site operations, the minimum level of PPE required is Level D as listed below, and is subject to change.

Level D PPE is required where minor skin hazards may exist, but no respiratory protection is required. The following constitutes Level D PPE and the minimum requirements for this Site:

- High visibility orange safety vests;
- Long sleeved shirt – Recommended;
- Full-length pants;
- Lace up safety or steel toe boots with a minimum of 4-inch leather or rubber ankle support and a distinctive heel;
- Gloves, (type of glove appropriate for the work task);
- Safety glasses or chemical splash goggles meeting ANSI Z.87.1 requirements or full mask face shield depending on the work task;
- Hardhat meeting ANSI Z.89.1 requirements; and
- Earplugs and/or earmuffs in work areas where noise levels equal or exceed 85 dB (A general field rule to determine areas with noise greater than 85 dB, is to evaluate how hard it is to hear normal conversation at 1 foot from the speaker. If conversation is difficult without shouting, then the area should be considered to be above 85 dB).

8.2 ATS Personal Protective Equipment Program

The purpose of the Personal Protective Equipment Program is to protect the employees of Active Treatment Systems, Inc. (ATS) from exposure to work place hazards and the risk of injury through the use of personal protective equipment (PPE). PPE is not a substitute for more effective control methods and its use will be considered only when other means of protection against hazards are not adequate or feasible. It will be used in conjunction with other controls unless no other means of hazard control exist.

Personal protective equipment will be provided, used, and maintained when it has been determined that its use is required to ensure the health and safety of employees and that such use will lessen the likelihood of occupational injury and/or illness.

This section addresses general PPE requirements, including eye and face, head, foot and leg, hand and arm, body (torso) protection, and protection from drowning.

ATS's Personal Protective Equipment Program includes:

- Responsibilities of supervisors and employees
- Hazard assessment and PPE selection
- Employee training
- Cleaning and Maintenance of PPE

8.2.1 Responsibilities

8.2.1.1 Company Safety Officer (CSO)

The Company Safety Officer (CSO) is responsible for the development, implementation, and administration of ATS's PPE policies.

This involves:

- Conducting workplace and jobsite hazard assessments to determine the presence of hazards which necessitate the use of PPE.
- Selecting and purchasing PPE.
- Reviewing, updating, and conducting PPE hazard assessments whenever:
  - a job changes
  - new equipment is used
  - there has been an accident
  - a supervisor or employee requests it
  - or at least every year
- Maintaining records on hazard assessments.
- Maintaining records on PPE assignments and training.
- Providing training, guidance, and assistance to supervisors and employees on the proper use, care, and cleaning of approved PPE.
- Periodically re-evaluating the suitability of previously selected PPE.
- Reviewing, updating, and evaluating the overall effectiveness of PPE use, training, and policies.

8.2.1.2 Employees

The PPE user is responsible for following the requirements of the PPE policies.

This involves:

- Properly wearing PPE as required.
- Attending required training sessions.
- Properly caring for, cleaning, maintaining, and inspecting PPE as required.
- Following ATS's PPE policies and rules.
- Informing the CSO of the need to repair or replace PPE.

Employees who repeatedly disregard and do not follow PPE policies and rules will be dealt with in accordance with ATS's Safety Disciplinary Policy as outlined in section 7.2.6.

8.2.2 Hazard Assessment for PPE

The CSO will conduct a walk-through survey of each work area to identify sources of work hazards.

The CSO will conduct, review, and update the hazard assessment for PPE whenever the following occurs:

- a job changes

- new equipment or process is installed
- there has been an accident
- whenever a supervisor or employee requests it
- or at least every year

8.2.3 Selection of PPE

Once the hazards of a workplace have been identified, the CSO will determine if the hazards can first be eliminated or reduced by methods other than PPE, i.e., methods that do not rely on employee behavior, such as engineering controls.

If such methods are not adequate or feasible, then the CSO will determine the suitability of the PPE presently available; and as necessary, will select new or additional equipment which ensures a level of protection greater than the minimum required to protect employees from the hazards. Care will be taken to recognize the possibility of multiple and simultaneous exposure to a variety of hazards. Adequate protection against the highest level of each of the hazards will be recommended for purchase.

All personal protective clothing and equipment will be of safe design and construction for the work to be performed and will be maintained in a sanitary and reliable condition. Only those items of protective clothing and equipment that meet NIOSH or ANSI standards will be procured or accepted for use. Newly purchased PPE must conform to the updated ANSI standards which have been incorporated into the PPE regulations, as follows:

- Eye and Face Protection ANSI Z87.1
- Head Protection ANSI Z89.1
- Foot Protection ANSI Z41.1
- Hand Protection: There are no ANSI standards for gloves; however, selection must be based on the performance characteristics of the glove in relation to the tasks to be performed.

Affected employees whose jobs require the use of PPE will be informed of the PPE selection and will be provided PPE by ATS Careful consideration will be given to the comfort and proper fit of PPE in order to ensure that the right size is selected and that it will be used.

8.2.4 Training

Any worker required to wear PPE will receive training in the proper use and care of PPE before being allowed to perform work requiring the use of PPE. Periodic retraining will be offered to PPE users as needed. The training will include, but not necessarily be limited to, the following subjects:

- When PPE is necessary to be worn
- What PPE is necessary
- How to properly don, doff, adjust, and wear PPE
- The limitations of the PPE
- The proper care, maintenance, useful life, and disposal of the PPE

After the training, the employees will demonstrate that they understand how to use PPE properly, or they will be retrained.

The need for retraining will be indicated when:

- an employee's work habits or knowledge indicates a lack of the necessary understanding, motivation, and skills required to use the PPE (i.e., uses PPE improperly)
- new equipment is installed
- changes in the work place make previous training out-of-date
- changes in the types of PPE to be used make previous training out-of-date

8.2.5 Cleaning and Maintenance of PPE

It is important that all PPE be kept clean and properly maintained. Cleaning is particularly important for eye and face protection where dirty or fogged lenses could impair vision. Employees must inspect, clean, and maintain their PPE according to the manufacturers' instructions before and after each use. The CSO and employees are responsible for ensuring that users properly maintain their PPE in good condition.

Personal protective equipment must not be shared between employees until it has been properly cleaned and sanitized. PPE will be distributed for individual use whenever possible.

If employees provide their own PPE, make sure that it is adequate for the work place hazards, and that it is maintained in a clean and reliable condition.

Defective or damaged PPE will not be used and will be immediately discarded and replaced.

NOTE: Defective equipment can be worse than no PPE at all. Employees would avoid a hazardous situation if they knew they were not protected; but they would get closer to the hazard if they erroneously believed they were protected, and therefore would be at greater risk.

It is also important to ensure that contaminated PPE which cannot be decontaminated is disposed of in a manner that protects employees from exposure to hazards.

8.2.6 Safety Disciplinary Policy

ATS believes that a health and safety program is unenforceable without some type of disciplinary policy. Our company believes that in order to maintain a safe and healthful workplace, the employees must be cognizant and aware of all company, State, and Federal health and safety regulations as they apply to the specific job duties required. The following disciplinary policy is in effect and will be applied to all health and safety violations.

The following steps will be followed unless the seriousness of the violation would dictate going directly to Step 2 or Step 3.

1. A first time violation will be discussed orally between company supervision and the employee. This will be done as soon as possible.

2. A second time offense will be followed up in written form and a copy of this written documentation will be entered into the employee's personnel folder.
3. A third time violation will result in time off or possible termination, depending on the seriousness of the violation.

9.0 JOBSITE HOUSEKEPING PROGRAM

It is every employee's responsibility to know and follow ATS Good Housekeeping Guidelines, Safe Work Practices, and promptly report and/or correct hazards at the worksite. Every worker on the site is responsible for safety. We can all do our part to keep the worksite a safer place for ourselves and our coworkers if we remember to clean up as we go and at the end of each shift.

A job site with good housekeeping practices benefits everyone in four important areas:

- A Safe Working Environment
- Productivity
- Equipment Retention & Maintenance
- Client Perception

9.1 Good Housekeeping Guidelines

DO:

- Clean up tools and unused materials after finishing a job or before leaving the job site.
- Frequently gather up and remove debris to keep the work site orderly.
- Keep the work area and all equipment tidy. Designate areas for waste materials and provide containers.
- Plan for the adequate disposal of scrap, waste and surplus materials.
- Place empty containers, pallets, etc. in designated locations.
- Bundle hoses, cables, extension cords, etc… when not in use.
- Report hazards when they are observed and as they develop.
- Ensure that boxes, drums, and piles are located on a firm foundation and properly stacked.
- Store equipment and materials in their assigned location.
- Minimize fire hazards by keeping workplace free of accumulated combustible materials and waste.
- Ensure that exits, aisles, passageways and areas of egress are clear of material, supplies, and obstructions to provide easy routes of travel.
- Place all trash and scrap in proper containers.
- Keep oily rags in covered metal containers.
- Dispose of hazardous materials in approved marked containers.
- Clean up spills promptly according to procedures, using personal protective equipment (PPE) where necessary.

- Dump small containers/boxes into larger ones.
- Keep only enough combustible materials at job site for job at hand.
- Secure loose or light material that is stored on roofs or on open floors.
- Remove or bend over nails protruding from lumber.

DO NOT:

- Do not pile material around fire extinguishers or sprinklers.
- Do not leave clean-up to last few minutes of shift or day.
- Do not clean equipment without "locking out."
- Do not reach into waste containers. Dump contents or remove bag.
- Do not blow off dust with compressed air. Use a vacuum or brush.
- Do not collect broken glass and metal straps in plastic bags.
- Do not use bare hands when collecting waste. Wear gloves to avoid cuts and splinters.
- Do not place materials on stairs.
- Do not use kegs or boxes as chairs or ladders.
- Do not permit rubbish to fall freely from any level of the project. Use chutes or other approved devices to materials.
- Do not throw tools or other materials.
- Do not raise or lower any tool or equipment by its own cable or supply hose.

10.0 CODES OF SAFE WORK PRACTICES

1. All employees of ATS shall follow these safe practice rules, render every possible aid to safe operations, and report all unsafe conditions or practices to the supervisor/employer.

2. Supervisors shall insist that employees observe and obey every rule, regulation, and order necessary to the safe conduct of the work and take such action necessary to obtain compliance.

3. All employees shall be given frequent accident prevention instructions. Instructions, practice drills, and articles concerning workplace health and safety shall be given at least once every 30 working days.

4. No one shall knowingly be permitted or required to work while his or her ability or alertness is impaired by fatigue, illness, or other causes that might expose the individual or others to injury.

5. Employees should be alert to see that all guards and other protective devices are in proper places and adjusted, and they shall report deficiencies. Approved protective equipment shall be worn in specified work areas.

6. Horseplay, and other acts that tend to endanger the safety or well-being of employees are prohibited.

7. Work shall be well planned and supervised to prevent injuries when working with equipment and handling heavy materials. When lifting heavy objects, employees should bend their knees and use the large muscles of the legs instead of the smaller muscles of the back. Back injuries are the most frequent and often the most persistent and painful type of workplace injury.

8. Workers shall not handle or tamper with any electrical equipment, machinery, or air or water lines in a manner not within the scope of their duties, unless they have received instructions from their supervisor/employer.

9. All injuries shall be reported promptly to the supervisor/employer so that arrangements can be made for medical and/or first aid treatment. First aid materials are located in jobsite trailers/containers, and company vehicles; emergency, fire, ambulance, rescue squad, and doctors' telephone numbers are located in jobsite trailers/containers; and fire extinguishers are located at jobsite trailers/containers, and company vehicles.

10. Employees shall not enter manholes, underground vaults, chambers, tanks, silos, or other similar places that receive little ventilation, unless it has been determined that is safe to enter; and they have been so instructed or released to do so by a supervisor.

11. Employees shall be instructed to ensure that all guards and other protective devices are in proper places and adjusted, and shall report deficiencies promptly to the foreman, superintendent, or project manager.

12. Crowding or pushing when boarding or leaving any vehicle or other conveyance shall be prohibited.

13. Inappropriate footwear or shoes with thin or badly worn soles shall not be worn.

14. Materials, tools, or other objects shall not be thrown from buildings or structures until proper precautions are taken to protect others from the falling objects.

15. All Employees shall wear the appropriate Personal Protective Equipment (PPE) at all times.

16. General Safety Rules:

- Do not throw material, tools, or other objects from heights (whether structures or buildings) until proper precautions are taken to protect others from the falling object hazard.
- Wash thoroughly after handling injurious or poisonous substances.
- Gasoline shall not be used for cleaning purposes.
- When using a ladder, always face the steps and use both hands while climbing.

<u>Use of Tools and Equipment</u>

- Do not lift or lower portable electric tools by the power cords; use a rope.
- Do not leave the cords of tools where cars or trucks will run over them.

<u>Machinery and Vehicles</u>

- Do not attempt to operate machinery or equipment without special permission unless it is part of your regular duties.
- Loose or frayed clothing, dangling ties, finger rings, etc., must not be worn around moving machinery or other places where they can get caught.
- Machinery shall not be repaired or adjusted while in operation.

11.0 DRUGS AND ALCOHOL POLICY

11.1 Drug and Weapons Policy

ATS is committed to maintain a safe workplace free from the influence of alcohol and drugs. In addition, the Company will vigorously comply with the requirements of the Drug-Free Workplace Act of 1988. Employees who use illegal drugs or abuse other controlled substances or alcohol, on or off duty, tend to be less productive, less reliable, and prone to greater absenteeism. These result in the potential for increased cost, delay, and the risk in the Company's business. For all these reasons, ATS will not tolerate any drug or alcohol use, which imperils the health and well-being of its employees or threatens its business.

Accordingly, ATS prohibits the following:

- Unauthorized use, possession, manufacture, distribution, dispensation, sale, or attempted sale of a controlled substance or drugs and drug paraphernalia on Company/Client premises, in Company/Client supplied vehicles, or during working hours

- Unauthorized use, manufacture, distribution, dispensation, possession, sale, or attempted sale of alcohol on Company/Client premises, in Company/Client supplied vehicles, or during working hours

- Storing in lockers, desks, automobiles, or other repositories on Company/Client premises any illegal drug, drug paraphernalia, any controlled substance for which use is unauthorized, or any alcohol

- Being under the influence of an unauthorized controlled substance, illegal drug, or alcohol on Company/Client premises, in Company/Client-supplied vehicles, or during working hours

- Use of alcohol off Company/Client premises that adversely affects the employee's work performance, or endangers his/her own or other's safety at work

- Use of illegal drugs off Company/Client premises that adversely affects the employee's work performance, his/her own or others' safety at work

- Refusing to submit to an inspection when requested by management

- Being convicted of a felony, under any criminal drug statute, which reflects on the employee's fitness for employment

- Being convicted, under any criminal drug statute, for a violation occurring in the workplace

- Failing to notify the Company of any arrest or conviction, under any criminal drug statute, within five days of the arrest or conviction

As a condition of employment, it is ATS policy to screen all applicants prior to employment, for alcohol and illegal drugs. In addition, ATS will screen any employee who is reasonably suspected to be in violation of its drug and alcohol policy.

11.2 WEAPONS POLICY

ATS Employees, contractors, sub-contractors, working on the project should ensure they do not bring weapons onto the worksite. Weapons include but are not limited to guns, knives, and explosives.

Failure to comply with the intent of this declaration can result in disciplinary action of up to and including immediate removal from site of the individual involved. Additionally, failure to enforce this declaration could lead to the termination of the contractor's contract.

12.0 DAILY TAILGATE SAFETY MEETINGS

During Mobilization, Operations, and Demobilization of the Stormwater ATS, the Company Safety Officer or delegated substitute will hold a daily toolbox meeting prior to the commencement of any work activities.

Any safety-related issue or problem pertaining to operations will immediately be conveyed to the company safety officer. General construction site safety issues will be conveyed to the site superintendent and Site safety officer.

The meeting will review the general requirements of the HASP, any special site-specific or job- specific requirements, and will discuss any safety-related issues that may have arisen since the previous meeting.

Blank Daily Tailgate Safety Forms and Completed Daily Tailgate Safety Forms can be found in the

13.0 SITE HEALTH AND SAFETY COMPLIANCE

All managers and supervisors are responsible for ensuring that all health and safety policies and procedures are clearly communicated and understood by all employees. Managers and supervisors are also responsible for implementing and maintaining the HASP and for answering worker questions about the HASP. Managers and supervisors are expected to enforce the rules fairly and uniformly. A copy of this program is available to each manager and supervisor in a hard copy and electronic copy form.

ATS field personnel working on-site will maintain vigilance at all times to ensure that the work is conducted in a safe and efficient manner. All employees are responsible for following all directives, policies and procedures, and for assisting in maintaining a safe work environment.

Our system of ensuring that all workers comply with the rules and maintain a safe work environment includes:

- Informing workers of the provisions of ATS HASP
- Informing workers of ATS "codes of safe work practices"
- Evaluating the safety performance of all workers
- Recognizing employees who use safe work practices
- Providing training to workers whose safety performance is deficient
- Disciplining workers for failure to comply with safe and healthful work practices

14.0 LOCK-OUT/TAG-OUT PROGRAM (LOTO)

The purpose of the lock-out/tag-out program (LOTO) is to ensure that persons assigned to tasks requiring the control of hazardous energy are fully trained in the procedures for isolating machines or equipment from energy sources. An energy source may be electrical, hydraulic, pneumatic, mechanical, chemical, or gravitational in nature.

Procedures are necessary to prevent the unintentional operation of equipment that could injure employees or damage property. Lock-out is the preferred method of isolating machines or equipment from energy sources. Tag-out will be used to identify the activities that require the lock-out procedures and will also identify the workers that initiated the lock-out.

14.1 Responsibilities

The Company Safety Officer (CSO) is responsible for directing the implementation of the LOTO program, and periodically reviewing and updating the Program. The CSO or his designated representative will maintain all records pertaining to the Program and will see that new information is passed on to affected personnel. The CSO is also responsible for scheduling health and safety training and ensuring that all field personnel have met the Program training requirements.

Employees involved in maintenance and repair will be instructed as to the significance and necessity of the lock-out/tag-out procedures. Each new or transferred employee whose work operations may involve the use of hazardous energy will be instructed in the purpose and use of the lock-out/tag-out procedures.

14.2 Information and Training

Employees will receive training on the following topics:

- Recognition of hazardous energy sources and methods of energy isolation and control
- Purpose and use of lock-out/tag-out procedures
- Worker and management responsibilities
- Reporting injuries
- First aid procedures
- Accident prevention program

Prior to starting work, each new employee potentially affected by the lock-out/tag-out program will receive lock-out/tag-out training. Retraining of employees may be conducted whenever 1) there is a change in job assignments, 2) there is a change in machinery, equipment, or processes that present new energy hazards and 3) inspections or other events reveal that energy control procedures are inadequate.

14.3 Preparation for Lock-out/Tag-out

The Company Safety Officer will make a survey to identify all energy isolating devices and to be certain that the correct switches, valves, or other energy isolating devices affecting the equipment are locked or tagged. Personnel will be informed of all precautionary measures that must be observed to protect workers during normal operating conditions and during potential emergencies.

14.4 Sequence of Lock-out/Tag-out

The following sequence of activities will be conducted whenever maintenance, repairs, or other work is performed on equipment subject to the release of hazardous energy:

1. Notify all affected employees that a lock-out/tag-out system is going to be utilized, and provide the reason for the lock-out/tag-out. The employees authorized to do the work will be informed of the type and magnitude of energy that the machine or equipment utilizes. The employees must demonstrate an understanding of the potential hazards.
2. If the machine or equipment is operating, shut it down by the normal stopping procedure (e.g., depress the stop button, turn the switch off, etc.).
3. Set the switch, breaker, valve, or other energy isolating device so that the equipment is isolated from the energy source. Stored energy (such as in springs, elevated machine members, flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc.) must be dissipated or restrained by methods such as repositioning, disconnecting, blocking, bleeding pressure, etc.
4. Lock and tag the energy source(s) with assigned locks and appropriately labeled tags. The use of tags without locks is only permissible when it is impossible to physically secure the energy control point. This exception may only be used with the permission of the Responsible Project Safety Officer.

Note: Tags are warning devices and do not provide physical restraint. They must never be ignored and are not to be removed without authorization of the worker that installed the tags.

5. Check the scene to make sure that no personnel are exposed; then attempt to use or operate the equipment as a means of check that all energy sources have been isolated or secured. Check electrical circuits for the presence of high voltage.
6. If there are any doubts or questions about the lock-out procedures, contact the Onsite Supervisor or the Responsible Project Safety Officer.

Tags must be legible and made of a durable material, and must be attached securely.

14.5 Procedures Involving More Than One Person

In the lock-out/tag-out sequence presented above, if more than one individual is required to lock-out/tag-out the equipment, then each individual will place their own lock-out device(s) or tags on the energy isolating apparatus. Where an energy isolating apparatus cannot accept multiple locks, a hasp capable of accepting multiple locks will be affixed to the apparatus.

14.6 Restoring Machines or Equipment to Normal Operations

After the servicing and maintenance is complete and equipment is ready for normal operation, check the area around the machines or equipment to ensure that all tools have been removed, guards have been reinstalled, and all personnel are in the clear. Remove all locks, tags, and deactivate energy isolating devices so that energy is restored to the equipment.

14.7 List of "Don'ts" Related to LOTO Procedures

- Don't count on control circuits to disable equipment
- Don't pull fuses and consider a system safe.
- Don't loan your lock-out lock to anyone.
- Don't forget to check <u>all</u> sources of energy affecting a system.
- Don't hesitate to ask others if you are not sure you have identified all energy sources.
- Don't fail to test the system after lock-out to be sure the power is truly disconnected.
- Don't ever remove the lock-out lock of another worker from an energy isolating device.
- Don't remove guards until equipment is locked out.
- Don't use push-button switches for lock-out.
- Don't assume that a job is too small to merit locking out.
- Don't make exceptions or compromises while performing lockout activities.

