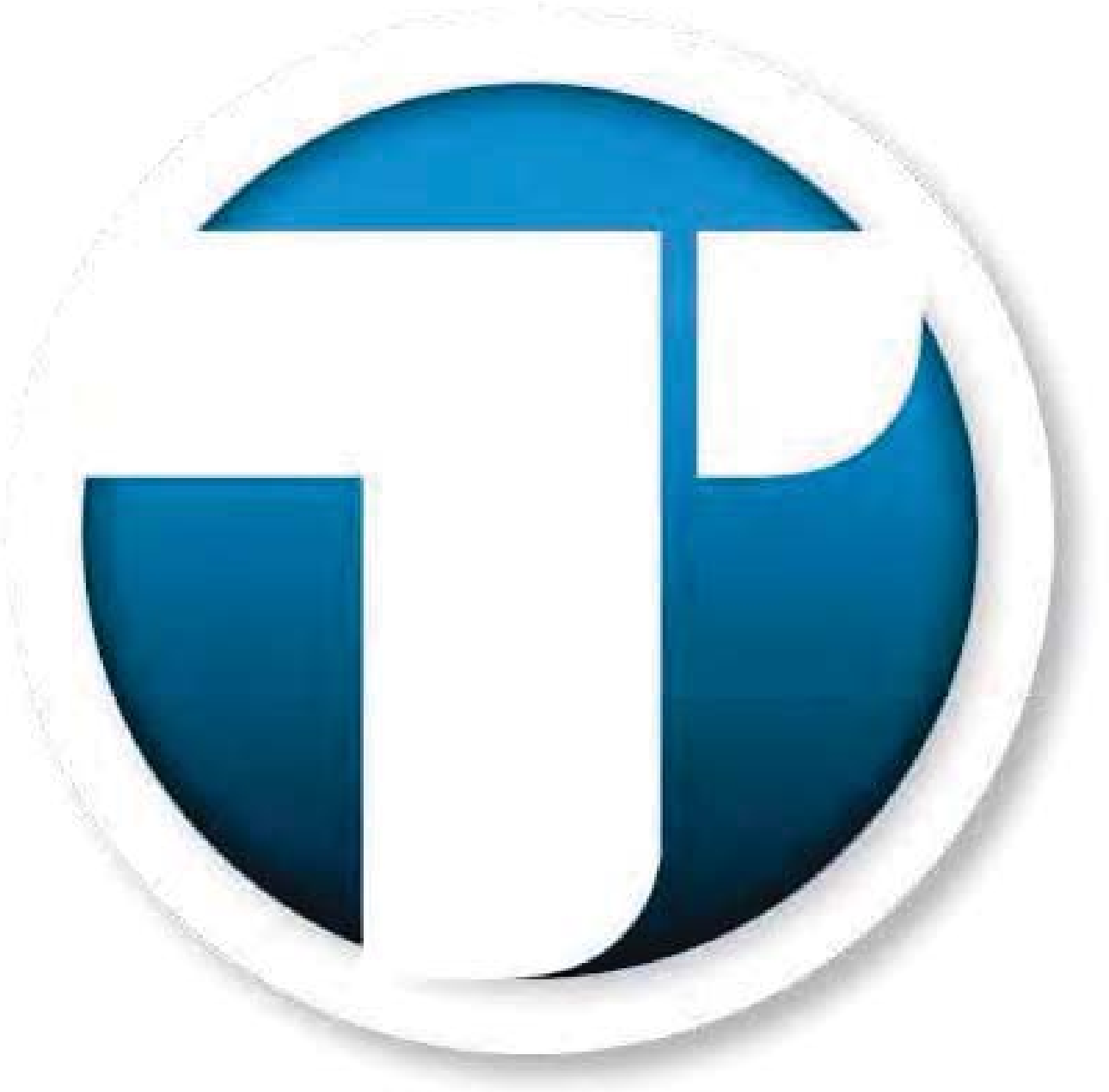
Tisch Environmental
TE-Wilbur10
TE-Wilbur 2.5
Low Volume Air Particulate Sampler



TE-Wilbur Operations Manual Table of Contents

1.0 Introduction

This instrument (TE-WILBUR) is named to honor Wilbur P. Tisch, an innovator and pioneer in the design and construction of particulate monitoring instruments since the 1950s. Wilbur and his father contracted with the US Department of Public Health (before the US EPA was commissioned) to develop a high volume air sampler which would become the first active particulate monitoring instrument used to monitor particulate matter in ambient air. As a result of Wilbur's 60+ years in this industry, more than one million instruments have been put to work collecting air samples that have been used to learn the effects and health issues of particulate concentrations in our air. Wilbur serves as the Ambassador of Tisch Environmental while working with his three sons Bob, Jim and John. Wilbur's rich work ethic, diligence, productiveness and conscientious attitude have laid the foundation for the success of Tisch Environmental. With four generations of experience, leadership and know-how, the Tisch family would like to welcome you to the company and thank you for choosing Tisch Environmental.

1.1 TE-Wilbur Overview

TE-Wilbur is a filter-based, ambient air particulate sampler. The USEPA has designated it a federal reference method for the collection of $PM_{2.5}$ and PM_{10} particulates using model number TE-Wilbur2.5 for $PM_{2.5}$ and TE-Wilbur10 for PM_{10}. This product is capable of collecting several different size fractions of particulate matter. When configured for collection of PM_{10}, only the PM_{10} size selective inlet (TE-PM10-D) is installed. When configured to collect $PM_{2.5}$, the TE-PM2.5C cyclone or WINS impactor is installed downstream of the PM_{10} size selective inlet. A TSP (Total Suspended Particulate) option is also available.

The unit has many features that make operation very simple and straightforward. The unit utilizes a full-color active touch screen and menus that makes operation quick and easy to understand. Operation of the unit is simple, with screens guiding the operator each step of the way. Sample run summary data is downloaded with a USB thumb drive and presented in a .CSV format. The system monitors and records all system sensors such as flow, temperatures and barometric pressure, and also records the system pressure, filter temperature variation, and flow total which provides the operator or laboratory technician additional information on the sample if warnings or alarms occurred during the sample run. The system runs solely from 24VDC power. An Uninterruptible Power Supply (UPS) is incorporated into the system that allows the system to keep operating for several hours

during a power loss. Although this system is not intended for running a full 24 hour sample without mains power, the system includes an external power connection that can be used to connect larger external batteries, solar, wind or any other 24VDC alternative energy sources. Help menus are included on the screen to assist the operator with calibration, leak checking and other features of the system. The system provides remote Ethernet control and monitoring from any standard browser and a Modbus interface for remote telemetry connections.

1.2 US EPA FRM Designation

The US EPA has designated the Tisch Environmental TE-Wilbur10 and TE-Wilbur2.5 as a Federal Reference Method (FRM) and a Federal Equivalency Method (FEM) per the table below for the measurement of particulate matter in ambient air based on the requirements of 40 CFR Part 53. This unit is a gravimetric method and meets all requirements of 40 CFR Part 50 Appendix L and has been tested and meets the requirements of 40 CFR Part 53.

Method	Configuration	Designation Type	Designation Number
PM_{10}	TE-PM10-D PM_{10} head	FRM	RFPS-0714-216
$PM_{2.5}$	TE-PM10-D PM_{10} head with VSCC Cyclone or WINS Impactor	FRM	RFPS-1014-219
$PM_{2.5}$	TE-PM10-D PM_{10} head TE-PM2.5C Cyclone	FEM Class II	EQPS-0415-223
$PM_{10-2.5}$ *Requires collocation of (2) samplers	Sampler 1: ($PM_{2.5}$) TE-PM10-D PM10 head with VSCC Cyclone or WINS Impactor Sampler 2: (PM_{10}) TE-PM10-D PM10 head	FRM	RFPS-1014-220
$PM_{10-2.5}$ *Requires collocation of (2) samplers	Sampler 1: ($PM_{2.5}$) TE-PM10-D PM10 head with TE-PM2.5C Sampler 2: (PM_{10}) TE-PM10-D PM10 head	FEM Class II	EQPS-0415-224

1.3 Copyrights and Trademarks

The 'Wilbur' trade name and Tisch logos are copyrights of Tisch Environmental, Inc. The software used in this instrument is proprietary intellectual property of Tisch Environmental and is not to be reproduced or replicated in any way.

1.4 References

This manual references the *US EPA Quality Assurance Guidance Document 2.12, Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods* which can be obtained from the Human Exposure and Atmospheric Sciences Division at the National Exposure Laboratory, Research Triangle Park, NC 27711. Updates to this document will take precedence over materials contained in this operations manual.

1.5 Warranty

Instruments manufactured by Tisch Environmental, Inc. are guaranteed by warranty to be free of defects in materials and workmanship for one year after shipment from Tisch Environmental factories. The liability of Tisch Environmental, Inc. is limited to servicing or replacing any defective part of any instrument returned to the factory by the original purchaser. All service traceable to defects in original material or workmanship is considered warranty service and is performed free of charge. The expense of warranty shipping charges to and from our factory will be borne by Tisch Environmental. Service performed to rectify an instrument malfunction caused by abuse, acts of god or neglect, and service performed after the one-year warranty period will be charged to the customer at the current prices for labor, parts, and transportation. The right is reserved to make changes in construction, design specifications, and prices without prior notice.

1.6 Symbols Used in This Document

The following symbols are used in this document

Shock hazard – this symbol is used to make the operator aware that there is a potential for an electrical shock hazard

General Attention – this symbol is used to make the operator aware of an important directive

1.7 Safety Warnings

Service and repair of this instrument should only be attempted by a trained technician whom is familiar with electrical safety.

Do not remove the inner enclosure covers without disconnecting mains power and powering down the unit completely.

Use grounded electrical connections at all times to prevent inadvertent electrical shock hazards.

Only use outdoor rated cords to supply mains power to the instrument. The power cord supplied with the instrument has an outdoor rated insulation.

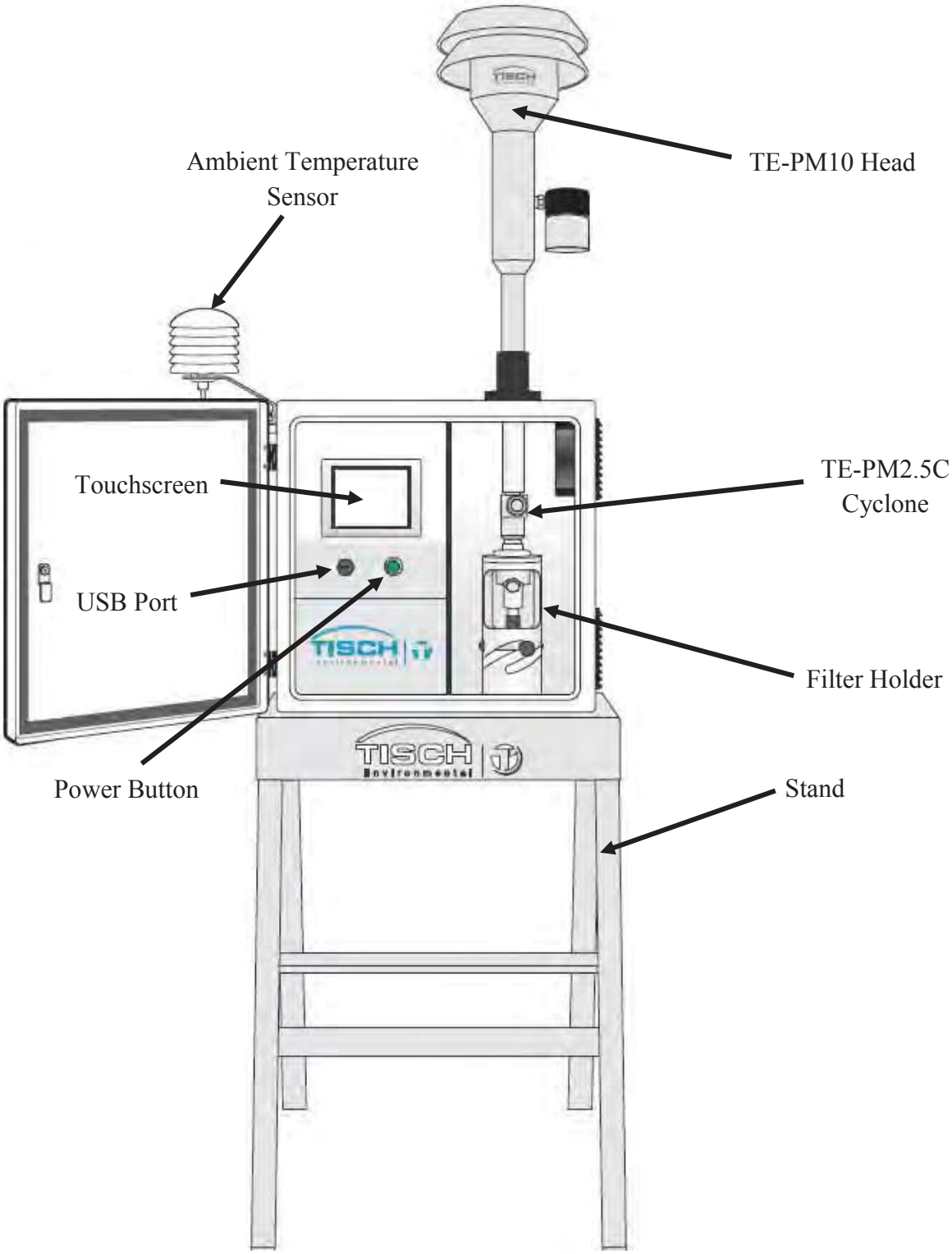
Care should be taken when operating the filter holder mechanism that fingers do not get pinched in the mechanism.

When installing the unit outdoors, ensure the unit is securely fastened to a level, hard surface and that measures are taken to prevent the unit from tipping over.

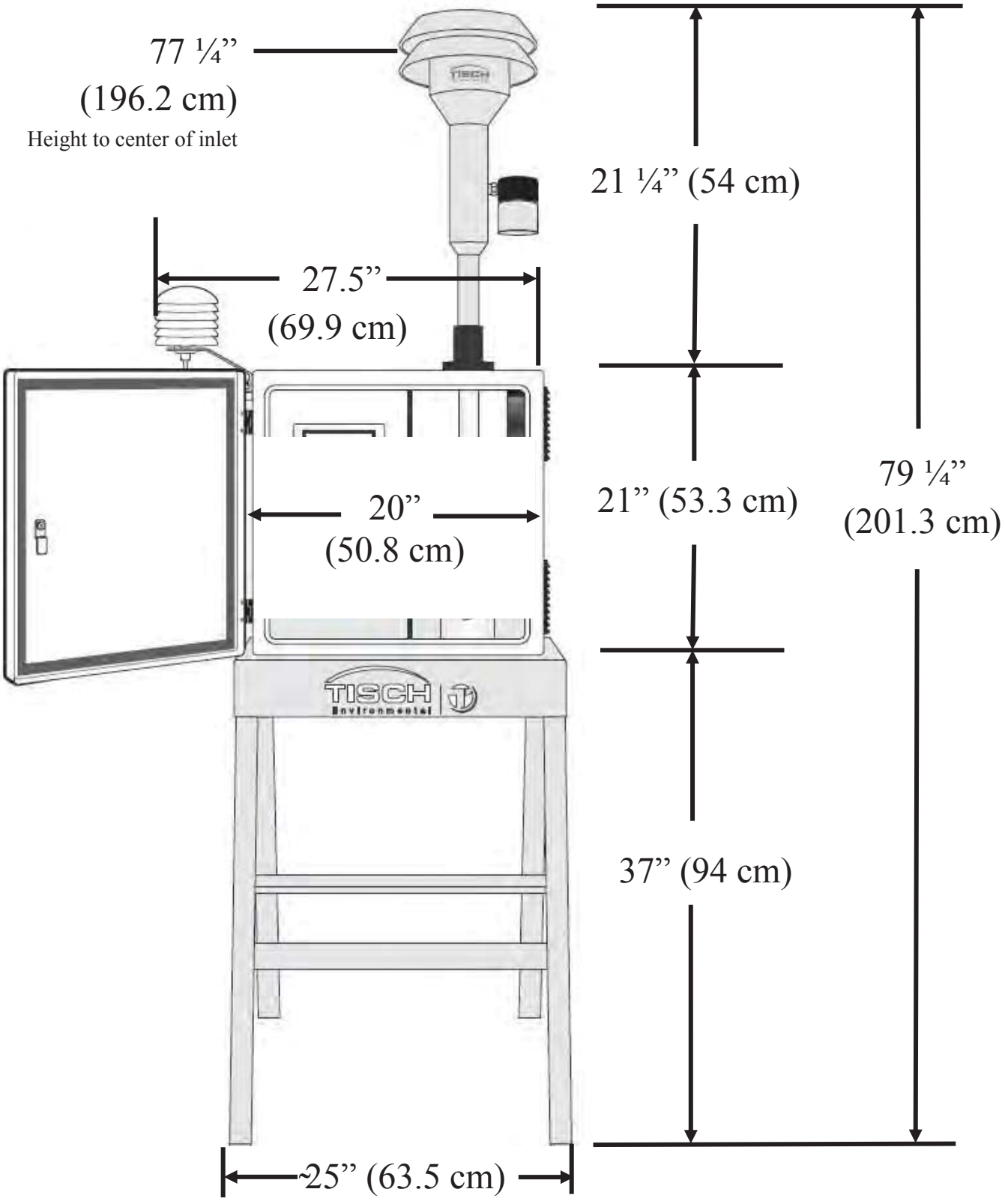
1.8 Ratings

Electrical	120 VAC / 60 Hz / 0.5 Amps 230 VAC / 50 Hz / 0.25 Amps Minimum Mains voltage 100 VAC Maximum Mains voltage 240 VAC Mains power is interrupted by a 1 amp circuit breaker. The system operates from a 24 VDC / 60 watt power supply that is fused at 2.5 amps using a quick-blow fuse.
Temperature	-25ºC to 50ºC
Weight	47 lbs / 21.8 kg without stand 40 lbs without stand and battery pack 83 lbs total shipping weight complete Shipping dimensions: 19x31x42” (48.3x78.7x106.7cm)
Dimensions	20”W x 20”H x 10”D / 508 mm x 508 mm x 254 mm
Flow System	Range 0 – 25 Liters per minute with an accuracy of ±3% of full scale (0.75 Lpm) with a repeatability of ±1% of full scale (0.25 Lpm) and resolution of 0.01 Lpm.
Ambient Temperature	The ambient temperature sensor is a PT100 RTD with an accuracy of ±0.15ºC and a resolution of 0.01ºC.
Filter Temperature	The filter temperature sensor is a PT100 RTD with an accuracy of ±0.15ºC and a resolution of 0.01ºC.
Barometric Pressure Sensor	The barometric pressure sensor is ranged 450 mmHg to 1238 mmHg and has an accuracy of ±10.00 mmHg and a resolution of 0.75 mmHg.

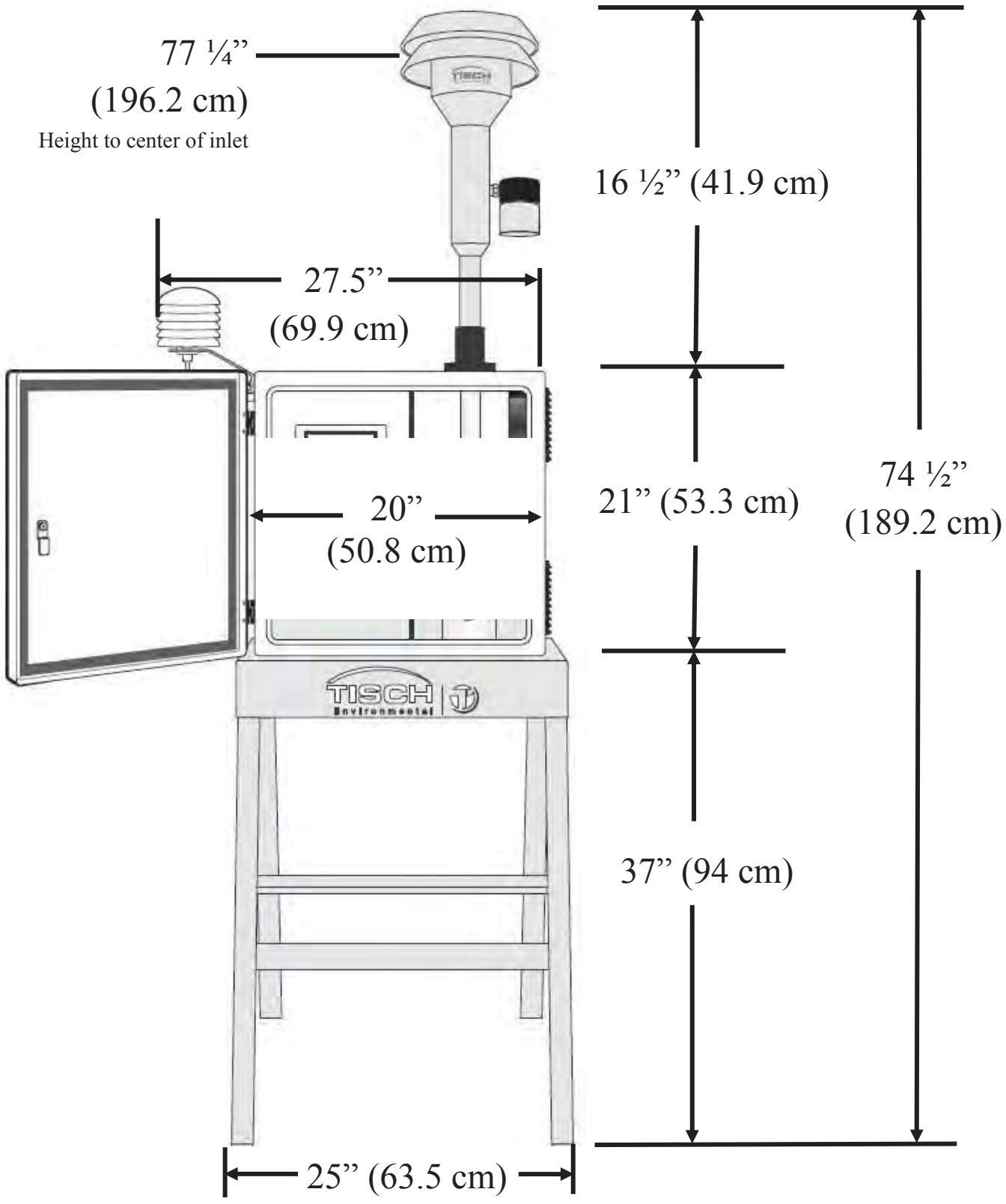
1.9 Major Component Diagram



1.10 Sampler Dimensions for Wilbur $PM_{2.5}$ (with TE-PM2.5C)



1.11 Sampler Dimensions for Wilbur PM_{10} (without TE-PM2.5C)



2.0 Assembly and Installation

This section describes the unpacking, assembly and installation of TE-Wilbur.

2.1 Packing List

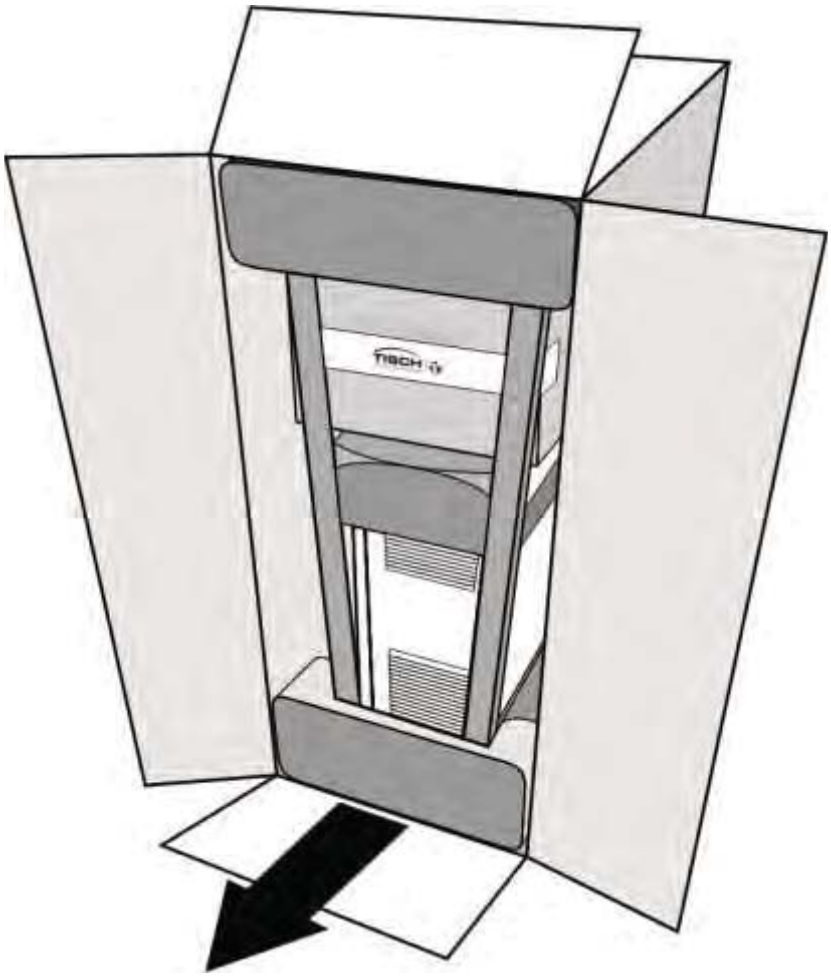
The TE-Wilbur PM sampler is packed in one complete box with the following packing components.

Quantity	Part Number	Description
1	TE-Wilbur2.5/10	TE-Wilbur unit configured either for $PM_{2.5}$ or PM_{10} collection
1	TE-PM-10-D	Tisch Environmental PM_{10} head with downtube
1	TE-PM2.5C	TE-PM2.5C cyclone fractionator
1	TE-W-STAND	Stand with (4) ¼-20 x ¾" SS bolts, (2) Mounting brackets and (8) ¼-20 x ¾" SS bolts for mounting enclosure to stand
1	TE-W-151	Ambient temperature probe with radiation shield
1	TE-FH47	Filter cassette with screen, tin and anti-static bag
1	TE-W-004	Internal Leak Check Disk
1	TE-W-005	Product Manual
1	TE-W-107	USB stick
2	TE-W-062	1/4-20 x 5/8" SS bolts to mount ambient temperature probe and shield
1		Build summary / Testing checklist

2.2 Unpacking unit

The TE-Wilbur is packed in one complete box. To unpack the unit, follow these steps:

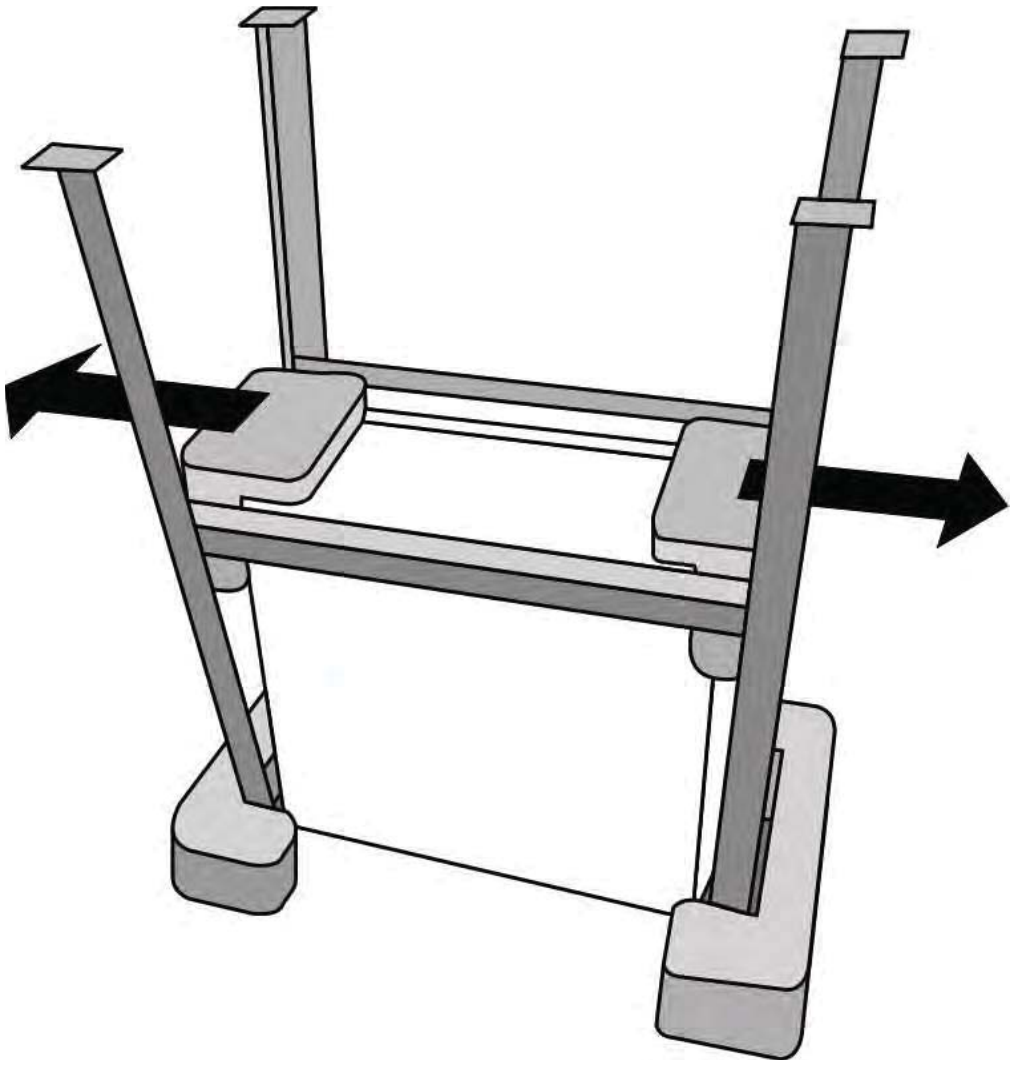
1. Place the box in the upright position and open one of the sides.



2. Remove the entire unit from the box by pulling from the bottom portion of the stand, sliding it from the box.

3. Remove the two top foam inserts and the top box, which will contain the PM_{10} head and/or cyclone and all of the miscellaneous parts and instruction manual.

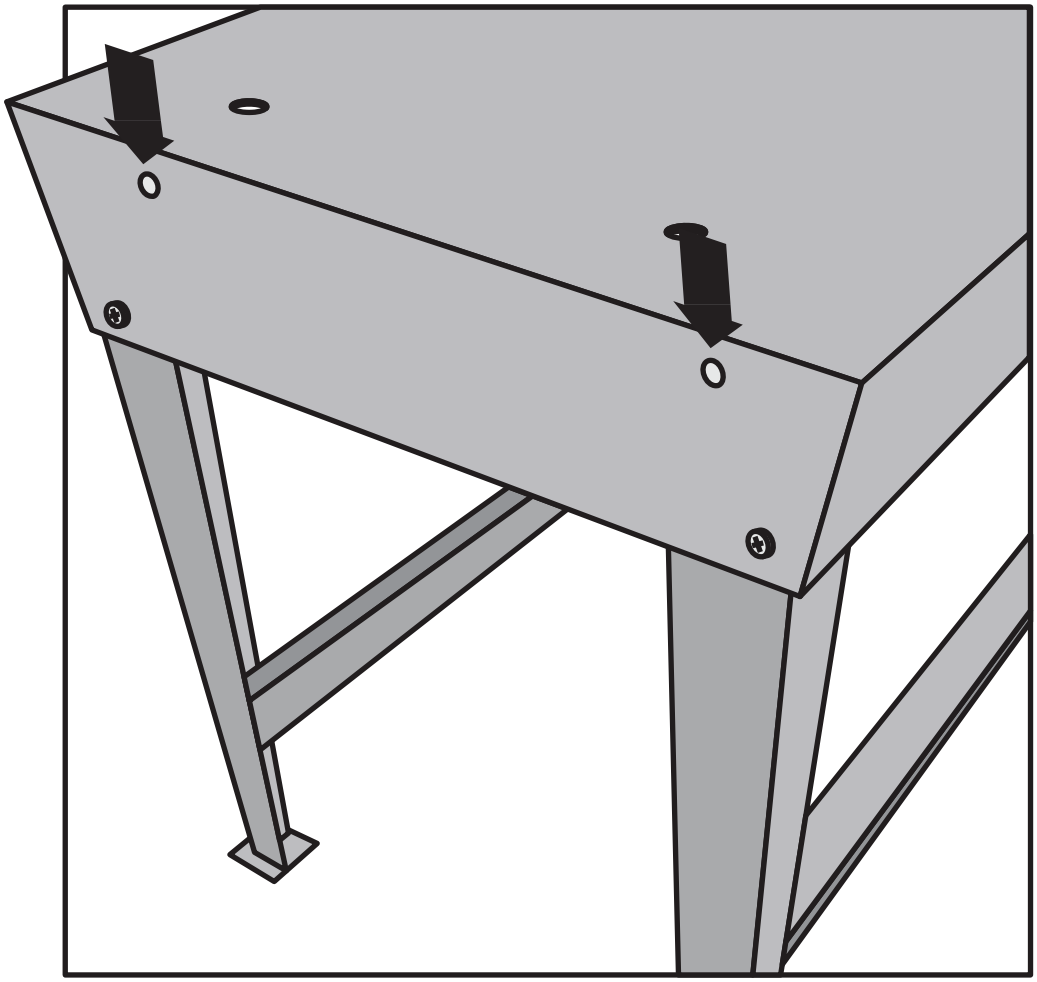
4. Spread the stand legs apart and remove the two foam inserts on top of the enclosure.



5. Remove the TE-Wilbur sampler from inside of the stand and remove the stand from the bottom two foam inserts

6. Place the stand in the upright position.

7. Using the (4) supplied ¼-20 x ¾" stainless steel bolts, secure the stand legs by screwing in one bolt on each side of the stand top/leg as shown.



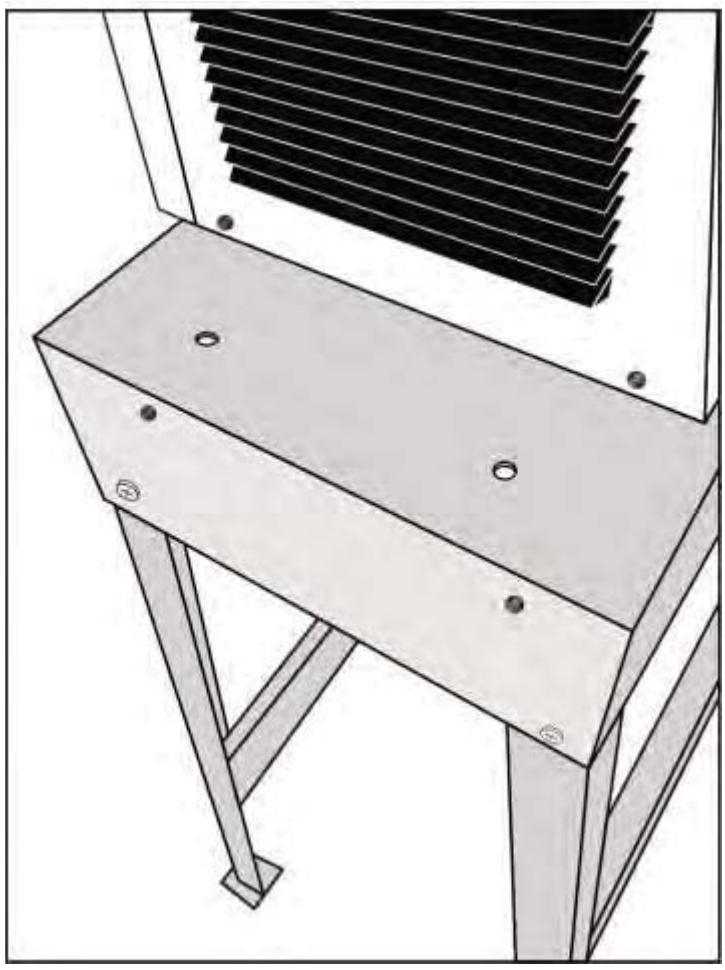
2.3 Placing unit on Stand

The TE-Wilbur sampler is supplied with an enclosure stand that allows the inlet to be placed 2m ± 0.2m above ground. To place the sampler on the stand, follow these steps:

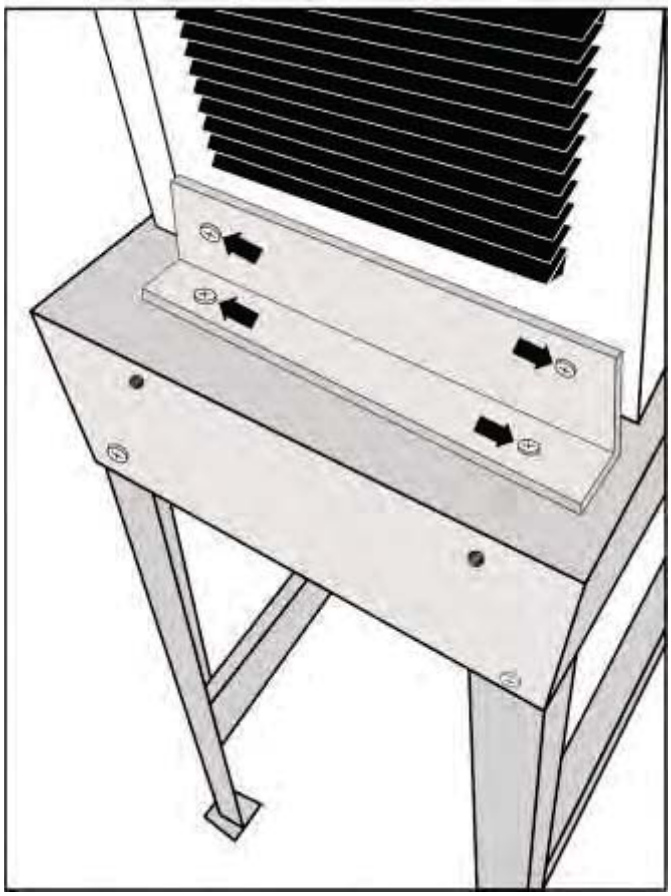
1. Unpack the stand and enclosure.
2. Place the stand on a level surface.
3. Secure the stand. The stand has holes in the feet that can be used to secure the unit to a level surface. The use of sandbags can also secure the unit to a level surface to prevent the unit from being knocked over.