15.0 MATERIAL SAFETY DATA SHEETS

15.1 Material Safety Data Sheets are separated into three categories:

1. Mobilization Process
2. Laboratory Chemistry
3. Treatment Chemical

The MSDS for all known chemicals and compounds of concern in relation to the ATS are included by the above categories in the sections which follow.

15.2 Material Safety Data Sheet Table

MSDS Table			
Item	**Product Name**	**Category**	**Used for**
	Iodine	Laboratory Chemistry	Polymer Residual Test
	Buffer Solution, pH 10.0	Laboratory Chemistry	Calibration
	Buffer Solution, pH 4.0	Laboratory Chemistry	Calibration
	Buffer Solution, pH 7.0	Laboratory Chemistry	Calibration
	Conductivity Standard 0.01	Laboratory Chemistry	Calibration
	Electrode Cleaning Solution	Laboratory Chemistry	Calibration
	STABLCAL Formazin Solution <0.1 NTU	Laboratory Chemistry	Calibration
	STABLCAL Formazin Solution 100 NTU	Laboratory Chemistry	Calibration
	STABLCAL Formazin Solution 20 NTU	Laboratory Chemistry	Calibration
	STABLCAL Formazin Solution 800 NTU	Laboratory Chemistry	Calibration
	Turbidity Standard Formazin 1.0 NTU	Laboratory Chemistry	Calibration
	Turbidity Standard Formazin 10.0 NTU	Laboratory Chemistry	Calibration
	Turbidity Standard Formazin 100.0 NTU	Laboratory Chemistry	Calibration
	Turbidity Standard Formazin 1000.0 NTU	Laboratory Chemistry	Calibration
	ChitoVan Stormwater Flocculent HV (1.5%)	Treatment Chemical	Sediment Removal
	Carbon Dioxide Gas	Treatment Chemical	pH Reduction
	Dry Ice - Carbon Dioxide	Treatment Chemical	pH Reduction
	Sodium Bicarbonate	Treatment Chemical	pH Increase
	Sodium Hydroxide	Treatment Chemical	pH Increase
	Sulfuric Acid 30% - 40%	Treatment Chemical	pH Reduction
	PVC Pipe Primer	Mobilization Process	PVC Pipe Plumbing
	PVC Pipe Glue	Mobilization Process	PVC Pipe Plumbing
	Pipe Thread Sealant	Mobilization Process	Plumbing Fitting Sealing
	Diesel Fuel	Mobilization Process	Electrical/Pump Power
	WD-40	Mobilization Process	Equipment Lubrication

15.3 Material Safety Data Sheet Library (See MSDS Attachment)

16.0 FORMS

16.1 Safety Suggestion Form

The guidelines for our company safety program include providing the opportunity for all employees to make suggestions and recommendations concerning health and safety.

Date: _____

Name: _____ (Optional)

Department/Area: _____

Suggestions/Comments: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Response: (available if employee info provided)

_____

_____

Signature: _____

Note: Signature and employee information is optional; however a response is not available if this information is not provided. Return your suggestion form to a Safety Committee member or place in safety suggestion box. Thank you.

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16.2 Incident/Accident Investigation Report

Instructions: Complete this form as soon as possible after an incident that results in serious injury or illness. (Optional: Use to investigate a minor injury or near miss that *could have resulted in a serious injury or illness*.)

This is a report of a: ❑ Death ❑ Lost Time ❑ Dr. Visit Only ❑ First Aid Only ❑ Near Miss	
Date of incident:	This report is made by: ❑ Employee ❑ Supervisor ❑ Team ❑ Final Report

Step 1: Injured employee (complete this part for each injured employee)

Name:	Sex: ❑ Male ❑ Female	Age:
Department:	Job title at time of incident:	
Part of body affected: (shade all that apply)	Nature of injury: (most serious one) ❑ Abrasion, scrapes ❑ Amputation ❑ Broken bone ❑ Bruise ❑ Burn (heat) ❑ Burn (chemical) ❑ Concussion (to the head) ❑ Crushing Injury ❑ Cut, laceration, puncture ❑ Hernia ❑ Illness ❑ Sprain, strain ❑ Damage to a body system: ❑ Other _____	This employee works: ❑ Regular full time ❑ Regular part time ❑ Seasonal ❑ Temporary Months with this employer Months doing this job: (e.g.: nervous, respiratory, or circulatory systems)

Step 2: Describe the incident			
Exact location of the incident:			Exact time:
What part of employee's workday? ❑ Entering or leaving work ❑ Doing normal work activities			
Names of witnesses (if any):			
Number of attachments:	Written witness statements:	Photographs:	Maps / drawings:
What personal protective equipment was being used (if any)?			
Describe, step-by-step the events that led up to the injury. Include names of any machines, parts, objects, tools, materials and other important details.			

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Step 3: Why did the incident happen?	
Unsafe workplace conditions: (Check all that apply) ❑ Inadequate guard ❑ Unguarded hazard ❑ Safety device is defective ❑ Tool or equipment defective ❑ Workstation layout is hazardous ❑ Unsafe lighting ❑ Unsafe ventilation ❑ Lack of needed personal protective equipment ❑ Lack of appropriate equipment / tools ❑ Unsafe clothing ❑ No training or insufficient training ❑ Other: _____	Unsafe acts by people: (Check all that apply) ❑ Operating without permission ❑ Operating at unsafe speed ❑ Servicing equipment that has power to it ❑ Making a safety device inoperative ❑ Using defective equipment ❑ Using equipment in an unapproved way ❑ Unsafe lifting by hand ❑ Taking an unsafe position or posture ❑ Distraction, teasing, horseplay ❑ Failure to wear personal protective equipment ❑ Failure to use the available equipment / tools ❑ Other: _____
Why did the unsafe conditions exist?	
Why did the unsafe acts occur?	
Is there a reward (such as "the job can be done more quickly" or "the product is less likely to be damaged" that may have encouraged the unsafe conditions or acts? ❑ Yes ❑ No If yes, describe:	
Were the unsafe acts or conditions reported prior to the incident? ❑ Yes ❑ No	
Have there been similar incidents or near misses prior to this one?	

Step 4: How can future incidents be prevented?

What changes do you suggest to prevent this injury/near miss from happening again?

❑ Stop this activity ❑ Guard the hazard ❑ Train the employee(s) ❑ Train the supervisor(s)

❑ Redesign task steps ❑ Redesign work station ❑ Write a new policy/rule ❑ Enforce existing policy

❑ Routinely inspect for the hazard ❑ Personal Protective Equipment ❑ Other: _____

What should be (or has been) done to carry out the suggestion(s) checked above?

Description continued on attached sheets: ❑

Step 5: Who completed and reviewed this form? (Please Print)	
Written by:	Title:
Names of investigation team members:	
Reviewed by:	Title: Date:

Blank Page

16.3 Safety Tailgate Meeting Form

Active Treatment Systems, Inc.

SAFETY MEETING RECORD

_____ _____

Person(s) Conducting **Date**

_____ _____

Location **Time**

Attendees:

CONTENT

What was the main topic: _____

_____

What was the subtopics/Safety rules reviewed? _____

_____

What questions or concerns were expressed? _____

_____

_____

Material Safety Data Sheet

Aqua Solutions
6913 Highway 225
Deer Park, TX 77536

Phone (281) 479-2569
Chemtrec 800-424-9300
24 Hour Emergency Assistance

Section 1 Identification

Product Number:	1525
Product Name:	Buffer Solution, pH 10.0 (Blue) Traceable to N.I.S.T.
Trade/ Chemical Synonyms	
Formula:	N/A
RTECS:	None
C.A.S	See Below

Health:	1
Flammability	0
Reactivity	0

Hazard Rating:

Least	Slight	Moderate	High	Extreme
0	1	2	3	4

NA = Not Applicable NE = Not Established

Section 2 Component Mixture

Sara 313	Component	CAS Number	%	Dim	Exposure Limits:
☐	Water, Deionized ASTM Type II	CAS# 7732-18-5	Balance	V/V	None Established
☐	Bromothymol Blue Sodium Salt	CAS# 34722-90-2	<0.01%	W/V	None established
☐	Sodium Bicarbonate	CAS# 144-55-8	0.21%	W/V	None Established
☐	Sodium Carbonate Anhydrous	CAS# 497-19-8	0.26%	W/V	None Established

Section 3 Hazard Identification (Also see section 11)

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

Section 4 First Aid Measures

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

FIRST AID: SKIN: Wash exposed area with soap and water. If irritation persists, seek medical attention.

EYES: Wash eyes with plenty of water for at least 15 minutes, lifting lids occasionally. Seek Medical Aid. INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen

INGESTION: Give several glasses of water. Vomiting may occur, but it is not necessary to induce.

Section 5 Fire Fighting Measures

Section 6 Accidental Release Measures

Absorb spill with inert material. Flush excess down drain.

Section 7 Handling and Storage

Store in a cool dry place. This Material is not considered hazardous. Handle using safe laboratory practices.

Section 8 Exposure Controls & Personal Protection

Respiratory Protection:None required

Ventilation:

Mechanical: ☐

Local Exhaust: ☑

Hand Protection: Gloves to prevent skin exposure as latex or vinyl

Eye Protection: Splash Goggles

Other Protective Equipment: Use safe laboratory handling procedures.

Section 9 Physical and Chemical Properties

Melting Point:	~0°C	Specific Gravity	~1
Boiling Point:	~100°C	Percent Volatile by Volume:	>98
Vapor Pressure:	Information not available	Evaporation Rate:	Information not available
Vapor Density:	Information not available	Evaporation Standard:	
Solubility in Water:	Soluble	Auto ignition Temperature:	Not applicable
Appearance and Odor:	Clear, blue, odorless liquid	Lower Flamm. Limit in Air:	Not applicable
Flash Point:	Not flammable	Upper Flamm. Limit in Air:	Not applicable

Section 10 Stability and Reactivity Information

Fire Extinguisher Type:	Any means suitable for extinguishing surrounding fire
Fire/Explosion Hazards:	None
Fire Fighting Procedure:	Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and clothing.

Stability: Stable

Conditions to Avoid: High Temperature

Materials to Avoid:
None known

Hazardous Decomposition Products:
None known

Hazardous Polymerization:Will Not Occur

Condition to Avoid:None known

Section 11 Additional Information

Overexposure symptoms. Acute: Essentially non-hazardous. Possible irritation of eyes/stomach. Chronic: None known. Conditions aggravated/ Target organs: none known.

DOT Classification: Not regulated

DOT regulations may change from time to time. Please consult the most recent version of the relevant regulations.

Revision No:0.1	Date Entered: 9/1/2006	Approved by: WPF

The information contained herein is believed to be accurate and is offered in good faith for the user's consideration and investigation. No warranty is expressed or implied regarding the completeness or accuracy of this information, whether originating from Aqua Solutions, Inc. or from an alternate source. Users of this material should satisfy themselves by independent investigation of current scientific and medical information that this material may be safely handled.

Material Safety Data Sheet

Aqua Solutions
6913 Highway 225
Deer Park, TX 77536

Phone (281) 479-2569
Chemtrec 800-424-9300
24 Hour Emergency Assistance

Section 1 Identification

Product Number:	1460
Product Name:	Buffer Solution, pH 4 (Red) Traceable to N.I.S.T.
Trade/ Chemical Synonyms	
Formula:	N/A
RTECS:	None
C.A.S	See Below

Health:	1
Flammability	0
Reactivity	0

Hazard Rating:

Least	Slight	Moderate	High	Extreme
0	1	2	3	4

NA = Not Applicable NE = Not Established

Section 2 Component Mixture

Sara 313	Component	CAS Number	%	Dim	Exposure Limits:
☐	Water, Deionized ASTM Type II	CAS# 7732-18-5	Balance	V/V	None Established
☐	Methyl Red Sodium Salt	CAS# 845-10-3	< 0.01%	W/V	None Established
☐	Potassium Hydrogen Phthalate	CAS# 877-24-7	1.02%	W/V	TXDS: orl-rat LD•: 3200 mg/Kg
☐	Thymol Crystal	CAS# 89-83-8	0.01%	W/V	TXDS: orl-rat LD•: 640 mg/Kg

Section 3 Hazard Identification (Also see section 11)

May be harmful if swallowed. May cause irritation. Avoid breathing vapors, or dusts. Use with adequate ventilation. Avoid contact with eyes, skin, and clothes. Wash thoroughly after handling. Keep container closed.

Section 4 First Aid Measures

May be harmful if swallowed. May cause irritation. Avoid breathing vapors, or dusts. Use with adequate ventilation. Avoid contact with eyes, skin, and clothes. Wash thoroughly after handling. Keep container closed.

FIRST AID: SKIN: Wash exposed area with soap and water. If irritation persists, seek medical attention.

EYES: Wash eyes with plenty of water for at least 15 minutes, lifting lids occasionally. Seek Medical Aid. INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen

INGESTION: If swallowed, induce vomiting immediately after giving two glasses of water. Never give anything by mouth to an unconscious person.

Section 5 Fire Fighting Measures

Section 6 Accidental Release Measures

Absorb spill with inert material. Flush excess down drain.

Section 7 Handling and Storage

Store in a cool dry place. This Material is not considered hazardous. Handle using safe laboratory practices.

Section 8 Exposure Controls & Personal Protection

Respiratory Protection:None required

Ventilation:

Mechanical: ☐

Local Exhaust: ☑

Hand Protection: Gloves to prevent skin exposure as latex or vinyl

Eye Protection: Safety Glasses w/Side Shields

Other Protective Equipment: Use safe laboratory handling procedures.

Section 9 Physical and Chemical Properties

Melting Point:	~0° C	Specific Gravity	~1
Boiling Point:	~100° C	Percent Volatile by Volume:	> 99%
Vapor Pressure:	Information not available	Evaporation Rate:	Information not available
Vapor Density:	Information not available	Evaporation Standard:	
Solubility in Water:	Soluble	Auto ignition Temperature:	Not applicable
Appearance and Odor:	Clear red solution/ Slight benzoic acid odor	Lower Flamm. Limit in Air:	Not applicable
Flash Point:	not flammable	Upper Flamm. Limit in Air:	Not applicable

Section 10 Stability and Reactivity Information

Fire Extinguisher Type:	Any means suitable for extinguishing surrounding fire
Fire/Explosion Hazards:	None
Fire Fighting Procedure:	Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and clothing.

Stability: Stable

Conditions to Avoid: High temperature, air

Materials to Avoid:
Strong acids and bases

Hazardous Decomposition Products:
Not known to occur

Hazardous Polymerization:Will Not Occur

Condition to Avoid:None known

Section 11 Additional Information

Overexposure symptoms. Acute: Essentially non-hazardous. Possible irritation of eyes/stomach. Chronic: None known. Conditions aggravated/ Target organs: none known.

DOT Classification: Not Regulated

DOT regulations may change from time to time. Please consult the most recent version of the relevant regulations.

Revision No:0.2	Date Entered: 9/1/2006	Approved by: WPF

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Material Safety Data Sheet

Aqua Solutions
6913 Highway 225
Deer Park, TX 77536

Phone (281) 479-2569
Chemtrec 800-424-9300
24 Hour Emergency Assistance

Section 1 Identification

Product Number:	1500
Product Name:	Buffer Solution, pH 7 (Yellow) Traceable to N.I.S.T.
Trade/ Chemical Synonyms	
Formula:	N/A
RTECS:	None
C.A.S	See Below

Health:	1
Flammability	0
Reactivity	0

Hazard Rating:

Least	Slight	Moderate	High	Extreme
0	1	2	3	4

NA = Not Applicable NE = Not Established

Section 2 Component Mixture

Sara 313	Component	CAS Number	%	Dim	Exposure Limits:
☐	Water, Deionized ASTM Type II	CAS# 7732-18-5	Balance	V/V	None Established
☐	Potassium Phosphate Monobasic	CAS# 7778-77-0	0.68%	W/V	None Established
☑	Sodium Hydroxide	CAS# 1310-73-2	0.01%	W/V	OSHA PEL 2 mg/mƒ ACGIH 2mg/mƒ

Section 3 Hazard Identification (Also see section 11)

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

Section 4 First Aid Measures

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

FIRST AID: SKIN: Wash exposed area with soap and water. If irritation persists, seek medical attention.

EYES: Wash eyes with plenty of water for at least 15 minutes, lifting lids occasionally. Seek Medical Aid. INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen

INGESTION: If swallowed, induce vomiting immediately after giving two glasses of water. Never give anything by mouth to an unconscious person.

Section 5 Fire Fighting Measures

Fire Extinguisher Type:	Any means suitable for extinguishing surrounding fire
Fire/Explosion Hazards:	None
Fire Fighting Procedure:	Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and clothing.

Section 6 Accidental Release Measures

Absorb spill with inert material. Flush excess down drain.

Section 7 Handling and Storage

Store in a cool dry place. This Material is not considered hazardous. Handle using safe laboratory practices.

Section 8 Exposure Controls & Personal Protection

Respiratory Protection:None required

Ventilation:

Mechanical: ☐

Local Exhaust: ☑

Hand Protection: Gloves to prevent skin exposure as latex or vinyl

Eye Protection: Splash Goggles

Other Protective Equipment: Use safe laboratory handling procedures.

Section 9 Physical and Chemical Properties

Melting Point:	~0°C	Specific Gravity	~1
Boiling Point:	~100°C	Percent Volatile by Volume:	>98
Vapor Pressure:	Information not available	Evaporation Rate:	Information not available
Vapor Density:	Information not available	Evaporation Standard:	
Solubility in Water:	Soluble	Auto ignition Temperature:	Not applicable
Appearance and Odor:	Clear, yellow, odorless liquid	Lower Flamm. Limit in Air:	Not applicable
Flash Point:	Not flammable	Upper Flamm. Limit in Air:	Not applicable

Section 10 Stability and Reactivity Information

Stability: Stable	Conditions to Avoid: High temperatures

Materials to Avoid:
Concentrated Acids and Bases, Water reactive materials.

Hazardous Decomposition Products:
None known

Hazardous Polymerization:Will Not Occur

Condition to Avoid:None known

Section 11 Additional Information

Conditions aggravated/target organs: None known. Acute: Essentially non-hazardous. Possible irritation of eyes/stomach. Chronic: none known.

DOT Classification: Not Regulated

DOT regulations may change from time to time. Please consult the most recent version of the relevant regulations.

Revision No:0.1	Date Entered: 9/1/2006	Approved by: WPF

The information contained herein is believed to be accurate and is offered in good faith for the user's consideration and investigation. No warranty is expressed or implied regarding the completeness or accuracy of this information, whether originating from Aqua Solutions, Inc. or from an alternate source. Users of this material should satisfy themselves by independent investigation of current scientific and medical information that this material may be safely handled.

BOC GASES

MATERIAL SAFETY DATA SHEET

PRODUCT NAME: CARBON DIOXIDE, GAS

1. Chemical Product and Company Identification

BOC Gases,
Division of
The BOC Group, Inc.
575 Mountain Avenue
Murray Hill, NJ 07974

TELEPHONE NUMBER: (908) 464-8100
24-HOUR EMERGENCY TELEPHONE NUMBER:
CHEMTREC (800) 424-9300

BOC Gases
Division of
BOC Canada Limited
5975 Falbourne Street, Unit 2
Mississauga, Ontario L5R 3W6

TELEPHONE NUMBER: (905) 501-1700
24-HOUR EMERGENCY TELEPHONE NUMBER:
(905) 501-0802
EMERGENCY RESPONSE PLAN NO: 20101

PRODUCT NAME: CARBON DIOXIDE, GAS
CHEMICAL NAME: Carbon Dioxide
COMMON NAMES/SYNONYMS: Carbonic Anhydride
TDG (Canada) CLASSIFICATION: 2.2
WHMIS CLASSIFICATION: A

PREPARED BY: Loss Control (908)464-8100/(905)501-1700
PREPARATION DATE: 6/1/95
REVIEW DATES: 6/7/96

2. Composition, Information on Ingredients

INGREDIENT	% VOLUME	PEL-OSHA[1]	TLV-ACGIH[2]	LD_{50} or LC_{50} Route/Species
Carbon Dioxide FORMULA: CO_2 CAS: 124-38-9 RTECS #: FF6400000	99.8 TO 99.999	5000 ppm TWA	5000 ppm TWA 30,000 ppm STEL	Not Available

[1] As stated in 29 CFR 1910, Subpart Z (revised July 1, 1993)
[2] As stated in the ACGIH 1994-95 Threshold Limit Values for Chemical Substances and Physical Agents

3. Hazards Identification

EMERGENCY OVERVIEW

Oxygen levels below 19.5% may cause asphyxia. Carbon dioxide exposure can cause nausea and respiratory problems. High concentrations may cause vasodilation leading to circulatory collapse.

ROUTE OF ENTRY:

Skin Contact	Skin Absorption	Eye Contact	Inhalation	Ingestion
Yes	No	Yes	Yes	Yes

HEALTH EFFECTS:

Exposure Limits	Irritant	Sensitization
Yes	No	No
Teratogen	Reproductive Hazard	Mutagen
No	No	No
Synergistic Effects None reported		

Carcinogenicity: -- NTP: No IARC: No OSHA: No

EYE EFFECTS:
No adverse effects anticipated.

SKIN EFFECTS:
No adverse effects anticipated.

INGESTION EFFECTS:
No adverse effects anticipated.

INHALATION EFFECTS:
Carbon dioxide is the most powerful cerebral vasodilator known. Inhaling large concentrations causes rapid circulatory insufficiency leading to coma and death. Asphyxiation is likely to occur before the effects of carbon dioxide overexposure. Chronic, harmful effects are not known from repeated inhalation of low concentrations. Low concentrations of carbon dioxide cause increased respiration and headache.

Effects of oxygen deficiency resulting from simple asphyxiants may include: rapid breathing, diminished mental alertness, impaired muscular coordination, faulty judgement, depression of all sensations, emotional instability, and fatigue. As asphyxiation progresses, nausea, vomiting, prostration, and loss of consciousness may result, eventually leading to convulsions, coma, and death.

Oxygen deficiency during pregnancy has produced developmental abnormalities in humans and experimental animals.

NFPA HAZARD CODES	HMIS HAZARD CODES	RATINGS SYSTEM
Health: 1	Health: 1	0 = No Hazard
Flammability: 0	Flammability: 0	1 = Slight Hazard
Reactivity: 0	Reactivity: 0	2 = Moderate Hazard
		3 = Serious Hazard
		4 = Severe Hazard

4. First Aid Measures

EYES:
Never introduce oil or ointment into the eyes without medical advice! If pain is present, refer the victim to an ophthalmologist for further treatment and follow up.

SKIN:
No adverse effects anticipated.

INGESTION:
Not anticipated.

INHALATION:
PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVEREXPOSURE TO CARBON DIOXIDE. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS. Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, given mouth-to-mouth resuscitation and supplemental oxygen. Further treatment should be symptomatic and supportive.

5. Fire Fighting Measures

Conditions of Flammability: Nonflammable		
Flash point: None	Method: Not Applicable	Autoignition Temperature: None
LEL(%): None	UEL(%): None	
Hazardous combustion products: None		
Sensitivity to mechanical shock: None		
Sensitivity to static discharge: None		

FIRE AND EXPLOSION HAZARDS:
None. Nonflammable

6. Accidental Release Measures

Evacuate all personnel from affected area. Use appropriate protective equipment. If leak is in user's equipment, be certain to purge piping with inert gas prior to attempting repairs. If leak is in container or container valve, contact the appropriate emergency telephone number listed in Section 1 or call your closest BOC location.

7. Handling and Storage

Electrical Classification:
Non-Hazardous

Dry carbon dioxide can be handled in most common structural materials. Moist carbon dioxide is generally corrosive by its formation of carbonic acid. For applications with moist Carbon Dioxide, 316, 309 and 310 stainless steels may be used as well as Hastelloy ® A, B, & C, and Monel ®. Ferrous Nickel alloys are slightly susceptible to corrosion. At normal temperatures carbon dioxide is compatible with most plastics and elastomers.

Use only in well-ventilated areas. Carbon dioxide vapor is heavier than air and will accumulate in low areas. Valve protection caps must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a pressure reducing regulator when connecting cylinder to lower pressure (<3000 psig) piping or systems. Do not heat cylinder by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into the system.

Protect cylinders from physical damage. Store in cool, dry, well-ventilated area away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are stored to exceed 125°F (52°C). Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Full and empty cylinders should be segregated. Use a "first in-first out" inventory system to prevent full cylinders being stored for excessive periods of time.

For additional storage recommendations, consult Compressed Gas Association's Pamphlet P-1.

Never carry a compressed gas cylinder or a container of a gas in cryogenic liquid form in an enclosed space such as a car trunk, van or station wagon. A leak can result in a fire, explosion, asphyxiation or a toxic exposure.

Maximum use for potable water 100 mg/l.

8. Exposure Controls, Personal Protection

EXPOSURE LIMITS[1]:

INGREDIENT	% VOLUME	PEL-OSHA[2]	TLV-ACGIH[3]	LD_{50} or LC_{50} Route/Species
Carbon Dioxide FORMULA: CO_2 CAS: 124-38-9 RTECS #: FF6400000	99.8 TO 99.999	5000 ppm TWA	5000 ppm TWA 30,000 ppm STEL	Not Available

[1] Refer to individual state of provincial regulations, as applicable, for limits which may be more stringent than those listed here.
[2] As stated in 29 CFR 1910, Subpart Z (revised July 1, 1993)
[3] As stated in the ACGIH 1994-1995 Threshold Limit Values for Chemical Substances and Physical Agents.

IDLH (Carbon Dioxide): 50,000 ppm

ENGINEERING CONTROLS:
Use local exhaust to prevent accumulation of high concentrations so as to reduce the oxygen level in the air to less than 19.5% and the carbon dioxide concentration below the exposure limit.

EYE/FACE PROTECTION:
Safety goggles or glasses as appropriate for the job.

SKIN PROTECTION:
Protective gloves of any material appropriate for the job.

RESPIRATORY PROTECTION:

Positive pressure air line with full-face mask and escape bottle or self-contained breathing apparatus should be available for emergency use.

OTHER/GENERAL PROTECTION:
Safety shoes.

9. Physical and Chemical Properties

PARAMETER	VALUE	UNITS
Physical state (gas, liquid, solid)	: Gas	
Vapor pressure at 70 ^{o}F	: 856	psia
Vapor density at 70 ^{o}F, 1 atm (Air = 1)	: 1.53	
Evaporation point	: Not Available	
Boiling point (CO2 Sublimes)	: -109.3	^{o}F
	: -78.5	^{o}C
Freezing point	: -69.8	^{o}F
	: -56.6	^{o}C
pH	: Not Available	
Specific gravity	: Not Available	
Oil/water partition coefficient	: Not Available	
Solubility (H20)	: Very soluble	
Odor threshold	: Not Applicable	
Odor and appearance	: A colorless, odorless gas.	

10. Stability and Reactivity

STABILITY:
Stable

INCOMPATIBLE MATERIALS:
Certain reactive metals, hydrides, moist cesium monoxide, or lithium acetylene carbide diammino may ignite. Passing carbon dioxide over a mixture of sodium peroxide and aluminum or magnesium may explode.

HAZARDOUS DECOMPOSITION PRODUCTS:
Carbon monoxide and oxygen when heated above 3092 ^{o}F (1700°C). Carbonic acid is formed in the presence of moisture.

HAZARDOUS POLYMERIZATION:
Will not occur.

11. Toxicological Information

REPRODUCTIVE:
Oxygen deficiency during pregnancy has produced developmental abnormalities in humans and experimental animals.

Exposure of female rats to 60,000 ppm carbon dioxide for 24 hours has produced toxic effects to the embryo and fetus in pregnant rats. Toxic effects to the reproductive system have been observed in other mammalian species at similar concentrations.

OTHER:

Carbon dioxide is the most powerful cerebral vasodilator known. Inhaling large concentrations causes rapid circulatory insufficiency leading to coma and death. Chronic, harmful effects are not known from repeated inhalation of low (3 to 5 molar %) concentrations.

12. Ecological Information

No data given.

13. Disposal Considerations

Do not attempt to dispose of residual waste or unused quantities. Return in the shipping container PROPERLY LABELED, WITH ANY VALVE OUTLET PLUGS OR CAPS SECURED AND VALVE PROTECTION CAP IN PLACE to BOC Gases or authorized distributor for proper disposal.

14. Transport Information

PARAMETER	United States DOT	Canada TDG
PROPER SHIPPING NAME:	Carbon Dioxide	Carbon Dioxide
HAZARD CLASS:	2.2	2.2
IDENTIFICATION NUMBER:	UN 1013	UN 1013
SHIPPING LABEL:	NONFLAMMABLE GAS	NONFLAMMABLE GAS

15. Regulatory Information

SARA TITLE III NOTIFICATIONS AND INFORMATION

SARA TITLE III HAZARD CLASSES:
Acute Health Hazard
Sudden Release of Pressure Hazard

16. Other Information

Compressed gas cylinders shall not be refilled without the express written permission of the owner. Shipment of a compressed gas cylinder which has not been filled by the owner or with his/her (written) consent is a violation of transportation regulations.

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES:
Although reasonable care has been taken in the preparation of this document, we extend no warranties and make no representations as to the accuracy or completeness of the information contained herein, and assume no responsibility regarding the suitability of this information for the user's intended purposes or for the consequences of its use. Each individual should make a determination as to the suitability of the information for their particular purpose(s).

MATERIAL SAFETY DATA SHEET

Dungeness Development Associates, Inc.

1. Product Name/Identification

ChitoVan™ Stormwater Flocculent HV

2. Composition

Active Ingredient: Chitosan	CAS # 90-12-76-4
Chemical name(s):	chitosan, acetic acid, and balance water
Source:	n/a

3. Physical/Chemical Properties

Appearance and Odor:	Clear to pale yellow viscous liquid with a pungent vinegar odor.
Solubility:	Completely soluble in water at pH < 6.5 and precipitates at pH > 6.5
Specific Gravity:	1.0 to 1.1
Boiling Point:	211^0F
pH:	3.9 to 4.1

4. Toxicological Data

Acute oral, LD50 (mice)	>16 g/kg

5. Fire and Explosion Hazard Data

Flash Point:	n/a
Flammability:	Non-flammable
Unusual Fire and Explosion Hazards:	In the form of a water solution, there is no danger of fire or explosion.
Fire Fighting Media:	Use water or foam (not flammable in nature)

6. Health Hazards Information

Acute Health Effects – Signs and Symptoms of Exposure, Emergency and First Aid Procedures:	Eye Contact: ChitoVan is mildly irritating to eyes. Flush with water for 15 minutes to remove and call a physician. Skin Contact: ChitoVan is not hazardous but cleansing the skin after use is advisable. Inhalation: if large amounts of fumes are inhaled remove to fresh air and call a physician. Ingestion: If swallowed, no specific intervention is indicated as the compound is not likely to be hazardous by ingestion. However, consult a physician if necessary.
Potential Chronic Health Effects:	n/a
Carcinogenicity:	n/a

7. Personal Protective Equipment

Respiratory Protection:	Not required, neither are local or mechanical exhausts.
Protective Gloves:	Rubber gloves are recommended.
Eye Protection:	Safety glasses are recommended.
Other Protective Clothing:	Not needed.

8. Regulatory

TSCA:	Not listed on the TSCA inventory.
OSHA:	Not considered hazardous.
RCRA	Under RCRA, it is the responsibility of the product user to determine at the time of disposal, whether a waste material containing the product, or derived from the product should be classified as a hazardous waste.
EPA:	Exempt from EPA code.

SARA Section 302:	Does not have an RQ or TPQ.
SARA Section 313:	Not reportable under Section 313.

9. Storage, Handling and Disposal

Storage:	10-50^{0}C recommended (will freeze at ~3^{0}C). Shelf life is indefinite but viscosity will decrease over time. The container should be kept closed to prevent contamination.
Usage Shelf-life	After 18 months from date of manufacture product must be retested to determine usability. Date of manufacture can be found on all storage containers.
For Spills of ChitoVan:	Utilize protective clothing. Dilute with water and hose down.
Waste Disposal Method:	Land disposal is acceptable as the compound is biodegradable. Follow local, state and federal regulations.
Work/Hygiene Practices:	Follow good hygienic and housekeeping practices. Clean up areas where Liqui-Floc was used.

10. Transportation Information

DOT Shipping Name:	Chitosan Acetate
Technical Shipping Name:	Chitosan Acetate
DOT Hazard Class	Class 55
Product RQ (lbs):	None
DOT Label:	None
DOT Placard:	None required
Product Label:	ChitoVan

11. Stability and Reactivity

Chemical Family:	Natural polysaccharide
Stability:	Stable minimum 18 months
Hazardous Polymerization:	Polymerization will not occur.
Incompatibility:	Incompatible with strong oxidants and strong bases.
Decomposition:	Decomposition will not occur.
Instability Conditions:	Stable at normal temperatures and storage conditions.
Decomposition Temperature:	211^{0}F (will boil)
Decomposition Products:	H_2O and chitosan acetate salt (clear film).

Ecological Information

Prepared by: Dungeness Development Associates– Revised 10/06

This information is furnished without warranty, expressed or implied, except that it is accurate to the best knowledge of Dungeness Development. The data on this MSDS relates only to the specific material designated herein. Dungeness Development assumes no legal responsibility for use or reliance upon these data.
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Material Safety Data Sheet

Aqua Solutions
6913 Highway 225
Deer Park, TX 77536

Phone (281) 479-2569
Chemtrec 800-424-9300
24 Hour Emergency Assistance

Section 1 Identification

Product Number:	6920
Product Name:	Conductivity Standard 0.01 Molar Traceable to N.I.S.T.
Trade/ Chemical Synonyms	
Formula:	N/A
RTECS:	None
C.A.S	See Below

Health:	1
Flammability	0
Reactivity	0

Hazard Rating:

Least	Slight	Moderate	High	Extreme
0	1	2	3	4

NA = Not Applicable NE = Not Established

Section 2 Component Mixture

Sara 313	Component	CAS Number	%	Dim	Exposure Limits:
☐	Water, Deionized ASTM Type II	CAS# 7732-18-5	Balance	V/V	None Established
☐	Potassium Chloride	CAS# 7447-40-7	<1%	W/V	None Established

Section 3 Hazard Identification (Also see section 11)

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

Section 4 First Aid Measures

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

FIRST AID: SKIN: Wash exposed area with soap and water. If irritation persists, seek medical attention.

EYES: Wash eyes with plenty of water for at least 15 minutes, lifting lids occasionally. Seek Medical Aid. INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen

INGESTION: Give several glasses of milk or water. Vomiting may occur spontaneously, but DO NOT INDUCE! Never give anything by mouth to an unconscious person.

Section 5 Fire Fighting Measures

Section 6 Accidental Release Measures

Absorb spill with inert material. Flush excess down drain.

Section 7 Handling and Storage

This Material is not considered hazardous. Handle using safe laboratory practices.

Section 8 Exposure Controls & Personal Protection

Respiratory Protection:None required

Ventilation:

Mechanical: ☐

Local Exhaust: ☑

Hand Protection: Wear appropriate gloves to prevent skin exposure

Eye Protection: Safety Glasses w/ Side Shields

Other Protective Equipment: None required

Section 9 Physical and Chemical Properties

Melting Point:	~0° C	Specific Gravity	1
Boiling Point:	~100° C	Percent Volatile by Volume:	>99%
Vapor Pressure:	N/E	Evaporation Rate:	N/A
Vapor Density:	information not available	Evaporation Standard:	Not Applicable
Solubility in Water:	Soluble	Auto ignition Temperature:	N/A
Appearance and Odor:	Clear water white / no odor	Lower Flamm. Limit in Air:	N/A
Flash Point:	N/A	Upper Flamm. Limit in Air:	N/A

Section 10 Stability and Reactivity Information

Fire Extinguisher Type:	Any means suitable for extinguishing surrounding fire
Fire/Explosion Hazards:	None
Fire Fighting Procedure:	Use any means suitable for extinguishing surrounding fire. Use water spray cool fire exposed containers.

Stability: Stable

Conditions to Avoid: Protect from freezing.

Materials to Avoid:
None

Hazardous Decomposition Products:
Not known to occur.

Hazardous Polymerization:Will Not Occur

Condition to Avoid:None known

Section 11 Additional Information

Conditions aggravated/target organs: Persons with preexisting skin, eye or respiratory disorders may be more susceptible. Acute: Essentially non-hazardous. Possible eye and digestive tract irritation. Chronic: None known.

DOT Classification: Not Regulated

DOT regulations may change from time to time. Please consult the most recent version of the relevant regulations.

Revision No:0	Date Entered: 9/1/2006	Approved by: WPF

The information contained herein is believed to be accurate and is offered in good faith for the user's consideration and investigation. No warranty is expressed or implied regarding the completeness or accuracy of this information, whether originating from Aqua Solutions, Inc. or from an alternate source. Users of this material should satisfy themselves by independent investigation of current scientific and medical information that this material may be safely handled.

Material Safety Data Sheet

Carbon Dioxide (Dry Ice)

Section 1. Chemical product and company identification

Product name : Carbon Dioxide (Dry Ice)

Supplier : AIRGAS INC., on behalf of its subsidiaries
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

Synonym : carbonice ; dry ice 6

MSDS # : 001091

Date of Preparation/Revision : **12/12/2008.**

In case of emergency : 1-866-734-3438

Section 2. Hazards identification

Physical state : Solid. [WHITE SNOW-LIKE SOLID]

Emergency overview : WARNING!
MAY CAUSE TARGET ORGAN DAMAGE, BASED ON ANIMAL DATA.
May cause target organ damage, based on animal data.

Target organs : May cause damage to the following organs: cardiovascular system, upper respiratory tract, skin.

Potential acute health effects

Eyes : No known significant effects or critical hazards.

Skin : Extremely cold material. Can cause burns similar to frostbite.

Inhalation : Acts as a simple asphyxiant.

Ingestion : No known significant effects or critical hazards.

Potential chronic health effects : **CARCINOGENIC EFFECTS**: Not available.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.

Medical conditions aggravated by over-exposure : Pre-existing disorders involving any target organs mentioned in this MSDS as being at risk may be aggravated by over-exposure to this product.

See toxicological information (section 11)

Section 3. Composition, Information on Ingredients

United States

			Exposure limits
carbon dioxide	124-38-9	100	**ACGIH TLV (United States, 1/2008).** STEL: 54000 mg/m³ 15 minute(s). STEL: 30000 ppm 15 minute(s). TWA: 9000 mg/m³ 8 hour(s). TWA: 5000 ppm 8 hour(s). **NIOSH REL (United States, 6/2008).** STEL: 54000 mg/m³ 15 minute(s). STEL: 30000 ppm 15 minute(s). TWA: 9000 mg/m³ 10 hour(s). TWA: 5000 ppm 10 hour(s). **OSHA PEL (United States, 11/2006).** TWA: 9000 mg/m³ 8 hour(s). TWA: 5000 ppm 8 hour(s). **OSHA PEL 1989 (United States, 3/1989).** STEL: 54000 mg/m³ 15 minute(s). STEL: 30000 ppm 15 minute(s). TWA: 18000 mg/m³ 8 hour(s).

Carbon Dioxide (Dry Ice)
TWA: 10000 ppm 8 hour(s).

Section 4. First aid measures

Eye contact : Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately.

Skin contact : In case of contact, immediately flush skin with plenty of water. Remove contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention.
Frostbite : Try to warm up the frozen tissues and seek medical attention.

Inhalation : Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Ingestion : Wash out mouth with water. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Section 5. Fire fighting measures

Flammability of the product : Non-flammable.

Products of combustion : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Extinguishing media

Suitable : Use an extinguishing agent suitable for the surrounding fire.

Not suitable : None known.

Special exposure hazards : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

No specific fire or explosion hazard.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment (see section 8).

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods for cleaning up : Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor. Note: see section 1 for emergency contact information and section 13 for waste disposal.

Section 7. Handling and storage

Handling : Wash thoroughly after handling. Use with adequate ventilation.

Storage : Keep container closed. Keep container in a cool, well-ventilated area.

Section 8. Exposure controls/personal protection

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment.

Engineering measures : No special ventilation requirements. Good general ventilation should be sufficient to control worker exposure to airborne contaminants. If this product contains ingredients with exposure limits, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure below any recommended or statutory limits.

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal protection

Eyes : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or dusts.

Skin : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory : Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Hands : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Insulated gloves suitable for low temperatures

Personal protection in case of a large spill : Self-contained breathing apparatus (SCBA) should be used to avoid inhalation of the product.

Product name	Exposure limits
United States	
carbon dioxide	**ACGIH TLV (United States, 1/2008).** STEL: 54000 mg/m³ 15 minute(s). STEL: 30000 ppm 15 minute(s). TWA: 9000 mg/m³ 8 hour(s). TWA: 5000 ppm 8 hour(s). **NIOSH REL (United States, 6/2008).** STEL: 54000 mg/m³ 15 minute(s). STEL: 30000 ppm 15 minute(s). TWA: 9000 mg/m³ 10 hour(s). TWA: 5000 ppm 10 hour(s). **OSHA PEL (United States, 11/2006).** TWA: 9000 mg/m³ 8 hour(s). TWA: 5000 ppm 8 hour(s). **OSHA PEL 1989 (United States, 3/1989).** STEL: 54000 mg/m³ 15 minute(s). STEL: 30000 ppm 15 minute(s). TWA: 18000 mg/m³ 8 hour(s). TWA: 10000 ppm 8 hour(s).

Section 9. Physical and chemical properties

Physical state : Solid. [WHITE SNOW-LIKE SOLID]

Color : WHITE

Molecular weight : 44.01 g/mole

Molecular formula : C-O2

Melting/freezing point : Sublimation temperature: -78.5°C (-109.3°F)

Critical temperature : 31°C (87.8°F)

Specific gravity : 1.56 (Water = 1)

Section 10. Stability and reactivity

Stability and reactivity : The product is stable.

Incompatibility with various substances : Not considered to be reactive according to our database.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Toxicity data

Product/ingredient name	Result	Species	Dose	Exposure
carbon dioxide	LC50 Inhalation Gas.	Rat	470000 ppm	30 minutes

IDLH : 40000 ppm

Chronic effects on humans : May cause damage to the following organs: cardiovascular system, upper respiratory tract, skin.

Other toxic effects on humans : No specific information is available in our database regarding the other toxic effects of this material to humans.

Specific effects

Carcinogenic effects : No known significant effects or critical hazards.

Mutagenic effects : No known significant effects or critical hazards.

Reproduction toxicity : No known significant effects or critical hazards.

Section 12. Ecological information

Aquatic ecotoxicity

Not available.

Products of degradation : Products of degradation: carbon oxides (CO, CO_2).

Section 13. Disposal considerations

Waste disposal : The generation of waste should be avoided or minimized wherever possible. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe way. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Product removed from the cylinder must be disposed of in accordance with appropriate Federal, State, local regulation.Return cylinders with residual product to Airgas, Inc.Do not dispose of locally.

Section 14. Transport information

Regulatory information	UN number	Proper shipping name	Class	Packing group	Label	Additional information
DOT Classification	UN1845	CARBON DIOXIDE, SOLID OR DRY ICE	9	III		**Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: 200 kg

Carbon Dioxide (Dry Ice)						
						Cargo aircraft Quantity limitation: 200 kg
TDG Classification	UN1845	CARBON DIOXIDE, SOLID; OR DRY ICE	9	III		**Explosive Limit and Limited Quantity Index** 5 **Passenger Carrying Ship Index** 200 **Special provisions** 18
Mexico Classification	UN1845	CARBON DIOXIDE, SOLID OR DRY ICE	9	III		**Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: 200 kg **Cargo aircraft** Quantity limitation: 200 kg

Section 15. Regulatory information

United States

HCS Classification : Target organ effects

U.S. Federal regulations : **United States inventory (TSCA 8b):** This material is listed or exempted.