NOTE: The stand needs to be secured to prevent tipping over and causing injury or damage to the unit.

4. Place sampler on top of stand, aligning the two holes on either bottom side with the bracket holes located on the side of the stand.



5. Place one of the mounting brackets onto the stand, aligning the holes in the stand and the enclosure with the holes in the mounting bracket. Secure the stand and the enclosure to the mounting bracket using the supplied ¼-20 x ¾" stainless steel bolts. Repeat for the other side. A total of (8) bolts are used to secure the enclosure to the stand.



2.4 Electrical Connection

The TE-Wilbur sampler is configured with a universal IEC320 socket that is located in the weatherproof side box. A standard USA-style cord is supplied with each unit. Contact Tisch Environmental for different cord-end options.

A 1 amp AC circuit breaker that is resettable is also located in the side box below the power socket.

NOTE: Always use grounded connections when connecting AC mains to the unit. Shock hazards could result if proper grounding is not followed or if outdoor-rated cords are not used. If using extension cords inspect for wear and damage and follow all local and national electrical codes for installation.

2.5 Other Connections

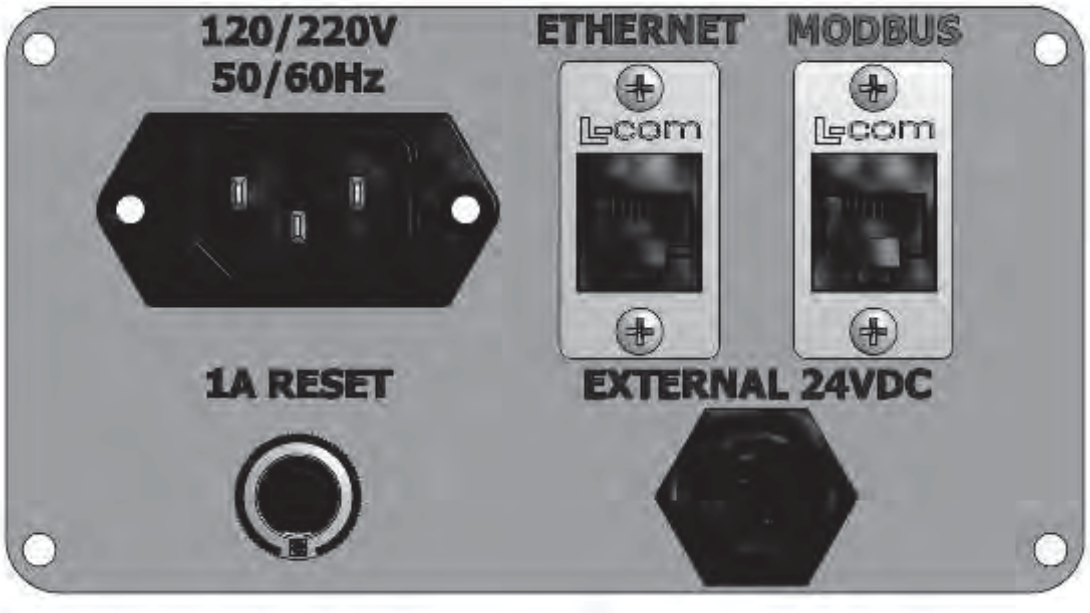
There are 3 other connections external to the sampler that are located in the weatherproof side box.

MODBUS RJ11 connection – 2-wire serial Modbus cable part number: TE-W-501. See section 15.0 - Communications for MODBUS information.

Solar / 24VDC Connection to supply unit with remote 24VDC - batteries, solar, wind or other alternative energy sources. External 24VDC connection cable part number TE-W-502. See section 12.0 for more information.

Ethernet For remote monitoring and control – RJ45 Ethernet cable part number: TE-W-503. See section 15.0 for Ethernet information.

External Connections



2.6 Siting

Siting is important for proper collection of $PM_{2.5}$ or PM_{10} particulate matter. Refer to 40CFR Part 58, Appendix D and the guidance document for network design and optimum site exposure for $PM_{2.5}$ and PM_{10} published by the US EPA Office of Air Quality Planning and Standards (OAQPS).

The following installation guidelines should be observed:

- The sampler must have an unobstructed air flow for a minimum of 2 meters in all directions. Provide sufficient area for a collocated FRM sampler and for installation of a portable FRM performance evaluation (PE) sampler.

- The sampler's inlet should be placed at a height of 2-15m above ground level.

- If the sampler is collocated with any other samplers, the spacing between sampler inlets must be greater or equal to 1m if the other samplers are low-volume (16.67 Lpm and below). If high-volume samplers are collocated next to the sampler, the spacing between sampler inlets must be greater or equal to 2m. The spacing between any air inlets should be no more than 4m.

- Location safety – ensure to locate the unit in a safe location that can be accessed easily and that routine maintenance can be performed by the operator easily and safely. The unit weighs over 40lbs so care must be taken if ladders are needed to access the sampling site.

- Location security – ensure to locate the units in areas that are well secured such as on rooftops with locked access and ground level sites with fencing. If the ground level site has fencing, ensure it is chain link and does not impede air flow. The sampler's inlet should extend above the fence.

2.7 Instrument Setup

Prior to field installation, it is recommended to get familiar with the operation and use of the sampler. Once operators are familiar with the operation of the unit the following should be followed for proper field operation

- Follow the siting guidelines in 2.6.
- Place the stand on a level surface and secure if necessary with screws or sand-bags to prevent strong winds from knocking over unit.
- Place the sampler onto the stand and secure with the (8) provided bolts and brackets
- Place the downtube through the hole on top of the unit and push down into unit. If sampling for PM_{10}, push the downtube onto the top of the filter holder. If sampling for $PM_{2.5}$, place the TE-PM2.5C cyclone on top of the filter holder first, then push the downtube onto the cyclone.
- Place the PM_{10} head on top of the downtube.
- Attach the ambient temperature probe and radiation shield onto the left side of the enclosure with (2) 1/4-20 x 5/8" bolts and screw in the cable connection to the socket.
- Plug the sampler into a reliable AC electrical source that is grounded.
- Turn on the unit by pressing the green power button on the inside front cover of the unit.
- Allow the unit to equilibrate to ambient conditions. This could take up to an hour if ambient temperatures are very warm or cold.
- Set the time and date.
- Perform an external leak check.
- Perform a calibration check of the temperatures, barometric pressure and flow system– unit comes from the factory pre-calibrated.
- Enter the site ID.
- Turn power off by pressing the green power button and make sure the unit remains powered on the batteries.
- Turn power back on.
- Setup a sample and install a clean filter, enter the filter ID.
- The unit is ready for field operation.

2.8 Choosing Language

When the TE-Wilbur instrument is powered up, the following splash screen will appear:

This screen will allow the instrument's language to be changed. Available languages are English (US), Spanish and Chinese.

In order to change the language the instrument must be powered down completely.

3.0 Quick Start Guide

The TE-Wilbur system comes from the factory with the following functions performed:

- Leak Check Passed
- Flow System Calibrated
- Ambient Temperature Calibrated
- Filter Temperature Calibrated
- Barometric Pressure Calibrated
- Pressure sensor zeroed
- 48-hour burn-in test running at 16.67 Lpm
- Time and Date set for Eastern Time (UTC -5.00, Eastern Time)

Perform the following to place unit in service:	**Manual Section**
Unpack Unit from Shipping Box.	2.2
Determine sampling location	2.6
Place stand on level surface and secure stand with sand-bags or screw onto a fixed surface. Place the sampler onto the stand and secure with (8) ¾" ¼-20 bolts (included) and mounting brackets.	2.3
Secure the ambient temperature radiation shield / probe onto left side of unit with (2) ¾" ¼-20 bolts (included) and screw the probe connection into the socket.	2.7
Place the Cyclone on top of the filter holder, place the downtube through the downtube adapter and push onto the top of the cyclone (if configuring for PM_{10} do not place the cyclone onto the filter holder) Leave the PM_{10} head off for now in order to perform a leak check.	5.5
Plug the unit into an AC power source and press the green button to power on unit.	2.7
Unit should power on – if problems see Troubleshooting – Section 13.0.	
At the splash screen, choose your language.	
If you are not in EST time zone, change the time and date if necessary by going to: MAINTENANCE➔SET TIME AND DATE.	8.1

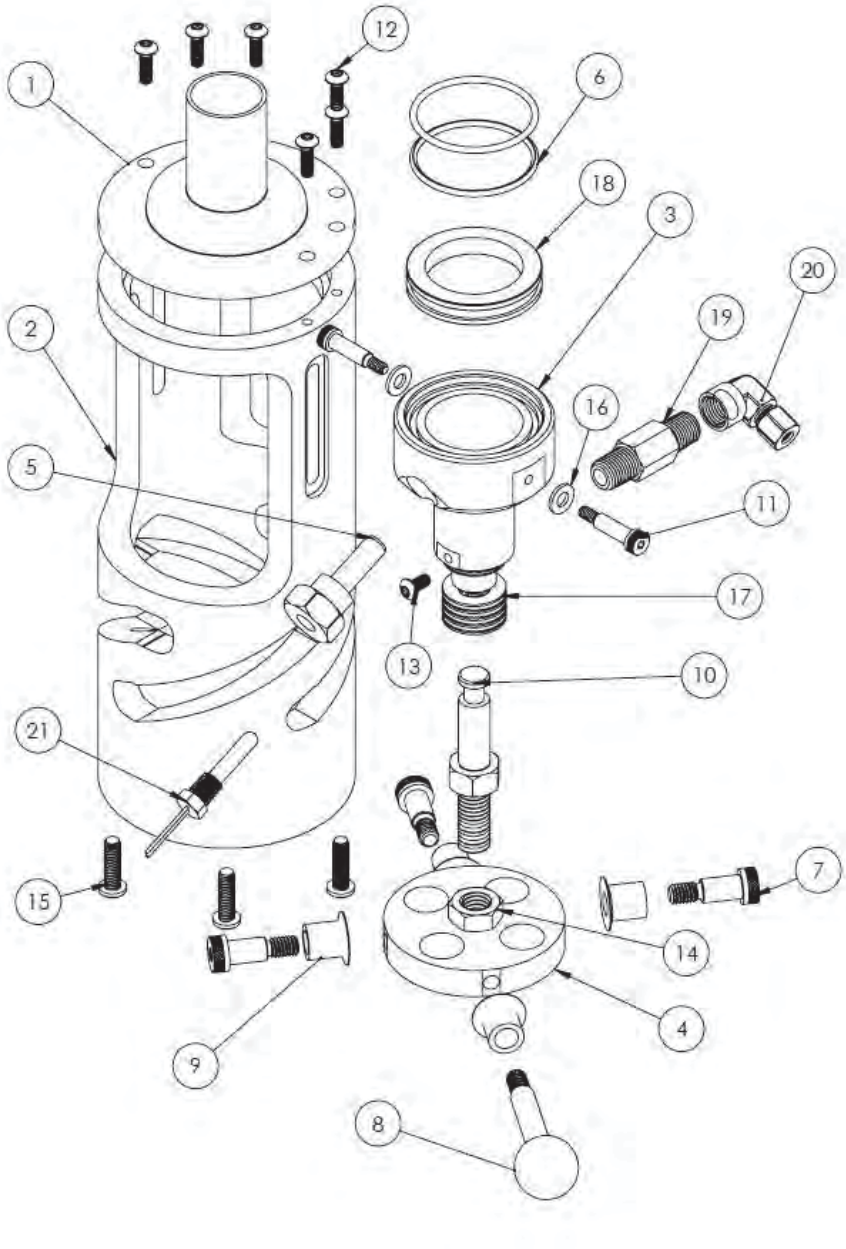
Perform an external leak check by placing the L30 leak check adapter on top of the down-tube and closing the valve. Then go to: MAIN MENU➔PERFORM LEAK CHECKS	11.0
Perform a flow calibration check of the flow system by going to: CALIBRATION➔FLOW CALIBRATION CHECK If the flow is within 4% no action is needed. If flow is not accurate, then a flow calibration must be performed. See section 6.5.	7.7
Check the barometric pressure, filter temperature and ambient temperature sensors, the values can be found by going to: MAIN MENU➔OPERATIONAL DATA If the sensors are not reading correctly, a calibration must be performed see section 6.0 – Calibration.	7.0
Enter the Site ID and Filter ID by going to: SAMPLE SETUP➔ENTER SITE AND FILTER ID	6.1
Choose the sample you would like to perform and the starting day: SAMPLE SETUP➔SET TO SAMPLE 1 in 6 DAYS (for example)	6.2
Place the PM_{10} head onto the top of the downtube.	5.5
Place a clean filter into the filter holder and close the filter holder.	4.0
Close the enclosure of unit.	
After sampling is complete, insert a USB thumb drive into the USB port and press download run summary data. After data downloads press 'EJECT USB' to eject the USB drive and then remove the USB drive.	9.0
Remove dirty filter and record all data as required by your agency.	
Place a new filter in the filter holder and close the filter holder.	
Update the filter ID and ensure the unit is still setup for the sample type you are running. The sample control screen will show the next date of the sample..	9.0

4.0 Filter Holder / Filter Handling

This section describes the TE-Wilbur Filter Holder and Filter Handling.

4.1 Filter Holder

The TE-Wilbur filter holder is used to hold the filter and filter cassette in place while sampling. The filter holder exploded view diagram is below:

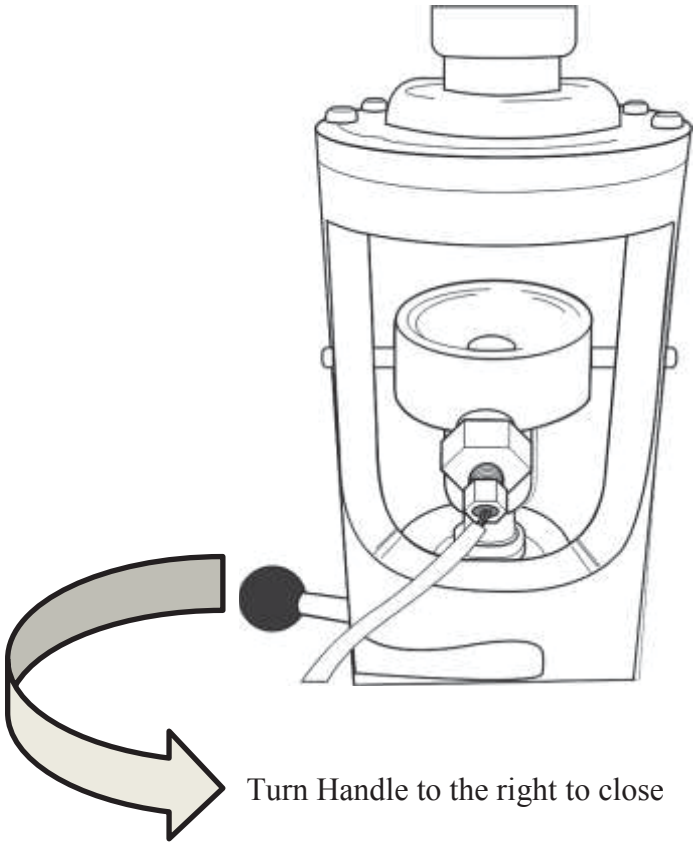


Number	Part Number	Description
1	TE-W-FH1	Top mate
2	TE-W-FH2	Helix Lever Base
3	TE-W-FH3	Bottom mate
4	TE-W-FH4	Cam lever plate
5	TE-W-FH5	Thermowell
6	TE-W-FH6	Bottom and top mate o-rings (Qty 2)
7	TE-W-FH7	5/16-18 shoulder bolt (Qty 3)
8	TE-W-FH8	Lever handle with ball (stainless steel)
9	TE-W-FH9	Cam bushing (Qty 4)
10	TE-W-FH10	Drive rod
11	TE-W-FH11	10-24 shoulder bolt (Qty 2)
12	TE-W-FH12	10-32 socket cap screw (Qty 6)
13	TE-W-FH13	Set screw
14	TE-W-FH14	Drive rod nut
15	TE-W-FH15	1/4-20 mounting bolts (Qty 4)
16	TE-W-FH16	PTFE washer (Qty 2)
17	TE-W-FH17	Belleville washers (Qty 10)
18	L27/L28/L29	Filter Cassette
19	TE-W-FH19	Filter holder hex nipple
20	TE-W-FH20	Compression fitting elbow
21	TE-W-152	PT100 RTD Filter Holder Temperature Probe

4.2 Operating the Filter Holder

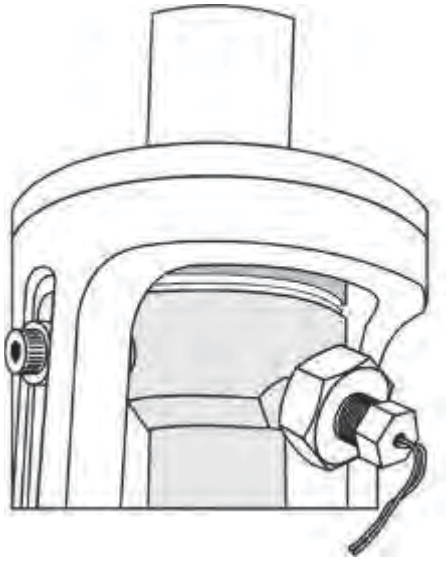
Opening and closing the filter holder is accomplished by sliding the ball lever handle to the far left to open and to the far right to close. When in the final closed position the ball lever handle will 'click' in place.

Filter holder in the open position



Turn Handle to the right to close

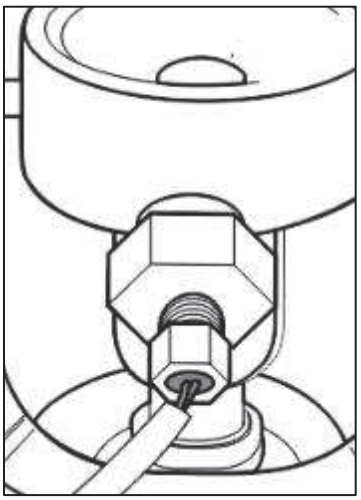
Filter holder in the closed position



4.3 Filter Temperature Probe

The filter holder temperature probe is located in the bottom mate section of the filter holder and measures the temperature of the filter. It is housed inside of a thermowell. This thermowell is secured into the bottom mate and should never have to be removed. The filter temperature probe can be easily threaded into the thermowell by hand.

Illustration showing filter temperature probe



4.4 Adjusting the Filter Holder

The filter holder is factory adjusted and will likely never need adjustment. If the assembly should become loose and require adjustment, perform the following steps:

1. Loosen the drive rod nut (see item 14 in section 4.1) with a ¾" wrench and turn counterclockwise a few turns.
2. The drive rod (see item 10 in section 4.1) should now be able to be turned freely.
3. To tighten the filter holder mechanism turn the drive rod in a counterclockwise rotation a few turns with the filter holder wrench, turning it out of the cam lever plate (see item 4 in section 4.1).
4. To loosen the filter holder mechanism turn the drive rod in a clockwise location, turning it a few turns into the cam lever plate.
5. Test the tightness or looseness of the drive rod by opening and closing the filter holder.
6. Keep turning the drive rod until the desired tightness or looseness is achieved, and then tighten the drive rod nut by turning clockwise with the filter holder wrench securing it and the drive rod onto the cam lever plate.

4.5 Filter Holder Maintenance

The filter holder is maintenance free with the exception of tightening or loosening the mechanism if the system should become loose or is having an issue passing a leak check.

There are o-rings on the top and bottom mate pieces that seal the filter cassette. If there appears to be a leak in the system, inspect these for wear or damage. Replace if needed. See section 13.0 Maintenance for instructions on replacing the o-rings on the filter holder.

The filter holder should be cleaned on a monthly basis to keep stray particulate matter from affecting sampling results. The inside of the bottom and top mate and the top tube can be cleaned with distilled water or a general purpose cleaner and a soft cloth.

4.6 Filter and Filter Cassette

The filter specifications for $PM_{2.5}$ and PM_{10} sampling are detailed in *EPA QA Guidance Document 2.12 – Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference for Class I Equivalent Methods* and are as follows:

- Material – PTFE Teflon with integral support ring.
- Size- circular 46.2mm diameter +/- 0.25mm (with support ring).
- Support ring – Polymethylpentene (PMP) or equivalent inert material, 0.38 ± 0.04mm thickness, outer diameter 46.2 ± 0.25mm, and width of 3.68mm.
- Pore size – 2µm as measured by ASTM F 316-94.
- Thickness – 30-50µm.
- Maximum pressure drop of a clean filter is 30cm of water column at 16.67 L/min clean air flow.
- Maximum moisture pickup – no more than 10µg weight increase after 24 hour exposure to air at 40% RH, relative to the weight after a 24 hour exposure to air at 35% RH.
- Collection efficiency – greater than 99.7% as measured by the dioctyl phthalate (DOP) test (ASTM 1995c) with 0.3µm particles at the sampler's operating face velocity.
- Filter weight stability (including test for loose, surface-particle contamination and test for temperature stability) - filter weight loss ≤ 20µg in either test, measured as specified in 40CFR Part 50, App. L, section 6.9.
- Alkalinity – less than 25 micro-equivalents/g of filter, as measured in a procedure based on Appendix A of *EPA QA Guidance Document 2.12 – Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference ro Class I Equivalent Methods.*

Filter media can be purchased from Tisch Environmental:

PART NUMBER: Tisch Brand SF17138 for 60/pack of filters, Whatman brand TE-7592-104 and MTL brand TE-PT47AN 50/pack.

The filters should be inspected prior to use for:

- Holes or damage
- Discoloration
- Loose media on the filter
- Non-uniformity of the filter

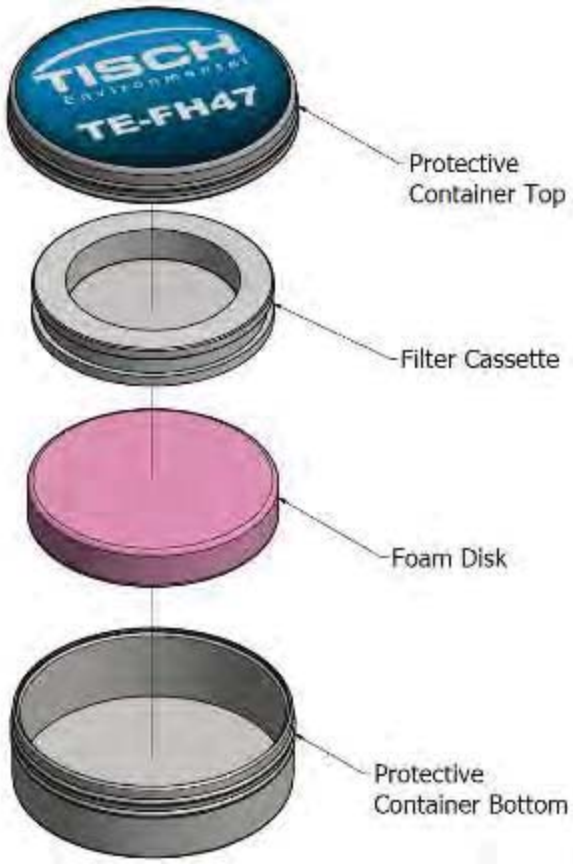
The filter cassette is detailed in 40CFR Part 50 Appendix L. The filter cassette is made up of the following USEPA specified components:

L-27 Filter Cassette Upper Section
L-28 Screen
L-29 Filter Cassette Lower Section

The filter cassette can be purchased from Tisch Environmental:

PART NUMBER: TE-FH47

The filter cassette comes with a protective case and an anti-static bag and is assembled as follows:



4.7 Lot, Field and Lab Blanks

Lot Blanks

Lot blanks are clean, unexposed filters that are used to determine the filter weight stability over a long period of time. Lot blanks are (3) filters selected from a single shipment of filters from a supplier. Lot blanks are conditioned for an initial 24 hours prior to the initial pre-weight determination. The (3) filters are then reweighed periodically (daily or weekly) and stored in the conditioning chamber with the other filters from the lot between being weighed.

This weighing of lot blanks should continue until the weekly weight change of the filters is less than 15µg. This determines the period of time a filter lot should be conditioned before it can be used for routine sampling.

Field Blanks

Field blanks are conditioned, weighed and clean unexposed filters that are used to determine if contamination occurs during sample setup, recovery and transport. Field blanks occur at 10% of the sampler's operating routine. Field blanks should be scheduled to ensure that a post weighing session contains 10% of blanks or at least (1) field blank.

Field blanks are taken out to the sampler, removed from their protective container and installed into the filter holder like a normal sample is. They are left there momentarily (a minute or two) then removed and placed back into their protective container. They are then left in the sampler's enclosure while the sampler is running a sample. Field blanks are retrieved along with the sample and weighed in the lab to determine if any contamination occurs in the field.

Lab Blanks

Lab blanks are clean, conditioned filters that are used to determine if any contamination or weight change is happening in the pre and post weighing functions in the laboratory. Laboratory blanks should be kept inside the conditioning chamber except during weighing. Each post-weighing session should include at least one laboratory blank. If the weight of the laboratory blank changes more than 15µg, there is contamination of the filters during the weighing process that need to be investigated and resolved.

4.8 Filter Pre-Conditioning and Weighing

NOTE: For PM_{10} and $PM_{2.5}$ sampling, refer to *EPA QA Guidance Document 2.12 – Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference for Class I Equivalent Methods* for information on filter weighing, conditioning and microbalance standards.

Conditioning of clean unexposed filters

New, unexposed filters must be conditioned in a conditioning environment for 24 hours before the pre-weighing. The mean %RH must be between 30 and 40 %RH ±5% over the 24 hours of conditioning and a mean temperature between 20 and 23ºC with a variability of no more than ±2ºC over the 24 hour conditioning period.

In the conditioning chamber the filter should be placed on a covered rack or an open-sided cabinet that will allow circulation over the filters while reducing the chance that airborne particulates will get onto the filters.

Take care that other filter media in the chamber does not contaminate the filters such as quartz and glass filter fibers. Filters should be conditioned in their filter-handling container such as a slide petri dish. Write the filter's unique filter ID onto the container's label. During conditioning, place the lid so it partially covers the open container.

Ensure with the use of lot blanks that the filter lot does not exhibit weight loss of more than 15µg per week.

Pre-weighing of unexposed filters

The filters must be weighed in the same room as they were conditioned in. Record the %RH and temperature and verify the mean temperature and %RH for the last 24 hours has remained between 20-23ºC (with instantaneous readings within ±2ºC) and 30-40% RH (with instantaneous readings within ±5%RH.

Using clean forceps two working mass reference standards must be weighed as a QC check such as 100mg and 200mg. Record these weights. If these weights disagree by more than 3µg from their actual weight, they must be reweighed.

Weigh enough laboratory blanks to provide at least 10% or at least one laboratory blank during the post sampling weighing session. Also, weigh enough field blanks to meet 10% or at least one field blank during the post weighing session.

Weigh each filter on the microbalance. Follow the microbalance manufacturer's operations manual for proper operation of the microbalance. The filters should be handled with forceps and only held by the right. Pass the filter, support ring side up near an antistatic strip for 60 seconds before weighing. Immediately transfer the filter to the microbalance for weighing. Record the filter ID, lot number and tare-weight (pre-weight).

After every 10 filters, reweigh one of the standards and record the data. These standards should be within 3µg. Also reweigh one of the 10 filters. It must be within 15µg of its original weight.

After all the filters are weighed, both working standards should be reweighed and must be within 3µg of their standard. Also one random filter of the total should be reweighed and it must be within 15µg of its original weight.

NOTE: Any unexposed filter whose weight is outside the range of the manufacturer's specifications should be discarded and investigated as to why.

Check the filter cassettes for cracks, evidence of wear, dirt and contamination. Cassettes can be cleaned in the dishwasher and rinsed with deionized water. Thoroughly dry the cassette before use. Filters must be used within 30 days of being pre-weighed. Install each filter into the filter cassette and place the cassette into its protective container and then into an antistatic bag for field transport and use.

4.9 Field Sample Handling

Remove the filter cassette from the antistatic bag and protective tin. Ensure the filter holder is open and place the filter cassette with filter into the filter holder. Close the filter holder and set the sampler for the appropriate sample date and time. At the completion of the sampling event, the filter must be collected within 4 days (96 hours) of the end of the run. The filter cassette should be carefully removed from the filter holder, placed into the protective tin with the particulate side upwards and then placed in an anti-static bag.

NOTE: The filter should never be touched. When handling the cassettes, make sure your hands are clean and if gloves are worn, ensure they are anti-static and powder-free.

Place the filter cassettes (in the tins and anti-static bags) into an insulated container such as a small cooler for storage. Use 'blue-ice' packs or frozen gel packs to achieve temperatures below 4ºC. Place a small min/max recording thermometer into the cooler to verify that the samples remained cool during transport to the laboratory.

The sample must be placed back into the conditioned laboratory and weighed within 10 days if stored below 25ºC. If stored below 4ºC, it is 30 days from the end of the run that the filter must be placed back into the laboratory and weighed.

NOTE: Any filter that is noticeably torn or has a hole in it should immediately be invalidated and investigated on what caused the problem.

4.10 Filter Post-Conditioning and Weighing

NOTE: For PM_{10} and $PM_{2.5}$ sampling, refer to *EPA QA Guidance Document 2.12 – Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference for Class I Equivalent Methods* for information on filter weighing, conditioning and microbalance standards.

Conditioning of exposed filters

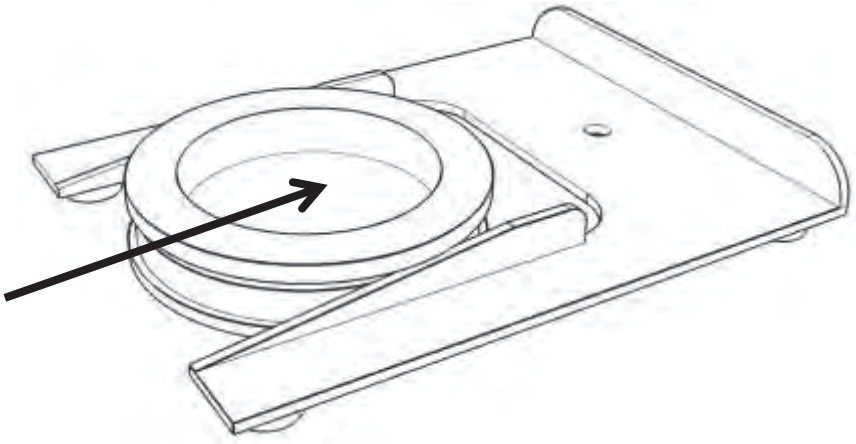
The lab technician who receives and logs in the sample shipment must verify that the shipment was maintained at below 25ºC for less than 10 days or less than 4ºC for less than 30 days of the filters being in the field.

The lab technician will also receive the data recorded from all the site samplers and any paperwork relating to the sample.

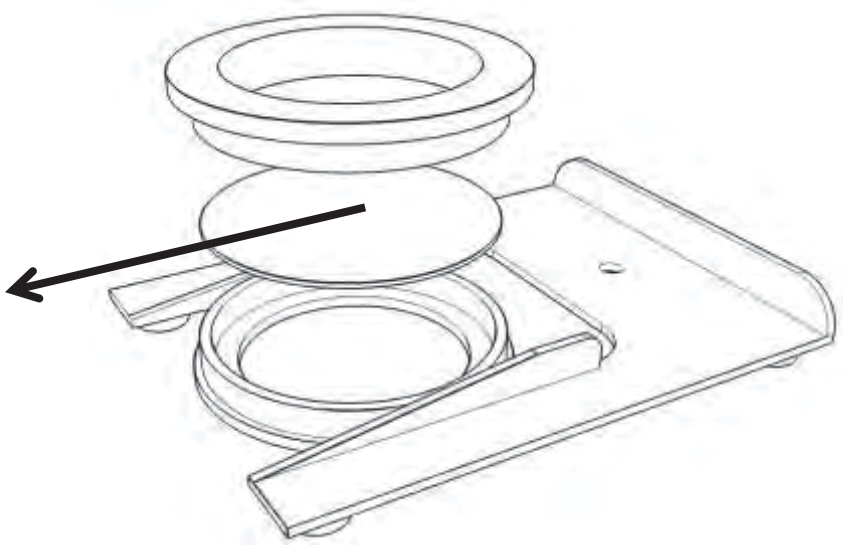
Remove the filter cassette containers from the cooler / freezer and allow each filter cassette container to warm to room temperature. After the containers warm to room temperature open each container to begin the filter equilibration process. During conditioning place the lid of the container partially over the opening so it is partially open. Inspect for any tears, holes or anomalies of the filter that may have occurred during sampling and note this and flag it for further analysis.

Using the Filter Cassette Removal Tool (TE-W-400)

Place the filter cassette removal tool on a flat surface. Grab the filter cassette and push into the opening carefully.



This will separate the top and bottom halves of the filter cassette.



Remove the filter carefully with forceps being careful to only handle the filter by the ring. Place the filter with the dirty-side up into a filter-handling container or petri dish with the corresponding filter ID.

Remove the cassettes and screens from the conditioning area to another area for cleaning.

Allow the filters to condition for at least 24 hours.

Weighing of exposed filters

The filters must be weighed in the same room as they were conditioned in. Record the %RH and temperature and verify the mean temperature and %RH for the last 24 hours has remained between 20-23ºC (with instantaneous readings within ±2ºC) and 30-40% RH (with instantaneous readings within ±5%RH.

Using clean forceps two working mass reference standards must be weighed as a QC check such as 100mg and 200mg. Record these weights. If these disagree by more than 3µg they must be reweighed.

Weigh enough laboratory blanks to provide at least 10% or at least one laboratory blank during the post sampling weighing session. Also, weigh enough field blanks to meet 10% or at least one field blank during the post weighing session.

Weigh each filter on the microbalance. Follow the microbalance manufacturer's operations manual for proper operation of the microbalance. The filters should be handled with forceps and only held by the support ring. Pass the filter, support ring side up near an antistatic strip for 60 seconds before weighing. Immediately transfer the filter to the microbalance for weighing. Record the filter ID, lot number and tare-weight (pre-weight).

After every 10 filters, reweigh one of the standards and record the data. These standards should be within 3µg. Also reweigh one of the 10 filters. It must be within 15µg of its original weight.

After all the filters are weighed, both working standards should be reweighed and must be within 3µg of their standard. Also one random filter of the total should be reweighed and it must be within 15µg of its original weight.