SARA 302/304/311/312 extremely hazardous substances: No products were found.
SARA 302/304 emergency planning and notification: No products were found.
SARA 302/304/311/312 hazardous chemicals: carbon dioxide
SARA 311/312 MSDS distribution - chemical inventory - hazard identification: carbon dioxide: Immediate (acute) health hazard, Delayed (chronic) health hazard

Clean Water Act (CWA) 307: No products were found.

Clean Water Act (CWA) 311: No products were found.

Clean Air Act (CAA) 112 accidental release prevention: No products were found.

Clean Air Act (CAA) 112 regulated flammable substances: No products were found.

Clean Air Act (CAA) 112 regulated toxic substances: No products were found.

Carbon Dioxide (Dry Ice)

State regulations : **Connecticut Carcinogen Reporting:** This material is not listed.
Connecticut Hazardous Material Survey: This material is not listed.
Florida substances: This material is not listed.
Illinois Chemical Safety Act: This material is not listed.
Illinois Toxic Substances Disclosure to Employee Act: This material is not listed.
Louisiana Reporting: This material is not listed.
Louisiana Spill: This material is not listed.
Massachusetts Spill: This material is not listed.
Massachusetts Substances: This material is listed.
Michigan Critical Material: This material is not listed.
Minnesota Hazardous Substances: This material is not listed.
New Jersey Hazardous Substances: This material is listed.
New Jersey Spill: This material is not listed.
New Jersey Toxic Catastrophe Prevention Act: This material is not listed.
New York Acutely Hazardous Substances: This material is not listed.
New York Toxic Chemical Release Reporting: This material is not listed.
Pennsylvania RTK Hazardous Substances: This material is listed.
Rhode Island Hazardous Substances: This material is not listed.

Canada

WHMIS (Canada) : Class A: Compressed gas.
CEPA Toxic substances: This material is listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is not listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

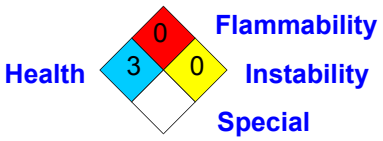
Section 16. Other information

Label requirements : MAY CAUSE TARGET ORGAN DAMAGE, BASED ON ANIMAL DATA.

Hazardous Material Information System (U.S.A.) :

Health	*	3
Flammability		0
Physical hazards		0

National Fire Protection Association (U.S.A.) :



Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

MSDS

Material Safety Data Sheet

Section 1: Chemical Product and Company Identification

Catalog Number: 2794	
Product Identity: ELECTRODE CLEANING SOLUTION	
Manufacturer's Name: RICCA CHEMICAL COMPANY LLC	**Emergency Contact(24 hr) --** CHEMTREC® Domestic: 800-424-9300 International: 703-527-3887
CAGE Code: 0V553	
Address: 448 West Fork Dr Arlington, TX 76012	**Telephone Number For Information:** 817-461-5601
Date Prepared: 4/7/99	**Revision:** 2 Last Revised: 09/10/2001 Date Printed: 06/14/2007 4:37:52 pm

Section 2. Composition/Information on Ingredients

Component	CAS Registry #	Concentration	ACGIH TLV	OSHA PEL
Hydrochloric Acid	7647-01-0	<1	C 5 ppm C 7.5 mg/m3	C 5 ppm C 7 mg/m3
Water, Deionized	7732-18-5	Balance	Not Available Not Available	Not Available Not Available
Pepsin	9001-75-6	0.9-1.1	Not Available Not Available	Not Available Not Available

Section 3: Hazard Identification

Emergency Overview: Does not present any significant health hazards. May cause irritation and allergic reaction. Wash areas of contact with water. If swallowed, give large amounts of water. Do not induce vomiting. Call a physician if necessary.

Target Organs: eyes, skin, respiratory system.

Eye Contact: May cause irritation, redness, pain, and tearing.

Inhalation: May cause irritation.

Skin Contact: May cause slight irritation.

Ingestion: Large doses may cause nausea, vomiting and diarrhea.

Chronic Effects/Carcinogenicity: None

IARC - Hydrochloric Acid is unclassifiable as to carcinogenicity to humans.

NTP - No.

OSHA - No.

Reproductive Information: Reproductive effects cited in 'Registry of Toxic Effects of Chemical Substances' for Hydrochloric Acid.

Teratology (Birth Defect) Information: Mutation data cited in 'Registry of Toxic Effects of Chemical Substances' for Hydrochloric Acid. Mutation data cited in 'Registry of Toxic Effects of Chemical Substances' for Pepsin.

Section 4: First Aid Measures - In all cases, seek qualified evaluation.

Eye Contact: Irrigate immediately with large quantity of water for at least 15 minutes. Call a physician if irritation develops.

Inhalation: Remove to fresh air. Give artificial respiration if necessary. If breathing is difficult, give oxygen.

Skin Contact: Flush with plenty of water for at least 15 minutes. Call a physician if irritation develops.

Ingestion: Dilute with water or milk. Call a physician if necessary.

Section 5: Fire Fighting Measures

Flash Point: Not Available.

Method Used: Not Available.

LFL: Not Available.

UFL: Not Available.

Extinguishing Media: Use any means suitable for extinguishing surrounding fire.

Fire & Explosion Hazards: Not considered to be a fire or explosion hazard.

Fire Fighting Instructions: Use normal procedures/instructions.

Fire Fighting Equipment: Use protective clothing and breathing equipment appropriate for the surrounding fire.

Section 6: Accidental Release Measures

Cover the spill with Sodium Carbonate or a soda ash-slaked lime mixture (50:50). Mix and add water to form slurry. Decant the liquid to the drain with excess water. Treat the solid residue as normal refuse. Wash site with soda ash solution. Always dispose of in accordance with local regulations.

Section 7. Handling and Storage

As with all chemicals, wash hands thoroughly after handling. Avoid contact with eyes and skin. Protect from freezing and physical damage. Store in the refrigerator.

Safety Storage Code: General

Section 8: Exposure Control/Personal Protection

Engineering Controls: No specific controls are needed. Normal room ventilation is adequate.

Respiratory Protection: Normal room ventilation is adequate.

Skin Protection: Chemical resistant gloves.

Eye Protection: Safety glasses or goggles.

Section 9: Physical and Chemical Properties

Appearance: Pale yellow liquid

Odor: Odorless to slightly pungent

Solubility in Water: Infinite

Specific Gravity: Approximately 1

pH: Approximately 1

Boiling Point(°C): Approximately 100

Melting Point(°C): Approximately 0

Vapor Pressure: Not Applicable.

Section 10: Stability and Reactivity

Chemical Stability: Stable under normal conditions of use and storage.

Incompatibility: Most metals, Alkalis, active metals, Cyanides, Sulfides, Sulfites, Metal Oxides, Formaldehyde, strong Oxidizers, salts of heavy metals, Tannins.

Hazardous Decomposition Products: Fumes of Hydrogen Chloride and Hydrogen in contact with metals, Chlorine gas from Oxidizers. Carbon Monoxide, Carbon Dioxide and Nitrogen Oxides may be produced in a fire.

Hazardous Polymerization: Will not occur.

Section 11. Toxicological Information

LD50, Oral, Rabbit (Hydrochloric Acid) 900 mg/kg; Details of toxic effects not reported other than lethal dose value. LCLo, inhalation, human: 3000 ppm/5 minutes: No toxic effects noted. Pepsin is investigated as a mutagen.

Section 12. Ecological Information

Ecotoxicological Information: Hydrogen Chloride has slight acute and chronic toxicity to aquatic life.
Chemical Fate Information: Virtually 100% of Hydrogen Chloride will eventually end up in the air.

Section 13. Disposal Considerations

Cover the spill with Sodium Carbonate or a soda ash-slaked lime mixture (50:50). Mix and add water to form slurry. Decant the liquid to the drain with excess water. Treat the solid residue as normal refuse. Always dispose of in accordance with local, state and federal regulations.

Section 14. Transport Information

Part Numbers:

This product is not regulated.

Section 15. Regulatory Information (Not meant to be all inclusive - selected regulation represented)

OSHA Status: The above items either do not contain any specifically hazardous material or the potentially hazardous material is present in such low concentration that the items do not present any immediate threat to health and safety. These items do not meet the OSHA Hazard Communication Standard (29 CFR 1910.1200) definition of a hazardous material.
TSCA Status: All components of this solution are listed on the TSCA Inventory or are mixtures (hydrates) of items listed on the TSCA Inventory.

Sara Title III:

Section 302 Extremely Hazardous Substances: Not Applicable.
Section 311/312 Hazardous Catagories: Acute: Yes Chronic, Fire, Pressure, Reactivity: No
Section 313 Toxic Chemicals: Not Applicable.

California: None Reported.
Pennsylvania: Hydrochloric Acid is listed as an Environmental Hazard on the state's Hazardous Substances List.
RCRA Status: Not Applicable.
CERCLA Reportable Quantity: Hydrochloric Acid - 5,000 pounds.

WHMIS: Not Applicable.

Section 16. Other Information

NFPA Ratings:

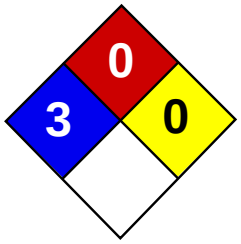
Health: 1	Flammability: 0	Reactivity: 0	Special Notice Key:None

HMIS Ratings:

Health: 1	Flammability: 0	Reactivity: 0	Protective Equipment:B (Protective Eyewear, Gloves)

Rev 1, 9-21-2000: Reformatted from WordPerfect® to Microsoft Word®; (Section 1) Revised emergency telephone number to CHEMTREC® 800-424-9300; (Section 2) revised exposure limits from mg/m3 to ppm; (Section 3) added IARC classification for Hydrochloric Acid, added mutation data citation for Hydrochloric Acid; (Section 6) added neutralization information; (Section 7) added storage code.
Rev 2, 10-09-2001: Reformatted to electronic data format.

When handled properly by qualified personnel, the product described herein does not present a significant health or safety hazard. Alteration of its characteristics by concentration, evaporation, addition of other substances, or other means may present hazards not specifically addressed herein and which must be evaluated by the user. The information furnished herein is believed to be accurate and represents the best data currently available to us. No warranty, expressed or implied, is made and RICCA CHEMICAL COMPANY assumes no legal responsibility or liability whatsoever resulting from its use.



Health	3
Fire	0
Reactivity	0
Personal Protection	J

Material Safety Data Sheet
Iodine MSDS

Section 1: Chemical Product and Company Identification

Product Name: Iodine

Catalog Codes: SLI1513

CAS#: 7553-56-2

RTECS: NN1575000

TSCA: TSCA 8(b) inventory: Iodine

CI#: Not available.

Synonym:

Chemical Name: Iodine

Chemical Formula: I2

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Iodine	7553-56-2	100

Toxicological Data on Ingredients: Iodine: ORAL (LD50): Acute: 14000 mg/kg [Rat]. 22000 mg/kg [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Hazardous in case of skin contact (corrosive), of eye contact (corrosive). Slightly hazardous in case of skin contact (permeator). The amount of tissue damage depends on length of contact. Eye contact can result in corneal damage or blindness. Skin contact can produce inflammation and blistering. Inhalation of dust will produce irritation to gastro-intestinal or respiratory tract, characterized by burning, sneezing and coughing. Severe over-exposure can produce lung damage, choking, unconsciousness or death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance is toxic to thyroid. The substance may be toxic to blood, kidneys, liver, skin, eyes. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure of the eyes to a low level of dust can produce eye irritation. Repeated skin exposure can produce local skin destruction, or dermatitis. Repeated inhalation of dust can produce varying degree of respiratory irritation or lung damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. WARM water MUST be used. Get medical attention immediately.

Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: Not applicable.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:
Ignition on contact with bromine, ... chlorine trifluoride, ...metals (powdered) + water, aluminum-titanium alloys + heat, metal acetylides, ... nonmetals, ... sodium phosphinate. Incandescent reaction with cesium oxide (above 150 deg C), bromine trifluoride, metal acetylides or carbides [e.g. barium acetylide (above 122 deg C), calcium acetylide (above 305 deg C), strontium acetylide (above 182 deg C), zirconium acetylide (above 400 degC)]. Magnesium burns vigorously when heated with iodine vapor. Iodine unites with fluorine at ordinary temperature with a luminous flame

Special Remarks on Explosion Hazards:
Explosive reactions with iodine and: hafnium powder + heat; tetraamine copper (II) sulfate + ethanol; trioxygen difluoride; polyacetylene (at 113 deg. C); potassium; sodium; butadiene+ ethanol +mercuric oxide;

Section 6: Accidental Release Measures

Small Spill: Use appropriate tools to put the spilled solid in a convenient waste disposal container.

Large Spill:
Corrosive solid. Stop leak if without risk. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep container dry. Do not ingest. Do not breathe dust. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, metals.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 25°C (77°F).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection:
Splash goggles. Synthetic apron. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor and dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
STEL: 1 (mg/m3) from ACGIH (TLV) [United States] STEL: 0.1 (ppm) from ACGIH (TLV) [United States] TWA: 1 CEIL: 1 (mg/m3) from OSHA (PEL) [United States] TWA: 0.1 CEIL: 0.1 (ppm) from OSHA (PEL) [United States] STEL: 0.1 (ppm) [United Kingdom (UK)] STEL: 1.1 (mg/m3) [United Kingdom (UK)]Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid.

Odor: Sharp Characteristic. (Strong.)

Taste: Not available.

Molecular Weight: 253.81 g/mole

Color: Purple solid with metalic luster. (Dark.)

pH (1% soln/water): Not available.

Boiling Point: 184.4°C (363.9°F)

Melting Point: 113.7°C (236.7°F)

Critical Temperature: Not available.

Specific Gravity: 4.93 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: The product is more soluble in oil; log(oil/water) = 2.5

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, methanol, diethyl ether.

Solubility:
Easily soluble in diethyl ether. Soluble in methanol. Very slightly soluble in cold water, hot water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Heat, direct sunlight, incompatible materials

Incompatibility with various substances: Reactive with oxidizing agents, reducing agents, metals.

Corrosivity:
Extremely corrosive in presence of steel, of stainless steel(304), of stainless steel(316). Non-corrosive in presence of glass, of aluminum, of copper.

Special Remarks on Reactivity:
Incompatible with liquid chlorine, acetaldehyde, ammonia, salt + ethanol, ammonium hydroxide, methyl alcohol, antimony, silver azide, lithium, potasssium , sodium, phosphorous, bromine pentafluoride, fluorine, oxygen difluoride, magnesium, finely divided metals, organic solvents, rubber goods, plastics, zinc, aluminum, alkali metals, sulphur, ammonia solutions, Bromine trifluoride, reducing agents, iron, ethanol + butadiene; ethanol + phosphorous; ethanol + methanol + HgO; foramide + pyrindine + sulfur trioxide; formamide; halogens or interhalogens; mercuric oxide; metal carbides; oxygen; pyridine; sodium hydride. Violent reaction with iodine and aluminum + diethyl ether ... (and) titanium (above 113 deg C)

Special Remarks on Corrosivity:
Corrodes steel. No corrosive effect on bronze

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.

Toxicity to Animals: Acute oral toxicity (LD50): 14000 mg/kg [Rat].

Chronic Effects on Humans:
Causes damage to the following organs: thyroid. May cause damage to the following organs: blood, kidneys, liver, skin, eyes.

Other Toxic Effects on Humans:
Very hazardous in case of skin contact (irritant), of ingestion, of inhalation. Hazardous in case of skin contact (corrosive), of eye contact (corrosive). Slightly hazardous in case of skin contact (permeator).

Special Remarks on Toxicity to Animals:
Lowest Published Lethal Dose: LDL [Human] - Route: Oral; Dose: 28 mg/kg LCL [Rat] - Route: Inhalation; Dose: 137 ppm/1H

Special Remarks on Chronic Effects on Humans: May cause adverse reproductive effects (effects on new born).

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: Corrosive action skin. Causes skin irritation and burns. It is corrosive and can cause penetrating lesions and brown staining. It can be absorbed by the skin. Eyes: Causes eye irritation and burns. May cause conjunctivitis. Exposure to vapor can cause burning sensation in the eyes, tearing, inflammation of the eye lids. Exposure

to high concentrations of vapor can cause Dendritic Keratitis in which the corneal epithelium is sloughed off. Inhalation: Excessive inhalation of iodine vapors may cause respiratory tract, nasal, and mucous membrane irritation with possible burns. Symptoms may include coughing, tightness in the chest, burning sensations to the mucosal, tracheal, and pulmonary tissues, rhinitis, dyspnea/respiratory distress, coughing, sneezing, pulmonary edema, chemical pneumonitis, edema of the larynx and bronchi, pharyngitis, swelling of the parotid gland, and cachexia. High exposure may lead to lung disease and may also affect behavior/central nervous system (delirium, hallucination, depression, seizure, dizziness, headache, stupor, somnolence). Ingestion: Ingestion of large doses may cause irritation of mouth of the digestive tract with thirst, nausea, vomiting, abdominal pain, hypermotility, and diarrhea, staining of mouth, esophagus, lips, mucous membranes, metallic taste, abdominal pain, fever. It ma y also affect the cardiovascular system (tachycardia, hypotension, cardiovascular collapse), behavior/central nervous system(delirium, dizziness, headache, hallucinations, seizures,

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

Identification: : Corrosive Solid, n.o.s (Iodine) UNNA: 1759 PG: III

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Illinois toxic substances disclosure to employee act: Iodine Rhode Island RTK hazardous substances: Iodine Pennsylvania RTK: Iodine Minnesota: Iodine Massachusetts RTK: Iodine Massachusetts spill list: Iodine New Jersey: Iodine California Director's List of Hazardous Substances: Iodine TSCA 8(b) inventory: Iodine

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS D-2A: Material causing other toxic effects (VERY TOXIC). CLASS E: Corrosive solid.

DSCL (EEC):
R38- Irritating to skin. R41- Risk of serious damage to eyes. S2- Keep out of the reach of children. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S39- Wear eye/face protection. S46- If swallowed, seek medical advice immediately and show this container or label.

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 0

Personal Protection: j

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 0

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Synthetic apron. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/11/2005 12:09 PM

Last Updated: 11/06/2008 12:00 PM

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GARDENA, CA
NEW BRUNSWICK, NJ

Material Safety Data Sheet

NFPA	HMIS	Personal Protective Equipment
	Health Hazard 1 Fire Hazard 0 Reactivity 0	 See Section 15.

Section 1. Chemical Product and Company Identification

Common Name/ Trade Name	**Sodium bicarbonate**	**Catalog Number(s).**	YY622, YY742, YY1191, YY1155, S1145, S1147, S1148, SO125
		CAS#	144-55-8
Manufacturer	SPECTRUM LABORATORY PRODUCTS INC. 14422 S. SAN PEDRO STREET GARDENA, CA 90248	**RTECS**	VZ0950000
		TSCA	TSCA 8(b) inventory: Sodium bicarbonate
Commercial Name(s)	Baking Soda	**CI#**	Not available.
Synonym	Bicarbonate of soda; Sodium acid carbonate; Monosodium carbonate; Sodium hydrogen carbonate; Carbonic acid monosodium salt	**IN CASE OF EMERGENCY CHEMTREC (24hr) 800-424-9300** CALL (310) 516-8000	
Chemical Name	Sodium Bicarbonate		
Chemical Family	Not available.		
Chemical Formula	NaHCO3		
Supplier	SPECTRUM LABORATORY PRODUCTS INC. 14422 S. SAN PEDRO STREET GARDENA, CA 90248		

Section 2.Composition and Information on Ingredients

		Exposure Limits			
Name	**CAS #**	**TWA (mg/m^3)**	**STEL (mg/m^3)**	**CEIL (mg/m^3)**	**% by Weight**
1) Sodium bicarbonate	144-55-8				100

Toxicological Data on Ingredients Not applicable.

Section 3. Hazards Identification

Potential Acute Health Effects Slightly hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation.

Potential Chronic Health Effects

CARCINOGENIC EFFECTS: Not available.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
Repeated or prolonged exposure is not known to aggravate medical condition.

Continued on Next Page

Section 4. First Aid Measures

Eye Contact	Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention if irritation occurs.
Skin Contact	Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops. Cold water may be used.
Serious Skin Contact	Not available.
Inhalation	If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Serious Inhalation	Not available.
Ingestion	Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.
Serious Ingestion	Not available.

Section 5. Fire and Explosion Data

Flammability of the Product	Non-flammable.
Auto-Ignition Temperature	Not applicable.
Flash Points	Not applicable.
Flammable Limits	Not applicable.
Products of Combustion	Not available.
Fire Hazards in Presence of Various Substances	Not applicable.
Explosion Hazards in Presence of Various Substances	Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.
Fire Fighting Media and Instructions	Not applicable.
Special Remarks on Fire Hazards	When heated to decomposition it emits acrid smoke and irritating fumes.
Special Remarks on Explosion Hazards	Not available.

Section 6. Accidental Release Measures

Small Spill	Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.
Large Spill	Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

Continued on Next Page

Section 7. Handling and Storage

Precautions	Do not ingest. Do not breathe dust. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as acids.
Storage	Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.
Personal Protection	Safety glasses. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.
Personal Protection in Case of a Large Spill	Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.
Exposure Limits	Not available.

Section 9. Physical and Chemical Properties

Physical state and appearance	Solid.	**Odor**	Odorless.
Molecular Weight	84.01g/mole	**Taste**	Saline. Alkaline.
pH (1% soln/water)	Not available.	**Color**	White.

Boiling Point	Not available.
Melting Point	Not available.
Critical Temperature	Not available.
Specific Gravity	Density: 2.159 (Water = 1)
Vapor Pressure	Not applicable.
Vapor Density	Not available.
Volatility	Not available.
Odor Threshold	Not available.
Water/Oil Dist. Coeff.	Not available.
Ionicity (in Water)	Not available.
Dispersion Properties	See solubility in water.
Solubility	Soluble in cold water. Slightly soluble in alcohol. Solubility in Water: 6.4, 7.6, 8.7, 10.0, 11.3, 12.7, 14.2, 16.5, 19.1 g/100 solution at 0, 10, 20, 30, 40, 50, 60, 80, adn 100 deg. C, respectively. Solubility in Water: 6.9, 8,2, 9.6, 11.1, 12.7, 14.5, 16.5, 19.7, and 23.6 g/100g water at 0, 10, 20, 30, 40, 50, 60, 80, 100 deg. C, respectively.

Continued on Next Page

Section 10. Stability and Reactivity Data

Stability	The product is stable.
Instability Temperature	Not available.
Conditions of Instability	Incompatible materials, Moisture. Stable in dry air, but slowly decomposes in moist air.
Incompatibility with various substances	Reactive with acids.
Corrosivity	Non-corrosive in presence of glass.
Special Remarks on Reactivity	Reacts with acids to form carbon dioxide. Dangerous reaction with monoammonium phosphate or a sodium-potassium alloy.
Special Remarks on Corrosivity	Not available.
Polymerization	Will not occur.

Section 11. Toxicological Information

Routes of Entry	Inhalation. Ingestion.
Toxicity to Animals	Acute oral toxicity (LD50): 3360 mg/kg [Mouse].
Chronic Effects on Humans	Not available.
Other Toxic Effects on Humans	Slightly hazardous in case of skin contact (irritant), of ingestion, of inhalation.
Special Remarks on Toxicity to Animals	Not available.
Special Remarks on Chronic Effects on Humans	Sodium Bicarbonate as produced genetic effects in rats (unscheduled DNA synthesis). However, no affects have been found in humans.
Special Remarks on other Toxic Effects on Humans	Acute Potential Health Effects: Skin: May cause mild skin irritation. Eyes: May cause mild eye irritation. Inhalation: May cause respiratory tract irritation. Symptoms may include coughing and sneezing. Ingestion: Symptoms of overexposure to Sodium Bicarbonate include thirst, abdominal pain, gastroenteritis, and inflammation of the digestive tract. Chronic Potential Health Effects: Skin: Repeated or prolonged skin contact may cause irritation, drying or cracking of the skin. Ingestion and Inhalation: Chronic toxicity usually occurs within 4 to 10 days following ingestion of very large amounts. Repeated or prolonged ingestion or inhalation of large amounts may cause metabolic abnormalities, and sodium retention. Metabolic abnormalities such as acidosis, hypernatremia, hypochloremia, alkalosis, hypocalcemia, or sodium retention may affect the blood, kidneys, respiration (cyanosis, apnea secondary to metabolic acidosis or pulmonary edema), and cardiovascular system (tachycardia, hypotension). Severe toxicity may also affect behavior/central nervous system/nervous system. Neurological changes may result from metabolic abnormalities. These may include fatigue, irritability, dizziness, mental confusion, paresthesia, seizures, tetany, cerebral edema Medical Conditions Aggravated by Exposure: Persons with pre-existing skin conditions might have increased sensitivity. Predisposing conditions that contribute to a mild alkali syndrome include, renal disease, dehydration, adn electrolyte imbalance, hypertension, sarcoidosis, congestive heart failure, edema, or other sodium retaining conditions.

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Section 12. Ecological Information

Ecotoxicity	Not available.
BOD5 and COD	Not available.
Products of Biodegradation	Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the Products of Biodegradation	The product itself and its products of degradation are not toxic.
Special Remarks on the Products of Biodegradation	Not available.

Section 13. Disposal Considerations

Waste Disposal	Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14. Transport Information

DOT Classification	Not a DOT controlled material (United States).
Identification	Not applicable.
Special Provisions for Transport	Not applicable.
DOT (Pictograms)	

Section 15. Other Regulatory Information and Pictograms

Federal and State Regulations	TSCA 8(b) inventory: Sodium bicarbonate FDA: Direct Food Additives GRAS (21CFR184): Listed as Sodium Bicarbonate. FDA: Everything Added to Food in the United States (EAFUS): Listed as Sodium Bicarbonate
California Proposition 65 Warnings	California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer which would require a warning under the statute: No products were found. California prop. 65: This product contains the following ingredients for which the State of California has found to cause birth defects which would require a warning under the statute: No products were found.
Other Regulations	EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances (EINECS No. 205-633-8). Canada: Listed on Canadian Domestic Substance List (DSL). China: Listed on National Inventory. Japan: Listed on National Inventory (ENCS). Korea: Listed on National Inventory (KECI). Philippines: Listed on National Inventory (PICCS). Australia: Listed on AICS.
Other Classifications	**WHMIS (Canada)** Not controlled under WHMIS (Canada). **DSCL (EEC)** This product is not classified according to the EU regulations. Not applicable.

Continued on Next Page

HMIS (U.S.A.)

Health Hazard	1
Fire Hazard	0
Reactivity	0
Personal Protection	E

National Fire Protection Association (U.S.A.)

Health

Flammability

Reactivity

Specific hazard

WHMIS (Canada) (Pictograms)

DSCL (Europe) (Pictograms)

TDG (Canada) (Pictograms)

ADR (Europe) (Pictograms)

Protective Equipment

Gloves.

Lab coat.

Dust respirator. Be sure to use an approved/certified respirator or equivalent.

Safety glasses.

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Section 16. Other Information

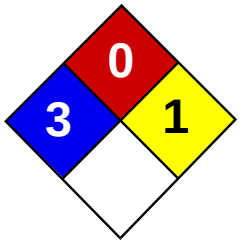
MSDS Code	**S3660**
References	Not available.
Other Special Considerations	Not available.

Validated by Sonia Owen on 1/2/2007.	**Verified by Sonia Owen.** **Printed 1/2/2007.**

CALL (310) 516-8000

Notice to Reader

All chemicals may pose unknown hazards and should be used with caution. This Material Safety Data Sheet (MSDS) applies only to the material as packaged. If this product is combined with other materials, deteriorates, or becomes contaminated, it may pose hazards not mentioned in this MSDS. It shall be the user's responsibility to develop proper methods of handling and personal protection based on the actual conditions of use. While this MSDS is based on technical data judged to be reliable, Spectrum Quality Products, Inc. assumes no responsibility for the completeness or accuracy of the information contained herein.



Health	3
Fire	0
Reactivity	1
Personal Protection	

Material Safety Data Sheet
Sodium Hydroxide, 50% MSDS

Section 1: Chemical Product and Company Identification

Product Name: Sodium Hydroxide, 50%

Catalog Codes: SLS3127, SLS4549

CAS#: Mixture.

RTECS: Not applicable.

TSCA: TSCA 8(b) inventory: Sodium hydroxide; Water

CI#: Not applicable.

Synonym: Sodium Hydroxide, 50% Solution

Chemical Name: Not applicable.

Chemical Formula: Not applicable.

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Sodium hydroxide	1310-73-2	50
Water	7732-18-5	50

Toxicological Data on Ingredients: Sodium hydroxide LD50: Not available. LC50: Not available.

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, . Slightly hazardous in case of inhalation (lung sensitizer). Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance is toxic to lungs. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation

leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Get medical attention immediately. Finish by rinsing thoroughly with running water to avoid a possible infection.

Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:
If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: Not applicable.

Explosion Hazards in Presence of Various Substances: Non-explosive in presence of open flames and sparks, of shocks.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards:
Sodium hydroxide reacts to form explosive products with ammonia + silver nitrate. Benzene extract of allyl benzenesulfonate prepared from allyl alcohol, and benzene sulfonyl chloride in presence of aquesous sodium hydroxide, under vacuum distillation, residue darkened and exploded. Sodium Hydroxde + impure tetrahydrofuran, which can contain peroxides, can cause serious explosions. Dry mixtures of sodium hydroxide and sodium tetrahydroborate liberate hydrogen explosively at 230-270 deg. C. Sodium Hydroxide reacts with sodium salt of trichlorophenol + methyl alcohol + trichlorobenzene + heat to cause an explosion. (Sodium hydroxide)

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of acetic acid.

Large Spill:
Corrosive liquid. Poisonous liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of acetic acid. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, metals, acids, alkalis, moisture.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value.

Personal Protection:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
Sodium hydroxide STEL: 2 (mg/m3) from ACGIH (TLV) [United States] TWA: 2 CEIL: 2 (mg/m3) from OSHA (PEL) [United States] CEIL: 2 (mg/m3) from NIOSHConsult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Odorless.

Taste: Alkaline. Bitter. (Strong.)

Molecular Weight: Not applicable.

Color: Clear Colorless.

pH (1% soln/water): Basic.

Boiling Point: 140°C (284°F)

Melting Point: 12°C (53.6°F)

Critical Temperature: Not available.

Specific Gravity: 1.53 (Water = 1)

Vapor Pressure: The highest known value is 2.3 kPa (@ 20°C) (Water).

Vapor Density: The highest known value is 0.62 (Air = 1) (Water).

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility: Easily soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Excess heat, incompatible materials, water/moisture

Incompatibility with various substances:
Reactive with oxidizing agents, reducing agents, metals, acids, alkalis. Slightly reactive with water

Corrosivity:
Extremely corrosive in presence of aluminum, brass. Corrosive in presence of copper, of stainless steel(304), of stainless steel(316). Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Hygroscopic. Much heat is evolved when solid material is dissolved in water. Therefore cold water and caution must be used for this process. Generates considerable heat when a sodium hydroxide solution is mixed with an acid Sodium hydroxide solution and octanol + diborane during a work-up of a reaction mixture of oxime and diborane in tetrahyrofuran is very exothermic, a mild explosion being noted on one occassion. Reactive with water, acids (mineral, non-oxidizing, e.g. hydrochloric, hydrofluoric acid, muriatic acid, phosphoric), acids (mineral, oxidizing e.g. chromic acid, hypochlorous acid, nitric acid, sulfuric acid), acids (organic e.g. acetic acid, benzoic acid, formic acid, methanoic acid, oxalic acid), aldehydes (e.g. acetaldehyde, acrolein, chloral hydrate, foraldehyde), carbamates (e.g. carbanolate, carbofuran), esters (e.g. butyl acetate, ethyl acetate, propyl formate), halogenated organics (dibromoethane, hexachlorobenzene, methyl chloride, trichloroethylene), isocyanates (e.g. methyl isocyanate), ketones (acetone, acetophenone, MEK, MIBK), acid chlorides, strong bases, strong oxidizing agents, strong reducing agents, flammable liquids, powdered metals and metals (i.e aluminum, tin, zinc, hafnium, raney nickel), metals (alkali and alkaline e.g. cesium, potassium, sodium), metal compounds (toxic e.g. berylium, lead acetate, nickel carbonyl, tetraethyl lead), mitrides (e.g. potassium nitride, sodium nitride), nitriles (e.g. acetonitrile, methyl cyanide), nitro compounds (organic e.g. nitrobenzene, nitromethane), acetic anhydride, hydroquinone, chlorohydrin, chlorosulfonic acid, ethylene cyanohydrin, glyoxal, hydrosulfuric acid, oleum, propiolactone, acylonitrile, phorosous pentoxide, chloroethanol, chloroform-methanol, tetrahydroborate, cyanogen azide, 1,2,4,5 tetrachlorobenzene, cinnamaldehyde. Reacts with formaldehyde hydroxide to yield formic acid, and hydrogen. (Sodium hydroxide)

Special Remarks on Corrosivity: Very caustic to aluminum and other metals in presence of moisture.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation.

Toxicity to Animals:
LD50: Not available. LC50: Not available.

Chronic Effects on Humans: Not available.

Other Toxic Effects on Humans:
Extremely hazardous in case of inhalation (lung corrosive). Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (corrosive), of ingestion, .

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Investigation as a mutagen (cytogenetic analysis), but no data available. (Sodium hydroxide)

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: May be harmful if absorbed through skin. Causes severe skin irritation and burns. May cause deep penetrating ulcers of the skin. Eyes: Causes severe eye irritation and burns. May cause chemical conjunctivitis and corneal damage. Inhalation: Harmful if inhaled. Causes severe irritation of the respiratory tract and mucous membranes with coughing, burns, breathing difficulty, and possible coma. Irritation may lead the chemical pneumonitis and pulmonary edema. Causes chemical burns to the respiratory tract and mucous membranes. Ingestion: May be fatal if swallowed. May cause severe and permanent damage to the digestive tract. Causes

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

Identification: : Sodium hydroxide, solution (Sodium hydroxide) UNNA: UN1824 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Illinois toxic substances disclosure to employee act: Sodium hydroxide Illinois chemical safety act: Sodium hydroxide New York release reporting list: Sodium hydroxide Rhode Island RTK hazardous substances: Sodium hydroxide Pennsylvania RTK: Sodium hydroxide Minnesota: Sodium hydroxide Massachusetts RTK: Sodium hydroxide New Jersey: Sodium hydroxide Louisiana spill reporting: Sodium hydroxide TSCA 8(b) inventory: Sodium hydroxide; Water CERCLA: Hazardous substances.: Sodium hydroxide: 1000 lbs. (453.6 kg);

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada):

CLASS D-2A: Material causing other toxic effects (VERY TOXIC). CLASS E: Corrosive liquid.

DSCL (EEC):

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 1

Personal Protection:

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 0

Reactivity: 1

Specific hazard:

Protective Equipment:
Gloves. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Face shield.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/09/2005 06:32 PM

Last Updated: 11/06/2008 12:00 PM

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The following list contains the Material Safety Data Sheets you requested. Please scoll down to view the requested MSDS(s).

Product	MSDS	Distributor	Format	Language	Quantity
2684701	N/A	Hach Company	OSHA	English	1

Total Enclosures: 1

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M01393

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: STABLCAL® FORMAZIN SOLUTION <0.1 NTU
Catalog Number: 2684701

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M01393
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: May cause irritation. May cause allergic reaction.
Date of MSDS Preparation:
Day: 06
Month: January
Year: 2006

2. COMPOSITION / INFORMATION ON INGREDIENTS

Hexamethylenetetramine
CAS No.: 100-97-0
TSCA CAS Number: 100-97-0
Percent Range: 5.0 - 10.0
Percent Range Units: weight / volume
LD50: Oral mouse LDLo = 512 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation. Flammable solid. May cause allergic reaction.

Demineralized Water
CAS No.: 7732-18-5
TSCA CAS Number: 7732-18-5
Percent Range: 90.0 - 100.0
Percent Range Units: volume / volume
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: No effects anticipated.

Other components, each
CAS No.: Not applicable
TSCA CAS Number: Not applicable

Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Clear, colorless liquid
Odor: None
MAY CAUSE EYE AND SKIN IRRITATION
MAY CAUSE ALLERGIC SKIN REACTION

HMIS:
Health: 2
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 2
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation May cause allergic reaction
Skin Absorption: None reported
Target Organs: Not applicable
Ingestion: May cause: gastrointestinal irritation kidney damage
Target Organs: Kidneys
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: Allergies or sensitivity to hexamethylenetetramine.
Chronic Effects: Chronic overexposure may cause symptoms similar to acute exposure.
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: Contains: an experimental mutagen.
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water.

Ingestion (First Aid): Induce vomiting using syrup of ipecac or by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, this product decomposes to form toxic gases.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined
Hazardous Combustion Products: Toxic fumes of: ammonia formaldehyde nitrogen oxides. carbon monoxide, carbon dioxide.
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Absorb spilled liquid with non-reactive sorbent material. Dike large spills to keep spilled material from entering sewage and drainage systems or bodies of water.
Clean-up Technique: Absorb spilled liquid with non-reactive sorbent material. Sweep up material. Place material in a plastic bag. Mark bag 'Non-hazardous trash', and dispose of as normal refuse. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: Not applicable

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin Do not breathe mist or vapors. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep container tightly closed when not in use. Protect from: heat
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves
Inhalation Protection: adequate ventilation

Precautionary Measures: Avoid contact with: eyes skin Do not breathe: mist/vapor Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Clear, colorless liquid
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 7.5-8.5
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: 100°C; 212°F
Melting Point: Not determined
Specific Gravity (water = 1): 1.01
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not determined
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Miscible
Acid: Miscible
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures
Reactivity / Incompatibility: Incompatible with: oxidizers
Hazardous Decomposition: Heating to decomposition releases: ammonia carbon monoxide formaldehyde nitrogen oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported
Mutation Data: Hexamethylenetetramine: Cytogenetic analysis in human Hela cells @ 1 mmol/l; Oncogenic Transformation - hamster kidney - 10 mg/L
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Hexamethylenetetramine: Oral mouse LDLo = 512 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.

Ingredient Ecological Information: Hexamethylenetetramine: Water Pollution Factors: BOD_5: 0.015, 0.026, std. dil. sew.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: None
Special Instructions (Disposal): Dilute material with excess water making a weaker than 5% solution. Open cold water tap completely, slowly pour the material to the drain. Flush system with plenty of water.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA
I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit Hazard Class: 9 UN Number 3316.

15. REGULATORY INFORMATION

U.S. Federal Regulations:
O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)
E.P.A.:
S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard Delayed (Chronic) Health Hazard
S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.
--
302 (EHS) TPQ (40 CFR 355): Not applicable

304 CERCLA RQ (40 CFR 302.4): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
Clean Water Act (40 CFR 116.4): Not applicable
RCRA: Contains no RCRA regulated substances.
C.P.S.C.: Not applicable
State Regulations:
California Prop. 65: No Prop. 65 listed chemicals are present in this product.
Identification of Prop. 65 Ingredient(s): None
Trade Secret Registry: Not applicable
National Inventories:
U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).
TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Standard solution
References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. Lefevre, Marc J. First Aid Manual for Chemical Accidents, 2nd Ed. New York: Van Nostrand Reinhold Company, 1989. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. Technical Judgment. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Verschueren, Karel. Handbook of Environmental Data on Organic Chemicals. New York: Van Nostrand Reinhold Co., 1977.
Revision Summary: European MSDS Only Updates in Heading(s) 2,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

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The following list contains the Material Safety Data Sheets you requested. Please scoll down to view the requested MSDS(s).

Product	MSDS	Distributor	Format	Language	Quantity
2684901	N/A	Hach Company	OSHA	English	1

Total Enclosures: 1

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M01360

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: STABLCAL® FORMAZIN STANDARD 100 NTU
Catalog Number: 2684901

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M01360
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: May cause irritation. May cause allergic reaction.
Date of MSDS Preparation:
Day: 10
Month: March
Year: 2005

2. COMPOSITION / INFORMATION ON INGREDIENTS

Hexamethylenetetramine
CAS No.: 100-97-0
TSCA CAS Number: 100-97-0
Percent Range: 1.0 - 10.0
Percent Range Units: weight / volume
LD50: Oral mouse LDLo = 512 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation. Flammable solid. May cause allergic reaction.

Demineralized Water
CAS No.: 7732-18-5
TSCA CAS Number: 7732-18-5
Percent Range: 90.0 - 100.0
Percent Range Units: volume / volume
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: No effects anticipated.

Other components, each
CAS No.: Not applicable
TSCA CAS Number: Not applicable

Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

Formazin Polymer
CAS No.: Not available
TSCA CAS Number: Various
Percent Range: < 1.0
Percent Range Units: weight / weight
LD50: None reported.
LC50: None reported.
TLV: Not established.
PEL: Not established.
Hazard: Toxic properties unknown.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Turbid, milky suspension
Odor: None
MAY CAUSE EYE AND SKIN IRRITATION
MAY CAUSE ALLERGIC SKIN REACTION

HMIS:
Health: 2
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 2
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation May cause allergic reaction
Skin Absorption: None reported
Target Organs: Not applicable
Ingestion: May cause: gastrointestinal irritation kidney damage
Target Organs: Kidneys
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: Allergies or sensitivity to hexamethylenetetramine.
Chronic Effects: Chronic overexposure may cause symptoms similar to acute exposure.
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: Contains: an experimental mutagen.
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water.
Ingestion (First Aid): Induce vomiting using syrup of ipecac or by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, this product decomposes to form toxic gases.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined
Hazardous Combustion Products: This material will not burn.
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Absorb spilled liquid with non-reactive sorbent material. Dike large spills to keep spilled material from entering sewage and drainage systems or bodies of water.
Clean-up Technique: Absorb spilled liquid with non-reactive sorbent material. Sweep up material. Place material in a plastic bag. Mark bag 'Non-hazardous trash', and dispose of as normal refuse. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: Not applicable

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin Do not breathe mist or vapors. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep container tightly closed when not in use. Protect from: heat
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin Do not breathe: mist/vapor Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Turbid, milky suspension
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 8.14
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: 100°C
Melting Point: Not applicable
Specific Gravity (water = 1): 1.01
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not determined
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Miscible
Acid: Miscible
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures
Reactivity / Incompatibility: Incompatible with: oxidizers
Hazardous Decomposition: Heating to decomposition releases: ammonia carbon monoxide formaldehyde nitrogen oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported

Mutation Data: Hexamethylenetetramine: Cytogenic analysis in human Hela cells @ 1 mmol/l; Oncogenic Transformation - hamster kidney - 10 mg/L
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Hexamethylenetetramine: Oral mouse LDLo = 512 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: Hexamethylenetetramine: Water Pollution Factors: BOD_5: 0.015, 0.026, std. dil. sew.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: Not applicable
Special Instructions (Disposal): Dilute material with excess water making a weaker than 5% solution. Open cold water tap completely, slowly pour the material to the drain. Flush system with plenty of water.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA
I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit Hazard Class: 9 UN Number 3316.