4.11 Calculating Mass Concentrations

The total sample volume can be calculated from the sample which is located on the sample completed screen. If the total volume is not available it can be calculated using the following formula:

$$V_a = \frac{(Q_{avg})(T)}{16.67}$$

Where: V_a = total sample volume (m^3)
Q_{avg} = average sample flow rate (Lpm)
T = total sample time (hours)
16.67 = conversion to m^3/hr

Using the pre and post sample filter weights, the total filter mass gain can be found by the following formula:

$$M_{delta} = (M_{post} - M_{pre})$$

Where: M_{delta} = total mass gained during sampling in µg
M_{post} = post sample weight in µg
M_{pre} = pre sample weight in µg

The total concentration of particulate can then be calculated using the following formula:

$$PM_x = \frac{M_{final}}{V_a}$$

Where: PM_x = concentration of $PM_{2.5}$ or PM_{10} particulates in $\mu g/m^3$
V_a = total volume of the sample

4.12 Data Validation

The sample run data should be verified by the following criteria:

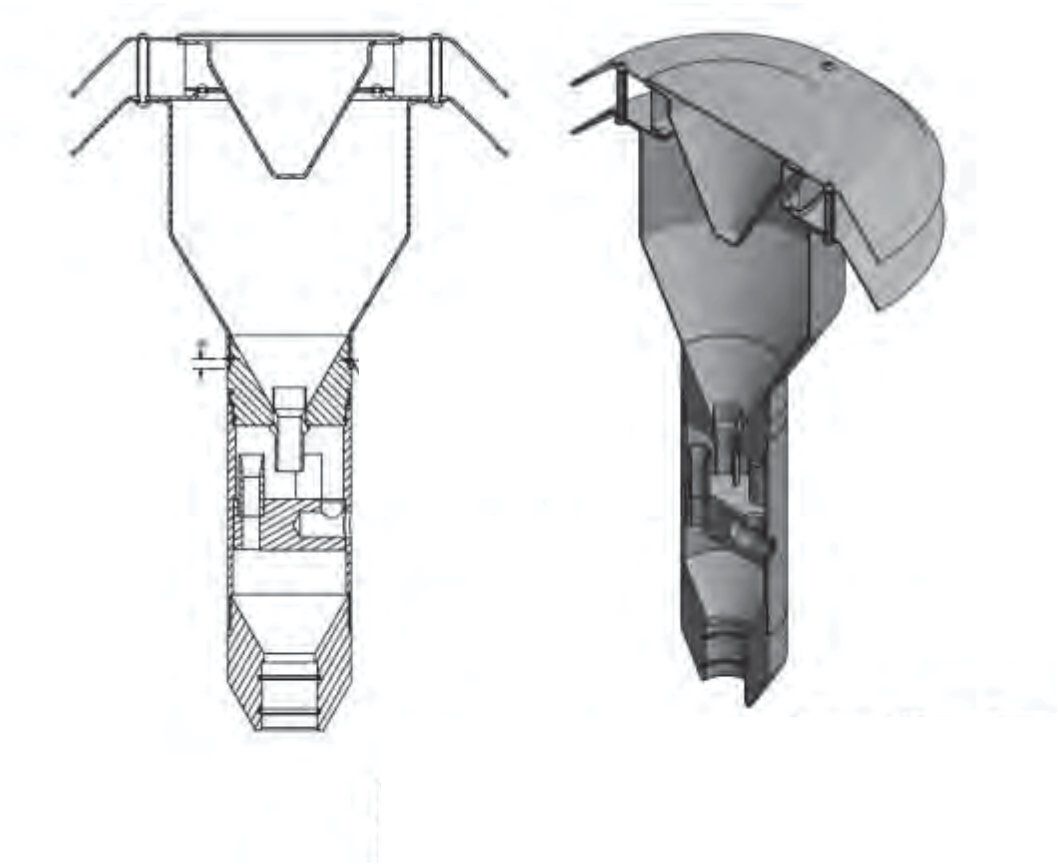
- Average volumetric flow rate = 16.7 L/min ± 5%.
- Flow rate coefficient of variation less than 4%.
- Temperature difference (filter – ambient) less than 5ºC.
- Sample Time is greater than 23 hours and less than 25 hours.
- Verify that the sample data sheet the technician filled out does not indicate an invalid sample or that there were warnings or alarms during the sample.
- Verify that the sample was retrieved within 4 days (96 hours) of the completion of the sample run.
- Verify that the container holding the filters did not exceed 25ºC during transport to the laboratory.
- Verify that filter was used within 30 days if kept at 4ºC or below, or 10 days if kept below 25ºC.
- Verify that the barometric pressure, filter temperature and ambient temperature were reading appropriately on the datalog and were not out of specifications or varied widely throughout the sample.
- Verify that there were not more than 10 power losses during the sample period or any other alarms that would invalidate the sample.

5.0 PM_{10} Inlet / $PM_{2.5}$ Cyclone

This section describes the TE-PM10 inlet and the TE-PM2.5C $PM_{2.5}$ cyclone fractionator.

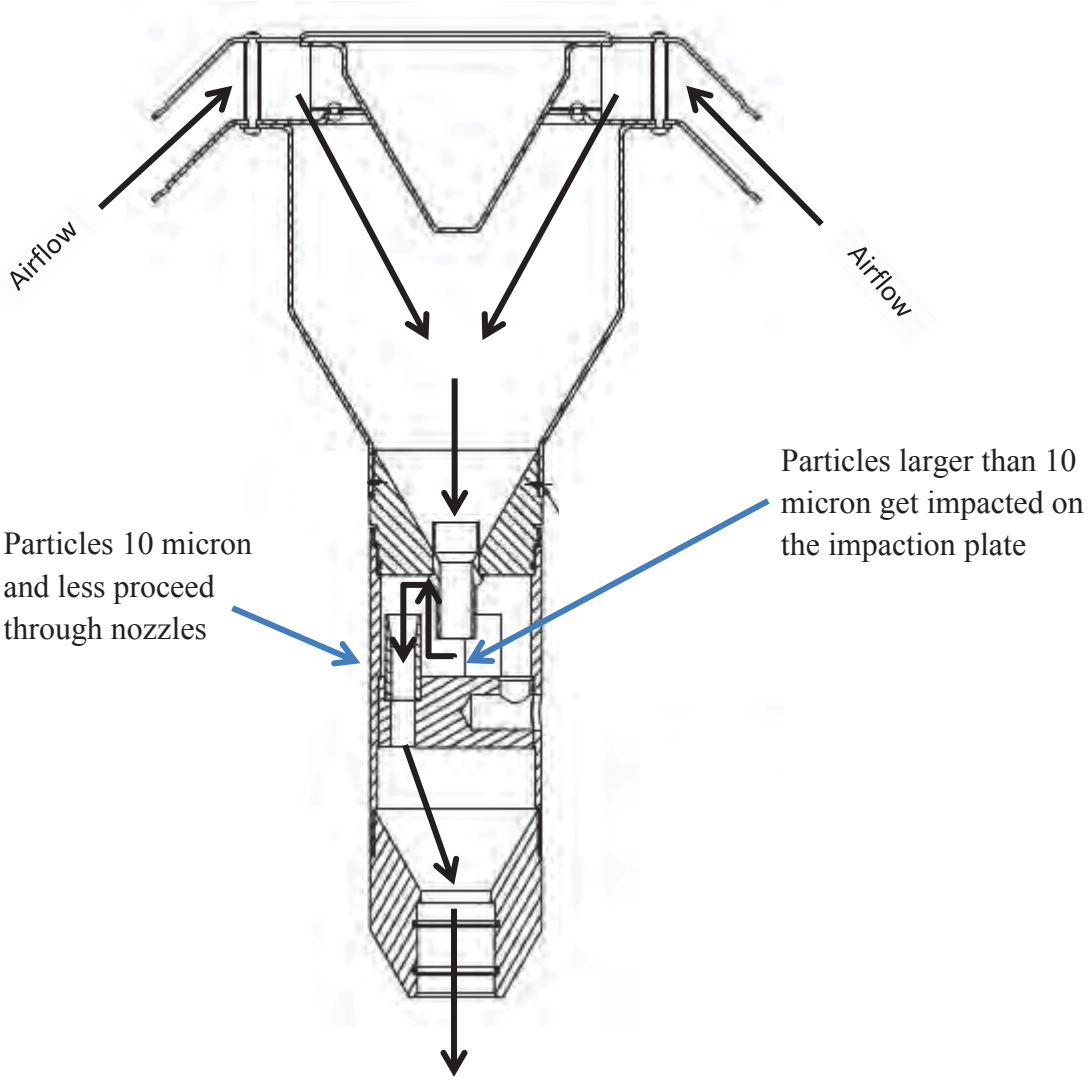
5.1 TE-PM10 Inlet

The TE-PM10 inlet is a 10 micron particulate fractionator. Below is a cut-away view of the TE-PM10.



Ambient air is pulled in through the top of the inlet and particles that have aerodynamic diameters greater than 10um are impacted on the inside plate of the unit. The particles that have less than 10um of aerodynamic diameter are expelled at the bottom, onto the next stage.

The following shows the airflow path through the TE-PM10 Inlet.



5.2 Cleaning the PM_{10} Inlet

USEPA *Quality Assurance Guidance Document 2.12, Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods* suggests the PM_{10} inlet must be cleaned every 4 weeks. To clean the TE-PM10 Inlet, perform the following:

1. Remove the glass jar and empty any water.
2. Place the jar aside.
3. Remove the PM_{10} inlet from the sampler and place on flat surface.
4. Unscrew the lower piece from the upper piece.
5. Using cotton swabs, q-tips and distilled water or general purpose cleaner, clean the impactor plate and the nozzles.

6. Using a soft brush, cloth and cotton swabs, lightly scrub all interior surfaces and the bug screen with distilled water and / or general purpose cleaner.
7. Check the o-ring around the upper unit that seals the upper and lower pieces for wear and damage. Replace if worn or damaged
8. Check the 2 o-rings in the bottom of the inlet for wear and damage. Replace if worn or damaged.
9. Place a small amount of o-ring grease around the o-ring that seals the upper and lower units.
10. Screw the upper and lower unit back together carefully.
11. Place a small amount of o-ring grease around the 2 o-rings on the bottom.
12. Screw the jar back into the inlet and place the inlet back onto the downtube.

The PM_{10} Inlet has the following O-rings that should be inspected for wear and replaced as needed.

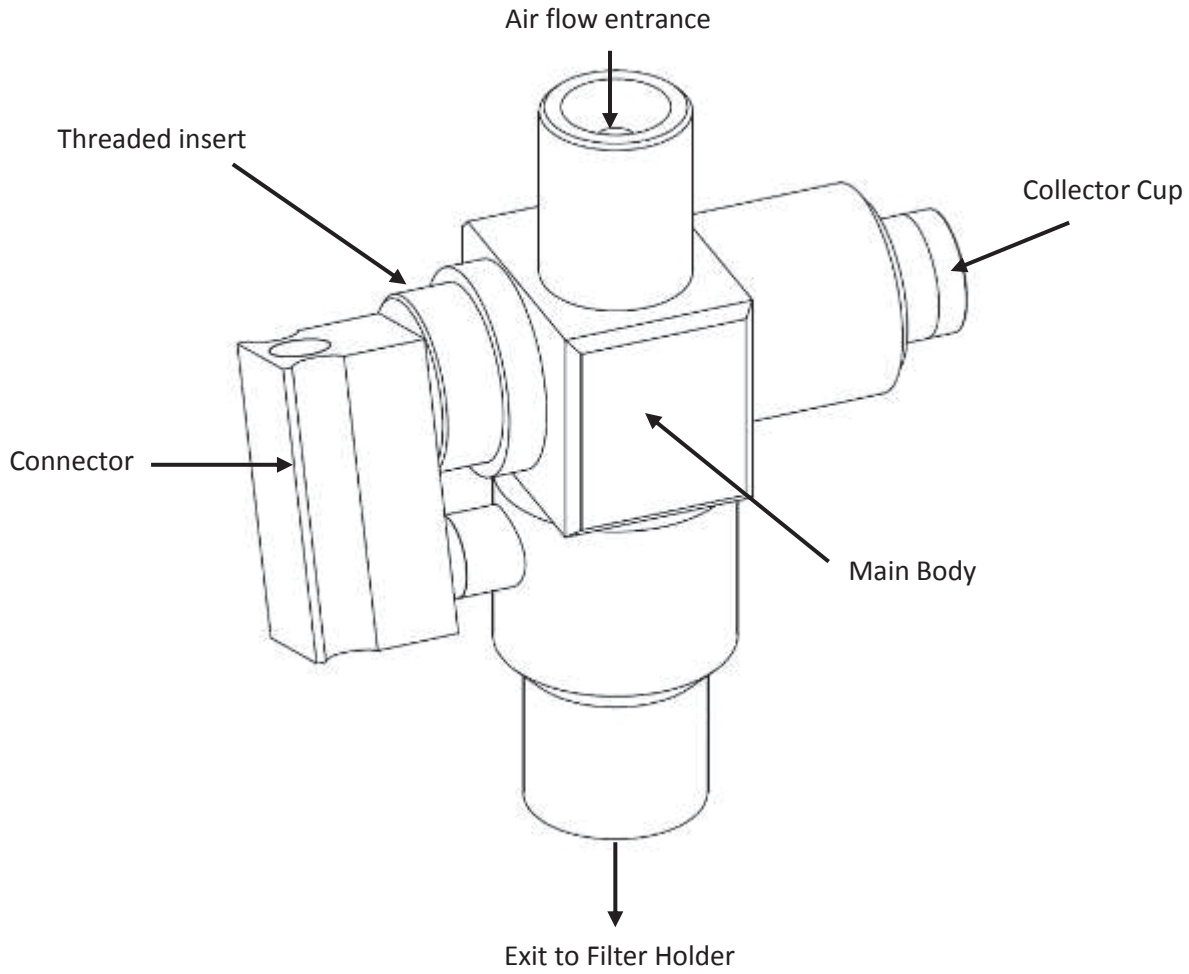
Quantity	Description	Part Number
2	Exit Adapter O-Rings	TE-W-022
1	Impactor Nozzle O-Ring	TE-W-023
2	Downtube O-Rings	TE-W-021

These can also be ordered together in a kit by part number TE-W-020.

There are also O-rings located in the black downtube adapter and those can be ordered using part number TE-W-024.

5.3 TE-PM2.5C Cyclone

The TE-PM2.5C is a $PM_{2.5}$ particle fractionator that utilizes a cyclonic effect to separate ambient particles that have an aerodynamic diameter less than 2.5um. The cyclone is placed directly underneath the PM_{10} inlet to achieve $PM_{2.5}$ collection.



5.4 Cleaning the TE-PM2.5C Cyclone

The following describes how to clean the TE-PM2.5C Cyclone.

1. Remove the cyclone from the sampler by pulling the downtube up and pulling the cyclone off of the top of the filter holder.
2. Place on a flat surface.
3. Unscrew the collector cup and wipe out the inner body with a lint-free laboratory wipe. Distilled water or general purpose cleaner can be used if the inner body is very dirty.
4. Wipe the inside of the collector with a lint-free wipe.
5. Remove the connector by pulling outward.
6. Inspect the o-rings, on the tubes that the connector plugs into, for wear or damage. Replace if worn or damaged.
7. Wipe down the connector and the outside of the tubes.

8. Unscrew the threaded insert.
9. Wipe down the threaded insert and the inside of the body where it inserts into with a lint-free laboratory wipe.
10. Inspect the o-ring on the outer lip of the threaded insert for wear or damage. Replace if worn or damaged.
11. Thread the threaded insert back into the cyclone body.
12. Place a small amount of o-ring grease around the o-rings on the connector tubes.
13. Push the connector onto the tubes.
14. Thread the collector cup back into the body.
15. Wipe out the bottom exit of the cyclone with a lint-free wipe.
16. Place back onto filter holder and push downtube back onto top of cyclone.
17. Ensure to place the PM_{10} inlet back onto unit prior to sampling.

The TE-PM2.5C Fractionator has the following O-rings that should be inspected for wear and replaced as needed.

Quantity	Description	Part Number
2	Exit Nozzle O-Rings	TE-W-031
1	Collector Cup O-Ring	TE-W-032
1	Threaded Insert O-Ring	TE-W-033
2	Connector tube O-Rings	TE-W-034
2	Stainless steel bolt O-Rings	TE-W-035

These can also be ordered together in a kit by part number TE-W-030.

5.5 Placing of the Cyclone and PM_{10} Head

To sample for PM_{10} you would install the downtube onto the top of the filter holder and then the TE-PM10 head onto the top of the downtube.

To sample for $PM_{2.5}$ you would install the TE-PM2.5C onto the top of the filter holder, then the downtube and lastly the TE-PM10 head on top of the downtube.

NOTE: The downtube adapter has o-rings inside of it to prevent water from entering the enclosure. Ensure these o-rings are greased when removing and installing the downtube.

6.0 Sample Setup

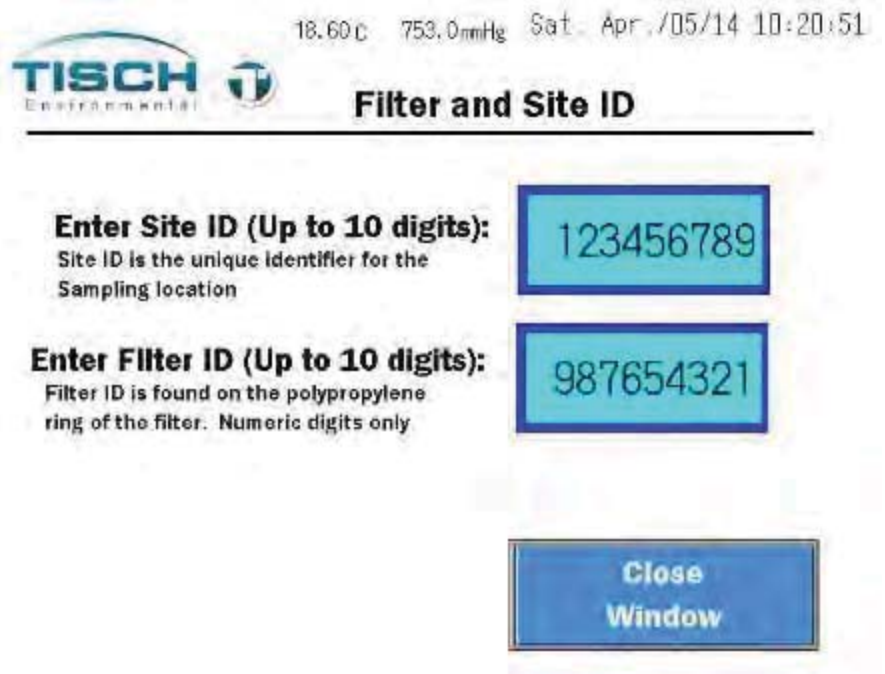
The sample setup menu allows you to setup the sampler to run on standard US EPA schedules for 1 in 3 day sampling, 1 in 6 day sampling and 1 in 12 day sampling for 24 hours, midnight to midnight. Also, a custom sample can be setup that will start and stop the sampler at a specific date and time.

6.1 Site and Filter ID

The Site ID and Filter ID can be entered by pressing the 'Enter Filter and Site ID' button located in the Sample Setup Menu. The Site ID and Filter ID can be up to a 10 digit number, with no alpha-numerical characters allowed.

MAIN MENU ➔ **SAMPLE SETUP** ➔ **ENTER SITE AND FILTER ID**

Filter and Site ID Screen



6.2 USEPA Sample Setup

The USEPA standard schedules of a 1 in 3, 1 in 6, or 1 in 12 day sample schedule can be easily programmed in the sample setup menu. This example uses the 1 in 3 day schedule. To setup a 1 in 6 or 1 in 12 the procedure is the same. When setting up an USEPA sample, the system is color coded to somewhat match the US EPA schedule found at:

http://www.epa.gov/ttnamti1/calendar.html.

The 1 in 12 schedule will be shown purple, The 1 in 6 will be shown in green and the 1 in 3 sample schedule will be shown in orange.

The 1 in 3 sample setup is found here:

MAIN MENU ➔ **SAMPLE SETUP** ➔ **SET TO SAMPLE 1 in 3 DAYS**

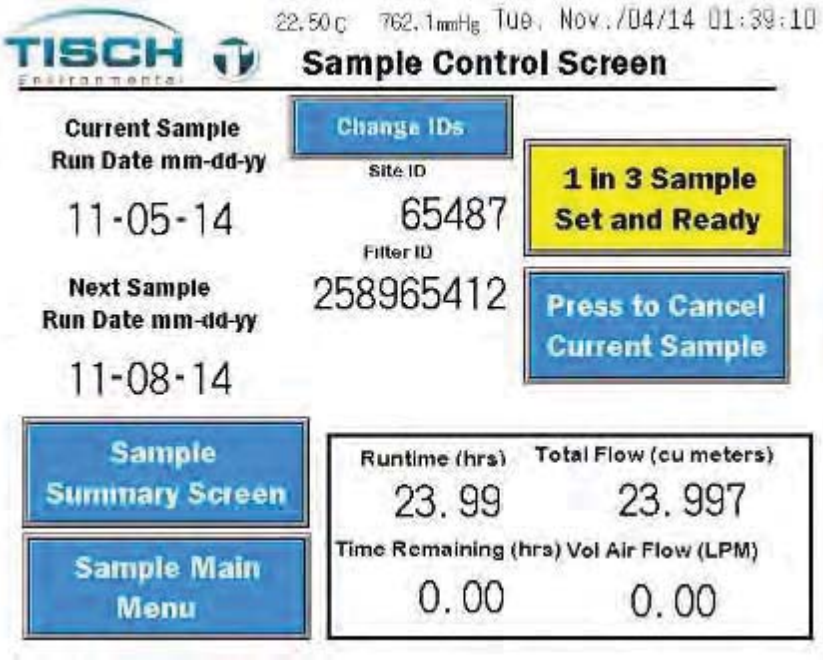
On this screen you have the ability to set a start Month / Day / Year. The system will not allow you to enter a date in the past.

The unit will start on Midnight of the day you enter. So if you enter 2/23/14 and the date is 2/22/14 and the time is 23:59:59, in one second the unit will turn on and sample for 24 hours midnight to midnight.

You also see the setpoint of the sample. This defaults to 16.67 Lpm which is the designed setpoint, so this value should never be changed. See Screen Maintenance section 8.0 to change the setpoint.

After the sample is setup press the **PROCEED TO SAMPLE CONTROL SCREEN** button.

Sample control screen



On this screen you have the ability to Cancel the current sample and see all the pertinent sample runtime information such as:

Current Sample Run Date This is the date that the sampler will start running at midnight.

Next Sample Run Date This is the date of the next sample. If the current start date is 2/23/14 and you are running a 1 in 3 schedule, the next sample run date will be 2/26/14.

Runtime This is the actual runtime of the sample. When the sample starts this value is reset to zero. The currently displayed value is the last sample's runtime or the current runtime if the sampler is running.

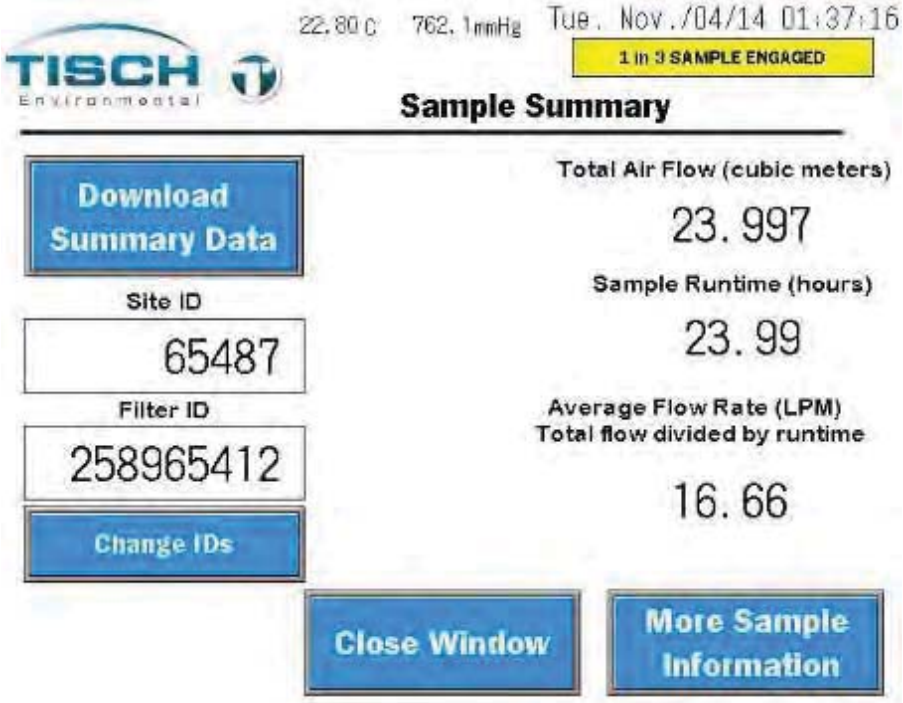
Time Remaining This is the time remaining of the current sample. When a 24 hour sample starts this value will be 24.

Total Flow This is the total airflow in cubic meters. At 16.67 Liters per minute, 1 cubic meter per hour of air will pass through the sampler. In 24 hours, approximately 24 cubic meters of air will flow through the sampler.

Vol Air Flow This is the actual volumetric flow in Lpm.

The **SAMPLE SUMMARY SCREEN** button will take you to the sample summary screen

Sample summary screen



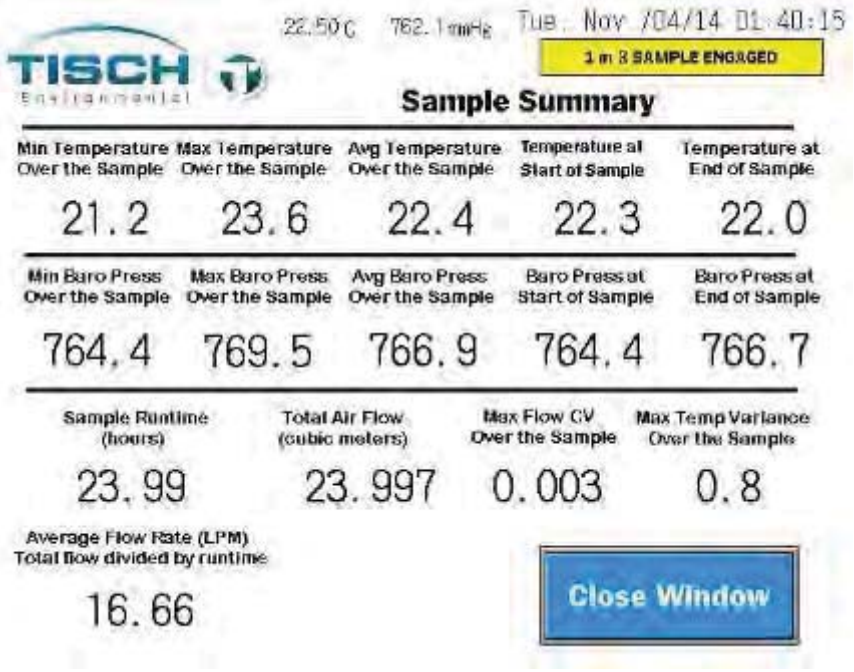
This screen is what appears after a successful sample. The last sample completed screen is a summary of the sample and gives the operator all the pertinent information for the sample such as total air flow, runtime and average flow rate.

NOTE: When a sample is setup to run (Engaged) there will be an indication on every screen at the top. When a sample is running there will also be an indication at the top of each screen.

NOTE: When a sample is running, all features such as changing the date and time, doing a calibration or leak check are disabled. The sample must be canceled if those are necessary.

Press the **MORE SAMPLE INFORMATION** to see more information about the sample that has just completed.

More Sample Information Screen



On the more sample information screen the following information is presented to the operator:

Min / Max / Avg Temperature This is the minimum, maximum and average ambient temperature over the entire sample period in degrees Celsius.

Temperature at Start of Sample This is the ambient temperature at the start of the sample in degrees Celsius.

Temperature at End of Sample This is the ambient temperature at the end of the sample in degrees Celsius.

Min / Max / Avg Baro Press This is the minimum, maximum and average barometric pressure over the entire sample period in mmHg.

Baro Press at Start of Sample This is the barometric pressure at the start of the sample in mmHg.

Baro Press at End of Sample This is the barometric pressure at the end of the sample in mmHg.

Max Flow CV This is the maximum flow coefficient of variance over the entire sample.

Max Temp Variance This is the maximum temperature variance between ambient and the filter temperature in degrees Celsius.

Runtime This is the actual runtime of the sample. When the sample starts this value is reset to zero.

Total Flow This is the total airflow in cubic meters. At 16.67 Liters per minute, 1 cubic meter per hour of air will pass through the sampler. In 24 hours it should be 24 cubic meters.

Average Flow Rate This is the total flow in Lpm divided by the runtime to derive the average flowrate over the sample period.

6.3 Custom Sample

A custom sample can be setup that allows the operator to enter a start Month / Day / Year / Hour / Minute and duration in Hours / Minutes. The sampler will start on the date entered and run for the duration of the runtime entered. The system does not allow the user to enter a date in the past.

The custom sample can be found here:

MAIN MENU ➔ **SAMPLE SETUP** ➔ **SET CUSTOM SAMPLE**

All alarms associated with shutting down a sample, datalogging and all features of the USEPA standard samples are associated with the custom sample.

When a custom sample is engaged, all screens will show a blue box indicating that a custom sample has been setup and engaged. When a custom sample is running a green box will show on all screens that a sample is running.

NOTE: Once a custom sample stops, it will not reoccur. It is a one-time sample.

6.4 Canceling a Sample

To cancel a sample, press the PRESS TO CANCEL CURRENT SAMPLE button located on the sample control screen. A popup will appear asking if you are sure you would like to cancel the current sample. Press YES to cancel or NO to return to the sample control screen.

NOTE: Once a sample is canceled, it must be setup again in the sample setup menu. If the sampler is set for a 1 in x sample schedule and the sample is canceled, the 1 in x sample schedule must be reconfigured in order for the sampler to run again.

NOTE: If the sampler is set for a 1 in x sample and the date is changed to the future, the sample will be automatically cancelled and must be setup again. Also, if there is an extended power fail and if the 1 in x sample is missed, it will cancel the sample and the sample must be setup again.

6.5 Sample Alarms

When a sample is running, there are certain events, or alarms, that will shut down a sample per USEPA specifications. There are also events that do not shut down the sample, but will be logged in the history log and are called Warnings.

When an alarm shuts down the sample, the history log will automatically appear alerting the operator that there has been an alarm and the sample has been shut down.

The following alarms will shut down a sample:

Shutdown Sample Alarms

Flow	Alarms when flowmeter is unplugged, goes over range (25 Lpm) or the electronics detects an internal problem with the sensor.
Barometric Pressure	Alarms when barometric pressure board is unplugged, if the pressure falls below 550mmHg, the pressure goes above 850mmHg or if the electronics detects an internal problem with the sensor.
Ambient Temperature	Alarms when the temperature drops below -90 Degrees Celsius, goes above 60 Degrees Celsius, is unplugged or the electronics detect an internal problem with the sensor.
Filter Temperature	Alarms when the temperature drops below -90 Degrees Celsius, goes above 60 Degrees Celsius, is unplugged or the electronics detect an internal problem with the sensor.

10% Flow Variance When a sample is running and the flow varies by 10% or more for 10 minutes, the sample will shut down.

High System Pressure When the internal pressure of the system exceeds 200 inches of H_2O it will shut down the sample and alarm.

10 Power Failures When a sample is running and 10 consecutive power fails occur, it will shut down the sample and active the alarm.

There are also warnings associated with a sample. A warning will not shut down the sample and will allow the sample to complete. A warning will alert the operator that a warning has occurred and to check the history log.

Warnings that do not shut down a sample

5% flow variance When a sample is running and the flow varies by 5% or more for 5 minutes, the system will log the event in the history log.

Power Failure A power fail will be logged in the history log.

Sample Time When a sample completes and the sample runtime is less than 23 hours or more than 25 hours it will log the event in the history log.

Temperature Variance If the ambient temperature and the filter temperature vary by more than 5 Deg C for 30 minutes.

NOTE: When a warning appears on the screen and is logged in the history log it must be acknowledged. If it is not acknowledged by the operator it will continue to be active in the history log and will continue to show on the sample completed screen.

6.6 More Sampling Information

The TE-Wilbur system has the ability to store the last (5) samples that occurred into the system. The oldest sample will be number 5 and the newest sample will be number 1. The oldest will get discarded as a new sample has completed. This information is updated after the sample has completed and can be found by the following keystrokes:

MAIN MENU → **SAMPLE SETUP** → **SAMPLE INFORMATION**

6.7 Other Sampling Features

When a sample has started, the following features are disabled:

Maintenance Menu
System Calibration Menu
Perform Leak Checks Menu

If the operator is performing a calibration, leak check or is running the system in manual mode, those will be terminated and the sample will take precedence and will start automatically.

When a sample is started, the sample control screen is automatically displayed.

When a sample is completed, the sample completed summary screen will be automatically displayed.

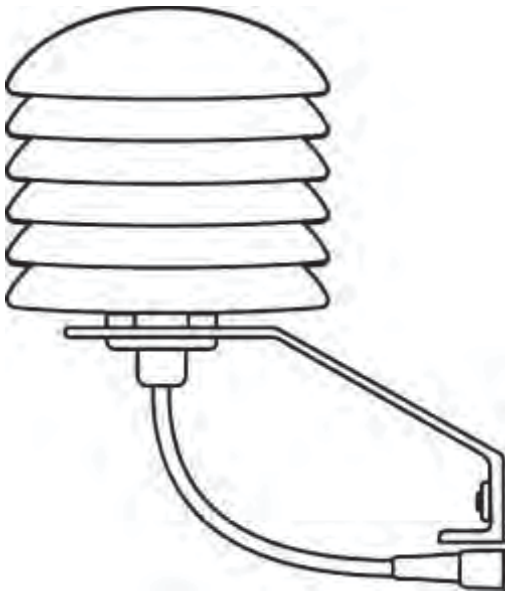
When a power fail occurs, on re-power the sampler will start sampling again as long as the sample time is within the time the operator has set it to.

7.0 Calibration

The Calibration menu is where the sensors for flow measurement, ambient temperature, filter temperature and barometric pressure can be verified and calibrated.

7.1 Ambient Temperature Calibration

The ambient temperature sensor is a highly accurate PT100 RTD (resistive temperature device). The ambient temperature sensor can be found inside the radiation shield, which is bolted to the left side of the enclosure.



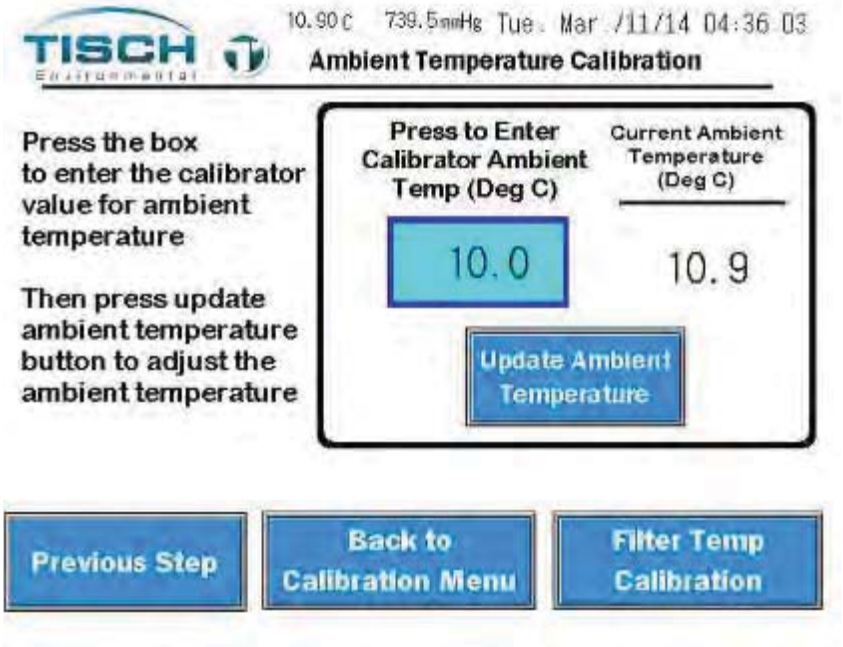
To calibrate the ambient temperature sensor perform the following:

1. Obtain a calibrated temperature device such as the Tisch FRM-CAL low volume calibration system.
2. Allow the calibrated temperature device to reach equilibrium with the ambient air and take a reading on the calibrated temperature device.
3. The temperature calibration can be performed by following these keystrokes:

MAIN MENU	➔	CALIBRATION	➔	AMBIENT TEMPERATURE CALIBRATION

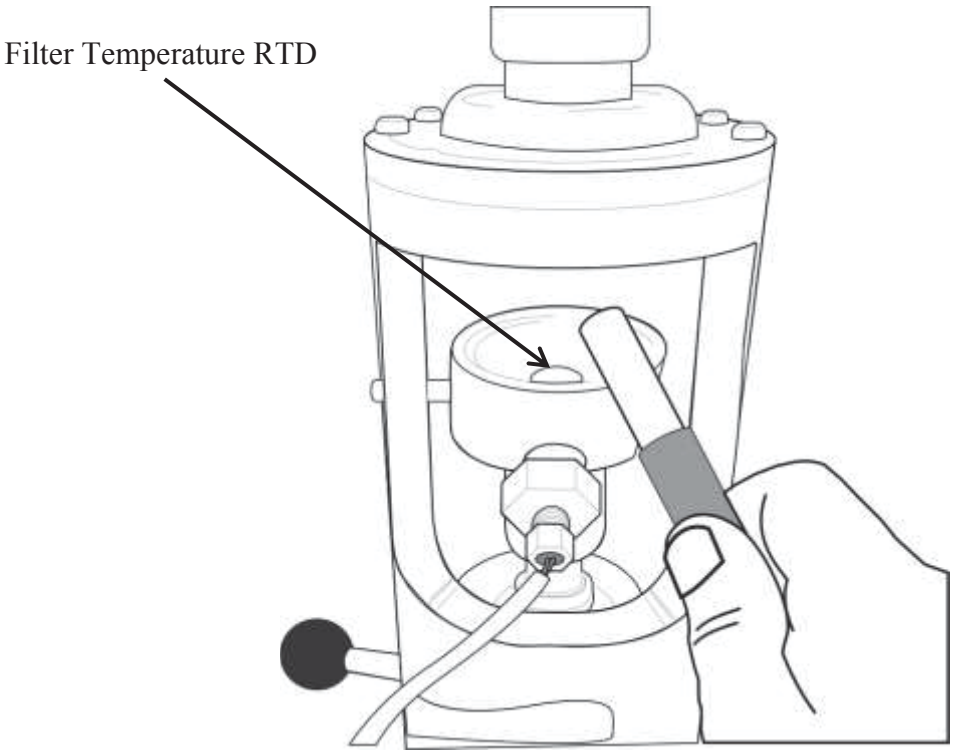
4. Press the box and enter the temperature reading from the calibrator.
5. Press UPDATE to update the temperature.

Ambient Temperature Calibration Screen



7.2 Filter Temperature Calibration

The Filter temperature sensor is a highly accurate PT100 RTD (resistive temperature device). The filter temperature sensor can be found inside the filter temperature thermo well which is on the front of the filter holder. The filter temperature RTD can be removed and inserted from the thermo well by screwing and unscrewing it. The thermo well is secured tightly into the filter holder body and provides a sealed fitting. Tightening the RTD into the thermo well is not important to seal the system so it can be tightened finger-tight into the thermowell.