15. REGULATORY INFORMATION

U.S. Federal Regulations:

O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)

E.P.A.:

S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard Delayed (Chronic) Health Hazard

S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.

--

302 (EHS) TPQ (40 CFR 355): Not applicable

304 CERCLA RQ (40 CFR 302.4): Not applicable

304 EHS RQ (40 CFR 355): Not applicable

Clean Water Act (40 CFR 116.4): Not applicable

RCRA: Contains no RCRA regulated substances.

C.P.S.C.: Not applicable

State Regulations:

California Prop. 65: No Prop. 65 listed chemicals are present in this product.

Identification of Prop. 65 Ingredient(s): Not applicable

Trade Secret Registry: Not applicable

National Inventories:

U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).

TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Standard solution

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. Lefevre, Marc J. First Aid Manual for Chemical Accidents, 2nd Ed. New York: Van Nostrand Reinhold Company, 1989. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. Technical Judgment. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Verschueren, Karel. Handbook of Environmental Data on Organic Chemicals. New York: Van Nostrand Reinhold Co., 1977.

Revision Summary: European MSDS Only Updates in Heading(s) 2,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

HACH COMPANY ©2007

The following list contains the Material Safety Data Sheets you requested. Please scoll down to view the requested MSDS(s).

Product	MSDS	Distributor	Format	Language	Quantity
2684801	N/A	Hach Company	OSHA	English	1

Total Enclosures: 1

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M01398

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: STABLCAL® FORMAZIN STANDARD 20 NTU
Catalog Number: 2684801

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M01398
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: May cause irritation. May cause allergic reaction.
Date of MSDS Preparation:
Day: 10
Month: October
Year: 2005

2. COMPOSITION / INFORMATION ON INGREDIENTS

Hexamethylenetetramine
CAS No.: 100-97-0
TSCA CAS Number: 100-97-0
Percent Range: 1.0 - 10.0
Percent Range Units: weight / volume
LD50: Oral mouse LDLo = 512 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation. Flammable solid. May cause allergic reaction.

Demineralized Water
CAS No.: 7732-18-5
TSCA CAS Number: 7732-18-5
Percent Range: 90.0 - 100.0
Percent Range Units: volume / volume
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: No effects anticipated.

Other components, each
CAS No.: Not applicable
TSCA CAS Number: Not applicable

Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

Formazin Polymer
CAS No.: Not available
TSCA CAS Number: Various
Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: None reported.
LC50: None reported.
TLV: Not established.
PEL: Not established.
Hazard: Toxic properties unknown.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Clear, colorless liquid
Odor: None
MAY CAUSE EYE AND SKIN IRRITATION
MAY CAUSE ALLERGIC SKIN REACTION

HMIS:
Health: 2
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 2
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation May cause allergic reaction
Skin Absorption: None reported
Target Organs: Not applicable
Ingestion: May cause: gastrointestinal irritation kidney damage
Target Organs: Kidneys
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: Allergies or sensitivity to hexamethylenetetramine.
Chronic Effects: Chronic overexposure may cause symptoms similar to acute exposure.
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: Contains: an experimental mutagen.
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water.
Ingestion (First Aid): Induce vomiting using syrup of ipecac or by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, this product decomposes to form toxic gases.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined
Hazardous Combustion Products: Toxic fumes of: ammonia formaldehyde nitrogen oxides. carbon monoxide, carbon dioxide.
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Absorb spilled liquid with non-reactive sorbent material. Dike large spills to keep spilled material from entering sewage and drainage systems or bodies of water.
Clean-up Technique: Absorb spilled liquid with non-reactive sorbent material. Sweep up material. Place material in a plastic bag. Mark bag 'Non-hazardous trash', and dispose of as normal refuse. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: Not applicable

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin Do not breathe mist or vapors. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep container tightly closed when not in use. Protect from: heat

Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin Do not breathe: mist/vapor Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Clear, colorless liquid
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 8.26
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: 100°C; 212°F
Melting Point: Not determined
Specific Gravity (water = 1): 1.01
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not determined
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Miscible
Acid: Miscible
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures
Reactivity / Incompatibility: Incompatible with: oxidizers
Hazardous Decomposition: Heating to decomposition releases: ammonia carbon monoxide formaldehyde nitrogen oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported

Mutation Data: Hexamethylenetetramine: Cytogenetic analysis in human Hela cells @ 1 mmol/l; Oncogenic Transformation - hamster kidney - 10 mg/L
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Hexamethylenetetramine: Oral mouse LDLo = 512 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: Hexamethylenetetramine: Water Pollution Factors: BOD_5: 0.015, 0.026 std. dil. sew.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: None
Special Instructions (Disposal): Dilute material with excess water making a weaker than 5% solution. Open cold water tap completely, slowly pour the material to the drain. Flush system with plenty of water.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA
I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit Hazard Class: 9 UN Number 3316.

15. REGULATORY INFORMATION

U.S. Federal Regulations:

O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)

E.P.A.:

S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard Delayed (Chronic) Health Hazard

S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.

--

302 (EHS) TPQ (40 CFR 355): Not applicable

304 CERCLA RQ (40 CFR 302.4): Not applicable

304 EHS RQ (40 CFR 355): Not applicable

Clean Water Act (40 CFR 116.4): Not applicable

RCRA: Contains no RCRA regulated substances.

C.P.S.C.: Not applicable

State Regulations:

California Prop. 65: No Prop. 65 listed chemicals are present in this product.

Identification of Prop. 65 Ingredient(s): None

Trade Secret Registry: Not applicable

National Inventories:

U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).

TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Standard solution

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. Lefevre, Marc J. First Aid Manual for Chemical Accidents, 2nd Ed. New York: Van Nostrand Reinhold Company, 1989. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. Technical Judgment. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Verschueren, Karel. Handbook of Environmental Data on Organic Chemicals. New York: Van Nostrand Reinhold Co., 1977.

Revision Summary: European MSDS Only Updates in Heading(s) 2,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

HACH COMPANY ©2007

The following list contains the Material Safety Data Sheets you requested. Please scoll down to view the requested MSDS(s).

Product	MSDS	Distributor	Format	Language	Quantity
2660501	N/A	Hach Company	OSHA	English	1

Total Enclosures: 1

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M01401

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: STABLCAL® FORMAZIN STANDARD 800 NTU
Catalog Number: 2660501

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M01401
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: May cause irritation. May cause allergic reaction.
Date of MSDS Preparation:
Day: 11
Month: October
Year: 2005

2. COMPOSITION / INFORMATION ON INGREDIENTS

Hexamethylenetetramine
CAS No.: 100-97-0
TSCA CAS Number: 100-97-0
Percent Range: 1.0 - 10.0
Percent Range Units: weight / volume
LD50: Oral mouse LDLo = 512 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation. Flammable solid. May cause allergic reaction.

Demineralized Water
CAS No.: 7732-18-5
TSCA CAS Number: 7732-18-5
Percent Range: 90.0 - 100.0
Percent Range Units: volume / volume
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: No effects anticipated.

Other components, each
CAS No.: Not applicable
TSCA CAS Number: Not applicable

Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

Formazin Polymer
CAS No.: Not available
TSCA CAS Number: Various
Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: None reported.
LC50: None reported.
TLV: Not established.
PEL: Not established.
Hazard: Toxic properties unknown.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Turbid, milky suspension
Odor: None
MAY CAUSE EYE AND SKIN IRRITATION
MAY CAUSE ALLERGIC SKIN REACTION

HMIS:
Health: 2
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 2
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation May cause allergic reaction
Skin Absorption: None reported
Target Organs: Not applicable
Ingestion: May cause: gastrointestinal irritation kidney damage
Target Organs: Kidneys
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: Allergies or sensitivity to hexamethylenetetramine.
Chronic Effects: Chronic overexposure may cause symptoms similar to acute exposure.
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: Contains: an experimental mutagen.
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water.
Ingestion (First Aid): Induce vomiting using syrup of ipecac or by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, this product decomposes to form toxic gases.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined
Hazardous Combustion Products: Toxic fumes of: ammonia formaldehyde nitrogen oxides. carbon monoxide, carbon dioxide.
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Absorb spilled liquid with non-reactive sorbent material. Dike large spills to keep spilled material from entering sewage and drainage systems or bodies of water.
Clean-up Technique: Absorb spilled liquid with non-reactive sorbent material. Sweep up material. Place material in a plastic bag. Mark bag 'Non-hazardous trash', and dispose of as normal refuse. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: Not applicable

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin Do not breathe mist or vapors. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep container tightly closed when not in use. Protect from: heat

Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin Do not breathe: mist/vapor Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Turbid, milky suspension
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 7.36
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: 100°C; 212°F
Melting Point: Not determined
Specific Gravity (water = 1): 1.01
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not determined
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Miscible
Acid: Miscible
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures
Reactivity / Incompatibility: Incompatible with: oxidizers
Hazardous Decomposition: Heating to decomposition releases: ammonia carbon monoxide formaldehyde nitrogen oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported

Mutation Data: Hexamethylenetetramine: Cytogenetic analysis in human Hela cells @ 1 mmol/l; Oncogenic Transformation - hamster kidney - 10 mg/L
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Hexamethylenetetramine: Oral mouse LDLo = 512 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: Hexamethylenetetramine: Water Pollution Factors: BOD_5: 0.015, 0.026, std. dil. sew.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: None
Special Instructions (Disposal): Dilute material with excess water making a weaker than 5% solution. Open cold water tap completely, slowly pour the material to the drain. Flush system with plenty of water.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA
I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit Hazard Class: 9 UN Number 3316.

15. REGULATORY INFORMATION

U.S. Federal Regulations:

O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)

E.P.A.:

S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard Delayed (Chronic) Health Hazard

S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.

--

302 (EHS) TPQ (40 CFR 355): Not applicable

304 CERCLA RQ (40 CFR 302.4): Not applicable

304 EHS RQ (40 CFR 355): Not applicable

Clean Water Act (40 CFR 116.4): Not applicable

RCRA: Contains no RCRA regulated substances.

C.P.S.C.: Not applicable

State Regulations:

California Prop. 65: No Prop. 65 listed chemicals are present in this product.

Identification of Prop. 65 Ingredient(s): None

Trade Secret Registry: Not applicable

National Inventories:

U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).

TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Standard solution

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. Lefevre, Marc J. First Aid Manual for Chemical Accidents, 2nd Ed. New York: Van Nostrand Reinhold Company, 1989. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. Technical Judgment. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Verschueren, Karel. Handbook of Environmental Data on Organic Chemicals. New York: Van Nostrand Reinhold Co., 1977.

Revision Summary: European MSDS Only Updates in Heading(s) 2,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

HACH COMPANY ©2007

Product #: 746489 Name: SULFURIC ACID 36% Desc:
From: BRENNTAG PACIFIC INC. To: Tuesday, April 13, 2010

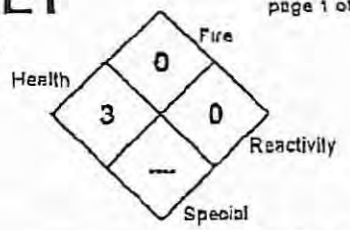
MATERIAL SAFETY DATA SHEET

BRENNTAG

Brenntag MSDS #:	BPI-33649
MSDS Revision/Issue Date:	04/12/06
Supersedes Revision Date:	10/10/04

NFPA 704 DESIGNATION
HAZARD RATING

4=Extreme
3=High
2=Moderate
1=Slight
0=Insignificant



1. CHEMICAL PRODUCT IDENTIFICATION & COMPANY IDENTIFICATION

PRODUCT IDENTIFIER: **Sulfuric Acid 30% - 40%**

GENERAL USE: Used in the manufacture of fertilizers, explosives, dyestuffs, parchment paper, glue, purification of petroleum, pickling of metal, manufacture of other acids and as an analytical reagent.

PRODUCT DESCRIPTION: An inorganic acid. Synonyms for this product include: oil of vitriol, hydroot, vitriol brown oil, dipping acid, matting acid, Nordhausen acid and sulphuric acid.

INFORMATION PROVIDED BY: Brenntag Pacific, Inc.
5700 N.W. Front Avenue
Portland, OR 97210

For MSDS call: PHONE: 503-242-0200

EMERGENCY PHONE NUMBERS

BRENNTAG:	503-699-7055
CHEMTREC:	800-424-9300
CANUTEC:	613-996-6666

2. COMPOSITION & INFORMATION ON INGREDIENTS

COMPONENT	CAS #	OSHA HAZARD	WT %	ACGIH TLV(TWA)	ACGIH STEL	OSHA PEL(TWA)	OSHA STEL
Sulfuric Acid	7664-93-9	Corrosive; Lung Toxin (See section 16.)	30 - 40	0.2 mg/m³ (Thoracic fraction) (A2)	None	1 mg/m³	None

NDA = No Data Available N/A = Not Applicable

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: A clear, colorless liquid having no characteristic odor. Vapors, mists and liquid can cause severe irritation or burns to the eyes, skin and respiratory tract. **The NIOSH I.D.L.H. for Sulfuric Acid is: 15 mg/m³.** Sulfuric Acid contained in strong, inorganic acid mists is listed by the ACGIH as A2 – a suspected human carcinogen. Any risk of cancer is dependent upon the length of exposure to the strong acid mist

POTENTIAL HEALTH EFFECTS

INHALATION: Inhalation of the vapors or mists can cause severe irritation or burns to the nose, mouth, throat, mucous membranes and lungs. Symptoms of exposure may include shortness of breath, sneezing, coughing, wheezing, choking, chest pain and impairment of lung function. Inhalation of high mist concentrations may cause permanent lung damage.

EYE CONTACT: Exposure to the vapors, mists or liquid can cause severe eye irritation or burns. Symptoms of exposure may include tearing, redness, swelling, mucous discharge and pain. Exposure may cause corneal damage and visual impairment unless treated promptly.

SKIN CONTACT: Exposure to the mists or liquid can cause severe skin irritation or burns. Symptoms of exposure may include redness, swelling and a burning sensation. Prolonged exposure to this product may cause destruction of the dermis with impairment of the skin, at the site of contact, to regenerate. No published reports indicate this product is absorbed through the skin.

INGESTION: Ingestion may cause severe irritation or burns to the entire gastrointestinal tract, including the stomach and intestines, characterized by nausea, vomiting, diarrhea, abdominal pain, bleeding and tissue ulceration.

CHRONIC: Repeated inhalation may cause bronchitis, impairment of lung function, permanent lung damage and an increased risk of cancer. Repeated ingestion can cause erosion of tooth enamel. Otherwise, the chronic effects of exposure to this product are expected to be the same as for acute exposure.

4. FIRST AID MEASURES

INHALATION: If inhaled, immediately move to fresh air. If not breathing, give artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; use the Holger Nielsen method (back pressure-arm lift) or proper respiratory device. If breathing is difficult, give oxygen. Call a physician

EYE CONTACT: In case of contact, immediately flush eyes with plenty of clean running water for at least 15 minutes, lifting the upper and lower lids occasionally. Remove contact lenses, if worn. Get medical attention immediately.

SKIN CONTACT: In case of contact, immediately flush skin with plenty of clean running water for at least 15 minutes, while removing contaminated clothing and shoes. If burn or irritation occurs, call a physician.

INGESTION: If swallowed, DO NOT induce vomiting. Get medical attention immediately. If victim is fully conscious, give plenty of water to drink. Never give anything by mouth to an unconscious person.

NOTE TO PHYSICIANS: Sulfuric Acid has a relatively low oral toxicity, but it can be severely irritating and/or corrosive to the eyes, skin and mucous membranes. If ingested, consideration should be given to careful endoscopy as stomach or esophageal burns, perforations or strictures may occur. Careful gastric lavage with an endotracheal tube in place should be considered. Treat exposure symptomatically.

5. FIRE FIGHTING MEASURES

Flashpoint and Method: This product does not flash.

Flammable Limits (in air, % by volume) **Lower:** Not applicable **Upper:** Not applicable

Autoignition Temperature: Not applicable

GENERAL HAZARD: This product is an aqueous solution of an inorganic acid. The Uniform Fire Code health hazard classification for this product is **Corrosive (Acidic)**. This product will generate flammable / explosive Hydrogen gas on contact with many metals (i.e. Aluminum, Iron, Magnesium, Zinc, etc.). Dilute solutions of this product may also be corrosive. This product may produce hazardous mists and hazardous decomposition products.

FIRE FIGHTING INSTRUCTIONS: **EXTINGUISHING MEDIA:** Water, foam, CO_2 or dry chemicals.
Use the extinguishing media appropriate to the surrounding fire.

FIRE FIGHTING EQUIPMENT: Fire fighters should wear full protective equipment, including self-contained breathing apparatus.

HAZARDOUS COMBUSTION PRODUCTS: When heated to dryness and decomposition, it emits toxic Sulfuric Acid fumes plus toxic Sulfur Dioxide and Sulfur Trioxide.

6. ACCIDENTAL RELEASE MEASURES

LAND SPILL: Wearing recommended protective equipment and clothing, dike the spill and pick up the bulk of liquid using pumps or a vacuum truck, or absorb the liquid in sand or a commercial absorbent. Place in approved containers for recovery, disposal, or satellite accumulation. Neutralize the acidity, of the remaining liquid, using soda ash, lime, or other agent appropriate for neutralizing acidic liquids. Flush the spill area with water; collect the rinsates for disposal or sewer, as appropriate.

WATER SPILL: Wear recommended protective equipment and clothing if contact with hazardous material can occur. Stop or divert water flow. Dike contaminated water and remove for disposal and/or treatment. As appropriate, notify all downstream users of possible contamination.

7. HANDLING AND STORAGE

STORAGE TEMPERATURE: Ambient STORAGE PRESSURE: Ambient

GENERAL: Store in a cool, dry, well-ventilated area, away from incompatible materials and products. Do not store in direct sunlight. Store above the freezing point.

Do not get this product in eyes, on skin or on clothing. Wear recommended personnel protective equipment. Do not breathe vapors, mists or aerosols. Use with adequate ventilation. Do not ingest / drink this product. Keep the containers tightly closed when not in use. Wash thoroughly after handling this product.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

CONTROL MEASURES: Use a local or general, mechanical exhaust ventilation system capable of maintaining emissions, in the work area, below the OSHA-PEL or ACGIH-TLV.

RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

RESPIRATOR: For exposures above the OSHA-PEL or ACGIH-TLV, wear a NIOSH approved full facepiece or half mask air-purifying cartridge respirator equipped with a good mist / particulate and acid gas cartridge or supplied air. For exposure to Sulfuric Acid fumes or mists above 15 mg/m^3, wear a full facepiece supplied air respirator, or a full facepiece self-contained breathing apparatus, operated in the pressure demand and positive pressure mode.

EYES: Wear chemical goggles (recommended by ANSI Z87.1-1979), unless a full facepiece respirator is worn.

GLOVES: Wear natural or butyl rubber, neoprene or Polyvinyl Chloride (PVC) gloves.

CLOTHING & EQUIPMENT: Wear a natural or butyl rubber, neoprene or PVC apron, or full protective clothing, when handling this product. An eye wash station and safety shower should be available in the work area.

FOOTWEAR: Wear natural rubber, butyl rubber or neoprene boots.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Clear, colorless	Bulk Density (pounds/ft³):	Not applicable
Physical State:	Liquid	Vapor Pressure:	No data available
Odor:	No characteristic odor	Vapor Density (air=1):	Greater than 1
Odor Threshold:	No data available	Evaporation Rate (n-Butyl Acetate=1):	Less than 1
Molecular Formula:	H_2SO_4 (in water)	VOC Content:	Not applicable
Molecular Weight:	98.08 (in water)	% Volatile:	60 – 70
Boiling Point:	Greater than 100° C. (212° F.)	Solubility in H_2O:	Complete
Freezing/Melting Point:	-37 to -68° C. (-34 to -90° F.)	Octanol/Water Partition Coefficient:	No data available
Specific Gravity:	1.218 – 1.303 @ 20° C.	pH (as is):	Less than 1.0
Density (pounds/gallon):	10.16 – 10.87	pH (1% solution):	Less than 1.5

10. STABILITY AND REACTIVITY

GENERAL: This product is stable and hazardous polymerization will not occur.

CONDITIONS TO AVOID: Avoid excessive hot and cold temperatures.

INCOMPATIBLE MATERIAL: Alkali and caustics, organic amines, powdered metals (especially Aluminum, Magnesium and Zinc), sulfides, sulfites, cyanides, chlorine releasers, oxidizers and anhydrides.

HAZARDOUS DECOMPOSITION PRODUCTS: When heated to dryness and decomposition, it emits toxic sulfuric acid fumes plus toxic oxides of sulfur.

SENSITIVITY TO MECHANICAL IMPACT: This product is not sensitive to mechanical impact.

SENSITIVITY TO STATIC DISCHARGE: This product is not sensitive to static discharge.

11. TOXICOLOGICAL INFORMATION

Components:	Sulfuric Acid
Eye Contact:	Rabbit: 5 mg/30 seconds (rinsed): Severe
Skin Contact:	No data available
Oral Rat LD_{50}:	2,140 mg/kg
Dermal Rabbit LD_{50}:	No data available
Inhalation Rat LC_{50}:	510 mg/m^3/2 hours
Human Data:	Inhalation Human TC_{Lo}: 3 mg/m^3/24 weeks
Other Toxicological Data:	Inhalation Mouse LC_{50}: 320 mg/m^3/2 hours
Carcinogenicity:	Inhalation Rat TC_{Lo}: 704 ug/m^3/24 hours/64 days
Teratogenicity:	Inhalation Rabbit TC_{Lo}: 20 mg/m^3/7 hours (female 6-18 Days pregnant) Specific Developmental Abnormalities – Musculoskeletal system
Mutagenicity:	Hamster Cytogenetic Analysis: Ovary: 4 mmol/Liter
Synergistic Products:	None reported
Target Organs:	Eyes, Skin, Mucous membranes, Lungs, Gastrointestinal tract & Teeth
Medical Conditions Aggravated By Exposure:	Skin, Respiratory or Gastrointestinal disorders

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL FATE:

This product is completely soluble in water and it will significantly affect the pH of water. No specific environmental fate data is available.