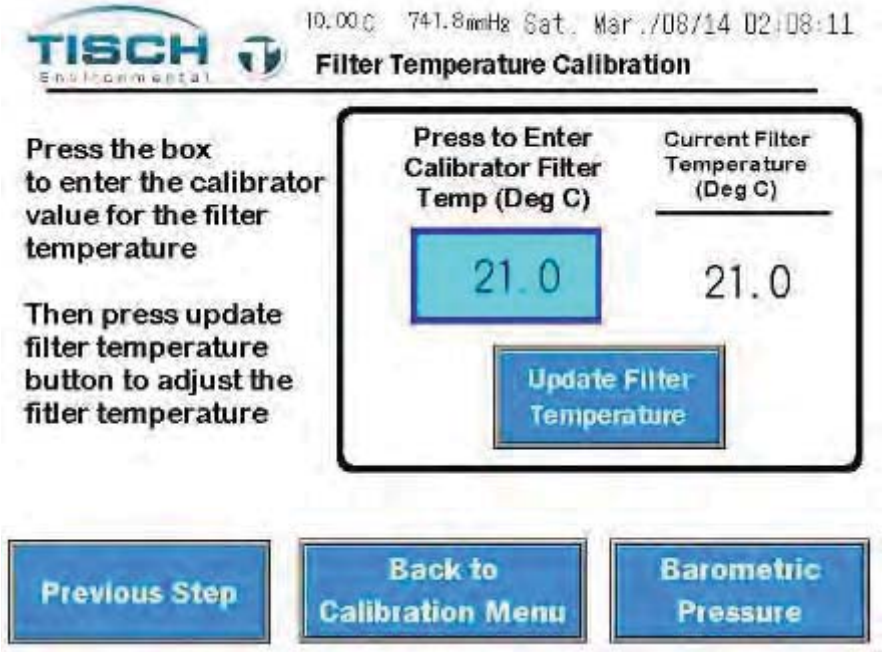
To calibrate the filter temperature sensor perform the following:

1. Obtain a calibrated temperature device such as the Tisch FRM-CAL low volume calibrator.
2. Allow the calibrated temperature device to reach equilibrium with the ambient air.
3. Place the temperature device into the filter holder holding it at the tip of the filter temperature RTD.
4. The temperature calibration can be performed by following these keystrokes:

MAIN MENU ➔ **CALIBRATION** ➔ **FILTER TEMPERATURE CALIBRATION**

5. Press the box and enter the temperature reading from the calibrator.
6. Press UPDATE to update the temperature.

Filter Temperature Calibration Screen



7.3 Barometric Pressure Calibration

The barometric pressure sensor is a highly accurate electronic sensor that is mounted inside the enclosure. Since pressure is equalized from inside the enclosure to outside the enclosure, measuring the barometric pressure outside of the enclosure will suffice.

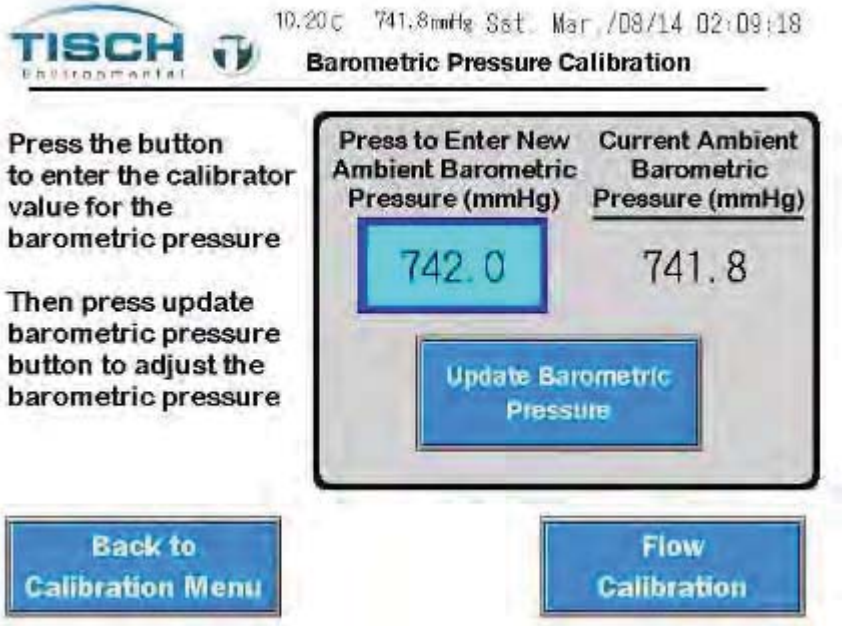
To calibrate the barometric sensor perform the following:

1. Obtain a calibrated barometric device such as the Tisch FRM-CAL low volume calibrator.
2. Allow the calibrated barometric pressure device to reach equilibrium with the ambient air.
3. The barometric calibration can be performed by following these keystrokes:

MAIN MENU ➔ **CALIBRATION** ➔ **BAROMETRIC PRESS CALIBRATION**

4. Press the box and enter the pressure reading from the calibrator.
5. Press UPDATE to update the barometric pressure.

Barometric Pressure Sensor Calibration Screen



7.4 Volumetric Flow Calculation

The TE-Wilbur uses a highly accurate mass flow sensor to measure the mass flow of the flow system. The system then calculates the actual volumetric flowrate using the following formula:

$$Q_a = Q_s \, x \left(\frac{P_s}{P_a}\right) x \left(\frac{T_a}{T_s}\right)$$

Where:
Q_a = Actual Flow or Volumetric Flow in Lpm
Q_s = Mass flow
P_s = Standard USEPA Barometric Pressure = 760 mmHg
P_a = Actual Barometric Pressure Conditions in mmHg
T_s = Standard USEPA ambient Temperature = 298.15 Deg K
T_a = Actual ambient Temperature Conditions in Deg K

Rewriting:

$$Q_a = Q_s \, x \left(\frac{760}{P_a}\right) x \left(\frac{T_a + 273.15}{298.15}\right)$$

Where: T_a is now ambient temperature in Degrees Celsius.

Rewriting:

$$Q_a = Q_s \; x \; 2.549 \; x \left(\frac{T_a + 273.15}{P_a}\right)$$

Where: Q_a is the flow in Lpm, T_a is ambient temperature in Degrees Celsius and P_a is ambient barometric pressure in millimeters of mercury.

7.5 Flow Calibration

Flow calibration is performed using a four-point linear regression formula. Four points of flow are generated at 90% / 95% / 100% / 105% of setpoint. When flow calibration is started, the system automatically will start the flow system and will achieve each setpoint, allowing the user to enter the calibrator's flow reading at each step.

To calibrate the flow system, perform the following:

1. Flow calibration can be performed by following these keystrokes:

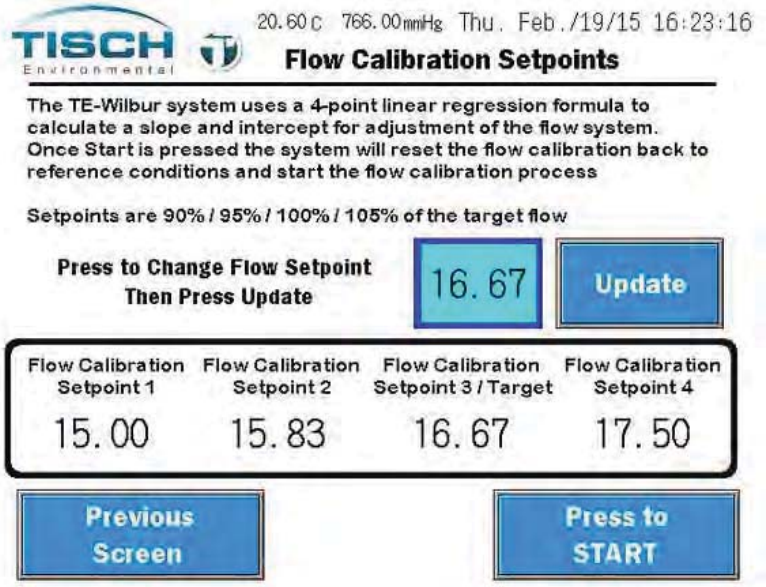
MAIN MENU	➔	CALIBRATION	➔	FLOW CALIBRATION

2. Place a known, calibrated flow standard onto the downtube of the TE-Wilbur unit such as the Tisch FRM-CAL low volume calibrator. This calibrator should be within its certification period.

Picture showing the TE-FRM-CAL calibration head inserted onto downtube

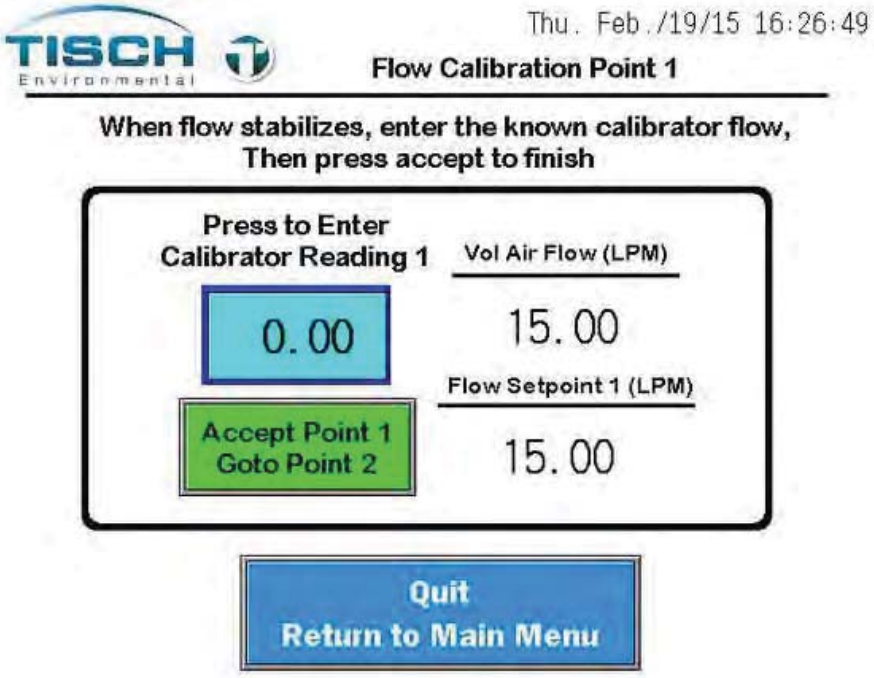
3. Place a filter cassette with a screen and filter into the filter holder and close the filter holder. NOTE: this filter cannot be used for subsequent sampling per USEPA Quality Assurance Guidance Document 2.12.
4. Proceed to the setpoint screen where the user can change the setpoint of the flow calibration. 16.67 Lpm is the default setpoint and should only be changed under abnormal operations.

Flow Calibration Setpoint Screen



5. Press START and the Calibration Point 1 screen will be displayed and the flow system will start and will achieve the first setpoint. The setpoint and flow is shown on the left.

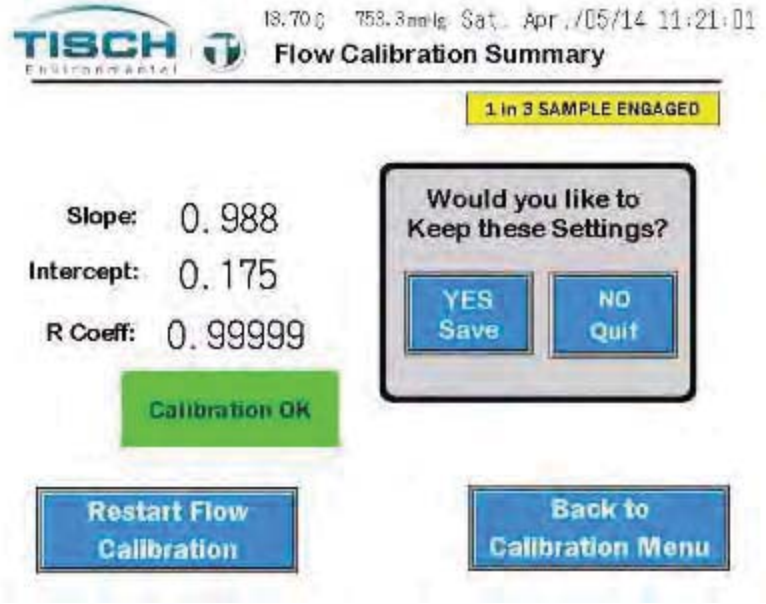
Flow Calibration Enter Reading Point 1 Screen



6. After the flow stabilizes, take a reading from the calibrator and press the blue box to enter the calibrator's reading.
7. Press the green ACCEPT box to accept that reading and continue to setpoint number two.
8. Perform setpoints two, three and four. After the fourth setpoint the final flow calibration screen will appear.

NOTE: If the **QUIT RETURN TO MAIN MENU** Button is pressed on any of the screens, the last successful calibration slope and intercept will be loaded into the flow calibration settings and the calibration will be terminated.

Flow Calibration Summary Screen



9. The user is presented with the slope, intercept and R coefficient of the four point linear regression formula. If the R coefficient is less than 0.98 the user is notified that the calibration needs attention.
10. If the R coefficient is greater than 0.98 and the user feels that the calibration was successful they can save the calibration values by pressing the YES SAVE button. If the user does not want to save the calibration settings they can press NO QUIT and the last calibration values will be used for flow adjustment.

7.6 Flow Calibration Equations

Linear Regression is a mathematical way to find the relationship between several variables. In the case of flow calibration, you are trying to find the relationship between what the calibrator is reading and what the flow sensor is reading you are trying to calibrate.

A straight regression line depicts a linear trend or relationship of the data. So the linear straight line equation of $y = mx + b$ holds true. This means that you can calculate any point along the line given the reading of your sensor after this formula has been created. Where m = the slope of the linear line and b = the intercept of the line. The flow sensor is a linear relationship.

To calculate the slope of the line the following formula is used:

$$Slope = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sum x^2 - \frac{(\sum x)^2}{n}}$$

Where n = the number of data points
y = flow calibrator values
x = sampler flow values

To calculate the intercept of the line the following formula is used:

$$Intercept = \frac{\sum y}{n} - m\frac{\sum x}{n}$$

Where m = the slope calculated above

The flow can then be adjusted using the following formula:

$$Q_{adjusted} = Q_{actual}\ x\ Slope + Intercept$$

Correlation Coefficient (r) - the closer this value is to 1.0 the better fit of the regression line. Simply put, the closer the line passes through all the points and the more accurate it is. A value of 1.0 is a perfect Correlation Coefficient any value less than 0.98 fails a calibration.

The Correlation Coefficient (r) is calculated by the following formula:

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{n(\sum x^2) - (\sum x)^2}\ \ \sqrt{n(\sum y^2) - (\sum y)^2}}$$

7.7 Flow Calibration Audit / Verification

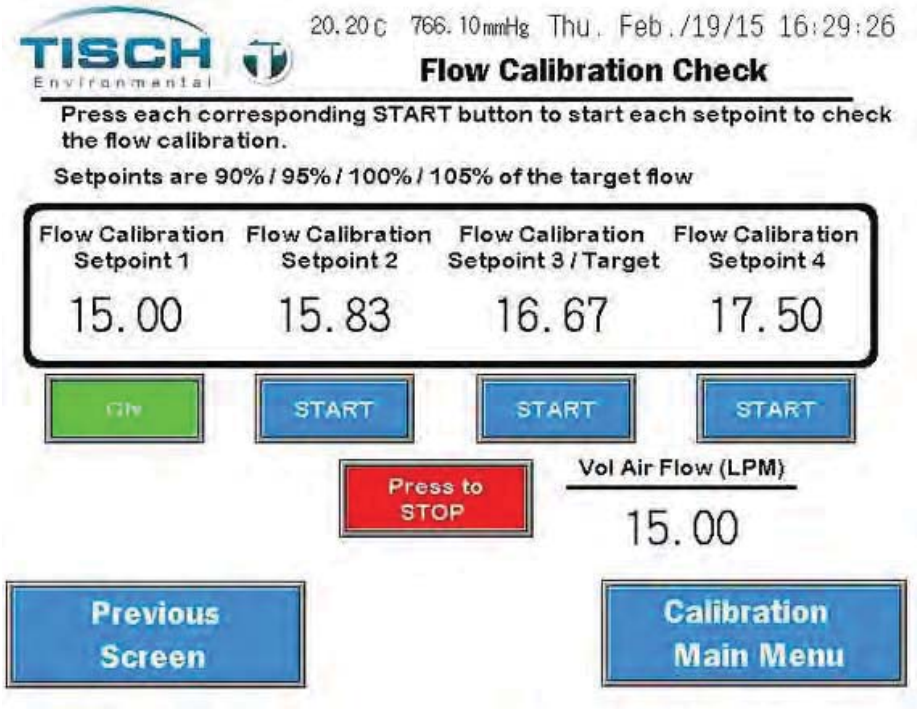
The flow system can be verified for audit purposes by these keystrokes:

MAIN MENU	➔	CALIBRATION	➔	FLOW CALIBRATION CHECK

To verify the flow calibration

1. Each flow setpoint has a corresponding START button below it. Press each start button to have the flow system reach that flow setpoint.
2. Let the flow stabilize at that setpoint and compare the reading with a calibrated flow device such as a Tisch FRM-CAL low volume calibrator.
3. Press the STOP button or press the Calibration Main Menu return button to stop the flow verification.

Flow Calibration Check Screen



NOTE: Calibration should be checked and verified at a minimum every 4 weeks. If the flow system is off by more than ± 4%, a full calibration should be performed.

7.8 Pressure Sensor Zero Trim

The pressure sensor is zeroed from the factory. If it does require a re-zero, follow these keystrokes:

MAIN MENU ➔ **CALIBRATION** ➔ **PRESSURE SENSOR ZERO TRIM**

When zeroing the pressure sensor, make sure there is no pressure on the system. Ensure the pump is not running and the system is vented to atmosphere.

First, press the **RESET PRESSURE SENSOR OFFSET** Button. This will set the offset to zero.

Once the pressure stabilizes, press the 'Pressure Sensor Zero' button to set the system pressure at zero.

7.9 TE-Wilbur Calibration Worksheet Instructions

1. Fill out the following information in the first box:

Date / Time	Current date and time
Serial Number	Serial Number of the TE-Wilbur unit
Technician	Technician performing the calibration
Calibrator Make/Model	The make and model of the calibrator you are using to perform the calibration
S/N:	The serial number of the calibrator you are using to perform the calibration
Calibrator Due Date	The date the calibrator is due for re-certification, this is typically 1-year after the last certification

2. The second box is the ambient temperature, filter temperature and barometric pressure calibration. Start an ambient temperature calibration. Refer to Section 7.1 of the Operations Manual for performing ambient temperature calibration. Enter the following information:

As Found	The current reading of ambient temperature of the TE-Wilbur system
Calibrator Reading	The current reading of the calibrator ambient temperature
As Left	The value of ambient temperature the TE-Wilbur system was left at. This should always be the calibrator reading

3. Perform a filter temperature calibration. Start a filter temperature calibration. Refer to Section 7.2 of the Operations Manual for performing an filter temperature calibration. Enter the following information:

As Found	The current reading of filter temperature of the TE-Wilbur system
Calibrator Reading	The current reading of the calibrator filter temperature
As Left	The value of filter temperature the TE-Wilbur system was left at. This should always be the calibrator reading

4. Perform a barometric pressure calibration. Start a barometric pressure calibration. Refer to Section 7.3 of the Operations Manual for performing a barometric pressure calibration. Enter the following information:

As Found	The current reading of barometric pressure of the TE-Wilbur system
Calibrator Reading	The current reading of the calibrator barometric pressure
As Left	The value of barometric pressure the TE-Wilbur system was left at. This should always be the calibrator reading

5. The second box is the flow calibration. Start a flow calibration. Refer to section 7.5 of the Operations Manual for performing a flow calibration.

   At each setpoint screen (Setpoints will be 15.00/15.83/16.67/17.50 LPM when running at 16.67 LPM setpoint) record the following values in the Flow Calibration section of the worksheet. Repeat this 4 times for each setpoint

As Found	This is the current reading of the TE-Wilbur flow
Calibrator Reading	This is the current reading of the calibrator
As left	The value of flow the TE-Wilbur system was left at. This should always be the calibrator reading

   After all 4 setpoints are entered and the calibration is successful, write down the Slope, Intercept and R^2 factor in the spaces provided. Perform a flow verification by running the sampler at 16.67 Lpm. Write down the setpoint and the as found value, these should be the same.

6. The last box is the leak check results. Start a leak check. Refer to Section 11.0 of the Operations Manual for instructions on performing a leak check.

   Record the start pressure after the system stabilizes, the fail pressure displayed on the screen and the final ending pressure after the leak check completes. Check the pass or fail box depending if the leak check has passed or failed.

7. Sign and date the calibration worksheet.

TE-Wilbur Calibration Worksheet

145 South Miami Ave. Cleves, OH 45002 513.467.9000 sales@tisch-env.com

Date / Time: _____ Serial Number: _____ Technician: _____

Calibrator Make/Model: _____ Due Date: _____ S/N: _____

AMBIENT TEMPERATURE (°C)

As Found	Calibrator Reading	As Left

FILTER TEMPERATURE (°C)

As Found	Calibrator Reading	As Left

BAROMETRIC PRESSURE (mmHg)

As Found	Calibrator Reading	As Left

FLOW CALIBRATION (Liters Per Minute)

Slope: _____
Intercept: _____
R factor: _____

	As Found	Calibrator Reading	As Left
1			
2			
3			
4			

	Setpoint	As Found
Calibration Verification:		

LEAK CHECK RESULTS

Leak Check Start Pressure: _____ (inches of H_2O)
Leak Check Fail Pressure: _____ (inches of H_2O)
Leak Check End Pressure: _____ (inches of H_2O)

Leak Check Pass / Fail Pass ☐ Fail ☐

Technician: _____ Date: _____

8.0 Screen Maintenance

The Maintenance Menu allows you to setup the date and time, download data, adjust screen brightness, provide system information, disconnect the battery, control the system manually and several other functions.

8.1 Changing Date and Time

The time format for Wilbur is in 24-hour format, HH:MM:SS. The date format is in the format of MM/DD/YY. To change the date and time follow these instructions.

Changing the time
The Set Time and Date screen can be found by following these keystrokes:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **SET DATE AND TIME**

The set time screen will appear first. To change the time, enter the Hours, Minutes and Seconds and press update. The time will be updated.

Change Time Screen

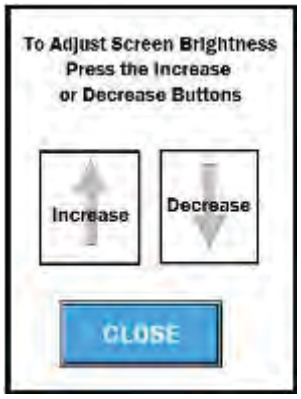
Changing the date
To change the date, press the CHANGE DATE button which is located on the Update Time Screen.

Press each Month, Day and Year box and press update to update the date. You can return to the Maintenance Menu by pressing the Back to Maintenance Menu button.

Change Date Screen

8.2 Change Screen Brightness

To change the screen brightness, under the maintenance menu press the Adjust Screen Brightness button and the following popup screen will be shown. Press the Increase button to increase the brightness and the Decrease button to decrease the brightness.



NOTE: After 5 minutes the brightness of the screen in halved and the screen is shutdown after 15 minutes to conserve power.

8.3 Battery Disconnect

In order to power down the sampler the battery must be disconnected before power is removed. To disconnect the battery, press the button that is labeled: **PRESS FOR BATTERY DISCONNECT**.

NOTE: If mains power is removed and the sampler is running on battery, pressing this button will power down the sampler. Mains power must be applied to the sampler to power on again.

8.4 Manual Control

In the manual control screen the system can be operated in automatic flow control mode by entering a flow setpoint or can be operated by adjusting the percent of speed of the pump with no flow control.

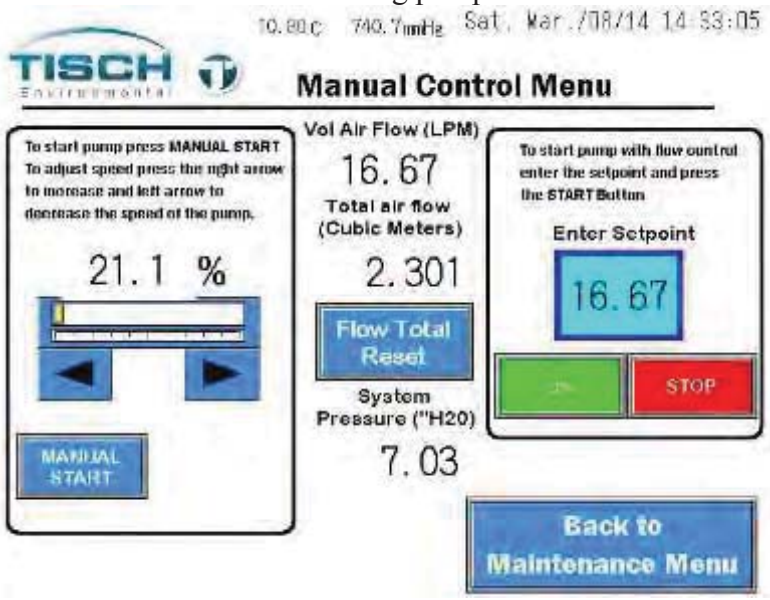
The manual control screen is found here:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **MANUAL CONTROL**

To run the pump with automatic flow control, perform the following:

1. Enter the setpoint by pressing the setpoint box and entering in the flow setpoint for automatic flow control.
2. Press the START button underneath the flow setpoint.
3. The system will turn on and the pump will operate at the desired setpoint.
4. To stop the system press the STOP button below the setpoint box.

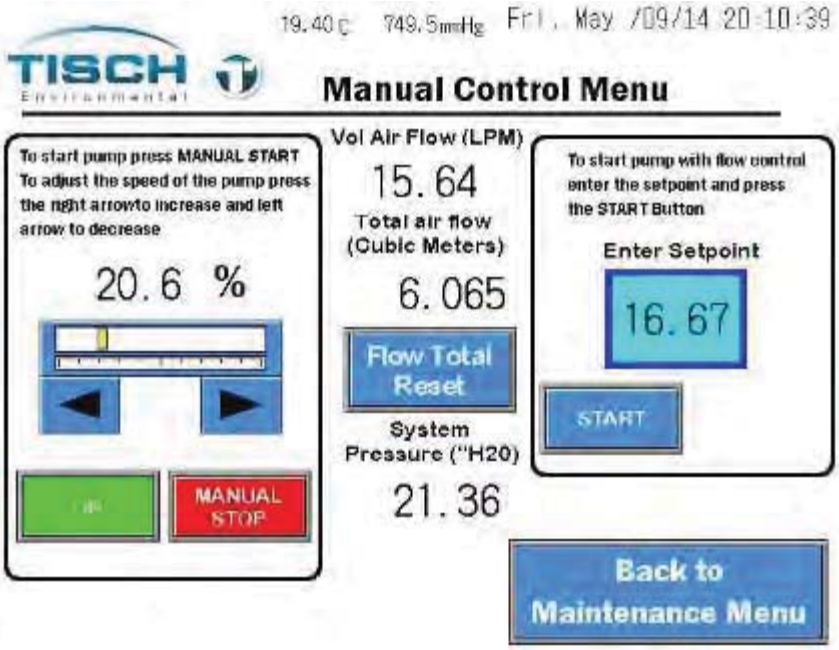
Manual Control Screen showing pump in flow control mode



To operate the pump manually with a percent of speed, perform the following:

1. Press the MANUAL START BUTTON.
2. Press the ▶ right arrow button to increase the speed of the pump.
3. Press the ◀ left arrow button to decrease the speed of the pump.
4. Press the MANUAL STOP button to stop the pump.

Manual control screen showing pump in manual % speed control



NOTE: If the system is running in manual mode and a sample starts, manual mode will be shut down and the sample will start as scheduled.

NOTE: When running in percent of pump speed manual mode, the only alarm that will shut down the pump is the high pressure alarm which is set to 200" H_2O of pressure.

NOTE: When running in flow control manual mode, all the alarms that will shut down a sample will also shut down the automatic flow control in manual mode with the exception of the flow variance alarm and the ten consecutive power fails alarm. See section 1.4 – Sample Alarms for details.

8.5 System Information

The system information screen is where the software versions can be found along with the total sampling runtime and the pump runtime. The pump runtime can be reset here.

The system information screen can be found by following these keystrokes:

MAIN MENU → **MAINTENANCE MENU** → **SYSTEM INFORMATION**

System Information Screen

Total Sampling Runtime This is the total in hours that a sample has been running. This value is not resettable.

Pump Runtime This is the amount of time the pump has been running either sampling, in manual mode or performing calibrations. The pump runtime can be reset by pressing the Reset Pump Runtime button. Pump rebuilds are recommended at 3,000 hours and the operator is prompted when the pump has 3,000 hours of runtime. See section 12.0 – Maintenance for information on rebuilding the pump.

PLC Software Version This is the software version that is currently loaded in the PLC controller.

Screen Software Version This is the software version that is currently loaded into the screen.

Unit Serial Number This is the serial number of the unit. The last 3 digits of the unit serial number is appended to the datalog and history log file names.

8.6 Data Download Menu

The data download menu can be found by following these keystrokes:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **DATA DOWNLOAD MENU**

In the data download menu, several functions regarding the data log and USB functions can be accomplished such as:

Download Run Summary Data Allows the operator to download the datalog that contains all of the pertinent run summary data. See Section 8.0 – Data Logging and Operational Data.

Download History Data Allows the operator to download the history log that contains all the events and alarms that occurred.

Eject USB Ejects the USB stick from the unit.

NOTE: If the USB stick is not ejected properly a warning will appear that will need acknowledged by pressing the ACK button in the center (See note below).

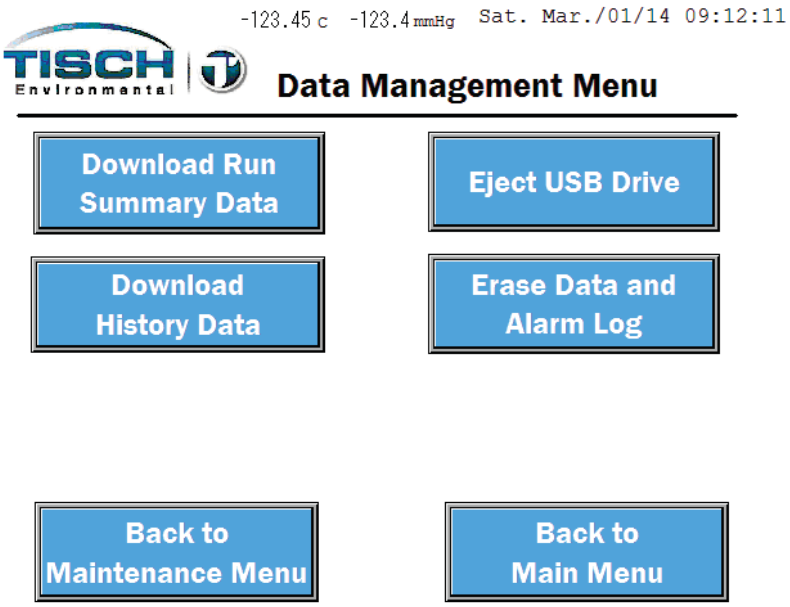
Erase Data and Alarm Log Allows the user to erase the data log and alarm log. **This is a permanent erase that is non-recoverable from the internal memory**. This does not erase any data from the USB stick, but will clear the internal data and history log to start new logs.

NOTE: The datalog and history log filenames are appended with the last 3 digits of the unit's serial number.

NOTE: Before removing the USB drive from the USB port, the USB must be ejected by pressing the Press to Eject USB Drive button. This is to prevent data loss by stopping the USB access before the drive is removed. If the USB is removed without ejecting, a small screen will alert the user that next time they need to eject the USB before removing it.

Press the Ack button to acknowledge this warning.

Data Download Menu



8.7 Update Firmware

To update the firmware of the screen or the controller perform the following:

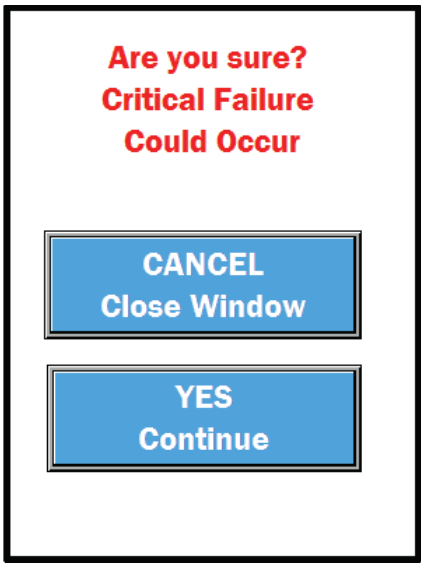
1. The firmware files must be first downloaded from the Tisch Environmental website at www.tisch-env.com.
2. Ensure you are downloading the latest firmware revision and read the firmware revision notes.

The filename for the screen is: wilburscreen.znv
The filename for the controller is: wilburplc.zld

3. Place these files on the root directory of a USB stick and insert the USB stick into the USB socket.
4. When the pop-up for inserting a USB appears press CLOSE WINDOW to close the pop-up.
5. The update firmware can be found by following these keystrokes:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **MORE MAINTENANCE MENU** ➔ **UPDATE FIRMWARE FROM USB**

6. When the Update Firmware from USB is pressed the following pop-up window will appear alerting the operator that there could be a critical failure if this is not done properly:



7. Ensure the system is plugged into a reliable power source before performing the firmware updates. Loss of power during a firmware update could corrupt the system causing a failure.
8. Press the YES Continue button and the operator will be prompted for which firmware update they would like to perform – screen update or controller update.

9. To update the controller firmware, press the Download PLC Program from USB. PLC stands for 'Programmable Logic Controller' which is the controller platform used in the TE-Wilbur. It will take about a minute to update the firmware and when complete the operator will be prompted that the update was successful or if the update failed and to press acknowledge.
10. To update the screen firmware, press the Download Screen Program from USB. It will take about a minute to update the firmware and when complete the operator will be prompted that the update was successful or if the update failed and to press acknowledge.
11. Press the CLOSE WINDOW button to close the firmware update popup and press the EJECT USB button to eject the USB drive. Remove the USB drive.

NOTE: If the Firmware update fails, ensure the file is on the root of the USB drive. Also ensure the files have the correct file names. Try using a different USB drive to perform the update and if you are still having troubles call Tisch Environmental at 1-877-263-7610 (1-877-TSP-AND-PM10).

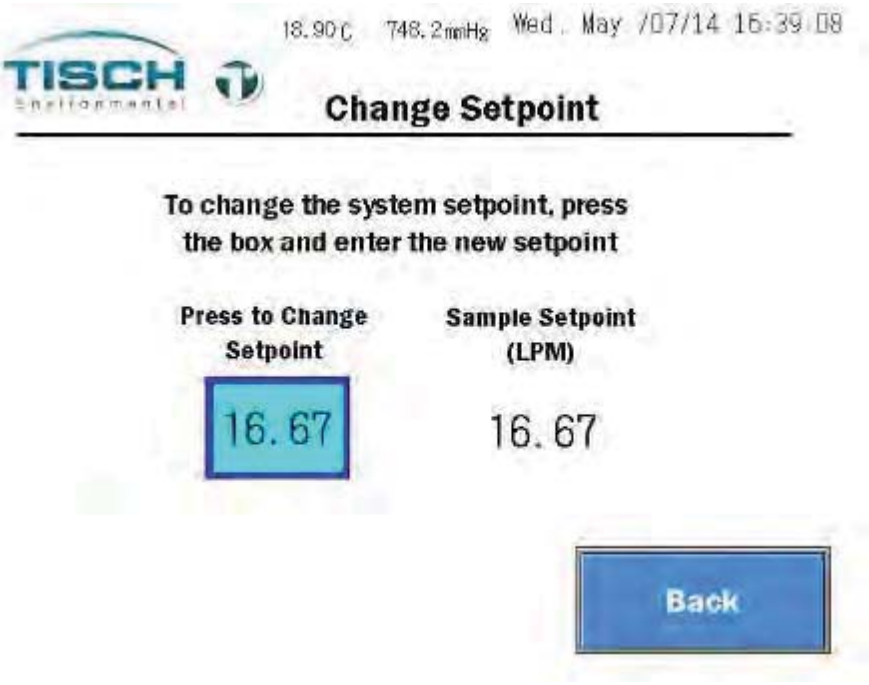
8.8 Change Sample Setpoint

The sample setpoint can be changed by following these keystrokes:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **MORE MAINTENANCE MENU** ➔ **CHANGE SAMPLE SETPOINT**

To change the setpoint press the setpoint box, type in the value of the setpoint and press the ENT key to accept.

NOTE: Changing the setpoint will cause the sampler when sampling to run at this setpoint. Per USEPA specifications the setpoint should always be set to 16.67 Lpm for proper operation.