ENVIRONMENTAL CONSIDERATIONS:

No aquatic toxicity information is available on Sulfuric Acid solutions. This product will affect the pH of the water, which does affect aquatic life. Rainbow trout LC_{50}: pH = 4.0 for a 7 day bioassay. Other species may vary from this pH, but all are susceptible to acidic pH conditions.

13. DISPOSAL CONSIDERATIONS

RCRA 40 CFR 261 CLASSIFICATON: Corrosive Waste

U.S. EPA WASTE NUMBER/DESCRIPTION: D002

If this product is disposed of as shipped, it meets the criteria of a hazardous waste as defined under 40 CFR 261 due to its corrosivity. If this product becomes a waste, it will be a hazardous waste which is subject to the Land Disposal Restrictions under 40 CFR 268 and must be managed accordingly. As a hazardous liquid waste, it must be disposed of in accordance with local, state, and federal regulations in a permitted hazardous waste treatment, storage, and disposal facility.

14. TRANSPORTATION INFORMATION

DOT PROPER SHIPPING NAME: Sulfuric acid

Hazard Class: 8 UN Number: UN2796 Packing Group: II

Primary Label: Corrosive Subsidiary Label(s): None Required

Primary/Subsidiary Placards: Corrosive

DOT Reportable Quantity (RQ): 1,000 pounds (H_2SO_4) RQ for Product: (See section 16)

Marine Pollutant: No

2004 North American Emergency Response Guidebook No.: 157

TDG PROPER SHIPPING NAME: SULFURIC ACID

Hazard Class: 8 UN Number: UN2796 Packing Group: II

Primary Label: Corrosive Subsidiary Label(s): None Required

Primary/Subsidiary Placards: Corrosive

TDG Reportable Quantity (RQ): # At least 5 kg or 5 liters.

TDG Schedule XII: Not listed

Regulated Limit (RL): ## 50 kg (H_2SO_4) RL for Product: (See section 16)

Other Shipping Information: None

Canadian Transportation of Dangerous Goods Regulations (TDGR), Part IX, Table I, Quantities or levels for Immediate Reporting: releases of reportable quantities, RQ, that meet the definition of a "dangerous occurrence" (a threat to life, health, property, or the environment) must be reported to the appropriate authorities as outlined in TDGR 9.13(1) and 9.14(1)

Reporting to Environment Canada is required for any releases exceeding the regulated limits, RL, of 9.2 materials (primary or secondary). The regulated limits are found in Schedule XIII of the TDGR.

15. REGULATORY INFORMATION

COMPONENTS:	Sulfuric Acid
OSHA Target Organs:	Eyes, Skin, Mucous membranes, Lungs, Gastrointestinal tract & Teeth
Carcinogenic Potential:	
Regulated by OSHA:	No
Listed on NTP Report:	No
Listed by IARC:	Yes (See section 16)
IARC Group:	Group 1
ACGIH Appendix A:	Listed
A1 Confirmed Human:	Not applicable
A2 Suspected Human:	Yes (Strong acid mist)
U.S. EPA Requirements	
Release Reporting	
CERCLA (40 CFR 302)	
Listed Substance:	Yes
Reportable Quantity:	1,000 pounds
Category:	C
RCRA Waste No.:	None listed
Unlisted Substance:	Not applicable
Reportable Quantity:	Not applicable
Characteristic:	Not applicable
RCRA Waste No.:	Not applicable
SARA TITLE III	
Section 302 & 303 (40 CFR 355):	
Listed Substance:	Yes
Reportable Quantity:	1,000 pounds
Planning Threshold:	1,000 pounds
Section 311 & 312 (40 CFR 370):	
Hazard Categories (product):	Fire: N Sudden Release of Pressure: N Reactive: N Acute Health: Y Chronic Health: N
Planning threshold:	10,000 pounds
Section 313 (40 CFR 372):	
Listed Toxic Chemical:	Yes (Strong acid mist)
Reporting Threshold:	25,000 pounds
U.S. TSCA Status	
Listed (40 CFR 710):	Yes
State Regulations	
State of California: Safe Drinking Water and Toxins Enforcement Act, 1986 (Proposition 65):	
Carcinogen:	No
Reproductive Toxin:	No
Other Regulations	
State Right To Know Laws:	MA, NJ, PA
Canadian Regulations	
Product Information:	
Controlled Product:	Yes
WHMIS Hazard Symbols:	Materials Causing Immediate and Serious Toxic Effect; Corrosive Material
WHMIS Class & Division:	D.1B; E
Ingredient Information:	
IDL Substance:	Yes
DSL or NDSL Lists:	DSL

Product #: 746489 Name: SULFURIC ACID 36% Desc:
From: BRENNTAG PACIFIC INC. To: Tuesday, April 13, 2010

16. OTHER INFORMATION

EPA Registration number: Not applicable
Approved Product Uses: Not applicable

Special Notes:

This product does not contain any material, which the State of California has found to cause cancer and/or birth defects or other reproductive harm

The International Agency for Research on Cancer (IARC) classified "strong inorganic acid mists containing sulfuric acid" as a Group 1 carcinogen, a substance that is "carcinogenic to humans". **This classification is for inorganic acid mists only and does not apply to Sulfuric Acid or Sulfuric Acid solutions.**

The basis for the IARC classification rests on several epidemiology studies, which have several deficiencies. These studies did not account for exposure to other substances, some known to be animal or potential human carcinogens, social influences (smoking or alcohol consumption) and included small numbers of subjects. Based on the overall weight of evidence, from all human and chronic animal studies, no definitive causal relationship between sulfuric acid mist exposure and respiratory tract cancer has been shown.

Additional Transportation and Environmental Information for Sulfuric Acid: (numbers are approximates)

	DOT RQ		TDG RL (Class 9.2)	
%	(pounds)	(gallons)	(kg)	(liters)
30	3,333.3	328.0	166.7	136.8
31	3,226.8	315.3	161.3	131.5
32	3,125.0	303.4	156.2	126.5
33	3,030.3	292.3	151.5	121.9
34	2,941.2	281.8	147.1	117.5
35	2,857.1	271.9	142.9	113.4
36	2,777.8	262.6	138.9	109.5
37	2,702.7	253.8	135.1	105.8
38	2,631.6	245.5	131.6	102.4
39	2,564.1	237.6	128.2	99.1
40	2,500.0	230.1	125.0	95.9

Special Instructions:

Do not add Sulfuric Acid, 30 - 40% to hypochlorite bleaches, chlorine sanitizers or chlorinated cleaners as this liberates toxic, corrosive Chlorine gas.

Do not mix this product with caustic or alkaline materials as a large amount of heat is generated and violent boiling and spattering may result.

MSDS Revision Information: Information Revised This Issue Date: **Updated per new ownership and information.**

Form Revision made 12/13/05

MSDS Distributed by: Brenntag Pacific, Inc.
NW Environmental Department
Phone: 503-242-0200 FAX: 503-412-3390

Prepared By:	Edward Doheny	Date Prepared:	April 12, 2006

This Material Safety Data Sheet is provided as an information resource only. It should not be taken as a warranty or representation for which Brenntag Pacific, Inc. assumes legal responsibility. While Brenntag Pacific, Inc. believes the information contained herein is accurate and compiled from sources believed to be reliable, it is the responsibility of the user to investigate and verify its validity. The buyer assumes all responsibility of using and handling the product in accordance with applicable federal, state, and local regulations.

Material Safety Data Sheet

Aqua Solutions
6913 Highway 225
Deer Park, TX 77536

Phone (281) 479-2569
Chemtrec 800-424-9300
24 Hour Emergency Assistance

Section 1 Identification

Product Number:	3867
Product Name:	Turbidity Std. (Formazin) 1.0 NTU (APHA)
Trade/Chemical Synonyms	
Formula:	N/A
RTECS:	None
C.A.S	See Below

Health:	1
Flammability	0
Reactivity	0

Hazard Rating:

Least	Slight	Moderate	High	Extreme
0	1	2	3	4

NA = Not Applicable NE = Not Established

Section 2 Component Mixture

Sara 313	Component	CAS Number	%	Dim	Exposure Limits:
☐	Water, Deionized ASTM Type II	CAS# 7732-18-5	Balance	V/V	None Established
☐	Hexamethylenetetramine	CAS# 100-97-0	<0.1%	V/V	TXDS: orl-mouse LD• : 569 mg/Kg
☑	Hydrazine Sulfate	CAS# 10034-93-2	<0.1%	W/V	TXDS: orl-hmn TDLo: 201 mg/Kg /8D

Section 3 Hazard Identification (Also see section 11)

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

Section 4 First Aid Measures

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

FIRST AID: SKIN: Wash exposed area with soap and water. If irritation persists, seek medical attention.

EYES: Wash eyes with plenty of water for at least 15 minutes, lifting lids occasionally. Seek Medical Aid. INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen

INGESTION: Give several glasses of milk or water. Vomiting may occur spontaneously, but DO NOT INDUCE! Never give anything by mouth to an unconscious person.

Section 5 Fire Fighting Measures

Fire Extinguisher Type:	Any means suitable for extinguishing surrounding fire
Fire/Explosion Hazards:	None Known.
Fire Fighting Procedure:	Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and clothing.

Section 6 Accidental Release Measures

Absorb spill with inert material. Flush excess down drain.

Section 7 Handling and Storage

Store in a cool dry place. Do not get in eyes, on skin, on clothing. Wash thoroughly after handling

Section 8 Exposure Controls & Personal Protection

Respiratory Protection:None required

Ventilation:

Mechanical: ☐

Local Exhaust: ☑

Hand Protection: Gloves to prevent skin exposure as latex or vinyl

Eye Protection: Splash Goggles

Other Protective Equipment: Wear appropriate clothing to prevent skin exposure

Section 9 Physical and Chemical Properties

Melting Point:	~0° C	Specific Gravity	~1.0
Boiling Point:	~100° C	Percent Volatile by Volume:	>99%
Vapor Pressure:	not available	Evaporation Rate:	information not available
Vapor Density:	not available	Evaporation Standard:	
Solubility in Water:	Soluble	Auto ignition Temperature:	Not applicable
Appearance and Odor:	slightly turbid odorless liquid	Lower Flamm. Limit in Air:	Not applicable
Flash Point:	not flammable	Upper Flamm. Limit in Air:	Not applicable

Section 10 Stability and Reactivity Information

Stability: Stable	Conditions to Avoid: Temperature extremes

Materials to Avoid:
Concentrated Acids and Bases, Water reactive materials.

Hazardous Decomposition Products:
none known

Hazardous Polymerization:not expected to occur

Condition to Avoid:None known

Section 11 Additional Information

Overexposure symptoms. Acute: Essentially non-hazardous. Possible irritation of eyes/stomach. Chronic: None known. Conditions aggravated/ Target organs: none known.

DOT Classification: Not Regulated

DOT regulations may change from time to time. Please consult the most recent version of the relevant regulations.

Revision No:0	Date Entered: 9/1/2006	Approved by: WPF

The information contained herein is believed to be accurate and is offered in good faith for the user's consideration and investigation. No warranty is expressed or implied regarding the completeness or accuracy of this information, whether originating from Aqua Solutions, Inc. or from an alternate source. Users of this material should satisfy themselves by independent investigation of current scientific and medical information that this material may be safely handled.

Material Safety Data Sheet

Aqua Solutions
6913 Highway 225
Deer Park, TX 77536

Phone (281) 479-2569
Chemtrec 800-424-9300
24 Hour Emergency Assistance

Section 1 Identification

Product Number:	3871
Product Name:	Turbidity Std. (Formazin) 10 NTU (APHA)
Trade/Chemical Synonyms	
Formula:	N/A
RTECS:	None
C.A.S	See Below

Health:	1
Flammability	0
Reactivity	0

Hazard Rating:

Least	Slight	Moderate	High	Extreme
0	1	2	3	4

NA = Not Applicable NE = Not Established

Section 2 Component Mixture

Sara 313	Component	CAS Number	%	Dim	Exposure Limits:
☐	Water, Deionized ASTM Type II	CAS# 7732-18-5	Balance	V/V	None Established
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FIRST AID: SKIN: Wash exposed area with soap and water. If irritation persists, seek medical attention.

EYES: Wash eyes with plenty of water for at least 15 minutes, lifting lids occasionally. Seek Medical Aid. INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen

INGESTION: Give several glasses of milk or water. Vomiting may occur spontaneously, but DO NOT INDUCE! Never give anything by mouth to an unconscious person.

Section 5 Fire Fighting Measures

Fire Extinguisher Type:	Any means suitable for extinguishing surrounding fire
Fire/Explosion Hazards:	None Known.
Fire Fighting Procedure:	Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and clothing.

Section 6 Accidental Release Measures

Absorb spill with inert material. Flush excess down drain.

Section 7 Handling and Storage

Store in a cool dry place. Do not get in eyes, on skin, on clothing. Wash thoroughly after handling

Section 8 Exposure Controls & Personal Protection

Respiratory Protection:None required

Ventilation:

Mechanical: ☐

Local Exhaust: ☑

Hand Protection: Gloves to prevent skin exposure as latex or vinyl

Eye Protection: Splash Goggles

Other Protective Equipment: Wear appropriate clothing to prevent skin exposure

Section 9 Physical and Chemical Properties

Melting Point:	~0° C	Specific Gravity	~1.0
Boiling Point:	~100° C	Percent Volatile by Volume:	>99%
Vapor Pressure:	not available	Evaporation Rate:	1
Vapor Density:	not available	Evaporation Standard:	Water =1
Solubility in Water:	Soluble	Auto ignition Temperature:	Not applicable
Appearance and Odor:	slightly turbid odorless liquid	Lower Flamm. Limit in Air:	Not applicable
Flash Point:	not flammable	Upper Flamm. Limit in Air:	Not applicable

Section 10 Stability and Reactivity Information

Stability: Stable	Conditions to Avoid: Temperature extremes

Materials to Avoid:
Concentrated Acids and Bases, Water reactive materials.

Hazardous Decomposition Products:
none known

Hazardous Polymerization:not expected to occur

Condition to Avoid:None known

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Revision No:0	Date Entered: 9/1/2006	Approved by: WPF

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Material Safety Data Sheet

Aqua Solutions
6913 Highway 225
Deer Park, TX 77536

Phone (281) 479-2569
Chemtrec 800-424-9300
24 Hour Emergency Assistance

Section 1 Identification

Product Number:	3874
Product Name:	Turbidity Std. (Formazin) 100 NTU (APHA)
Trade/ Chemical Synonyms	
Formula:	N/A
RTECS:	None
C.A.S	See Below

Health:	1
Flammability	0
Reactivity	0

Hazard Rating:

Least	Slight	Moderate	High	Extreme
0	1	2	3	4

NA = Not Applicable NE = Not Established

Section 2 Component Mixture

Sara 313	Component	CAS Number	%	Dim	Exposure Limits:
☐	Water, Deionized ASTM Type II	CAS# 7732-18-5	Balance	V/V	None Established
☐	Hexamethylenetetramine	CAS# 100-97-0	<0.1%	V/V	TXDS: orl-mouse LD• : 569 mg/Kg
☑	Hydrazine Sulfate	CAS# 10034-93-2	<0.1%	W/V	TXDS: orl-hmn TDLo: 201 mg/Kg /8D

Section 3 Hazard Identification (Also see section 11)

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

Section 4 First Aid Measures

Generally not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation.

FIRST AID: SKIN: Wash exposed area with soap and water. If irritation persists, seek medical attention.

EYES: Wash eyes with plenty of water for at least 15 minutes, lifting lids occasionally. Seek Medical Aid. INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen

INGESTION: If swallowed, induce vomiting immediately after giving two glasses of water. Never give anything by mouth to an unconscious person.

Section 5 Fire Fighting Measures

Fire Extinguisher Type:	Any means suitable for extinguishing surrounding fire
Fire/Explosion Hazards:	None Known.
Fire Fighting Procedure:	Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and clothing.

Section 6 Accidental Release Measures

Absorb spill with inert material. Flush excess down drain.

Section 7 Handling and Storage

Store in a cool dry place. Do not get in eyes, on skin, on clothing. Wash thoroughly after handling

Section 8 Exposure Controls & Personal Protection

Respiratory Protection:None required

Ventilation:

Mechanical: ☐

Local Exhaust: ☑

Hand Protection: Gloves to prevent skin exposure as latex or vinyl

Eye Protection: Splash Goggles

Other Protective Equipment: Wear appropriate clothing to prevent skin exposure

Section 9 Physical and Chemical Properties

Melting Point:	~0° C	Specific Gravity	~1.0
Boiling Point:	~100° C	Percent Volatile by Volume:	>99%
Vapor Pressure:	not available	Evaporation Rate:	1
Vapor Density:	not available	Evaporation Standard:	
Solubility in Water:	Soluble	Auto ignition Temperature:	Not applicable
Appearance and Odor:	slightly turbid odorless liquid	Lower Flamm. Limit in Air:	Not applicable
Flash Point:	not flammable	Upper Flamm. Limit in Air:	Not applicable

Section 10 Stability and Reactivity Information

Stability: Stable Conditions to Avoid: None known

Materials to Avoid:
Concentrated Acids and Bases, Water reactive materials.

Hazardous Decomposition Products:
none known

Hazardous Polymerization:not expected to occur

Condition to Avoid:None known

Section 11 Additional Information

Overexposure symptoms. Acute: Essentially non-hazardous. Possible irritation of eyes/stomach. Chronic: None known. Conditions aggravated/ Target organs: none known.

DOT Classification: Not Regulated

DOT regulations may change from time to time. Please consult the most recent version of the relevant regulations.

Revision No:0	Date Entered: 9/1/2006	Approved by: WPF

The information contained herein is believed to be accurate and is offered in good faith for the user's consideration and investigation. No warranty is expressed or implied regarding the completeness or accuracy of this information, whether originating from Aqua Solutions, Inc. or from an alternate source. Users of this material should satisfy themselves by independent investigation of current scientific and medical information that this material may be safely handled.

Material Safety Data Sheet

Aqua Solutions
6913 Highway 225
Deer Park, TX 77536

Phone (281) 479-2569
Chemtrec 800-424-9300
24 Hour Emergency Assistance

Section 1 Identification

Product Number:	3879
Product Name:	Turbidity Std. (Formazin) 1000 NTU (APHA)
Trade/ Chemical Synonyms	
Formula:	N/A
RTECS:	None
C.A.S	See Below

Health:	2
Flammability	0
Reactivity	0

Hazard Rating:

Least	Slight	Moderate	High	Extreme
0	1	2	3	4

NA = Not Applicable NE = Not Established

Section 2 Component Mixture

Sara 313	Component	CAS Number	%	Dim	Exposure Limits:
☐	Water, Deionized ASTM Type II	CAS# 7732-18-5	Balance	V/V	None Established
☐	Hexamethylenetetramine	CAS# 100-97-0	1.25%	W/V	TXDS: orl-mouse LD• : 569 mg/Kg
☑	Hydrazine Sulfate	CAS# 10034-93-2	0.125%	W/V	TXDS: orl-hmn TDLo: 201 mg/Kg /8D

Section 3 Hazard Identification (Also see section 11)

May be harmful if swallowed. May cause irritation. Avoid breathing vapors, or dusts. Use with adequate ventilation. Avoid contact with eyes, skin, and clothes. Wash thoroughly after handling.

Section 4 First Aid Measures

May be harmful if swallowed. May cause irritation. Avoid breathing vapors, or dusts. Use with adequate ventilation. Avoid contact with eyes, skin, and clothes. Wash thoroughly after handling.

FIRST AID: SKIN: Wash exposed area with soap and water. If irritation persists, seek medical attention.

EYES: Wash eyes with plenty of water for at least 15 minutes, lifting lids occasionally. Seek Medical Aid. INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen

INGESTION: If swallowed, induce vomiting immediately after giving two glasses of water. Never give anything by mouth to an unconscious person.

Section 5 Fire Fighting Measures

Fire Extinguisher Type:	Any means suitable for extinguishing surrounding fire
Fire/Explosion Hazards:	None Known.
Fire Fighting Procedure:	Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and clothing.

Section 6 Accidental Release Measures

Absorb spill with inert material, then place in a chemical waste container. Dispose of in a manner consistent with federal, local law.

Section 7 Handling and Storage

Wash thoroughly after handling. Remove contaminated clothes and wash before reuse. Use with adequate ventilation.

Section 8 Exposure Controls & Personal Protection

Respiratory Protection:None required

Ventilation:

Mechanical: ☐

Local Exhaust: ☑

Hand Protection: Wear appropriate gloves to prevent skin exposure

Eye Protection: Splash Goggles

Other Protective Equipment: Wear appropriate clothing to prevent skin exposure

Section 9 Physical and Chemical Properties

Melting Point:	0° C	Specific Gravity	1.002
Boiling Point:	100° C	Percent Volatile by Volume:	>98%
Vapor Pressure:	Information not available	Evaporation Rate:	0.63
Vapor Density:	Information not available	Evaporation Standard:	
Solubility in Water:	Soluble	Auto ignition Temperature:	Not applicable
Appearance and Odor:	Turbid milky white odorless liquid	Lower Flamm. Limit in Air:	Not applicable
Flash Point:	not flammable	Upper Flamm. Limit in Air:	Not applicable

Section 10 Stability and Reactivity Information

Stability: Stable	Conditions to Avoid: Extreme temperatures, light

Materials to Avoid:
Concentrated Acids and Bases, Water reactive materials.

Hazardous Decomposition Products:
Oxides of carbon, nitrogen and ammonia.