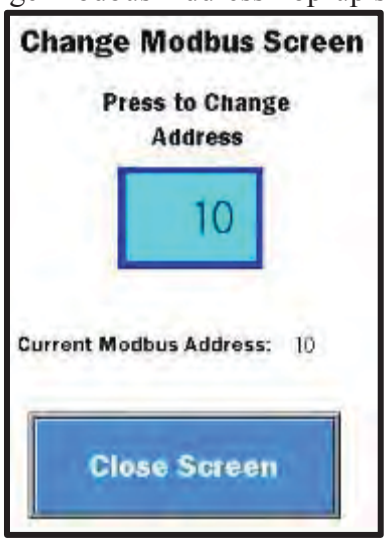


8.9 Change MODBUS Address

The address of the MODBUS communication port can be changed by pressing the Change Modbus Address button found by following these keystrokes:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **MORE MAINTENANCE MENU** ➔ **CHANGE MODBUS ADDRESS**

Change Modbus Address Pop-up screen



See Section 14 - Communications for more information on Modbus.

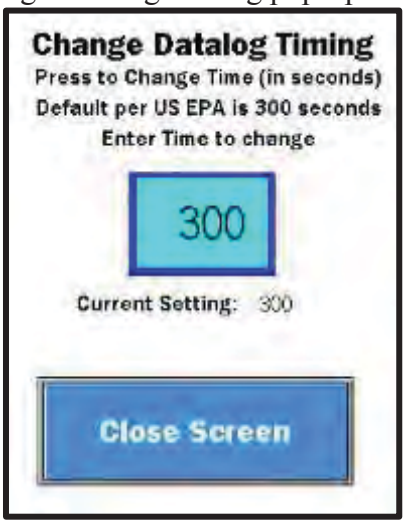
8.10 Datalogging Time

The time that the data log stores its values can be changed by pressing the Datalog Time Setting button found by following these keystrokes:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **MORE MAINTENANCE MENU** ➔ **DATALOG TIME SETTING**

NOTE: Per USEPA this value is defaulted to 300 seconds (5 minutes). Any deviation of this may invalidate sample data.

Change Datalog Timing pop-up screen



9.0 Data Logging / Operational Data

This section explains the data functions with TE-Wilbur, how data is collected, stored in the datalog and displayed on the screen.

9.1 Operational Data

The operational data can be found by following these keystrokes:

MAIN MENU ➔ **OPERATIONAL DATA**

There are (3) screens of operational data. On these screens the following information is presented to the operator:

Volumetric Air Flow (Lpm)	The volumetric air flow (Q_{actual}) of the system in real time and the maximum and minimum volumetric flow rate updated every 30 seconds.
Barometric Pressure (mmHg)	The barometric pressure in millimeters of mercury in real time and the maximum and minimum barometric pressure updated every 30 seconds.
System Pressure ("H_2O)	The system vacuum pressure in inches of water in real time and the maximum and minimum system pressure updated every 30 seconds.
Filter Temp (Deg C)	The filter temperature in degrees Celsius in real time and the maximum and minimum filter temperature updated every 30 seconds.
Ambient Temp (Deg C)	The ambient temperature in degrees Celsius in real time and the maximum and minimum ambient temperature updated every 30 seconds.
Temperature Variance (Deg C)	The difference between the ambient temperature and the filter temperature in real time and the maximum and minimum temperature variance updated every 30 seconds.
Total Airflow (Liters / m^3)	The total air flow shown in cubic meters and in liters.

Sample runtime (Hours)	The sample runtime that is currently running or the last sample runtime that has just completed.
Average flowrate of the sample (Lpm)	The average flowrate of the sample that is currently running or the average flowrate of the sample that has just completed.
Filter and Site ID	The filter and site ID entered by the operator.

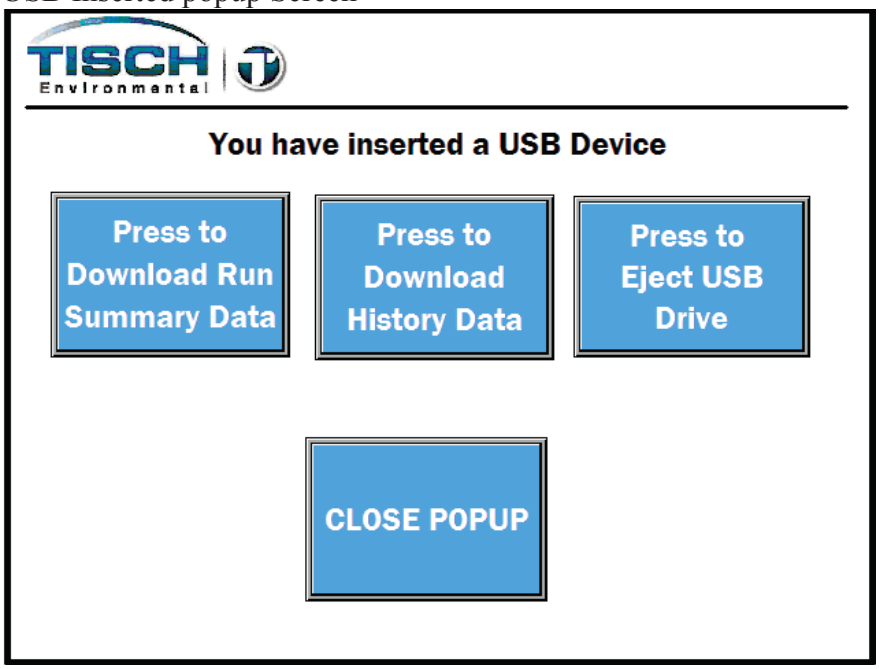
9.2 Downloading Data to USB

Data from the data log and the history log are saved from the internal memory of the screen onto an SD card located in the screen. The data that is saved to the SD card can then be downloaded to a USB by inserting a USB drive into the USB port on the front of the unit or by accessing the Data Download screen at the following location:

MAIN MENU → **MAINTENANCE MENU** → **DATA DOWNLOAD MENU**

When inserting a USB drive into the USB port on the front the following popup screen will appear:

USB Inserted popup Screen



On this popup screen the operator can download the run summary data which is the operational log described in 9.3 of this section and the history log which is described in Section 10.0 of this manual.

NOTE: Before removing the USB drive from the USB port, the USB must be ejected by pressing the Press to Eject USB Drive button. This is to prevent data loss by stopping the USB access before the drive is removed. If the USB is removed without ejecting, a small screen will alert the user that next time they need to eject the USB before removing it.

Press the Ack button to acknowledge this warning.

9.3 Datalog and Sample Summary Datalog

The datalog stores all data values based on the datalog timer setting which can be changed here:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **MORE MAINTENANCE MENU** ➔ **DATALOG TIME SETTING**

The default time for the data log is 5 minutes (300 seconds).

The datalog will continuously log data regardless if a sample is running.

The datalog is in a standard comma separated value (.CSV) file which can be opened from any standard spreadsheet program. The datalog is stored as the filename wilbur_data.csv with the three digit number of the sampler's serial number appended to the file name. So if the sampler's serial number is 4786 the filename will be: wilbur_data786.CSV.

When downloading to a USB drive, a folder called run_summary_data is created and the datalog will be stored in that location.

Another datalog is downloaded along with the run summary data. This datalog is called the sample summary datalog.

The datalog contains the following information:

Qvol avg The average volumetric air flow (Qactual) over the time of the datalog timer in liters per minute.

Qvol max The maximum value of volumetric air flow (Qactual) over the time of the datalog timer in liters per minute.

Qvol min The minimum value of volumetric air flow (Qactual) over the time of the datalog timer in liters per minute.

Pa avg The average barometric pressure in mmHg over the time of the datalog timer.

Pa max The maximum barometric pressure in mmHg over the time of the datalog timer.

Pa min The minimum barometric pressure in mmHg over the time of the datalog timer.

Tfilter avg The average temperature in degrees Celsius of the filter temperature over the time of the datalog timer.

Tfilter max The maximum temperature in degrees Celsius of the filter temperature over the time of the datalog timer.

Tfilter min The minimum temperature in degrees Celsius of the filter temperature over the time of the datalog timer.

Tamb avg The average temperature in degrees Celsius of the ambient temperature over the time of the datalog timer.

Tamb max The maximum temperature in degrees Celsius of the ambient temperature over the time of the datalog timer.

Tamb min The minimum temperature in degrees Celsius of the ambient temperature over the time of the datalog timer.

Press avg The average suction pressure in inches of water of the system over the time of the datalog timer.

Press max The maximum suction pressure in inches of water of the system over the time of the datalog timer.

Press min The minimum suction pressure in inches of water of the system over the time of the datalog timer.

TVar avg The average temperature variance between the ambient temperature sensor and the filter temperature sensor in degrees Celsius over the time of the datalog timer.

TVar max The maximum temperature variance between the ambient temperature sensor and the filter temperature sensor in degrees Celsius over the time of the datalog timer.

TVar min The minimum temperature variance between the ambient temperature sensor and the filter temperature sensor in degrees Celsius over the time of the datalog timer.

Flow total The total flow in liters updated based on the time of the datalog timer. If the sample has stopped this will be the total flow of the last sample completed. The flow total is reset to zero when a new sample is started.

Flow CV The flow coefficient of variance from the start of the datalog timer to the end of the datalog timer.

Filter ID The filter ID entered by the operator.

Site ID The site ID entered by the operator.

Unit S/N The serial number of the sampler.

NOTE: The datalog will fill up after its size allocation is exceeded. When this happens the older data will get replaced by the newer data. If the data log is set to the 5 minute recommended setting, it will take several years to fill up the data log.

The larger the data and history logs are, the longer it will take to copy them to the USB stick. Resetting them periodically is recommended.

The sample summary datalog contains the following information:

Filter ID The filter ID entered by the operator.

Site ID The site ID entered by the operator.

Unit S/N The serial number of the sampler.

Min Tamb The minimum ambient temperature that occurred during the sample

Max Tamb The maximum ambient temperature that occurred during the sample

Avg Tamb The average ambient temperature that occurred during the sample

Start Tamb The ambient temperature at the start of the sample

End Tamb The ambient temperature at the end of the sample

Min Pamb The minimum ambient pressure that occurred during the sample

Max Pamb The maximum ambient pressure that occurred during the sample

Avg Pamb The average ambient pressure that occurred during the sample

Start Pamb The ambient pressure at the start of the sample

End Pamb The ambient pressure at the end of the sample

Total Sample Time The total sample time of the sample in hours (decimal)

Volume The total volume of the sample in m^3/hour

Max CV The maximum coefficient of variance of the flow over the sample

Max Tdiff The maximum difference between the ambient temperature and the filter temperature over the sample

Min Tf	The minimum filter temperature over the sample
Max Tf	The maximum filter temperature over the sample
Avg Tf	The average filter temperature over the sample
Start Date	The start date of the sample in the format MMDDYYYY
Start Time	The start time of the sample in the format HHMM
Sample Warning	When 0, there were no sample warnings over the sample. When set to a 1, there was a sample warning and the history log must be examined to determine the warning.

9.4 Erasing the Datalog

To erase the datalog go to the following screen:

MAIN MENU → **MAINTENANCE MENU** → **DATA DOWNLOAD MENU** → **ERASE DATA AND ALARM LOG**

The datalog, sample summary log, and the alarm log will be erased. This function cannot be undone, so ensure the datalog, sample summary and history log have been saved before continuing.

NOTE: This is a permanent erase that is non-recoverable from the internal memory. This does not erase any data from the USB stick, but will clear the internal data and history log to start new logs. Ensure the data is downloaded and verified prior to erasing the logs.

10.0 History Log

This section explains the history log, alarms and how data is stored and retrieved from the history log.

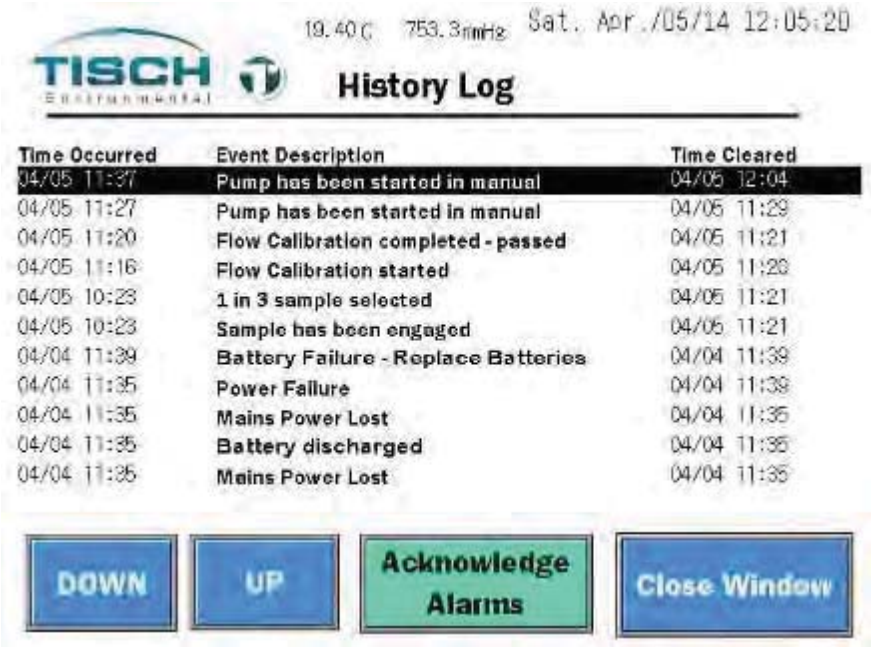
10.1 History Log Introduction

The history log can be found by following these keystrokes:

MAIN MENU ➔ **HISTORY LOG**

The history log contains all pertinent information that has occurred operationally with the sampler.

History Log Screen



When an event or an alarm occurs it is logged on this screen and also saved to the SD card, which then can be downloaded to a USB drive by either inserting a USB drive into the USB port or proceeding to the data download menu at:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **DATA DOWNLOAD MENU**

When an alarm occurs, it must first be resolved then it can be acknowledged by pressing the Acknowledge Alarms button.

So if for example, the ambient temperature sensor is unplugged, the history log screen will be shown notifying the operator that there is a problem. The ambient temperature sensor notification will be highlighted and will be red.

If the operator plugs the ambient temperature sensor back in, the alarm will still be highlighted and active until the operator acknowledges the alarm by pressing the acknowledge alarm button. Once that is pressed, the alarm will turn black indicating that it is no longer active and the system will be back to normal.

The alarm/event is time and date stamped when it occurred and when it was resolved.

The following two colors are used:

RED Indicates that an event or an alarm is active and is in progress. So for example when a sample is engaged this will be shown in red on the history log until that sample is canceled.

BLACK Indicates that an event or an alarm is no longer active or in progress. So when an alarm is cleared and then acknowledged it will be black.

NOTE: When there is an active alarm that requires attention, there will be this symbol shown on the top right corner of every screen:

The operator can go directly to the history log by pressing this symbol.

10.2 Alarms and Events

The following alarms and events are shown and logged in the history log:

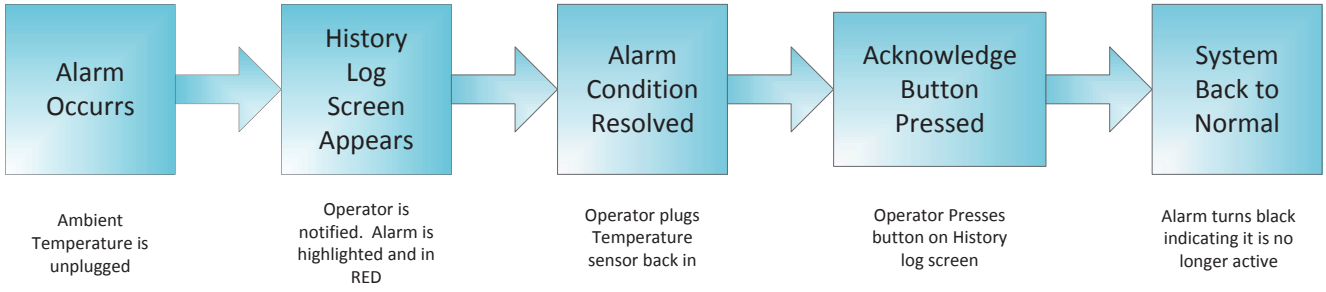
Pump has been started from the screen	The pump has been started in either manual by pump speed percentage or by manual, automatic flow control.
Leak check started	Leak check was started.
Leak check passed	Leak check has passed and any leaks are less than 80mL/min.
Leak check failed	Leak check failed and there was a leak greater than 80mL/min.
Leak check failed – did not reach pressure	Indicates the Leak Check Failed due to the 60 second fail timer ending and the system pressure did not reach 50" H_2O. Indicates the filter holder or valve adapter was not closed.
Flow calibration started	A flow calibration was started.
Flow calibration quit by operator	A flow calibration was started but was terminated by the operator.
Flow calibration completed – Passed	Flow calibration was completed and R factor was less than 0.98 and passed.
Flow calibration completed – Failed	Flow calibration was completed and R factor was greater than 0.98 and failed.
Flow Check Setpoint 1 Started	Operator performed a flow system verification for setpoint 1.
Flow Check Setpoint 2 Started	Operator performed a flow system verification for setpoint 2.
Flow Check Setpoint 3 Started	Operator performed a flow system verification for setpoint 3.
Flow Check Setpoint 4 Started	Operator performed a flow system verification for setpoint 4.
Sample has been engaged	1in3, 1in6, 1in12 or custom sample is engaged.
Sample has been started	1in3, 1in6, 1in12 or custom sample is started.
1 in 3 sample selected	1in3 sample has been selected and engaged.

1 in 6 sample selected	1in6 sample has been selected and engaged.
1 in 12 sample selected	1in12 sample has been selected and engaged.
Custom sample selected	A custom sample has been selected and engaged.
Flow variance alarm during sample	The flow varied by more than 10% for 10 minutes during a sample – this will shut down a sample.
5% Flow variance warning	The flow varied by more than 5% for 5 minutes, will give a warning for the sample.
Sample less than 23or greater than 25 hours	The sample time was less than 23 hours or greater than 25 hours, most probably due to a complete loss of power. Will give a warning for a sample.
Ambient temperature unplugged or failed	The ambient temperature sensor was unplugged, dropped below -90 Deg C, went above +60 Deg C or there was an internal problem with the controller– this will shut down a sample.
Filter temperature unplugged or failed	The filter temperature sensor was unplugged, dropped below -90 Deg C, went above +60 Deg C or there was an internal problem with the controller – this will shut down a sample.
Flowmeter unplugged or failed	The flowmeter was unplugged, went above 25 Lpm, below 0 Lpm or there was an internal problem with the controller – this will shut down a sample.
Barometric press sensor unplugged or failed	The barometric pressure sensor was unplugged, went below 450 mmHg, went above 850mmHg or there was an internal problem with the controller – this will shut down a sample.
System pressure sensor unplugged or failed	The pressure sensor went above 15 psi of vacuum, fell below 0 psi or there was an internal problem with the controller.
Sample shutdown due to alarm condition	The current sample was terminated due to an alarm.
5 Deg temp variance for 30 minutes	The difference between the ambient temperature and the filter temperature was greater than 5 Degrees Celsius
Barometric pressure updated	The barometric pressure sensor was calibrated and updated to a new value
Filter temperature updated	The filter temperature sensor was calibrated and updated to a new

	value.
Ambient temperature updated	The ambient temperature sensor was calibrated and updated to a new value.
Mains power lost	The system lost mains (AC) power and is now running on reserve DC power.
Power Fail	The system lost mains (AC) power and also reserve DC power and powered down completely.
Pump maintenance needed	The pump maintenance timer which is set to 5,000 hours has been exceeded. Indicating that pump maintenance is needed.
High system pressure shutdown	The system pressure reached 250 "H_2O of vacuum pressure – this will shut down a sample.
Flow Check Setpoint 1-4 Started	The operator has started a flow verification and used setpoint 1 thru 4.
Screen battery needs replaced	The battery in the touchscreen needs replaced. This battery is crucial for proper system operation see 12.0 Maintenance for instructions on replacing the screen battery.
Battery Discharged	The internal batteries have reached a voltage level where they are fully depleted.
Battery failure – replace batteries	The internal batteries have failed and need replaced. See section 12.0 Maintenance for instruction on replacing the battery pack.

10.3 Alarm Flowchart

The following shows how an alarm occurs, is acknowledged and returns to normal operation with an example of the ambient temperature sensor being unplugged.



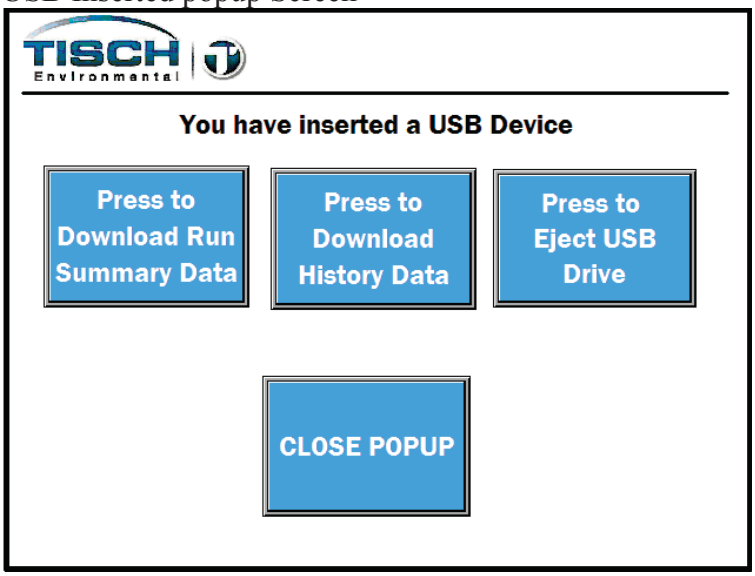
10.4 History Log Download

Data from the data log and the history log are saved from the internal memory of the screen onto an SD located in the screen. The data that is saved to the SD card can then be downloaded to the USB stick by inserting a USB stick into the USB port on the front of the unit or by accessing the Data Download screen by the following keystrokes:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **DATA DOWNLOAD MENU**

When inserting a USB drive into the USB port on the front the following popup screen will appear:

USB Inserted popup Screen



On this popup the operator can download the run summary data which is the datalog described in Section 8.0 of this section and the history log.

NOTE: Before removing the USB drive from the USB port, the USB must be ejected by pressing the Press to Eject USB Drive button. This is to prevent data loss by stopping the USB access before the drive is removed. If the USB is removed without ejecting, a small screen will alert the user that next time they need to eject the USB before removing it.

Press the Ack button to acknowledge this warning.

The history log is in a standard comma separated value (.CSV) file which can be opened from any spreadsheet program. The history log is stored as the filename wilbur_history.csv with the last three digits of the units serial number appended to the file name. So if the serial number of the unit is 4786 the filename will be: wilbur_history786.CSV.

When downloading to a USB drive, a folder called history log is created and the history log will be stored in that location.

10.5 Erasing the History Log

To erase the history follow these keystrokes:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **DATA DOWNLOAD MENU** ➔ **ERASE DATA AND ALARM LOG**

The datalog and the alarm log will be erased. This function cannot be undone, so ensure the datalog and history log have been saved before continuing.

NOTE: This is a permanent erase that is non-recoverable from the internal memory. This does not erase any data from the USB stick, but will clear the internal data and history log to start new logs. Ensure the data is downloaded and verified prior to erasing the logs.

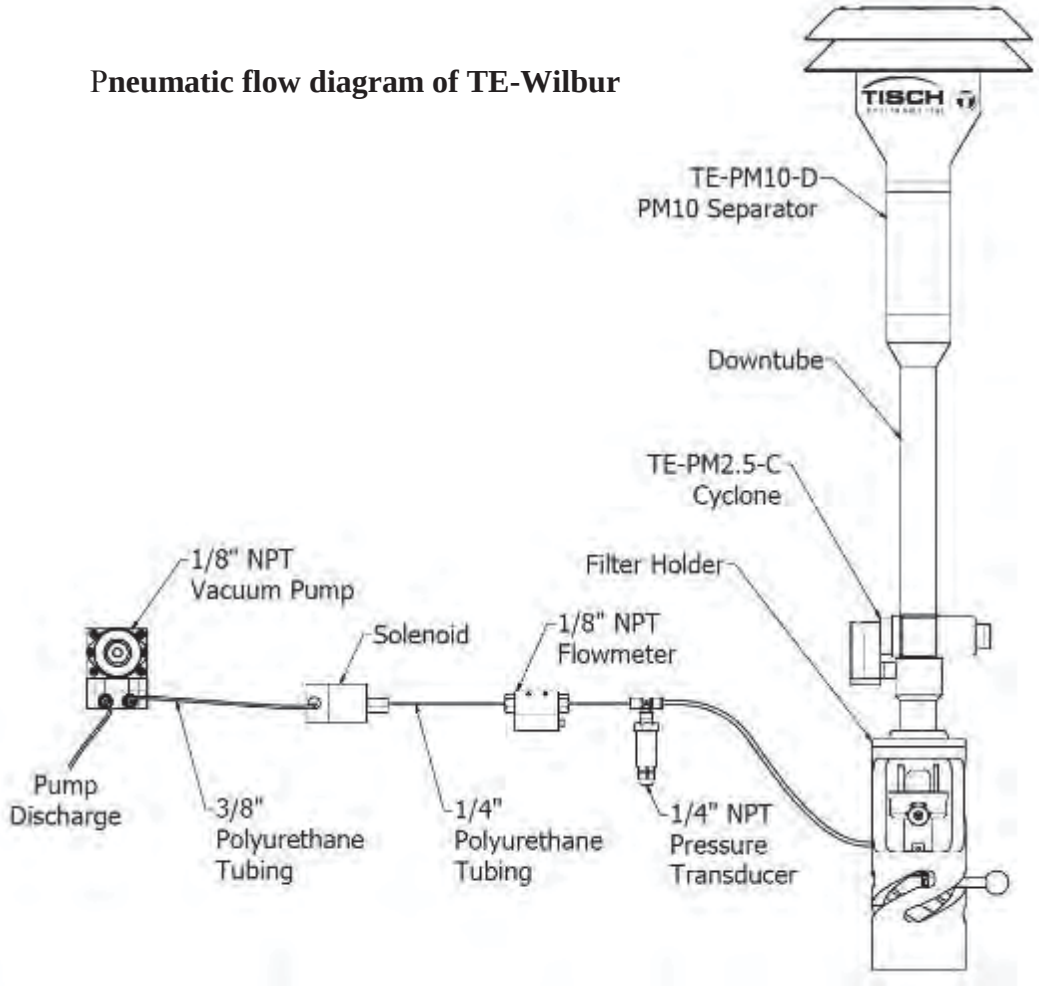
11.0 Leak Checks

This section details the leak check functions of TE-Wilbur.

11.1 Leak Check Introduction

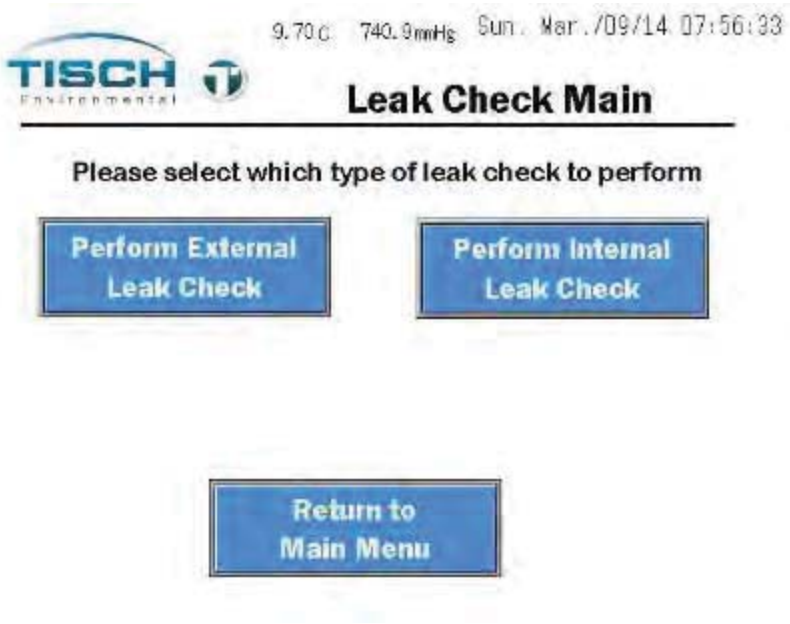
There are two types of leak checks, an internal leak check and an external leak check. The external leak check checks the entire system from the output of the solenoid, to the end of the downtube and utilizes a TE-L30 adapter to plug the flow stream where the TE-PM10-D head would normally be. The internal leak check uses a TE-W-004 solid, blank disk that is inserted into the filter holder and checks the leak from the bottom of the filter holder to the output of the solenoid, bypassing any leaks in the filter holder, downtube or TE-L30 adapter. Per USEPA 40CFR Part50 App. L the sampler must be able to pass a leak check to demonstrate a leak of no more than 80mL/min is present. Using thermodynamic formulas the sampler calculates the ending pressure necessary to pass a leak check that demonstrates no more than an 80mL/min leak in the system.

Pneumatic flow diagram of TE-Wilbur



Leak checks can be performed by following these keystrokes:

MAIN MENU ➔ **PERFORM LEAK CHECKS**



NOTE: If the pressure sensor is failed, leak checks will not be available and the following box will appear, disabling the leak check feature.

11.2 External Leak Check

To perform an external leak check, perform the following steps:

1. Insert a clean filter (designated the "leak check filter") into a filter cassette with a screen and insert the cassette into the sampler filter holder.

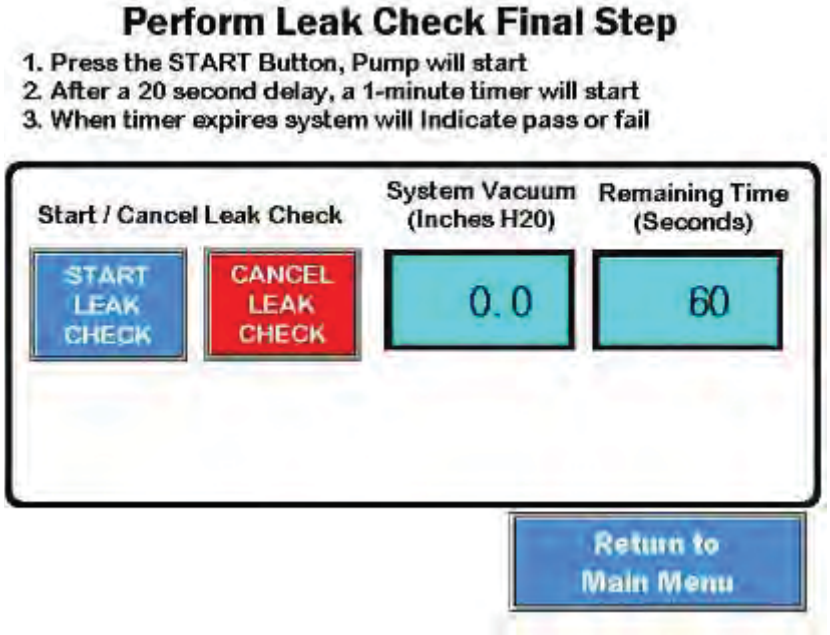
   NOTE: Leak check filters should never be used for subsequent sampling. The same filter may be used for the leak check that was used for the flow rate verification check.

2. Close the filter holder
3. Remove the PM-10 inlet and install the TE-L30 flow rate adapter on the top of the downtube.

Picture of the TE-L30 Downtube adapter placed on top of the downtube with the valve in the closed position

4. Close the valve on the flow rate adapter to plug the air flow.
5. Press the Select External Leak Check button on the Leak check selection screen.
6. At the Perform External Leak Check Next Steps screen, the screen will show the TE-L30 adapter closed and the filter holder closed. Press next step and then press the Final Step button.
7. You will now be at the Leak Check Control Screen.

Leak Check Control screen



8. Press the START LEAK CHECK button.
9. The system will start the pump and pull a vacuum on the system.

   NOTE: if the TE-L30 adapter is not closed and the vacuum does not reach 50" H_2O, after 60 seconds the system will stop and fail.

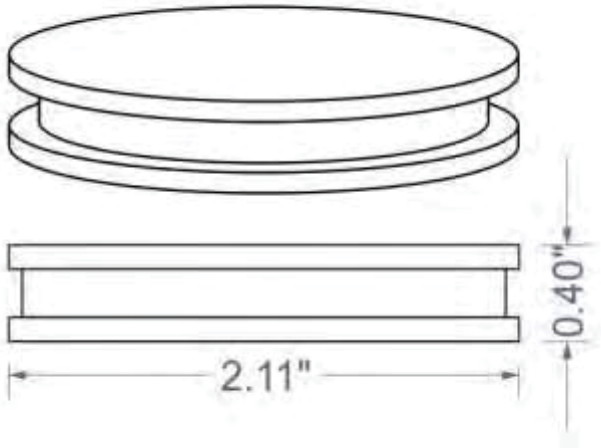
10. Once the system pulls a vacuum of 50" H_2O, the solenoid will close, isolating the system from the solenoid to the TE-L30 adapter. The final ending pressure will be much greater than 50" H_2O since the system will stabilize to a final ending pressure.
11. After 20 seconds to allow the system to stabilize, the leak check timer of 60 seconds will start and the system will calculate the final ending pressure in order to pass an external leak check of less than 80mL/min.
12. If the external leak check passes, a green box will appear after the leak check timer expires indicating the external leak check has passed.
13. If the external leak check fails, meaning the vacuum pressure has dropped below the final ending pressure, meaning a leak of more than 80mL/min is present, a red box will appear after the leak check timer expires indicating the external leak check has failed.
14. To cancel the external leak check press the CANCEL LEAK CHECK button at any point or press the return to main menu button.
15. After the external leak check is completed, open the TE-L30 adapter slowly to prevent any damage from the inrush of air into the system.

11.3 Internal Leak Check

To perform an internal leak check, perform the following:

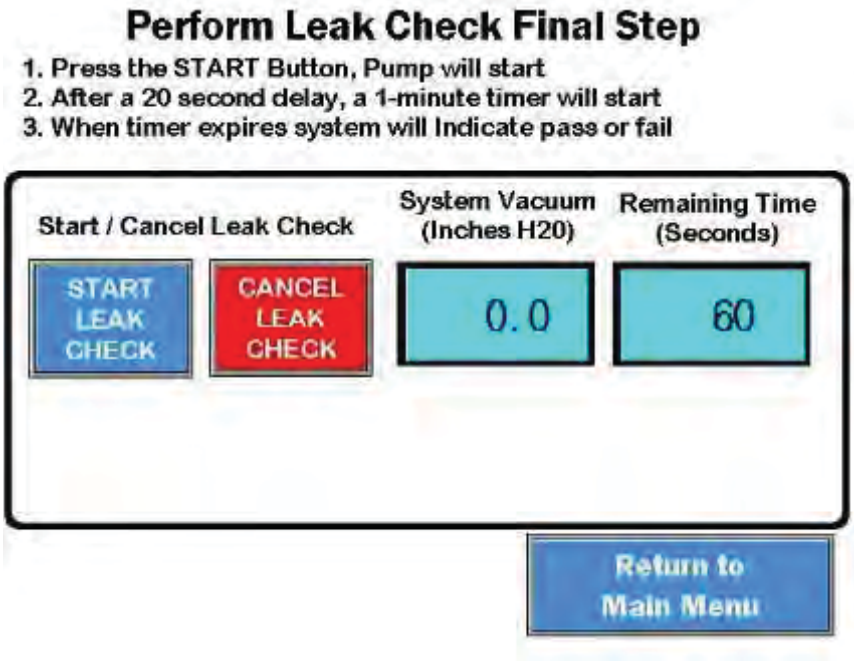
1. Place the solid internal leak check disk into the filter holder.

   TE-W-004 Solid internal leak check disk



2. Close the filter holder.
3. Press the Perform Internal Leak Check at the leak check select screen.
4. At the step 1 screen press next step to go to the step 2 screen.
5. At the step 2 screen press final step to go to the leak check control screen.
6. You will now be at the Leak Check Control Screen.

Leak Check Control screen



7. Press the START LEAK CHECK button.
8. The system will start the pump and pull a vacuum on the system.

   NOTE: if the system vacuum does not reach 50" H_2O, after 60 seconds the system will stop and fail.

9. Once the system pulls a vacuum of 50" H_2O, the solenoid will close, isolating the system from the solenoid to the bottom half of the filter cassette. The final ending pressure will be greater than 50" H_2O since the system will stabilize to a final ending pressure.
10. After 20 seconds to allow the system to stabilize, the leak check timer of 60 seconds will start and the system will calculate the final ending pressure in order to pass an internal leak check of less than 80mL/min.
11. If the internal leak check passes, a green box will appear after the leak check timer expires indicating the leak check has passed.
12. If the internal leak check fails, meaning the vacuum pressure has dropped below the final ending pressure, a red box will appear after the leak check timer expires indicating the internal leak check has failed.
13. To cancel the internal leak check press the CANCEL LEAK CHECK button at any point or press the return to main menu button.
14. After the internal leak check is completed, remove the internal leak check disk and return unit back to normal operation.

11.4 Leak Check Troubleshooting

If the external or internal leak check fails, consider the following troubleshooting techniques.

External Leak Check

- Ensure there is a filter and screen in the filter cassette, the filter holder is closed and the filter cassette is seated properly in the filter holder.
- Ensure the TE-L30 adapter is on top of the downtube and the valve is closed.
- Check all the o-rings in the TE-L30, the downtube and the filter holder top and bottom halves for wear or damage. Replace worn or damaged o-rings.
- Ensure the o-rings are greased.
- Try a different filter cassette, TE-L30 adapter or downtube.
- If leak checking with a cyclone in place, ensure all o-rings in the cyclone are not damaged or worn. Ensure the connector is tight and the collector cup is tight.
- Perform an internal leak check. If the internal leak check passes, then the leak is somewhere from the filter holder up to the TE-L30 adapter
- Make adjustments to the filter holder to tighten it. See section 3.0 for instructions on the filter holder adjustment.
- If the external leak check fails see below for troubleshooting.

Internal Leak Check

- Make sure the solid internal leak check disk is inserted and seated properly into the filter holder.
- Ensure the filter holder is closed and the filter cassette is seated properly in the filter holder.
- Try a different leak check disk.
- Check the thermo-well on the front of the filter holder to ensure it is tight and sealed.
- Check all internal fittings to ensure they are tight and sealed – see section 12.0 Maintenance for instructions on opening the front cover.
- Check the tightness of the filter holder mechanism and adjust to tighten. See Section 3.0 – Filter Handling / Filter Holder for instructions on tightening the filter holder mechanism.

DISCONNECT MAINS POWER AND BATTERY POWER BEFORE OPENING THE FRONT COVER

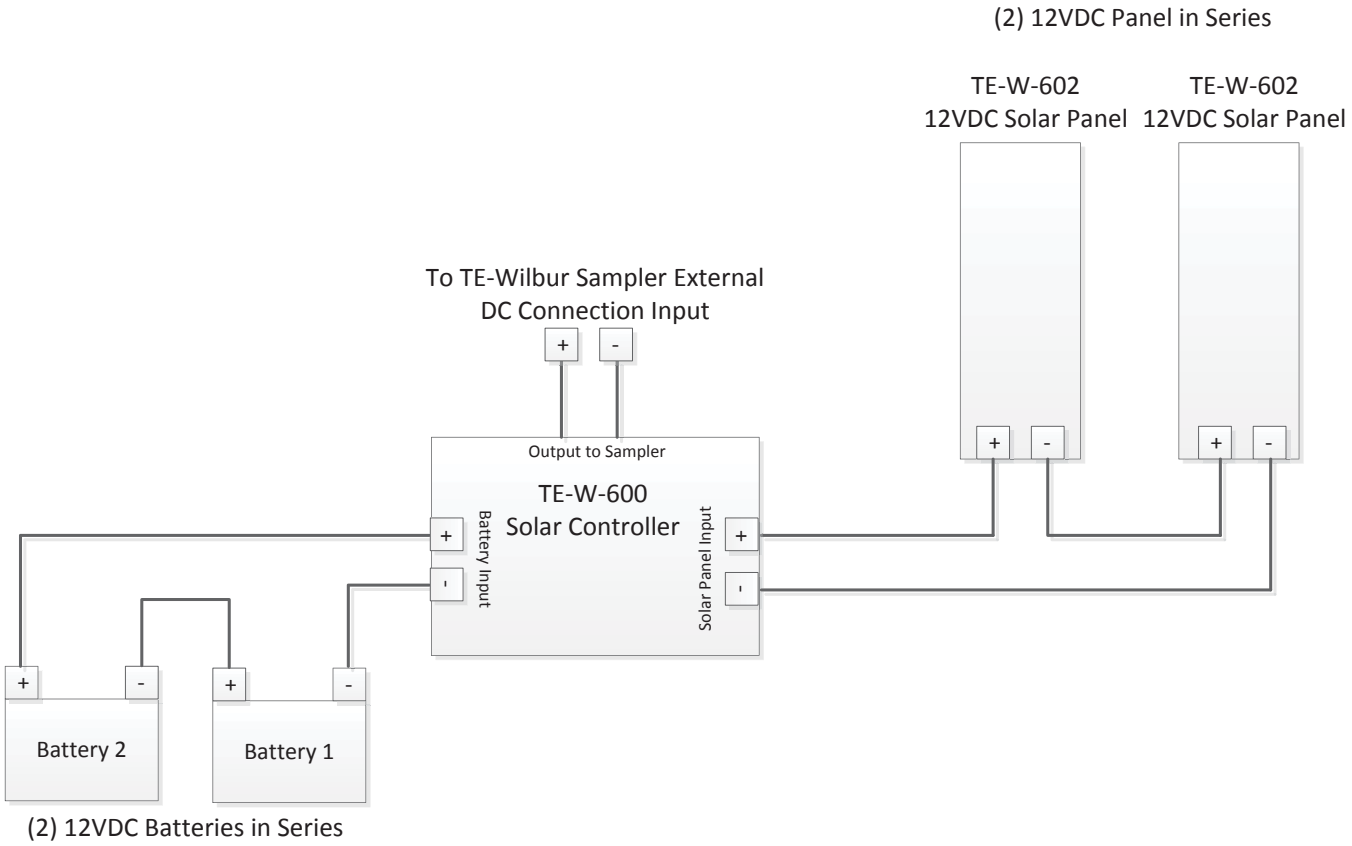
12.0 Solar / Alternative Energy

This section explains the optional solar panel accessory and the alternative energy connection for TE-Wilbur.

12.1 Introduction

The TE-Wilbur sampler has the ability to be run on alternative 24VDC power from solar, wind, external batteries or any other 24VDC source. An external DC connector is provided to allow connection to the alternative DC source.

12.2 Solar Wiring Overview

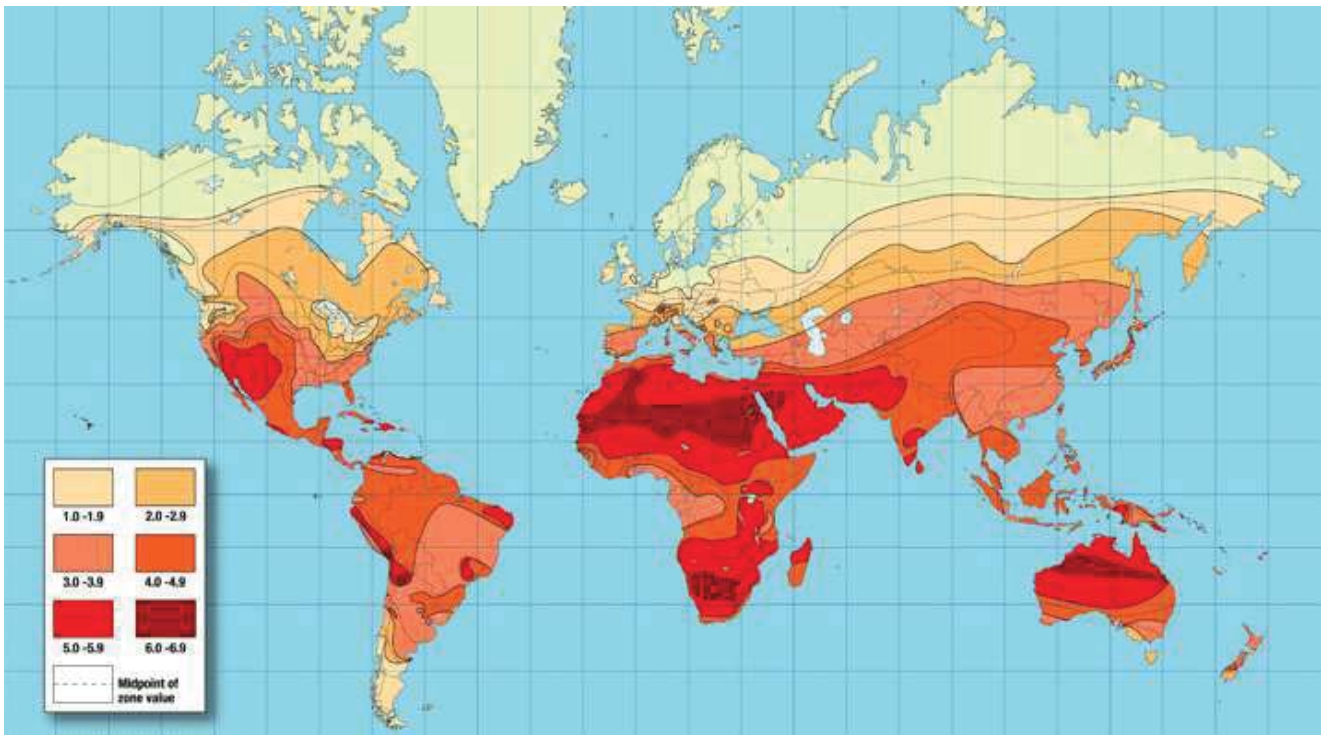


12.3 Solar Accessories

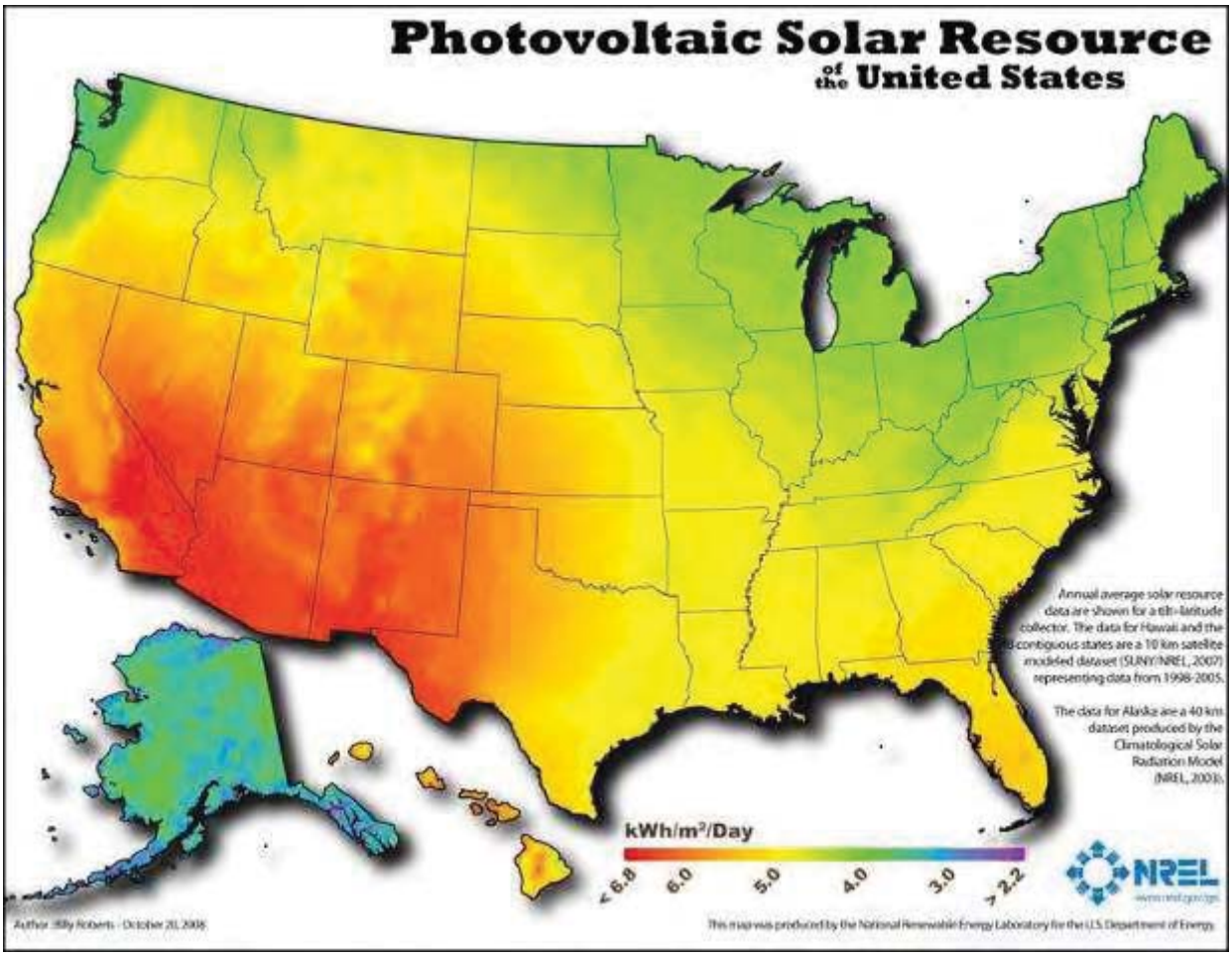
Accessory P/N	Description
TE-W-600	Complete solar kit with (2) 12V 100Watt panels, MC cables, solar controller mounted in weatherproof enclosure with fusing. Batteries NOT included
TE-W-602	24VDC Solar Panel only.
TE-W-608	Connection cable from Solar panel or other alternative energy source to TE-Wilbur sampler.

12.4 Solar Siting Guidelines

The following map shows average solar hours per day throughout the world. The lighter shades have lower sun hours versus the darker shades



The following map shows the solar radiation across the United States



TE-Wilbur Power Requirements at 24VDC:

When sampling	1250mA	30 watts
When idle	625mA	15 watts

Some useful links for Solar applications:

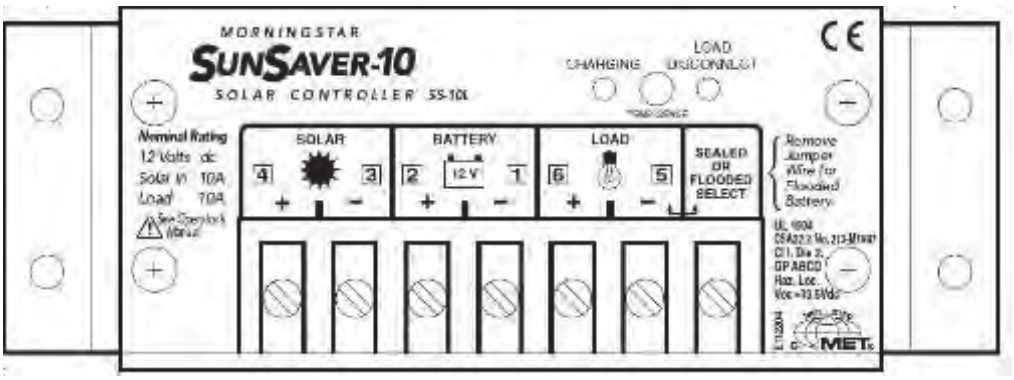
National Oceanic and Atmospheric Administration (NOAA)
http://www.esrl.noaa.gov/gmd/grad/solcalc/

National Renewable Energy Laboratory (NREL)
http://www.nrel.gov/

12.5 Solar Controller Operation

The Solar accessory is controlled from a Morningstar SunSaver MPPT charge controller.

NOTE: The instruction manual is included with each solar accessory and should be consulted for proper operation of the solar controller.



The controller has system status and battery status LEDs. Consult the user manual for LED status indications

12.6 Proper Solar Panel Orientation

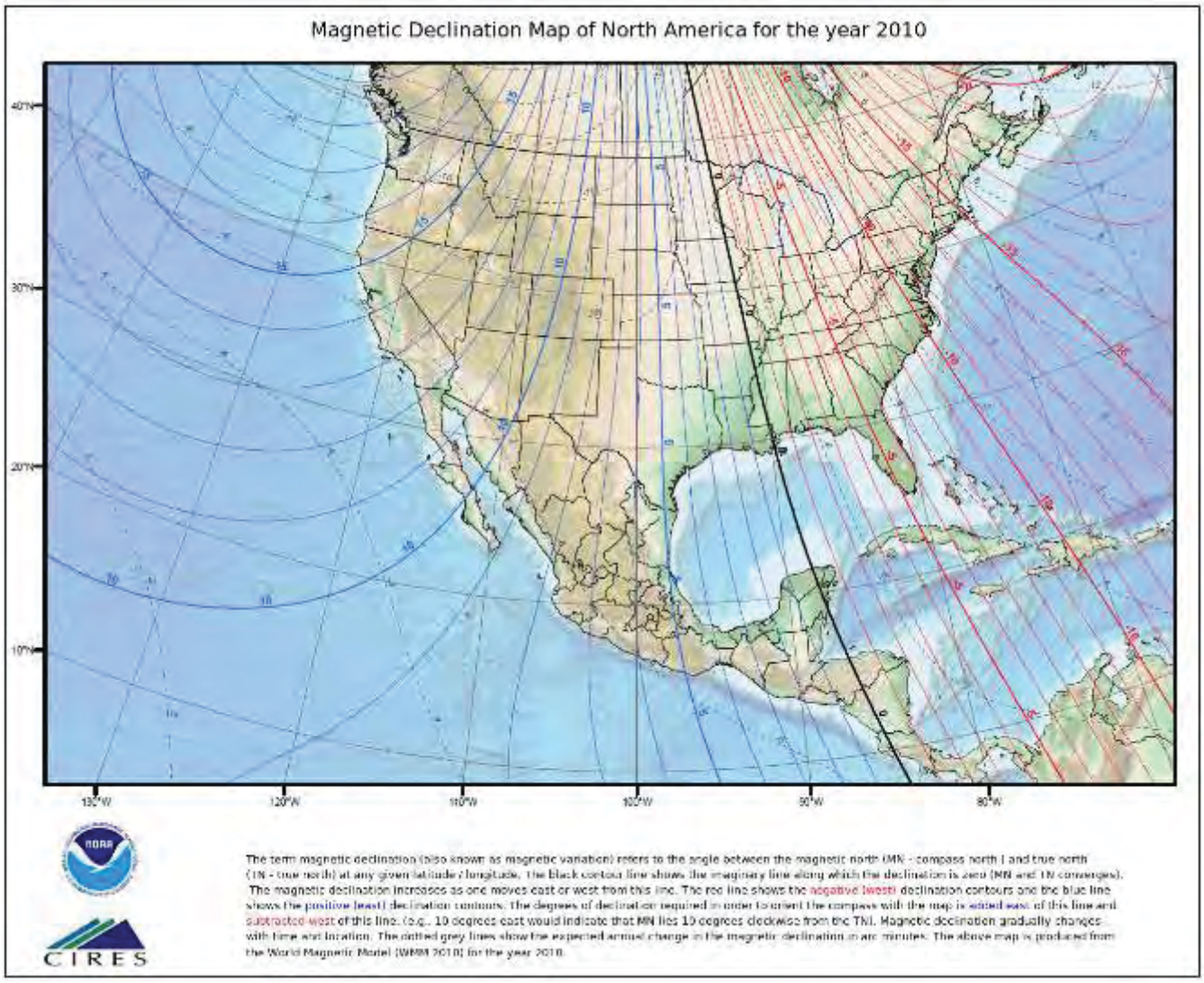
Direction to face a solar panel

Solar panels should always face true south if you are located in the northern hemisphere and true north if you are located in the southern hemisphere. 'True' North and South are not the same as magnetic north and south. If using a compass you must find out your location's magnetic declination. There are several websites that are useful for this. The National Geophysical Data Center offers a calculator.

http://www.ngdc.noaa.gov/geomag-web/#declination

This website will calculate your latitude and longitude and the magnetic declination at that location. At our facility in Cleves, OH the magnetic declination is 5 Degrees West. So to properly point a solar panel you would use a compass to find magnetic north, then move 5 degrees to the west to find the true north since our facility is located in the northern hemisphere.

This map shows the magnetic declination for the year 2010



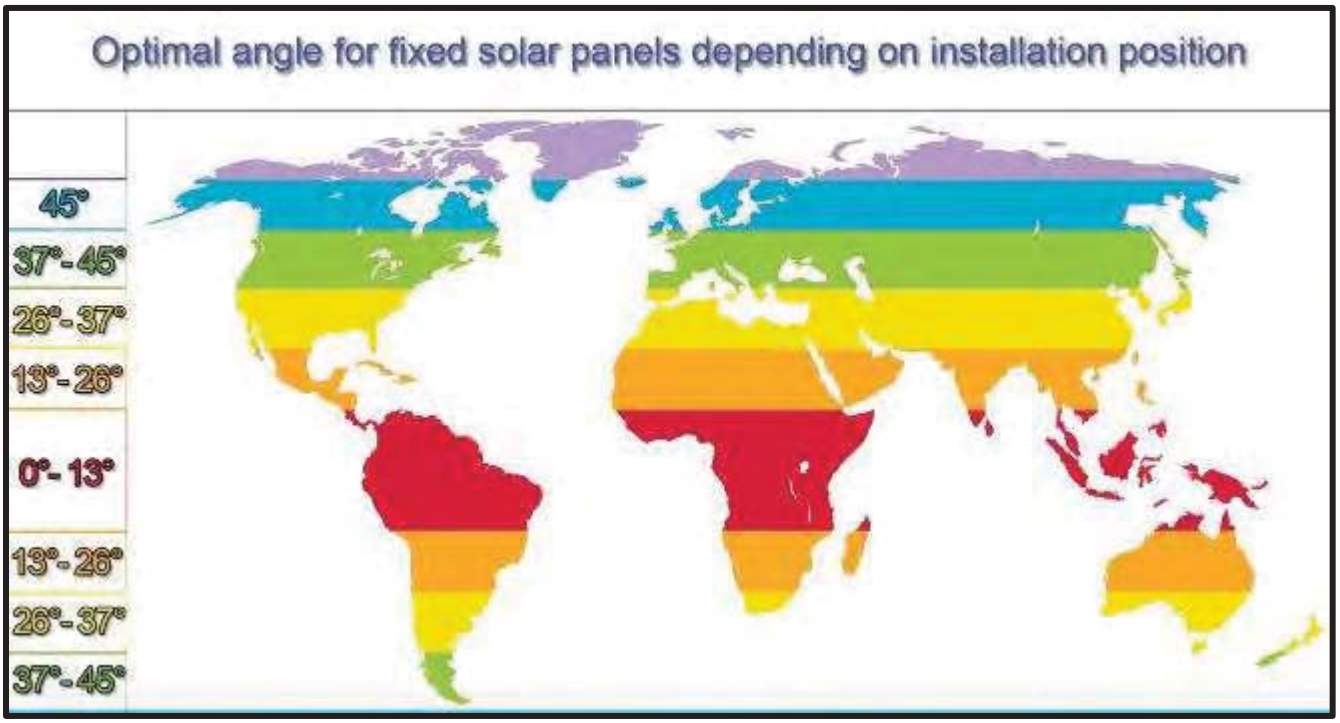
Proper Solar Panel Tilt

The tilt of the solar panel is important. If setting up the solar panel as fixed, meaning it will not move from summer to winter, use the following guidelines:

To find the angle from horizontal to tilt the solar panel:

Latitude	Tilt angle Calculation
Below 25º	Latitude x 0.87
Between 25º and 50º	Latitude x 0.76 + 3.1º
Over 50º	Best angle is 45º

This map gives an overview of the proper tilt angle for solar panels around the world:



There are also many resources online to assist with getting the right tilt angle for the solar panels:

http://www.otilt.com/index.php

http://solarelectricityhandbook.com/solar-angle-calculator.html

13.0 Maintenance

This section describes the maintenance procedures for the TE-Wilbur sampler.

13.1 Electrical System

The TE-Wilbur operates on 120V/230VAC mains power. The system is then converted to 24VDC power which is supplied by a 60watt power supply.

Turning on the system

Plug the system into mains power, either 120VAC or 230VAC
Press the green button on the inside front cover, just below the touch-screen. The button has an internal green LED that will illuminate letting the operator know that mains power is on. When this light is off, mains power has been lost. When this happens, the system will switch to battery power. There will be a notification on the screen that mains power was lost and an entry in the history log.

A battery backup UPS (uninterruptable power supply) is used with 5 amp-hour batteries.

When power is lost, the system will automatically switch over to battery power and will continue to operate. This feature is only to keep a sample running for a few hours if there is an intermittent loss of mains power. If a longer runtime is needed, please refer to section 12.0 Solar / Alternative Energy.

The sealed lead-acid batteries in the system should last approximately 5 years.

Typical Runtime During Sampling: Approximately 3-4 hours

Typical Runtime Idle: Approximately 8-9 hours

Allow the batteries to fully charge by plugging the sampler into mains power for 24 hours.

Powering off the system

In order to power off the system, the batteries must be disconnected. To disconnect the batteries perform the following keystrokes:

MAIN MENU	➔	MAINTENANCE MENU	➔	BATTERY DISCONNECT

Pressing this button will disconnect the batteries from the system and allow the system to be powered down completely by removing mains power.

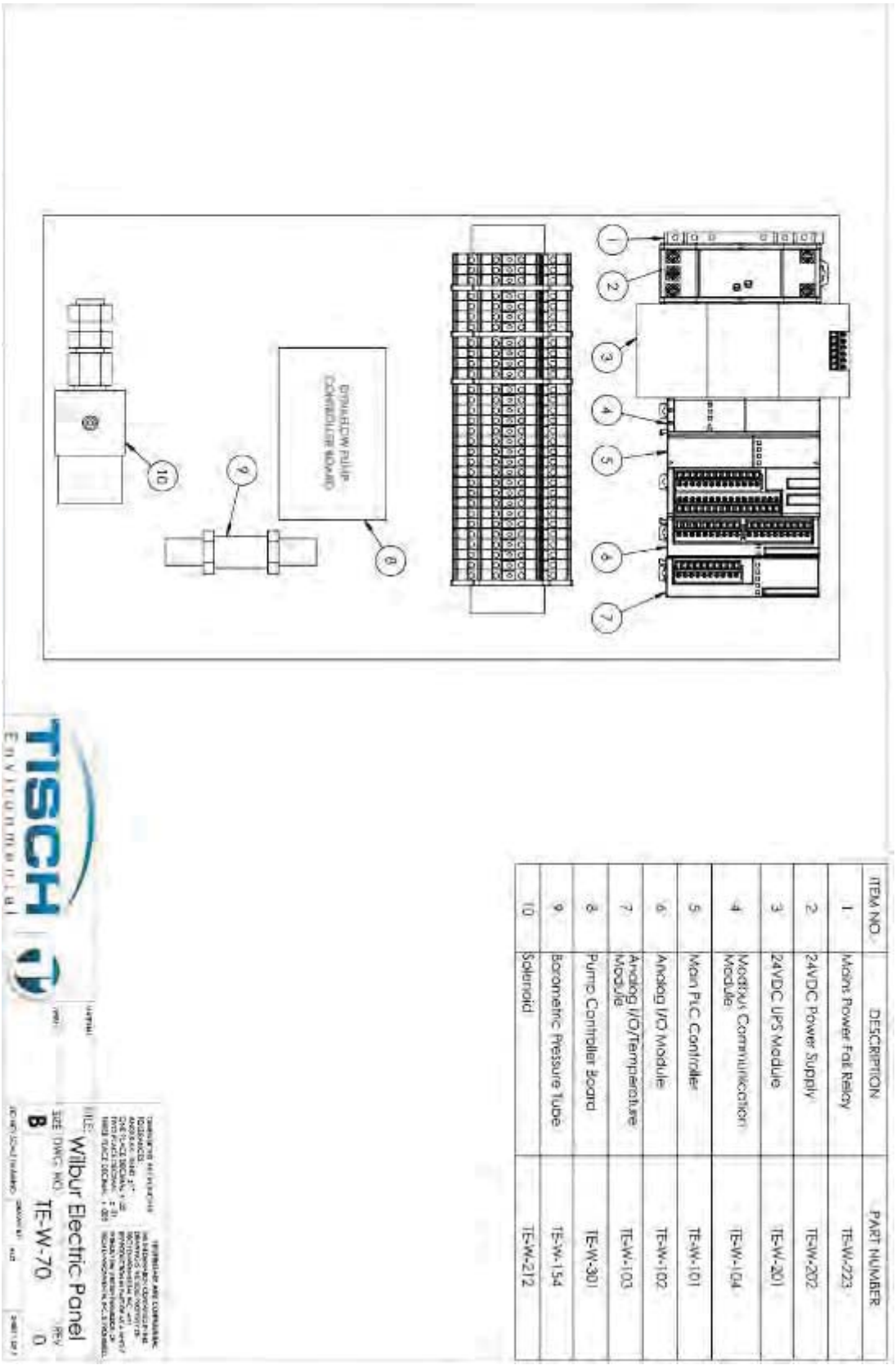
NOTE: If mains power is removed and the sampler is running on battery, pressing the disconnect battery button will power down the sampler. **Mains power must be applied to the sampler to power on again**.

The mains electrical connection is a standard IEC-320 plug configuration and is found in the weatherproof box on the side of the sampler.

A 1Amp resettable circuit breaker is located just below the AC inlet plug. If this circuit breaker would trip, it can be reset by pushing the button on the front.

WARNING – When powering down the system to perform maintenance, it is important to remove mains power from the sampler by unplugging the cord from the power source. The terminals for the plug and circuit breaker will be energized and could be accidentally touched inside the unit, resulting in a shock hazard.

Electrical System Layout



ITEM NO.	DESCRIPTION	PART NUMBER
1	Mains Power Fail Relay	TE-W-223
2	24VDC Power Supply	TE-W-202
3	24VDC UPS Module	TE-W-201
4	Modbus Communication Module	TE-W-104
5	Main PLC Controller	TE-W-101
6	Analog I/O Module	TE-W-102
7	Analog I/O/Temperature Module	TE-W-103
8	Pump Controller Board	TE-W-301
9	Barometric Pressure Tube	TE-W-154
10	Solenoid	TE-W-212

TISCH Environmental

FILE: Wilbur Electric Panel

SIZE B DWG NO. TE-W-70 REV 0

13.2 Fuse Location and Replacement

There is one fuse used in the sampler and it is located in a fuse holder on the terminal strip left side.

WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

MAIN MENU	➔	MAINTENANCE MENU	➔	BATTERY DISCONNECT

To replace the fuse perform the following:

1. Open the front, lower cover by removing the 4 screws with a phillips screwdriver.
2. Remove the upper front cover by removing the 4 screws with a phillips screwdriver.
3. Notice the cabling - especially the cable that extends from the PLC on the rear plate to the screen, this cable could become unplugged if the upper panel is pulled away too far from the sampler.
4. The upper plate should be able to be placed on top of the sampler without disconnecting any of the cables.
5. The fuse holder is located on the left side of the terminal strip on the rear panel.
6. Open the fuse holder by pulling down on the top tab of the lever arm.
7. The fuse is located in the lever arm. Remove the fuse and check either visually and/or with a continuity / ohmmeter to see if it has blown.
8. Replace the fuse as needed.
9. Push fuse holder lever arm back into the fuse holder ensuring it is seated correctly.
10. Reinstall upper and lower plates.

Fuse table

F1	Littlefuse	021702.5HXP (5x20mm glass)	2.5 Amp / 250V

Tisch Environmental fuse part number TE-W-208.

13.3 Replacing the Batteries

The battery pack that is utilized in the sampler is 24VDC at 5 amp-hours. It contains two sealed lead acid (SLA) type batteries and can be ordered by part number TE-W-200. When the batteries have failed there will be an alarm that indicates battery failure. There is also an alarm when the batteries have been fully discharged. When this alarm activates, there is only several minutes of battery time before power is lost. If the batteries are not keeping the system energized for very long this is also an indication that the batteries need replacing. When the batteries fail, the sampler will continue to operate as normal, except when there is a mains power loss, the unit will power down completely.

The sealed lead-acid batteries in the system should last approximately 5 years.

Typical Runtime During Sampling: Approximately 3-4 hours

Typical Runtime Idle: Approximately 8-9 hours

To replace the batteries perform the following:

WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

MAIN MENU → **MAINTENANCE MENU** → **BATTERY DISCONNECT**

1. Power down the sampler.
2. Remove the lower front cover by removing the 4 screws with a phillips screwdriver.
3. Locate the cable that is connected to the battery pack. Unplug the battery pack from the unit.
4. Unhook the Velcro straps that secure the battery pack into the battery pack tray.
5. Remove the old battery pack.

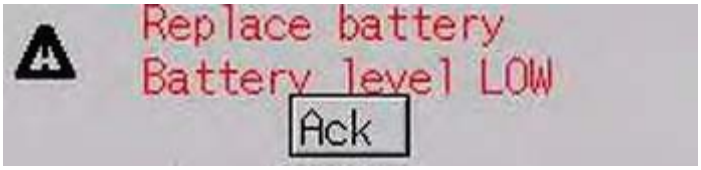
   NOTE: Check with local environmental and recycling agencies for the proper disposal of sealed lead-acid batteries (SLA).

6. Install new battery pack and secure with Velcro straps into the battery pack tray.
7. Plug the new battery pack in to the unit.
8. Reinstall the lower front cover.
9. Allow the batteries to charge a full 24 hours by having unit plugged into mains power.

13.4 Replacing the Screen Internal Battery

The internal battery in the screen is critical for proper operation of the sampler. This battery is used to store the configuration of the unit and when it is depleted this information could be lost.

When the battery is low and needs replaced, the following message will apprear on the screen:



Also, an alarm will be shown in the history log that the internal screen battery needs replaced.

The battery is a standard CR2032 3.3V lithium Ion battery manufactured by several companies such as Duracell, Energizer, Sony and Panasonic. The Tisch Environmental part number for this battery is a TE-W-215.

To replace the internal screen battery, perform the following:

WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **BATTERY DISCONNECT**

1. Power down the sampler.
2. Remove the upper front cover by removing the 4 screws with a phillips screwdriver.
3. The battery cover is located on the rear of the touchpanel in the center of the screen.
4. Open the battery cover and remove the old battery
5. Replace with a new battery and close the battery cover
6. Reinstall the upper front cover and secure with the 4 screws
7. Power unit on and acknowledge the replace screen battery alarm

NOTE: Check with local environmental and recycling agencies for the proper disposal of Lithium Ion batteries

13.5 Sample Pump Maintenance

The sample pump used in TE-Wilbur is a single head diaphragm pump that is powered by a 24VDC brushless motor.

Pump rebuilds are recommended every 3,000 hours of pump operation or when the pump is making extreme noises or is not pumping the correct air flow.

The part numbers for the pump are as follows:

TE-W-300	Entire sample pump with brushless 24VDC motor and single head diaphragm pump.
TE-W-303	Pump rebuild kit that includes the single head diaphragm pump housing assembly, diaphragm replacement, o-ring, stainless washer and flat-head screw.

Removing the sample pump

The sample pump can be removed by following these steps:

WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **BATTERY DISCONNECT**

1. Remove the lower front plate using a phillips screwdriver.
2. Unplug the pump control cable from the pump control circuit board, noting the direction of the connector onto the board.
3. Unscrew the two screws holding the sample pump plate into the side of the internal side plate.
4. Remove the pump and pump plate, noting the slot the pump plate end seats into.

Replacing the diaphragm pump

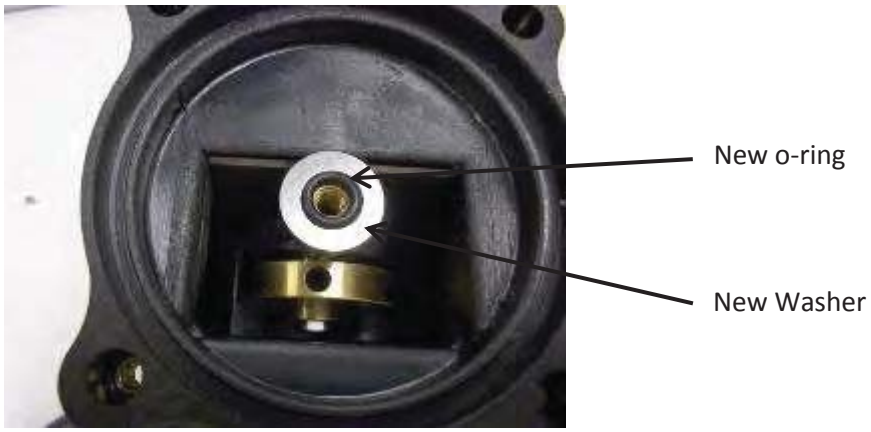
The diaphragm pump can be easily field replaced by following these steps:

Picture showing pump, screwdriver and pump rebuild kit

1. Remove the pump and motor from the pump plate by turning the pump mounting plate over and removing the two screws securing the pump to the pump mounting plate.
2. Using a phillips screwdriver, remove the four screws that secure the pump head to the motor body.

3. Discard old pump head.
4. Now remove the screw that holds the diaphragm on the pump body.

5. Discard the old diaphragm, screw, o-ring and washer.
6. Replace the o-ring and the stainless steel washer that are on the pump shaft.



7. Carefully center the motor shaft in the center of the body and press the new diaphragm onto the motor shaft aligning the hole for the screw.

8. Place the new screw into the hole and tighten the screw with the screwdriver.

9. Place the new pump head over the diaphragm and line up the four bolt holes.
10. Tighten the four bolts.

Inserting the pump back into the unit

The pump can be easily inserted back into the unit by following these steps:

1. Make sure the pump is mounted on the pump bracket.
2. Note the slot that is located on the left inside of the enclosure, the ear of the pump plate gets inserted into this slot.
3. Secure the pump plate with the two 8-32 stainless steel bolts.
4. Place lower front cover back in place and secure with 4 bolts.

13.6 Filter Holder Maintenance

The filter holder is maintenance free with the exception of tightening or loosening the mechanism if the system should become loose or is having an issue passing a leak check.

There are o-rings on the top and bottom mate pieces that seal the filter cassette, inspect these for wear or damage if there appears to be a leak. Replace if needed. Tisch Environmental part number TE-W-FH6 for (2) filter holder o-rings.

To replace the filter holder o-rings:

- Remove the filter holder from the enclosure by removing the downtube, the four bolts on the filter holder plate and disconnecting the sample tubing to remove the filter holder from the enclosure.
- Remove the 6 screws on the top of the filter holder to remove the top mate piece.
- The o-ring can be removed with a small thin flat-blade screwdriver by pushing the screwdriver into the o-ring groove and prying the o-ring from the groove.
- Replace with a new o-ring and push the o-ring into the grove with your finger, ensure it gets seated entirely.
- Using the small thin flat-blade screwdriver pry the bottom mate o-ring from the groove.
- Replace with a new o-ring and push the o-ring into the grove with your finger, ensure it gets seated entirely.
- Place top mate back on top of the filter holder aligning the 6 holes and secure with the 6 bolts.