Hazardous Polymerization:not known to occur

Condition to Avoid:None known

Section 11 Additional Information

Eyes: may cause irritation. Skin: may cause irritation. Moderately toxic. May damage kidneys. If ingested, induce vomiting by sticking finger down throat.

DOT Classification: Not Regulated

DOT regulations may change from time to time. Please consult the most recent version of the relevant regulations.

Revision No:0	Date Entered: 9/1/2006	Approved by: WPF

The information contained herein is believed to be accurate and is offered in good faith for the user's consideration and investigation. No warranty is expressed or implied regarding the completeness or accuracy of this information, whether originating from Aqua Solutions, Inc. or from an alternate source. Users of this material should satisfy themselves by independent investigation of current scientific and medical information that this material may be safely handled.

Attachment F

ATS Spill Prevention Plan

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

6301 Angelo Court #9, Loomis, CA 95650 | Phone: 916-652-9745 | Fax: 916-652-9705 | www.ats-env.com

Spill Prevention Plan

Construction Phase Non-Sediment Control
Best Management Practices and Procedures for:
ATS (Active Treatment System)

INTRODUCTION:

The purpose of the Spill Prevention Plan (SPP) is to outline the project scope of work (including equipment, materials, and activities) and present a plan to prevent, respond to, and report spills or releases to the environment. The SPP will be updated as project work progresses or site activities change. An updated copy of this SPP will be maintained at the project site.

The SPP is a working document designed to be a tool used regularly to prevent or minimize spills. As such, agents and employees shall be properly informed of the provisions of the SPP and know their role in maintaining the SPP or in minimizing a spill that occurs.

The following two parameters are areas of concern with the deployment of ATS.

1. Chemical Additives: An ATS uses potentially toxic chemicals as a treatment step to control turbidity from construction sites.

2. Diesel Fuel: Typically ATS utilizes Temporary Generator power for pumps, monitoring systems, metering pumps, etc.

CONCLUSIONS:

These following safeguards shall be implemented for the entire duration the ATS is onsite.

- Areas for storage of liquid chemicals and shall include secondary containment provisions of 150%.

- Store dry chemicals and bagged materials on covered pallets or indoors.

- Designated trash/debris disposal containers should be used.

- Potentially hazardous liquid waste and chemicals must not be disposed of in dumpsters designated for construction debris. Store waste materials in secured, corrosion-resistant, and compatible containers for removal from site and disposal at designated disposal facilities at appropriate intervals.

- Perform maintenance and repairs of oil containing equipment inside second containment at all times. Immediately dispose of spent fluids as required by law.

- Prevent leaks of machinery fluids; routinely inspect equipment.

- Employ drip pans and properly dispose of fluids. Use EVAC equipment to capture oils and store for removal from site.

- In the event that repairs need to be made on the Project or in the field, use appropriate BMPs to protect the release of contaminants to surface runoff. Use drip pans or absorbent drop cloths to capture spills.

- Do not wash equipment of vehicles where effluent can flow into storm drains, water bodies, wetlands or other drainages.

- Dispose of accumulated storm water inside of Spill Containment as required by law. DO NOT EMPTY SPILL CONTAINMENT ONSITE.

- Recycle spent fluids whenever possible; store fluids in separate containers. Note that some spent fluids may be considered hazardous; recycling may avoid the disposal expenses and administrative difficulties associated with hazardous materials disposal.

- Conduct vehicle and equipment fueling at equipment storage areas. Park fuel truck overnight with secondary containment.

Attachment G

ATS Operator Training and Certification

Overview of the Requirement

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

6301 Angelo Court #9, Loomis, CA 95650 | Phone: 916-652-9745 | Fax: 916-652-9705 | www.ats-env.com

Required Training

- Personnel Training – Attachment F Requirements
  - Coagulation Basics – Chemistry and physical processes
  - ATS System Design and Operating Principles
  - ATS Control Systems
  - Coagulant Selection – Jar testing, dose determination, etc.
  - Aquatic Safety/Toxicity of Coagulants, proper handling and safety
  - Monitoring, Sampling, and Analysis
  - Reporting and Recordkeeping
  - Emergency Response
- In Classroom (8 Hours) and In Field Operations (32 Hours)
- ATS Operator Certification following 40 Hours of Training and Demonstration of Required Knowledge to Operate an ATS

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

ATS Operator Certification Training

8:00AM to 8:15AM – Introduction (WS)
- Who is Active Treatment Systems, Inc.?
- What do we do?

8:15AM to 8:30AM – Regulation (WS)
- Why are we here?
- CWA/ESA
- Construction General Permit (NPDES)
- Attachment F – ATS
- What is ATS – Active Treatment System?
- Personnel Training – Attachment F Requirements

8:30AM to 10:30AM – ATS Foundation Topics (MH)
- Water Chemistry
- Polymer Basics
- Jar Testing
- ATS Instruments
- Residual in effluent – Why an issue?

Break (15 minutes)

10:45AM to 12:00Noon – ATS Design (MH)
- Rainfall and Runoff
- Equipment Selection and Sizing
- Water Storage – Basins and/or Tanks
- Instrumentation

Lunch Break (1 Hour)

1:00PM to 1:15PM – ATS Submittals (JH)
- ATS Plan – Addendum to Project SWPPP
  - ATS O&M Manual
  - ATS Monitoring, Sampling & Reporting including QA/QC
  - ATS Health & Safety Plan
  - ATS Spill Prevention Plan

1:00PM to 3:15PM – ATS Operations (JH)
- Basic Processes
- Sampling
- Monitoring
- Residual Testing
- Effluent Discharges

Break (15 Minutes)

3:30PM to 5:00PM – Records and Reporting (JH)

- Record Keeping and Retention
- Emergency Response
- Non-Compliance Reporting
- Non-Compliance Exemption

Certificate of ATS Operator Training

This is to certify that:

Sample Certificate

has successfully completed the Clear Water Compliance Services ATS Operator Training Course and is certified to operate ATS, Inc. ActiveTreatment Systems for Construction Site Stormwater Management

Effective October 1, 2010 to September 30, 2011

Meets Minimum Requirement:
Eight (8) Hours of ATS Classroom Training
Thirty Two (32) Hours of ATS Field Training
Written and Oral Examination

Active Treatment Systems, Inc.
WATER SOLUTIONS FOR THE ENVIRONMENT

6301 Angelo Ct.
Loomis, CA 95650
916-652-9745

Wendell Sawyer, President

Issued Date: October 1, 2010

ATTACHMENT F:
Active Treatment System (ATS) Requirements

Table 1 – Numeric Effluent Limitations, Numeric Action Levels, Test Methods, Detection Limits, and Reporting Units

Parameter	Test Method	Discharge Type	Min. Detection Limit	Units	Numeric Action Level	Numeric Effluent Limitation
Turbidity	EPA 0180.1 and/or field test with a calibrated portable instrument	For ATS discharges	1	NTU	N/A	10 NTU for Daily Flow-Weighted Average & 20 NTU for Any Single Sample

A. Dischargers choosing to implement an Active Treatment System (ATS) on their site shall comply with all of the requirements in this Attachment.

B. The discharger shall maintain a paper copy of each ATS specification onsite in compliance with the record retention requirements in the Special Provisions of this General Permit.

C. ATS Design, Operation and Submittals

1. The ATS shall be designed and approved by a Certified Professional in Erosion and Sediment Control (CPESC), a Certified Professional in Storm Water Quality (CPSWQ); a California registered civil engineer; or any other California registered engineer.

2. The discharger shall ensure that the ATS is designed in a manner to preclude the accidental discharge of settled floc[1] during floc pumping or related operations.

3. The discharger shall design outlets to dissipate energy from concentrated flows.

4. The discharger shall install and operate an ATS by assigning a lead person (or project manager) who has either a minimum of five years construction storm

[1] Floc is defined as a clump of solids formed by the chemical action in ATS systems.

water experience or who is a licensed contractors specifically holding a California Class A Contractors license.[2]

5. The discharger shall prepare an ATS Plan that combines the site-specific data and treatment system information required to safely and efficiently operate an ATS. The ATS Plan shall be electronically submitted to the State Water Board at least 14 days prior to the planned operation of the ATS and a paper copy shall be available onsite during ATS operation. At a minimum, the ATS Plan shall include:

   a. ATS Operation and Maintenance Manual for All Equipment.

   b. ATS Monitoring, Sampling & Reporting Plan, including Quality Assurance/Quality Control (QA/QC).

   c. ATS Health and Safety Plan.

   d. ATS Spill Prevention Plan.

6. The ATS shall be designed to capture and treat (within a 72-hour period) a volume equivalent to the runoff from a 10-year, 24-hour storm event using a watershed runoff coefficient of 1.0.

D. Treatment – Chemical Coagulation/Flocculation

1. Jar tests shall be conducted using water samples selected to represent typical site conditions and in accordance with ASTM D2035-08 (2003).

2. The discharger shall conduct, at minimum, six site-specific jar tests (per polymer with one test serving as a control) for each project to determine the proper polymer and dosage levels for their ATS.

3. Single field jar tests may also be conducted during a project if conditions warrant, for example if construction activities disturb changing types of soils, which consequently cause change in storm water and runoff characteristics.

E. Residual Chemical and Toxicity Requirements

1. The discharger shall utilize a residual chemical test method that has a method detection limit (MDL) of 10% or less than the maximum allowable threshold

[2] Business and Professions Code Division 3, Chapter 9, Article 4, Class A Contractor: A general engineering contractor is a contractor whose principal contracting business is in connection with fixed works requiring specialized engineering knowledge and skill. [http://www.cslb.ca.gov/General-Information/library/licensing-classifications.asp].

concentration[3] (MATC) for the specific coagulant in use and for the most sensitive species of the chemical used.

2. The discharger shall utilize a residual chemical test method that produces a result within one hour of sampling.

3. The discharger shall have a California State certified laboratory validate the selected residual chemical test. Specifically the lab will review the test protocol, test parameters, and the detection limit of the coagulant. The discharger shall electronically submit this documentation as part of the ATS Plan.

4. If the discharger cannot utilize a residual chemical test method that meets the requirements above, the discharger shall operate the ATS in Batch Treatment[4] mode.

5. A discharger planning to operate in Batch Treatment mode shall perform toxicity testing in accordance with the following:

   a. The discharger shall initiate acute toxicity testing on effluent samples representing effluent from each batch prior to discharge[5]. All bioassays shall be sent to a laboratory certified by the Department of Health Services (DHS) Environmental Laboratory Accreditation Program (ELAP). The required field of testing number for Whole Effluent Toxicity (WET) testing is E113.[6]

   b. Acute toxicity tests shall be conducted with the following species and protocols. The methods to be used in the acute toxicity testing shall be those outlined for a 96-hour acute test in "Methods for Measuring the Acute Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms, USEPA-841-R-02-012" for Fathead minnow, *Pimephales promelas* (fathead minnow). Acute toxicity for *Oncorhynchus mykiss* (Rainbow Trout) may be used as a substitute for testing fathead minnows.

   c. All toxicity tests shall meet quality assurance criteria and test acceptability criteria in the most recent versions of the EPA test method for WET testing.

   d. The discharger shall electronically report all acute toxicity testing.

---

[3] The Maximum Allowable Threshold Concentration (MATC) is the allowable concentration of residual, or dissolved, coagulant/flocculant in effluent. The MATC shall be coagulant/flocculant-specific, and based on toxicity testing conducted by an independent, third-party laboratory. A typical MATC would be:
The MATC is equal to the geometric mean of the NOEC (No Observed Effect Concentration) and LOEC (Lowest Observed Effect Concentration) Acute and Chronic toxicity results for most sensitive species determined for the specific coagulant. The most sensitive species test shall be used to determine the MATC.
[4] Batch Treatment mode is defined as holding or recirculating the treated water in a holding basin or tank(s) until treatment is complete or the basin or storage tank(s) is full.
[5] This requirement only requires that the test be initiated prior to discharge.
[6] http://www.dhs.ca.gov/ps/ls/elap/pdf/FOT_Desc.pdf.

F. Filtration

1. The ATS shall include a filtration step between the coagulant treatment train and the effluent discharge. This is commonly provided by sand, bag, or cartridge filters, which are sized to capture suspended material that might pass through the clarifier tanks.

2. Differential pressure measurements shall be taken to monitor filter loading and confirm that the final filter stage is functioning properly.

G. Residuals Management

1. Sediment shall be removed from the storage or treatment cells as necessary to ensure that the cells maintain their required water storage (i.e., volume) capability.

2. Handling and disposal of all solids generated during ATS operations shall be done in accordance with all local, state, and federal laws and regulations.

H. ATS Instrumentation

1. The ATS shall be equipped with instrumentation that automatically measures and records effluent water quality data and flow rate.

2. The minimum data recorded shall be consistent with the Monitoring and Reporting requirements below, and shall include:

   a. Influent Turbidity

   b. Effluent Turbidity

   c. Influent pH

   d. Effluent pH

   e. Residual Chemical

   f. Effluent Flow rate

   g. Effluent Flow volume

3. Systems shall be equipped with a data recording system, such as data loggers or webserver-based systems, which records each measurement on a frequency no longer than once every 15 minutes.

4. Cumulative flow volume shall be recorded daily. The data recording system shall have the capacity to record a minimum of seven days continuous data.

5. Instrumentation systems shall be interfaced with system control to provide auto shutoff or recirculation in the event that effluent measurements exceed turbidity or pH.

6. The system shall also assure that upon system upset, power failure, or other catastrophic event, the ATS will default to a recirculation mode or safe shut down.

7. Instrumentation (flow meters, probes, valves, streaming current detectors, controlling computers, etc.) shall be installed and maintained per manufacturer's recommendations, which shall be included in the QA/QC plan.

8. The QA/QC plan shall also specify calibration procedures and frequencies, instrument method detection limit or sensitivity verification, laboratory duplicate procedures, and other pertinent procedures.

9. The instrumentation system shall include a method for controlling coagulant dose, to prevent potential overdosing. Available technologies include flow/turbidity proportional metering, periodic jar testing and metering pump adjustment, and ionic charge measurement controlling the metering pump.

I. ATS Effluent Discharge

1. ATS effluent shall comply with all provisions and prohibitions in this General Permit, specifically the NELs.

2. NELs for discharges from an ATS:

   a. Turbidity of all ATS discharges shall be less than 10 NTU for daily flow-weighted average of all samples and 20 NTU for any single sample.

   b. Residual Chemical shall be < 10% of MATC[7] for the most sensitive species of the chemical used.

3. If an analytical effluent sampling result is outside the range of pH NELs (i.e., is below the lower NEL for pH or exceeds the upper NEL for pH) or exceeds the turbidity NEL (as listed in Table 1), the discharger is in violation of this General

[7] The Maximum Allowable Threshold Concentration (MATC) is the allowable concentration of residual, or dissolved, coagulant/flocculant in effluent. The MATC shall be coagulant/flocculant-specific, and based on toxicity testing conducted by an independent, third-party laboratory. The MATC is equal to the geometric mean of the NOEC (No Observed Effect Concentration) and LOEC (Lowest Observed Effect Concentration) Acute and Chronic toxicity results for most sensitive species determined for the specific coagulant. The most sensitive species test shall be used to determine the MATC.

Permit and shall electronically file the results in violation within 24-hours of obtaining the results.

4. If ATS effluent is authorized to discharge into a sanitary sewer system, the discharger shall comply with any pre-treatment requirements applicable for that system. The discharger shall include any specific criteria required by the municipality in the ATS Plan.

5. Compliance Storm Event:

   Discharges of storm water from ATS shall comply with applicable NELs (above) unless the storm event causing the discharges is determined after the fact to be equal to or larger than the Compliance Storm Event (expressed in inches of rainfall). The Compliance Storm Event for ATS discharges is the 10 year, 24 hour storm, as determined using these maps:

   http://www.wrcc.dri.edu/pcpnfreq/nca10y24.gif
   http://www.wrcc.dri.edu/pcpnfreq/sca10y24.gif

   This exemption is dependent on the submission of rain gauge data verifying the storm event is equal to or larger than the Compliance Storm.

J. Operation and Maintenance Plan

1. Each Project shall have a site-specific Operation and Maintenance (O&M) Manual covering the procedures required to install, operate and maintain the ATS.[8]

2. The O&M Manual shall only be used in conjunction with appropriate project-specific design specifications that describe the system configuration and operating parameters.

3. The O&M Manual shall have operating manuals for specific pumps, generators, control systems,and other equipment.

K. Sampling and Reporting Quality Assurance/ Quality Check (QA/QC) Plan

4. A project-specific QA/QC Plan shall be developed for each project. The QA/QC Plan shall include at a minimum:

   a. Calibration – Calibration methods and frequencies for all system and field instruments shall be specified.

   b. Method Detection Limits (MDLs) – The methods for determining MDLs shall be specified for each residual coagulant measurement method. Acceptable

[8] The manual is typically in a modular format covering generalized procedures for each component that is utilized in a particular system.

minimum MDLs for each method, specific to individual coagulants, shall be specified.

c. Laboratory Duplicates – Requirements for monthly laboratory duplicates for residual coagulant analysis shall be specified.

L. Personnel Training

1. Operators shall have training specific to using an ATS and liquid coagulants for storm water discharges in California.

2. The training shall be in the form of a formal class with a certificate and requirements for testing and certificate renewal.

3. Training shall include a minimum of eight hours classroom and 32 hours field training. The course shall cover the following topics:

   a. Coagulation Basics –Chemistry and physical processes

   b. ATS System Design and Operating Principles

   c. ATS Control Systems

   d. Coagulant Selection – Jar testing, dose determination, etc.

   e. Aquatic Safety/Toxicity of Coagulants, proper handling and safety

   f. Monitoring, Sampling, and Analysis

   g. Reporting and Recordkeeping

   h. Emergency Response

M. Active Treatment System (ATS) Monitoring Requirements

Any discharger who deploys an ATS on their site shall conduct the following:

1. Visual Monitoring

   a. A designated responsible person shall be on site daily at all times during treatment operations.

   b. Daily on-site visual monitoring of the system for proper performance shall be conducted and recorded in the project data log.

i. The log shall include the name and phone number of the person responsible for system operation and monitoring.

ii. The log shall include documentation of the responsible person's training.

2. Operational and Compliance Monitoring

a. Flow shall be continuously monitored and recorded at not greater than 15-minute intervals for total volume treated and discharged.

b. Influent and effluent pH must be continuously monitored and recorded at not greater than 15-minute intervals.

c. Influent and effluent turbidity (expressed in NTU) must be continuously monitored and recorded at not greater than 15-minute intervals.

d. The type and amount of chemical used for pH adjustment, if any, shall be monitored and recorded.

e. Dose rate of chemical used in the ATS system (expressed in mg/L) shall be monitored and reported 15-minutes after startup and every 8 hours of operation.

f. Laboratory duplicates – monthly laboratory duplicates for residual coagulant analysis must be performed and records shall be maintained onsite.

g. Effluent shall be monitored and recorded for residual chemical/additive levels.

h. If a residual chemical/additive test does not exist and the ATS is operating in a batch treatment mode of operation refer to the toxicity monitoring requirements below.

3. Toxicity Monitoring

A discharger operating in batch treatment mode shall perform toxicity testing in accordance with the following:

a. The discharger shall initiate acute toxicity testing on effluent samples representing effluent from each batch prior to discharge.[9] All bioassays shall be sent to a laboratory certified by the Department of Health Services (DHS) Environmental Laboratory Accreditation Program (ELAP). The required field of testing number for Whole Effluent Toxicity (WET) testing is E113.[10]

[9] This requirement only requires that the test be initiated prior to discharge.
[10] http://www.dhs.ca.gov/ps/ls/elap/pdf/FOT_Desc.pdf.

b. Acute toxicity tests shall be conducted with the following species and protocols. The methods to be used in the acute toxicity testing shall be those outlined for a 96-hour acute test in "Methods for Measuring the Acute Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms, USEPA-841-R-02-012" for Fathead minnow, *Pimephales promelas or* Rainbow trout *Oncorhynchus mykiss* may be used as a substitute for fathead minnow.

c. All toxicity tests shall meet quality assurance criteria and test acceptability criteria in the most recent versions of the EPA test method for WET testing.[11]

4. Reporting and Recordkeeping

At a minimum, every 30 days a LRP representing the discharger shall access the State Water Boards Storm Water Mulit-Application and Report Tracking system (SMARTS) and electronically upload field data from the ATS. Records must be kept for three years after the project is completed .

5. Non-compliance Reporting

a. Any indications of toxicity or other violations of water quality objectives shall be reported to the appropriate regulatory agency as required by this General Permit.

b. Upon any measurements that exceed water quality standards, the system operator shall immediately notify his supervisor or other responsible parties, who shall notify the Regional Water Board.

c. If any monitoring data exceeds any applicable NEL in this General Permit, the discharger shall electronically submit a NEL Violation Report to the State Water Board within 24 hours after the NEL exceedance has been identified.

i. ATS dischargers shall certify each NEL Violation Report in accordance with the Special Provisions for Construction Activity in this General Permit.

ii. ATS dischargers shall retain an electronic or paper copy of each NEL Violation Report for a minimum of three years after the date the annual report is filed.

iii. ATS dischargers shall include in the NEL Violation Report:

(1) The analytical method(s), method reporting unit(s), and method detection limit(s) of each analytical parameter (analytical results that are less than the method detection limit shall be reported as "less than the method detection limit");

[11] http://www.epa.gov/waterscience/methods/wet/.

(2) The date, place, time of sampling, visual observation (inspections), and/or measurements, including precipitation; and

(3) A description of the current onsite BMPs, and the proposed corrective actions taken to manage the NEL exceedance.

iv. Compliance Storm Exemption - In the event that an applicable NEL has been exceeded during a storm event equal to or larger than the Compliance Storm Event, ATS dischargers shall report the on-site rain gauge reading and nearby governmental rain gauge readings for verification.