The filter holder should be cleaned on a monthly basis to keep stray particulate matter from affecting sampling results. The inside of the bottom and top mate and the top tube can be cleaned with distilled water or a general purpose cleaner and a soft cloth.

See section 4.4, adjusting the filter holder for information on making adjustments to the filter holder mechanism.

13.7 UPS System Replacement

If the UPS needs replaced, perform the following:

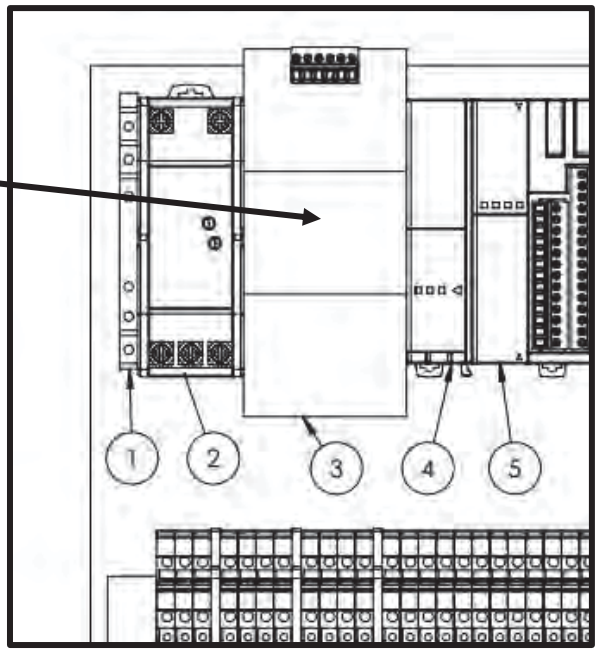
The part number for the UPS module is TE-W-201.

WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

MAIN MENU	→	MAINTENANCE MENU	→	BATTERY DISCONNECT

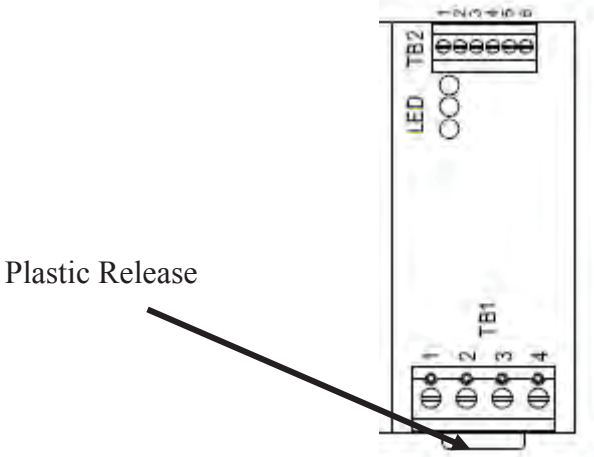
1. Remove both the upper and lower left plates using a phillips screwdriver.
2. The UPS module is located in the top left corner on the rear plate.

UPS Module
TE-W-201



3. There are wires that enter on the top of the UPS and on the bottom of the UPS.
4. On top there are (4) wires on TB2 terminals 1 through 4 that are the alarm outputs for battery fail and battery discharge that route over to the controller. Label each of these wires and unscrew the terminals and remove the (4) top wires.

5. On the bottom of the UPS there are (4) wires on TB1, 2 wires for DC+ and DC- and 2 wires for Battery + and Battery -. Label each of these wires and unscrew the terminals and remove the (4) bottom wires.



Terminal Pin No. Assignment (TB1)

Pin No.	Assignment
1	BATTERY INPUT +
2	BATTERY INPUT -
3	DC INPUT -
4	DC INPUT +

Terminal Pin No. Assignment (TB2)

Pin No.	Assignment
1	BAT DISC 1
2	BAT DISC 2
3	BAT FAIL 1
4	BAT FAIL 2
5	DC OK 1
6	DC OK 2

} Not used

6. Notice the plastic release at the very back, on the bottom of the UPS module. Using a flat-head screwdriver push this lip downward, releasing the UPS module from the DIN rail. Tilt the module towards you and remove from the enclosure.
7. To install a new UPS module, you must first hook the top onto the DIN rail, then push downward to secure the UPS module onto the DIN rail. You will hear and feel a 'click' as the UPS module is seated onto the DIN rail properly.
8. Reattach the wires on TB1 and TB2 (4) wires on each top and bottom terminals.
9. Reinstall the upper and lower front panel and power unit on.
10. Test the UPS by connecting charged batteries and disconnecting power. The UPS should switch and run on the batteries.

13.8 Power Supply Replacement

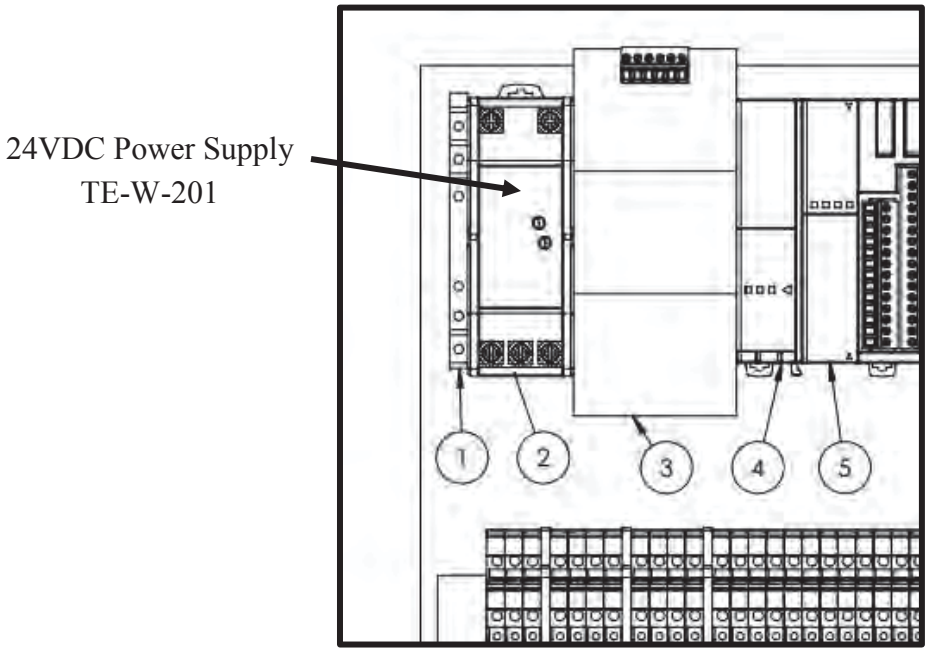
If the 24VDC power supply needs replaced, perform the following:

The part number for the power supply is TE-W-202.

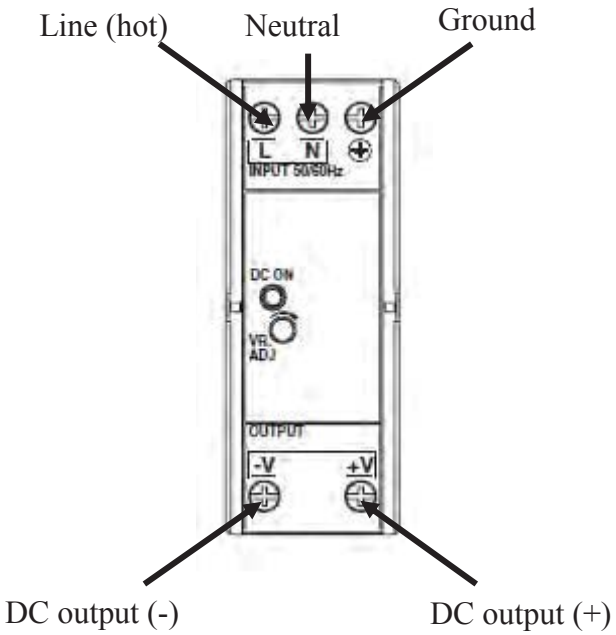
WARNING – Before opening covers and maintaining unit, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

MAIN MENU → **MAINTENANCE MENU** → **BATTERY DISCONNECT**

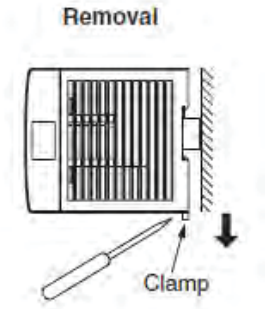
1. Remove both the upper and lower left plates using a Philips screwdriver.
2. The power supply is located at the top on the rear plate between the controller and UPS module.



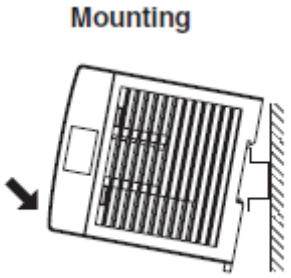
3. There are wires that enter on the top of the power supply and on the bottom of the power supply.



4. On top there are (3) wires on top for Line Voltage (hot), Neutral and Ground. These will be colored black, white and green respectively. Unscrew the terminals and remove the (3) top wires.
5. There are (2) wires on the bottom for DC output (+) and (-), label these and unscrew the terminals and remove the bottom (2) wires.
6. The Power supply has a plastic clamp on the bottom at the rear of the unit that is used to attach the unit to the DIN rail. Using a small flat-blade screwdriver insert the blade into the hole on the clamp and push downwards. The clamp will 'click' into the open / downward position.

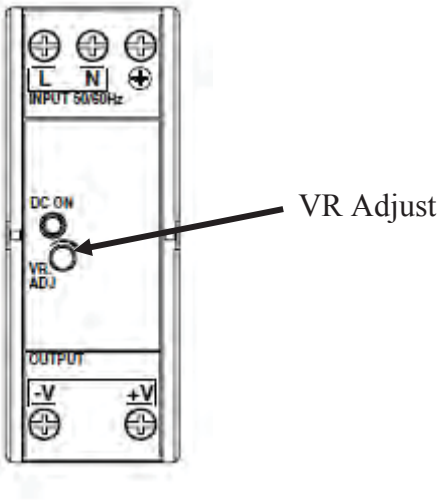


7. Now the power supply can be removed by tilting upwards and removing from the DIN rail.
8. To insert a new power supply, the top notches must be attached to the DIN rail first, then push the bottom towards the DIN rail until the unit 'clicks' into place.



9. Reinstall the (3) top wires for the hot, neutral and ground by placing the wire into terminal and screwing tight with screwdriver.
10. Reinstall the (2) bottom wires for the DC output.
11. Now that the power supply is installed and wired, it must be checked for proper voltage.
12. Turn on the unit. The power supply light on the front should be on and green, noting proper operation. If this light is not on check all wiring.
13. Place a DC voltage meter on the DC output of the power supply, red on positive and black on negative.

14. The voltage of the power supply needs to be set at around 27 volts. Read the voltage on the voltage meter, if the voltage is not 27 volts the voltage must be adjusted.



15. To adjust the voltage, turn the VR Adjust knob clockwise to increase and counter-clockwise to decrease. Set the voltage of the power supply at 27.0 volts. This voltage is necessary to provide proper charging voltage for the batteries.
16. Reinstall the upper and lower front panel and power unit on.

13.9 Controller Replacement

If the Programmable Logic Controller needs replaced perform the following:

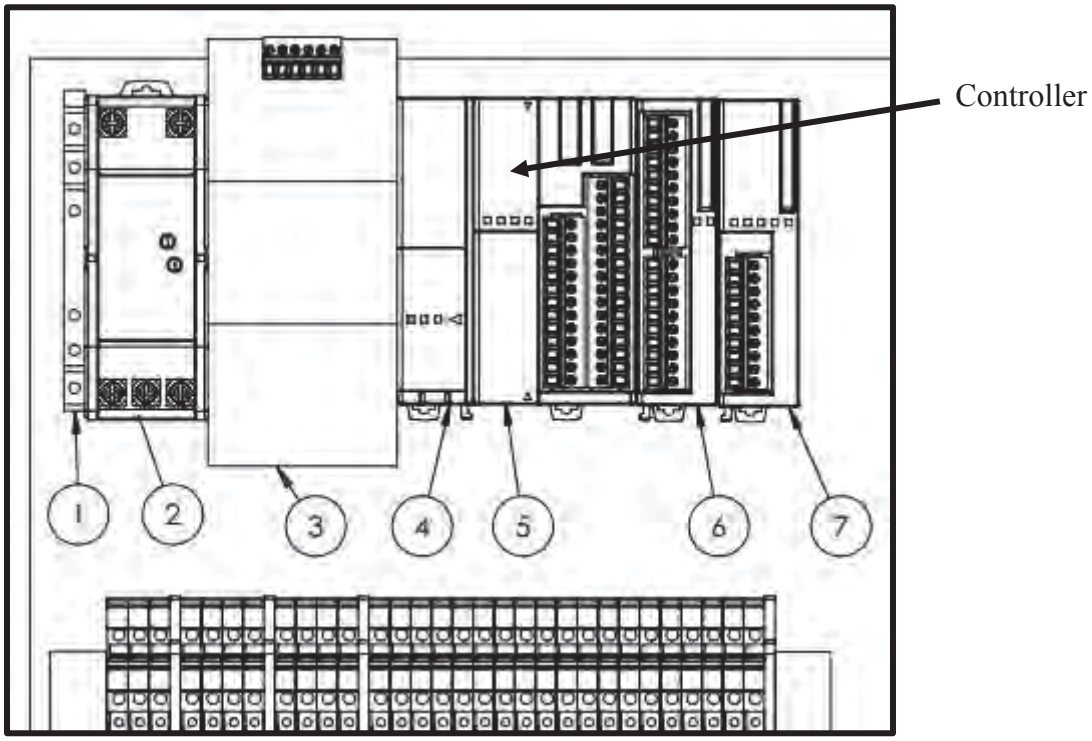
The part number for the PLC is made up of the following modules:

TE-W-101	Main Controller Module
TE-W-102	Analog input module
TE-W-103	Analog input / output module
TE-W-104	Modbus communication module

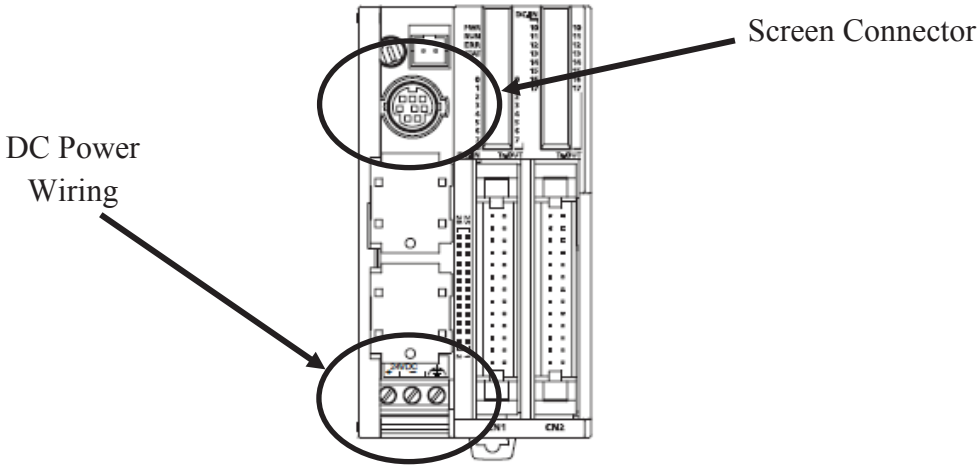
WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **BATTERY DISCONNECT**

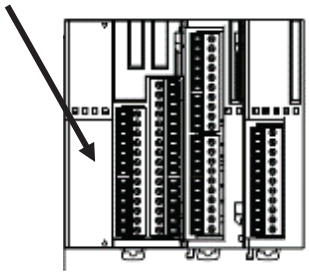
1. Remove both the upper and lower left plates using a Phillips screwdriver.
2. The controller is located at the top on the rear plate on the right side.



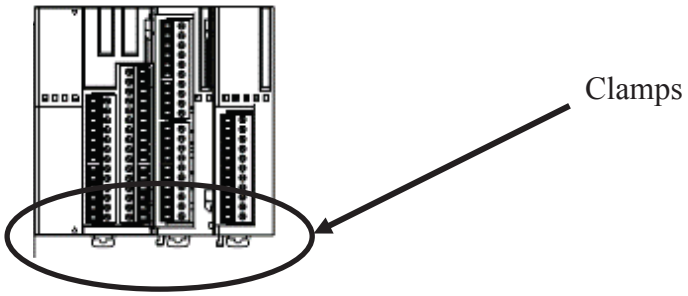
3. Unplug the cable from the screen.
4. There are two wires that enter the controller at the bottom for DC power, label these wires and remove them.



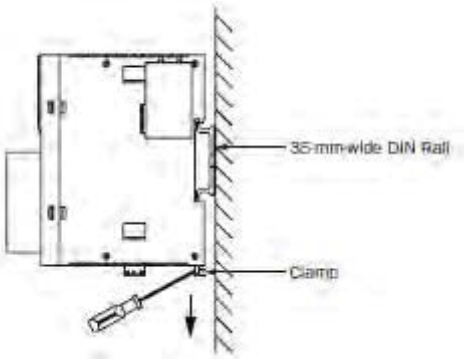
5. The wiring of the Modbus module must now be removed. The Modbus module is located here:



6. The Modbus module has (2) wires, label each wire and remove them by unscrewing the terminal and removing the wire.
7. The rest of the wiring is modular and can be removed by grasping each terminal block in the center and pulling straight out.
8. Now that all the wiring is removed, notice the clamps at the bottom of the controller. There are (3) of them.



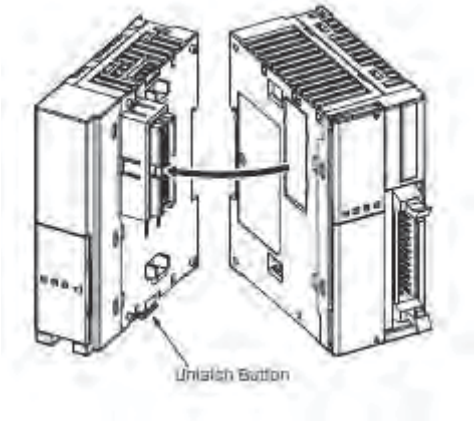
9. Using a small flat-blade screwdriver insert the blade into the hole on the clamp and push downwards. The clamp will 'click' into the open / downward position.



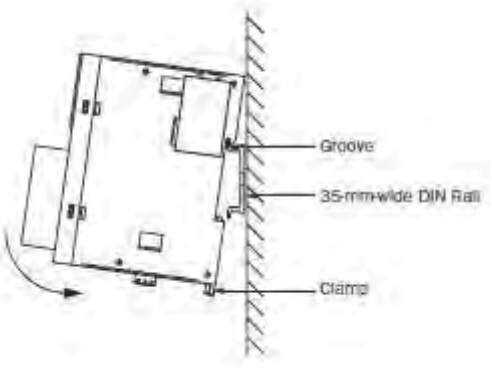
10. Now the controller can be removed by tilting upwards and removing from the DIN rail.
11. The controller consists of (4) modules:

TE-W-101	Main Controller Module
TE-W-102	Analog input module
TE-W-103	Analog input / output module
TE-W-104	Modbus communication module

12. Each module can be removed or replaced individually. Notice the latch in the center of the modules. When the latch is in the downward position, the modules can be pulled apart. When the latch is in the upward position the modules cannot be pulled apart.



13. Replace each module or entire controller assembly as required. When modules are all put back together, ensure all the latches are in the upward position.
14. Place the controller assembly onto the DIN rail. The top must first be attached, then the bottom can be pushed onto the DIN rail until a 'click' is heard denoting the controller is properly seated onto the DIN rail.



15. Once the controller is seated on the Din rail properly you must now reinstall the wiring.
16. Reinstall the (2) Modbus wires onto the Modbus module securing by tightening the terminal screw.
17. Reinstall the (2) DC Power wires onto the controller securing by tightening the terminal screw.
18. Reinstall the (5) connectors in their proper locations on the controller assembly.
19. Plug the communication cable from the screen back into the controller port on the front.
20. Reinstall the upper and lower front panels and power unit on.

13.10 Flowmeter Replacement

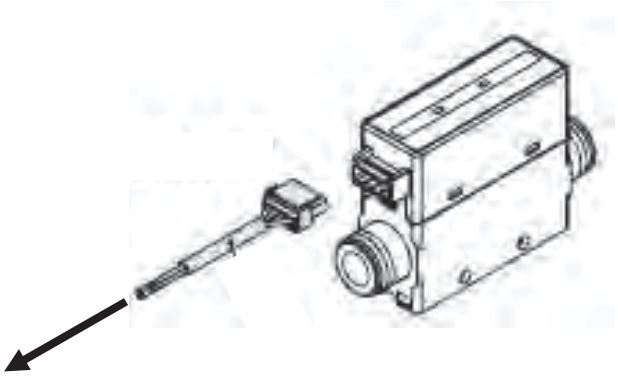
If the thermal mass flowmeter needs replaced, perform the following:

The part number for the thermal mass flowmeter is TE-W-150.

WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

MAIN MENU	➔	MAINTENANCE MENU	➔	BATTERY DISCONNECT

1. Remove both the upper and lower left plates using a Phillips screwdriver.
2. The thermal mass flowmeter is located on the inside right wall (center divider) of the enclosure.
3. Unplug the connector on the flowmeter by pushing down on the tab on top and pulling outwards.



4. The flowmeter has a 17mm twist-nut for the process connection. You will need to hold the 17mm nut as you turn the compression fitting with a 9/16 wrench to loosen the compression fitting.
5. Loosen each compression fitting and disconnect the entry and exit tubing from the flowmeter.
6. Remove the two screws and nuts that secure the flowmeter to the sidewall.
7. Remove flowmeter.
8. Remove the compression fittings from the old flowmeter and install in the new flowmeter – make sure to use thread tape on the threads to ensure a leak-free seal.
9. Place new flowmeter in place and secure to the sidewall with the screws and nuts.
10. Connect the entry and exit tubing and tighten 1 and ¼ turns after the compression fitting is finger tight.
11. Plug connector back into flowmeter.
12. Reinstall the upper and lower front panels and power unit on.
13. See section 7.5 to perform a calibration of the flow system.

13.11 Pressure Sensor Replacement

If the pressure sensor needs replaced, perform the following:

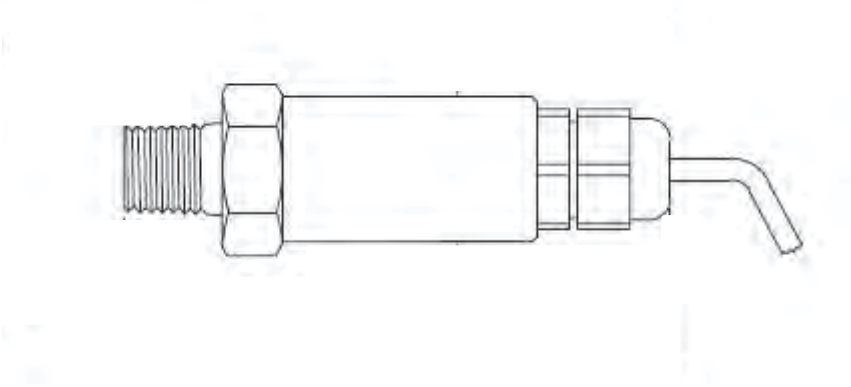
The part number for the pressure sensor is TE-W-153.

WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

MAIN MENU	➔	MAINTENANCE MENU	➔	BATTERY DISCONNECT

1. Remove both the upper and lower left plates using a Phillips screwdriver.
2. The pressure sensor is located on the inside right wall (center divider) of the enclosure. It is downstream of the flowmeter.
3. Remove the compression fittings on the tee that the flowmeter is screwed into using a 9/16 wrench and disconnect the entry and exit tubing.

4. Remove the (2) screws that secure the clamp that secures the pressure to the sidewall of the enclosure.
5. Unplug the pressure sensor connector and remove the pressure sensor.
6. Remove the tee from the old pressure sensor and install on the new pressure sensor. Use thread tape on the male thread of the new pressure sensor to ensure a leak-free seal.



7. Install the new pressure sensor on the sidewall with the clamp and screws.
8. Plug pressure into pressure sensor connector.
9. Reinstall upper and lower left panels and turn power on.
10. Refer to section 7.8 to zero the pressure sensor.

13.12 Barometric Pressure Sensor Replacement

If the barometric pressure sensor needs replaced, perform the following:

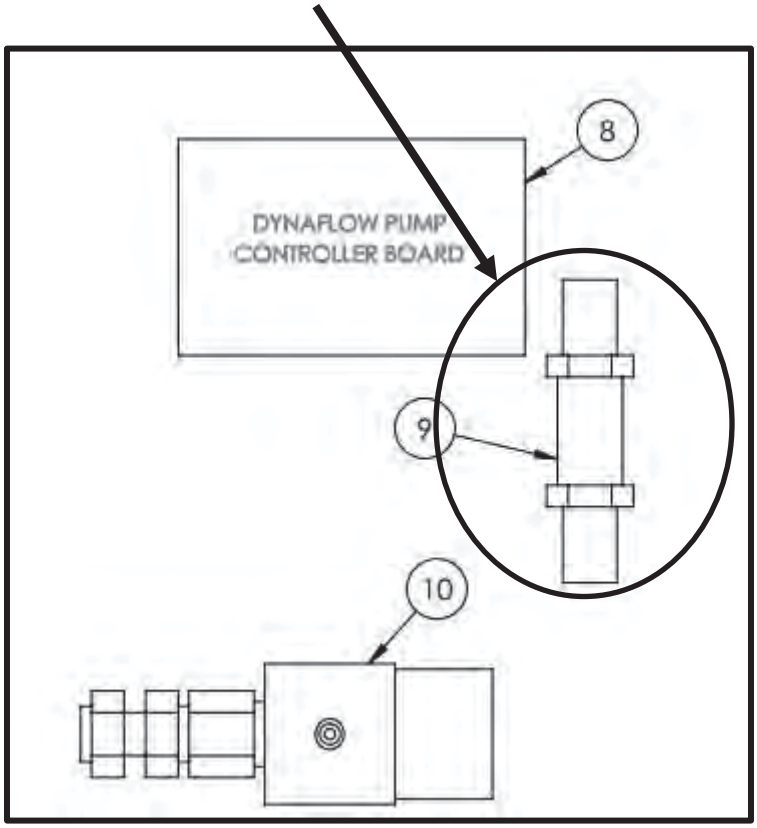
The part number for the barometric pressure sensor is TE-W-154.

WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

MAIN MENU → **MAINTENANCE MENU** → **BATTERY DISCONNECT**

1. Remove both the upper and lower left plates using a Phillips screwdriver.

The barometric pressure sensor is located on the back of the panel towards the right side and attached to the back panel with a stainless steel strap.



2. Remove the wires on terminal 9, 10 and 11. They should be white, black and red respectively.
3. Remove the 8-32 screw securing the clamp to the back panel.
4. Remove the barometric pressure sensor.
5. Install new barometric pressure sensor and secure to the back panel with the clamp and screw.
6. Terminate the white wire on terminal 9, the black wire on terminal 10 and the red wire on terminal 11.
7. Reinstall the upper and lower left panels and power unit on.
8. See section 7.3 to perform a full calibration of the new barometric pressure sensor.

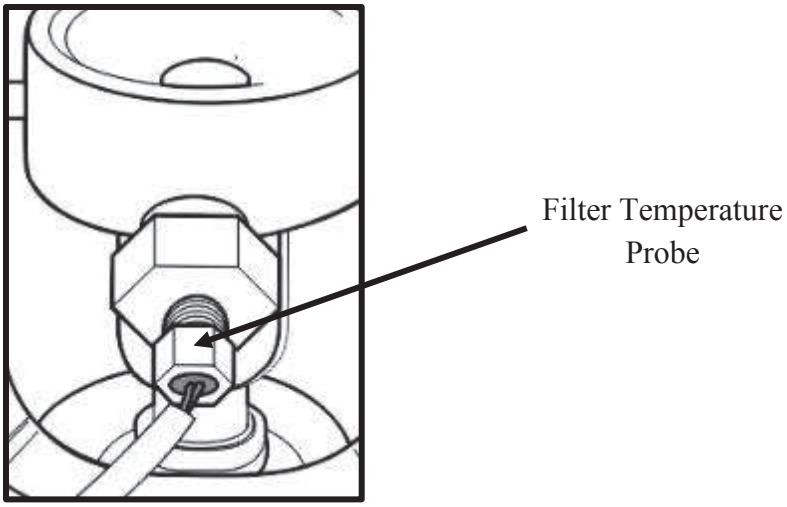
13.13 Filter Temperature Probe Replacement

If the filter temperature probe needs replaced, perform the following:

The part number for the filter temperature probe is TE-W-152.

1. Unplug the filter temperature probe connector.
2. Unscrew the filter temperature probe from the thermowell on the filter holder.
3. Install new filter temperature probe and connect to filter temperature connector.
4. Acknowledge the filter temperature probe was unplugged alarm.
5. See section 7.2 to perform a calibration of the filter holder temperature sensor.

Illustration showing filter temperature probe



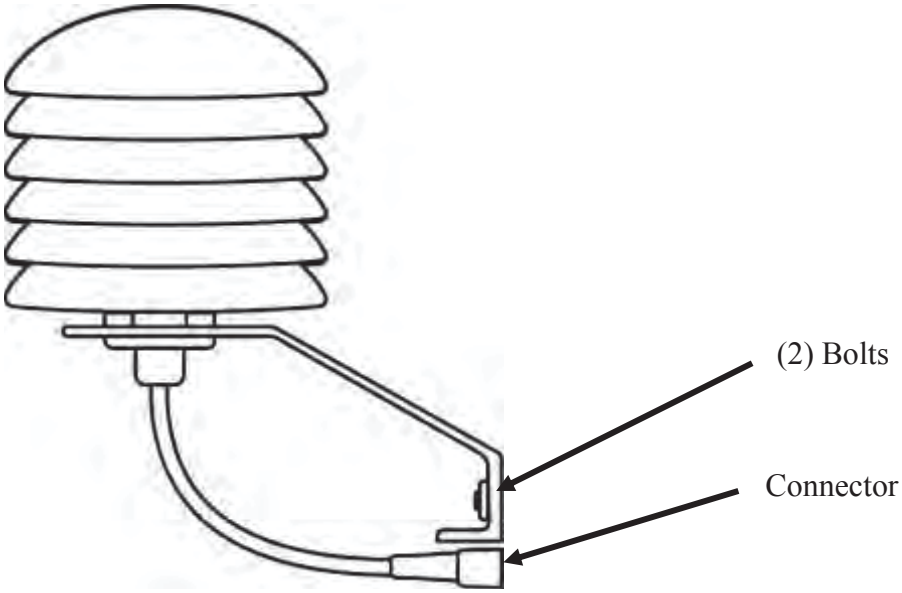
13.14 Ambient Temperature Replacement

If the ambient temperature probe needs replaced, perform the following:

The part number for the ambient temperature probe with radiation shield is TE-W-151.

1. Unplug the ambient temperature probe from the connector located on the left side of the enclosure.

2. Remove the (2) 1/4-20x5/8" bolts that secure the radiation shield bracket to the enclosure.



3. Install new radiation shield with ambient temperature probe onto the enclosure with the (2) bolts.
4. Plug the temperature probe into the socket on the left side of the enclosure.
5. Acknowledge the ambient temperature probe was unplugged alarm.
6. See section 7.1 to perform a calibration of the ambient temperature sensor.

13.15 Solenoid Replacement

If the solenoid needs replaced, perform the following:

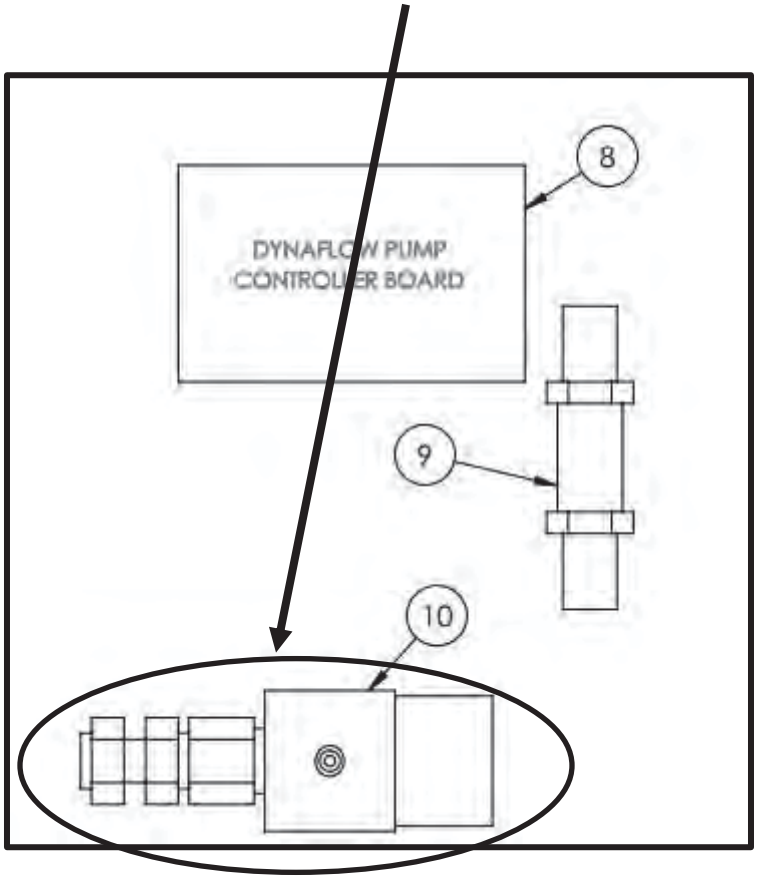
The part number for the solenoid is TE-W-212.

WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

MAIN MENU	→	MAINTENANCE MENU	→	BATTERY DISCONNECT

1. Remove both the upper and lower left plates using a Phillips screwdriver.

The solenoid is located on the back of the panel towards the bottom right side



2. Remove the compression fittings from the inlet and outlet using a 9/16” wrench.
3. Remove the wiring on terminals (3) and (-) of the solenoid.
4. Remove the two screws that secure the solenoid to the back panel and remove the solenoid.
5. Remove the compression fittings from the solenoid.
6. Install the compression fittings onto the new solenoid using thread tape on the connector threads to ensure a leak-free seal.
7. Install the new solenoid onto the back panel using the two screws.
8. Wire the solenoid to terminals (3) and (-) **NOTE:** there is no concern with polarity either wire from the solenoid can be terminated on either terminal.

9. Connect the compression hose fittings to the inlet and outlet of the solenoid.
10. Reinstall the upper and lower right plates and turn power on.

13.16 Pump Controller Replacement

If the pump controller needs replaced, perform the following:

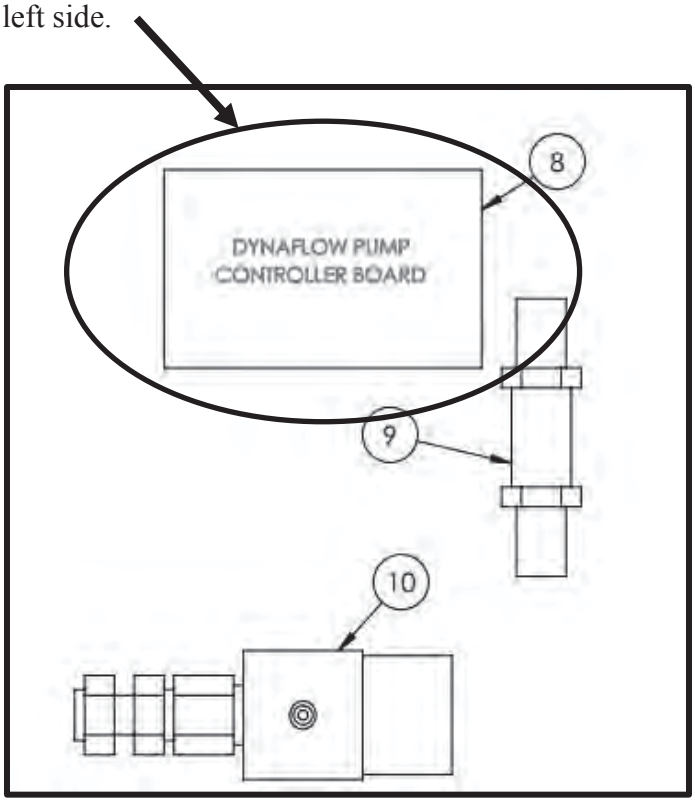
The part number for the pump controller is TE-W-301with the TE-W-302 pump controller cable.

WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

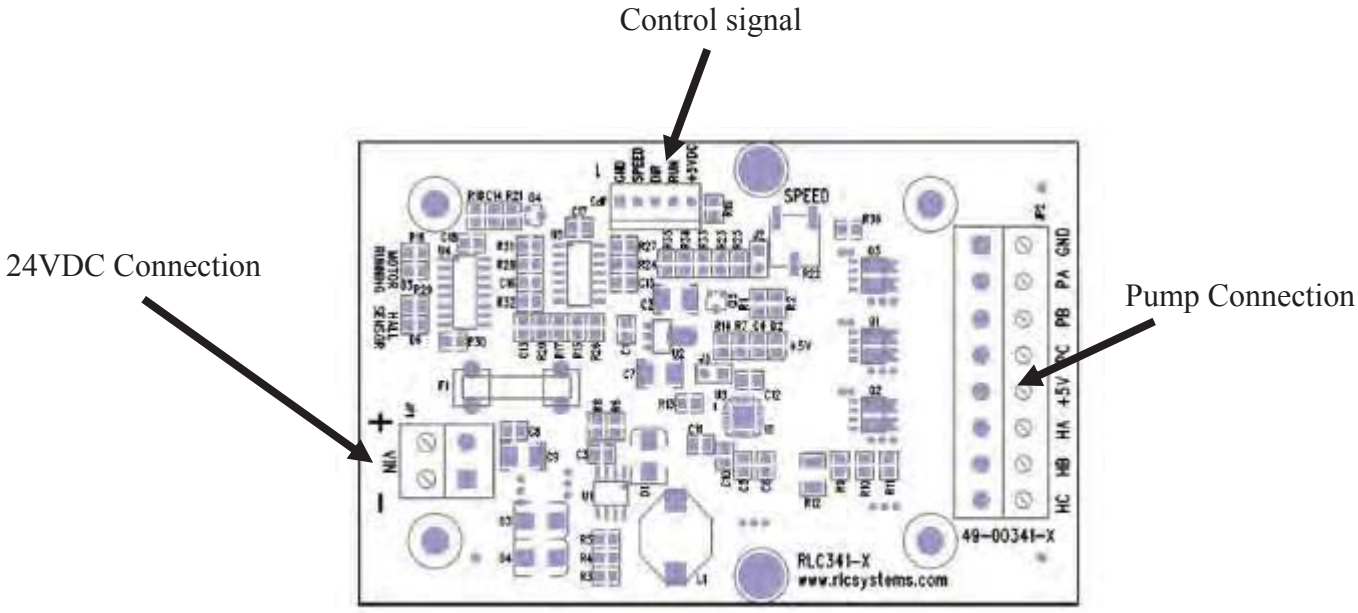
MAIN MENU	➔	MAINTENANCE MENU	➔	BATTERY DISCONNECT

1. Remove both the upper and lower left plates using a Phillips screwdriver.

The pump controller is located on the back of the panel towards the bottom left side.



2. There are (3) connectors on the pump controller board, one for 24VDC, the pump connection and the other for the control signal. Unplug the three connectors.



3. Remove the (4) 6-32x3/8” screws that secure the board to the back panel.
4. Install a new pump controller board and secure with the (4) screws.
5. Plug connectors back into board.
6. Reinstall the upper and lower fronts panel and power unit on.

13.17 Touch Screen Replacement

If the touch screen needs replaced, perform the following:

The part number for the touch screen is TE-W-100 with the following related part numbers:

TE-W-106	32MB SD Card
TE-W-105	Cable from screen to controller
TE-W-207	USB interconnection cable
TE-W-216	3ft RJ45 patch cable

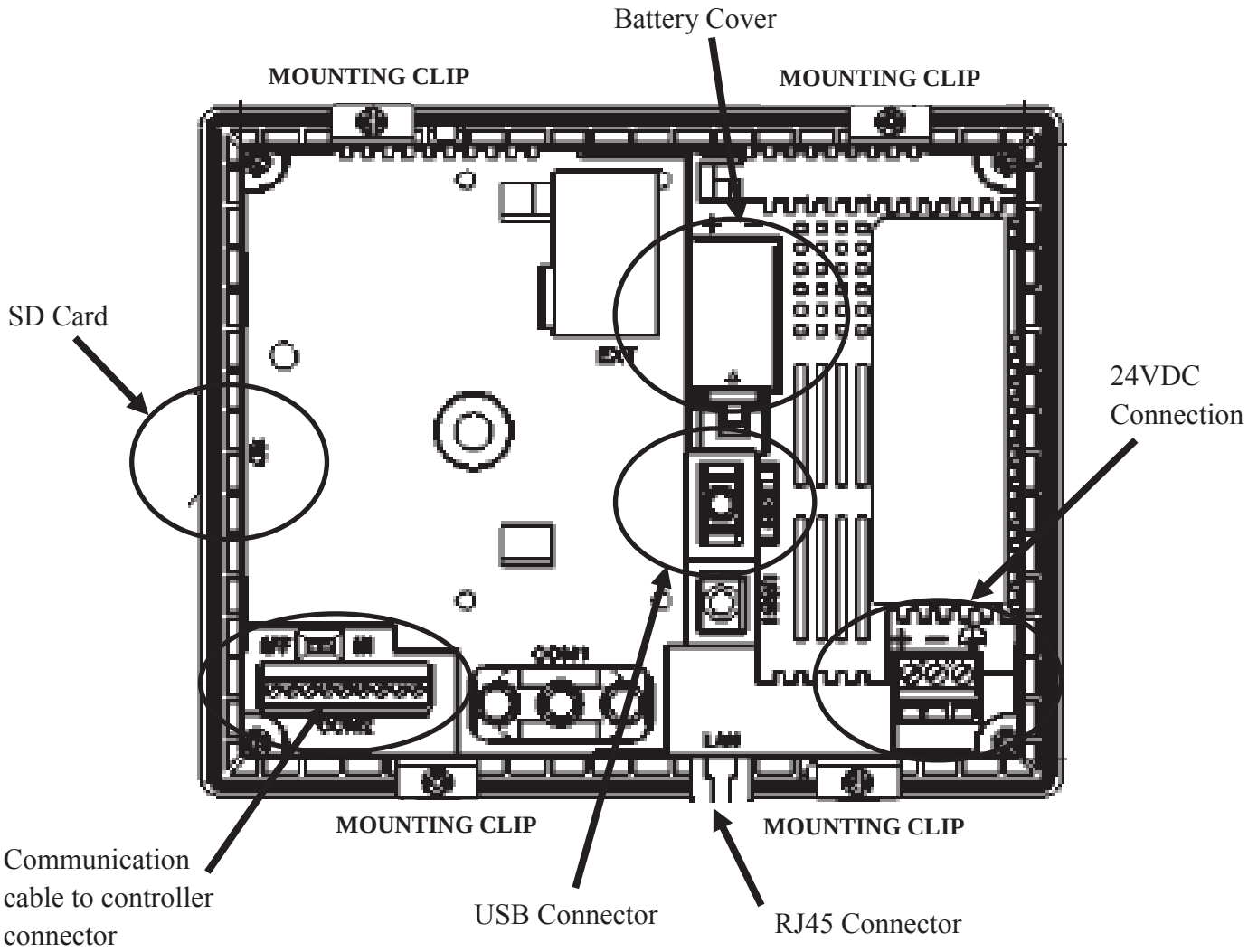
WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **BATTERY DISCONNECT**

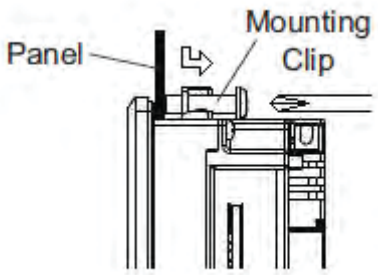
1. Remove both the upper and lower left plates using a Phillips screwdriver.
2. Turn the upper plate over and disconnect the following connectors on the screen:

   The 24VDC power to the screen
   The communication cable to the controller
   The Ethernet cable
   The USB interconnect cable

3. Remove the SD card from the side by pressing it in to eject, then pulling out completely.

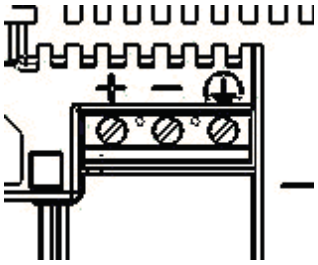


4. Using a Phillips screwdriver, unscrew the (4) mounting clips. There are two on the top and two on the bottom of the screen.



5. The mounting clips will snap out of the slots on the screen. Snap out all four of the mounting clips and pull the screen out of the upper front panel from the front.

6. Label the wires on the 24VDC power connection. Unscrew the terminal screws and remove the wires from the 24VDC connection along with the connector.



7. Install the 24VDC wires and connector onto the new screen by placing wires in their terminal and tightening the terminal screw.
8. Install new screen through the front of the panel and using the clips, secure to the panel.

NOTE: Do not over tighten the clips, otherwise the screen may warp and cause a wrinkle on the display. These need to be 0.2 to 0.3 N·m of torque.

9. Install the SD card on the side.
10. Connect the 24VDC power connector, communication cable to the controller, USB interconnect cable and Ethernet cable.
11. Reinstall the upper and lower front panels and power unit on.

13.18 Power Button Replacement

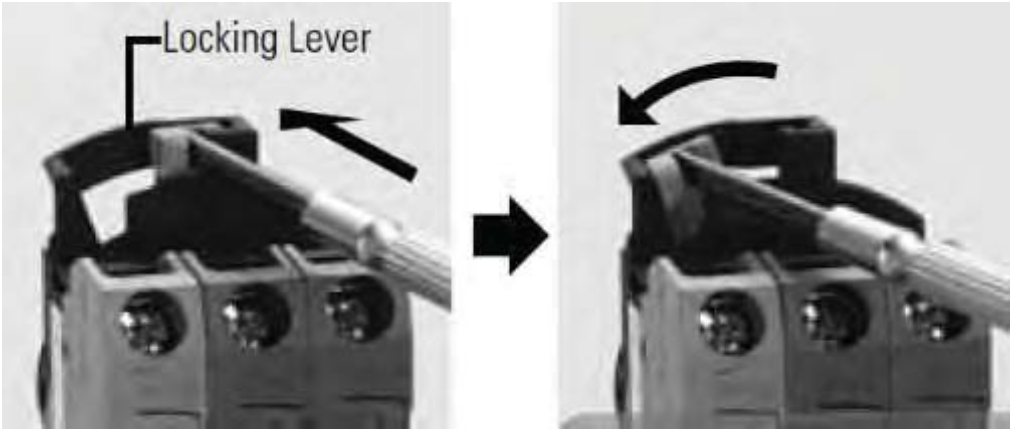
If the power button needs replaced, perform the following:

The part number for the power button is TE-W-206.

WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

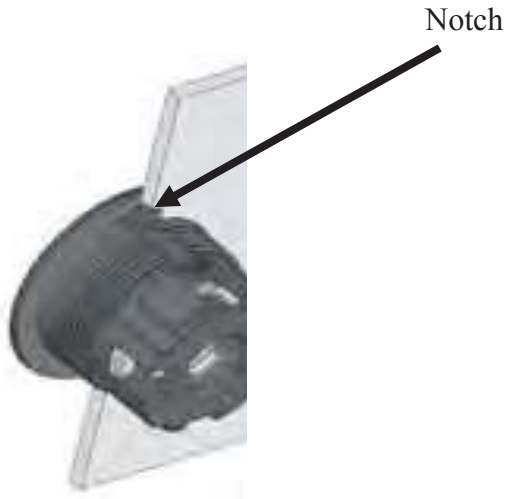
MAIN MENU	➔	MAINTENANCE MENU	➔	BATTERY DISCONNECT

1. Remove both the upper and lower left plates using a Phillips screwdriver.
2. Turn the front panel over and unplug the two connectors that are wired to the power button.
3. Notice the yellow locking lever on the back of the power button, turn this to the left to release the contact blocks from the LED portion of the button.



4. On the new pushbutton, remove the contact blocks from the pushbutton housing by performing the same step as above.
5. Remove each wire from the old terminal blocks and place into the new terminal blocks, ensuring each wire is terminated in the same identical terminal location.
6. Now remove the circular LED of the old pushbutton from the panel by using pliers to remove the locking ring and pulling the pushbutton housing out from the front.

7. Place the new pushbutton housing that you removed the contact blocks from in step 4 into the cutout in the panel, noting the notched hole in the cutout. The notch on the pushbutton must be seated into the notch in the panel cutout.



8. Screw on the new locking ring and tighten with pliers. Do not over-tighten as you could strip the plastic threads on the pushbutton.
9. Place the contact blocks onto the pushbutton housing and push the yellow locking lever all the way to the right until you hear and feel a 'click, locking the contact blocks onto the pushbutton housing.
10. Push the button on the pushbutton a few times ensuring proper operation of the switch.
11. Connect the two power in and out connectors.
12. Reinstall the upper and lower front panels and power unit on.

13.19 Power Fail Relay Replacement

If the power fail relay needs replaced, perform the following:

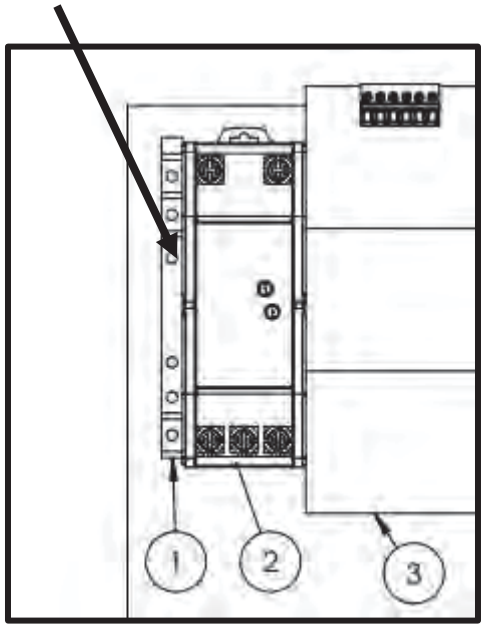
The part number for the power fail relay is TE-W-214.

WARNING – Before opening covers to perform maintenance, ensure unit is powered down completely. To power down completely, remove mains power and disconnect the battery at:

MAIN MENU → **MAINTENANCE MENU** → **BATTERY DISCONNECT**

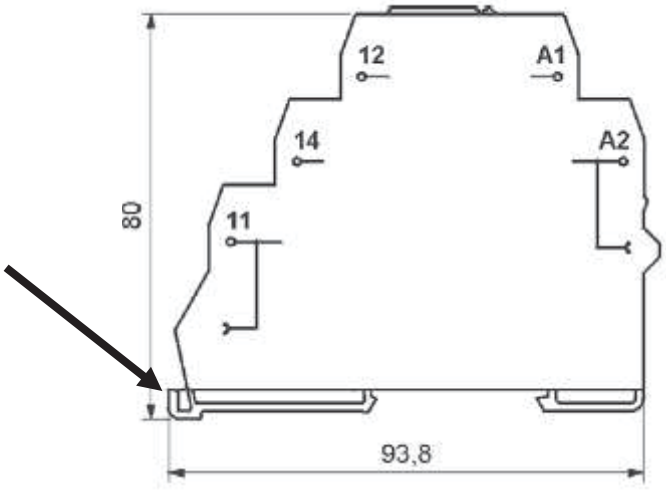
1. Remove both the upper and lower left plates using a Phillips screwdriver.

2. The power fail relay is located on the right side of the rear panel.

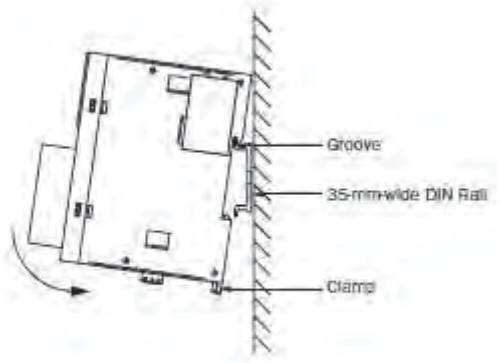


3. Mark the (4) wires that are located on the relay and remove them by pushing down on the slot with a small flat-head screwdriver – the terminals are spring-loaded, so push down and pull the wire out. Remove (4) wires from the power fail relay.

4. The relay can be removed from the DIN rail by placing a small flat-head screwdriver into the plastic slot at the bottom of the relay where it is attached to the DIN rail. Pull this outward and up, unlatching it from the DIN rail.



5. Install the new relay onto the DIN rail – it is installed in the same manner as the controller by placing the top part into the DIN rail groove and pushing down until a 'click' is heard and felt.



6. Reattach the wires by pushing down on the slot with a small flat-head screwdriver and pushing the wire into the terminal. The wiring diagram is as follows:

Terminal	Connection
A2	Neutral
A1	Hot
11	DC (-)
12	Controller TB1 Terminal 3

7. Reinstall the upper and lower front panels and power unit on.

13.20 Louver Filter Media Replacement

The filter media inside the louvers on the right side of the enclosure will need checked quarterly for buildup of dirt and debris.

The replacement part number for the louver filters are TE-W-232

To replace the louver filter media follow these steps:

1. Using a small flat-blade screwdriver, pry the corner of the louver from the louver housing.

2. The louver cover will snap out of the housing

3. Replace each of the filter louver filter media with new media.

4. Push the louver cover back onto the louver housing, snapping it into place.

14.0 Troubleshooting

This section explains methods to troubleshoot various conditions and alarms with the TE-Wilbur sampler.

WARNING – Maintenance should only be performed by trained individuals. This troubleshooting section assumes the person that is performing the troubleshooting steps is trained to recognize electrical hazards.

WARNING – Some troubleshooting techniques will require that mains power is ON while the front covers are removed. Only an electrically trained person should be performing these tasks and care should be taken to prevent electrical shock at all times.

14.1 Service Locations

For additional assistance, questions or technical support, please contact:

Tisch Environmental
145 South Miami Ave.
Cleves, OH 45002
513.467.9000
sales@tisch-env.com

Visit us on the web for product updates at www.tisch-env.com.

14.2 Electrical System

The electrical system is rated for 120/230VAC at 50/60Hz. The system is transitioned to 24VDC using a 60 watt power supply which in turn powers the system. AC Mains power is switched through the front green LED pushbutton switch. AC power is interrupted from a 1A pushbutton circuit breaker and DC power is interrupted from a 3A fuse.

Condition	Possible Cause	Possible Remedy
Unit will not power on	No AC Mains power	Using a voltage meter, check power on the cord and ensure cord is seated properly in the socket in the side box.

Condition	Possible Cause	Possible Remedy
		Open front cover, if green LED is not ON check voltage on black connector, if voltage is present, check operation of the pushbutton and ensure voltage to the purple connector when button is pressed, replace green LED pushbutton if not functioning properly. If voltage is not present on the black connector and mains power is plugged in, then check the 1A circuit breaker for proper operation.
	No DC power	Check DC operation – ensure AC mains power is present on L and N on the top of the power supply and DC(+) and DC(-) has 27VDC present. If DC power is present and the unit will not power on, check and replace the 3A fuse. If there is AC voltage present on the power supply and no DC voltage from the power supply, disconnect the DC(+) terminal and measure again. If still no voltage replace power supply. If after disconnecting the DC(+) wire and there is 27VDC on the DC(-) and DC(+) terminals, there is a short somewhere between the DC(+) and DC(-) terminals.
Sampler states 'mains power off' but unit is plugged into mains source	Power fail relay needs replaced	Ensure mains power is on and by following steps above. There is a green LED on the front of the relay that indicates the unit is powered. Check to ensure there is AC voltage on terminals A1 and A2 on the power fail relay. Check continuity on terminals 11 and 12. When power is off, these terminals should be closed and when power is on the terminals should be open. If power fail relay is operating properly, check the input to the PLC. The power fail relay is connected to input 3. When mains power is off the LED on the PLC for input 3 should be ON.

Condition	Possible Cause	Possible Remedy
UPS does not switch to battery during a power failure	UPS defective	Check voltage on DC(+) and DC(-) terminals on UPS, should be 27VDC. Check the battery (+) and (-) terminals, these should also be 27VDC. Disconnect battery pack and measure voltage from the battery pack. This should be 24VDC. Replace UPS.
System does not stay powered during loss of mains power	Battery pack needs replaced	Turn off mains power and measure the voltage on the Battery (+) and (-) terminals. This should be 24VDC. Ensure the battery pack is fully charged by leaving it plugged in for 24 hours. Ensure when mains power is on that the voltage on the Battery (+) and (-) terminals is 27VDC, this is necessary to properly charge the batteries. Replace battery pack.

14.3 Touchscreen Troubleshooting

The touchscreen is TE-Wilbur part number TE-W-100. The touchscreen is powered from the DC power supply and connects to the PLC via a communication cable. The screen has an internal SD card that is located on the left side when looking at the rear of the screen.

Condition	Possible Cause	Possible Remedy
No display	No DC power to screen	Check voltage on connector to the screen. Should be 27VDC. Check green LED on front of screen, should be ON when voltage is present. Replace screen.
Message stating battery	Internal battery	Replace internal battery.

low	needs replaced	
Condition	**Possible Cause**	**Possible Remedy**
Message stating Host communication lost	Communication to PLC has stopped	Check cable from the screen to the PLC and ensure it did not become unseated on both ends. Check to ensure the PLC is in run mode by observing the LED on the PLC. Update firmware of both screen and PLC. Replace screen and or PLC.
USB does not function	USB stick not working	Try a different make and model of USB stick. Check to ensure the USB interconnect cable is plugged into the screen and is seated into the socket. Update firmware of screen. Remove DC power from screen (reboot screen) by unplugging the screen power connector. Replace screen.
Graphics are missing on screen and logs are not working	SD Card is not functioning	The SD card is located on the left side as you are looking at the rear of the touchscreen. Ensure the SD card is seated properly by pushing in and pulling out. Replace SD card. Update firmware. Replace screen.

14.4 Flowmeter

The flowmeter is a TE-Wilbur part number TE-W-150. The flowmeter is a thermal mass type that is ranged 0-25 Lpm and provides a 4/20mA analog output to the PLC for flow indication. The flowmeter is powered from the DC power supply.

Condition	Possible Cause	Possible Remedy
No flow when pump is running or alarm that flowmeter is failed	Cable unplugged	Check the cable that connects to the flowmeter and ensure it is seated properly.
	Flowmeter failed	There is an indicator light on the top of the flowmeter that will blink green when flow is present and red when a failure occurs. Check that there is 27VDC on terminals 5(+) and 6(-) which is the power for the flowmeter. Remove the wire from terminal 4 (signal) and place a current meter that can measure mA signals in series from the wire to the terminal. When flow is traveling through the flowmeter there should be a proportional 4-20mA signal through this signal wire. If 4-20mA signal is present and working, then replace the analog card on the PLC. Replace flowmeter.
	No flow	Check all pneumatic connections to the flowmeter to ensure there is air flow through the flowmeter sensor. Replace flowmeter.

14.5 Barometric Pressure

The barometric pressure sensor is a TE-Wilbur part number TE-W-154. The barometric pressure sensor is a highly accurate sensor that is powered from the DC power supply and provides a 4/20mA signal proportional to the range of the barometric pressure. The range of the sensor is 450 to 1238 mmHg.

Condition	Possible Cause	Possible Remedy
Wrong or no reading of barometric pressure or alarm that sensor has failed	Sensor unplugged	Check the cable that connects to the barometric pressure sensor and ensure it is connected properly onto the terminal strip at the following terminal locations: White wire (signal) – Terminal 9 Black wire (Ground) – Terminal 10 Red wire (Supply) – Terminal 11
	No Voltage	Check to make sure there is 27VDC on terminals 11(+) and 10(-).
	Sensor or PLC input card failed	Remove the wire from terminal 9 (signal) and place a current meter that can measure mA signals in series from the wire to the terminal. At standard barometric pressure of 760mmHg the sensor should be outputting around 5mA. If 4-20mA signal is present and working, then replace the analog card on the PLC. Replace Barometric pressure sensor.

14.6 Temperature Sensors

The ambient temperature probe, part number TE-W-151, and the filter temperature probe, part number TE-W-152, are both the same types of probes so troubleshooting steps apply to both the ambient and filter temperatures. The probes are PT100 RTDs (Resistive Temperature Devices). When at 0ºC the resistance of the probe will be 100Ω and as temperature increases and decreases, the resistance of the probe will increase and decrease respectively. The probes are highly accurate when used for measuring ambient conditions and are very linear throughout their temperature range.

Condition	Possible Cause	Possible Remedy
No reading or alarm that sensor is unplugged or failed	Sensor unplugged	Ensure the connector for the probe is seated properly.
	Sensor failed	Measure the resistance on terminals 13 and 14 for the ambient temperature and 15 and 16 for the filter temperature. See the PT100 lookup table to verify the correct resistance versus temperature.

ºC Resistance of PT100 Temperature Sensor

-40	84.27	83.87	83.48	83.08	82.69	82.29	81.89	81.50	81.10	80.70	80.31	-40
-30	88.22	87.83	87.43	87.04	86.64	86.25	85.85	85.46	85.06	84.67	84.27	-30
-20	92.16	91.77	91.37	90.98	90.59	90.19	89.80	89.40	89.01	88.62	88.22	-20
-10	96.09	95.69	95.30	94.91	94.52	94.12	93.73	93.34	92.95	92.55	92.16	-10
0	100.00	99.61	99.22	98.83	98.44	98.04	97.65	97.26	96.87	96.48	96.09	0
0	100.00	100.39	100.78	101.17	101.56	101.95	102.34	102.73	103.12	103.51	103.90	0
10	103.90	104.29	104.68	105.07	105.46	105.85	106.24	106.63	107.02	107.40	107.79	10
20	107.79	108.18	108.57	108.96	109.35	109.73	110.12	110.51	110.90	111.29	111.67	20
30	111.67	112.06	112.45	112.83	113.22	113.61	114.00	114.38	114.77	115.15	115.54	30
40	115.54	115.93	116.31	116.70	117.08	117.47	117.86	118.24	118.63	119.01	119.40	40

Condition	Possible Cause	Possible Remedy
	Sensor failed	If resistance does not match within 10% replace the sensor. If resistance is correct, but the temperature is still not reading correctly or there is still an alarm for sensor unplugged or failed, replace the PLC analog input/output card.

14.7 Pump system

The pump is a TE-Wilbur part number TE-W-300 with the TE-W-301 pump controller circuit board. The pump is a brushless 24VDC motor with a diaphragm-type pump. The pump is controlled via a pump controller circuit board located inside on the back panel. The pump controller takes a voltage input from the PLC output card that is ranged 1-5 VDC from zero speed to full speed. The pump controller board is also powered from the 24VDC supply.

Condition	Possible Cause	Possible Remedy
Pump will not start	Cable unplugged	Ensure all the connectors on the pump controller are seated properly.
	Controller board pump or analog output card failed	Measure voltage on the 24VDC terminals, should be 27VDC. See Section 12 for diagram of the controller board. Put the pump in manual by selecting on the screen <Maintenance> <Manual Control> and select to run the pump in manual control. Ramp up the pump speed to about 50%. Measure the voltage on the control signal connector – it should be a 2-3VDC. If no voltage is present when in manual mode check all wiring to the PLC card. Replace the PLC analog output card. Make sure the pump cable is seated properly and is in the terminal correctly. Remove and seat again. Try replacing the pump if all signals to the board are working. Replace the controller board if you have 27VDC on the power connection and the PLC is giving a correct output control signal and you have replaced the pump.

14.8 Pressure Sensor

The vacuum pressure sensor is a TE-Wilbur part number TE-W-153. The vacuum pressure sensor used in the TE-Wilbur sampler is ranged 0-15psia vacuum and provides a 4/20mA signal based on vacuum pressure.

Condition	Possible Cause	Possible Remedy
Pressure sensor alarm, cable unplugged or failed	Cable unplugged	Ensure the connector for the pressure sensor is plugged in and seated properly.
	Sensor failed	Ensure there is 27VDC on terminal 7 to DC ground which is the pressure sensor supply voltage.
	PLC input card failed	Using an amp-meter capable of measuring mA disconnect the wire on terminal 8 and place one probe on terminal 8 and one probe on the wire from the pressure sensor you just removed. At no pressure you should have a pressure reading between 4-5mA. If you have no mA reading, replace the pressure sensor. If you have a 4-5mA reading with no pressure you can pressurize the sensor by running the pump in manual mode and restricting the flow. As you restrict the flow you should see the mA output climb. If the mA output is working and the alarm still exists or it is still not reading correctly, replace the analog input card.

14.9 Solenoid

The solenoid is a TE-Wilbur part number TE-W-212.

Condition	Possible Cause	Possible Remedy
Solenoid does not activate during leak check	Ensure pressure is working properly	The solenoid will turn on (Close) when the system pressure exceeds 50" H_2O during a leak check.
	Solenoid failed	Take a jumper wire and place one end on 24VDC and the other end on terminal 3. The solenoid should come on and you should hear a 'click' from the valve closing. If the solenoid does not come on check the wiring. Replace solenoid.
	PLC failed	If solenoid does come on when placing the jumper on terminal 3, check the wiring to the PLC card (outputs right side). When solenoid is supposed to be ON from a leak check being performed and the pressure being greater than 50" the LED for output 4 should be on. Replace PLC card.

14.10 Exhaust Fan

The exhaust fan is a TE-Wilbur part number TE-W-203

Condition	Possible Cause	Possible Remedy
Exhaust fan does not come on when temperature variance is 3 Deg C	Temperature sensor failed	The fan will come on and run for 30 seconds when the temperature variance between ambient and the filter temperature exceeds 3 Deg C. Calibrate the ambient temperature to a false value to achieve a temperature variance of more than 3 degrees to check fan operation.
	Fan failed	Take a jumper wire and place one end on 24VDC and the other end on terminal 2. The fan should come on. Check for 27VDC on the connector to the fan. If the fan does not come on check the wiring. Replace fan.

	PLC failed	If the fan does come on when placing the jumper on terminal 3, check the wiring to the PLC card (outputs right side). When the fan is supposed to be ON the LED for output 4 should be on. Replace PLC card.

14.11 Lighting Strip

The LED lighting strip is TE-Wilbur part number TE-W-59-R for the right side of the enclosure and TE-W-59-L for the left side of the enclosure.

Condition	Possible Cause	Possible Remedy
LED Lights do not come on when button is pressed	LED Lighting failed	Take a jumper wire and place one end on 24VDC and the other end on terminal 1. The lighting strips should come on. Check for 27VDC on the connector to each lighting strip. If the LED lighting strip(s) do not come on check the wiring. Replace lighting strip(s).
	PLC failed	If the LED lighting strips do come on when placing the jumper on terminal 1, check the wiring to the PLC card (outputs right side). When the lighting strip(s) are turned on, the LED for output 3 should be on. Replace PLC card.

14.12 Solar / Alternative Energy

For help with troubleshooting issues with the solar / alternative energy options see section 12.0 Solar and Alternative Energy.

14.13 Communications

For help with troubleshooting communication issues with the TE-Wilbur sampler, see section 15.0 Communications.

15.0 Communications

This section outlines the communication options, configuration and operation available with the TE-Wilbur sampler.

15.1 Introduction

The TE-Wilbur has a built-in RJ-45 Ethernet connection that allows for remote access of the system, a web browser interface and the ability to download data remotely. Also, the TE-Wilbur sampler has a Modbus slave port that allows connection to a telemetry system for remote data logging and viewing and connection to the Tisch Environmental FRM-CAL Calibrator.

15.2 Ethernet Connection

The TE-Wilbur sampler has a standard RJ-45 Ethernet connection that is located in the weatherproof box on the side. This connection is routed through to the touchscreen where the connection is made.

If connection of the sampler is made to a switch, then a standard RJ45 CAT5/6 patch cable can be used.

If connecting this port directly to a PC an RJ45 CAT5/6 crossover cable must be used.

The system is set for a default IP address as follows:

IP Address 192.168.1.123
Subnet Mask 255.255.255.0
No gateway is set

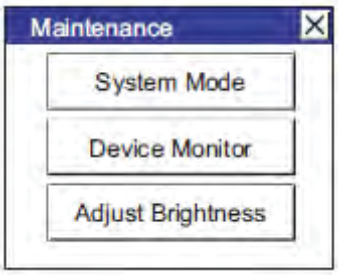
In order to connect to the sampler via the Ethernet port your PC must also be set to the same subnet, for example:

IP Address 192.168.1.124 (notice the IPs cannot be the same)
Subnet Mask 255.255.255.0

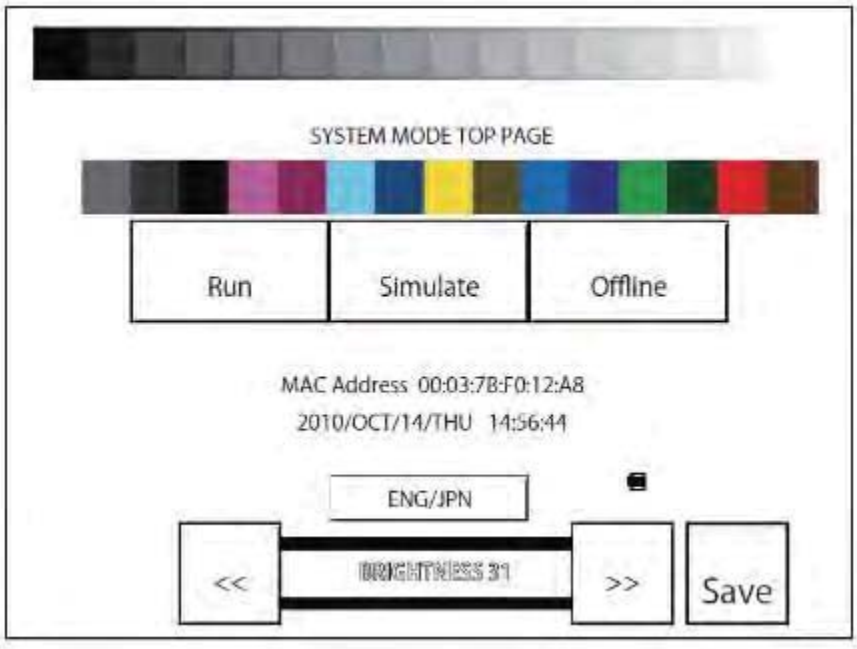
In this example the subnet is ‘192.168.1’ and any addresses from 1 to 255 can be used except the ‘.123’ that is being used by the sampler.

To change the IP address / Subnet of the sampler perform the following steps:

Press and hold the top right corner of the touchscreen to enter Maintenance mode and the following screen will appear:



Press system mode to enter the internal setup of the touch screen and the following screen will appear. Press Offline.



NOTE: Care must be taken when entering the Maintenance Mode of the touch screen. Failure could result if the wrong keys are pressed.

Now press the following menu buttons:

INITIAL SETTING ➔ **COMMUNICATION I/F** ➔ **ETHERNET IP ADDRESS**

Use the keypad to enter the desired IP address and subnet mask. Press the enter button to apply the entered values.

Press Exit to return, then at the Main Menu, press the RUN button to start the system and return to the sampler's operation screens.

15.3 Webserver Functions

To access the webserver functions, the sampler must be hooked up to a network and configured for the correct subnet.

Using a standard browser that supports frames (IE 8.0 and higher is recommended or Google chrome) open a new browser window and type the following in the address bar:

http://192.168.1.123/

Where 192.168.1.123 is the touchscreen's IP address, if this address has changed, then you must type the new address in the address bar.

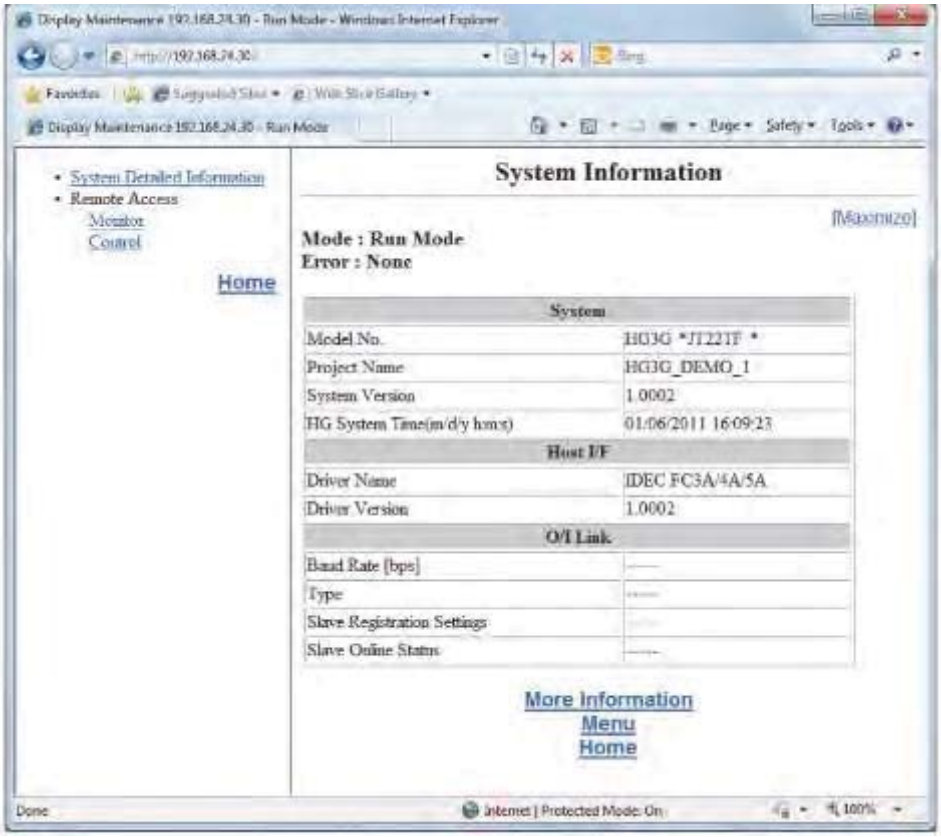
A security window will appear to enter a username and password:

Username: Wilbur
Password: *'blank'*

The user name is 'Wilbur' which is case sensitive so the capital 'W' must be used in the username field.

Leave the password field empty, there is no password.

The following screen will appear:



On the left window pane the following options are available:

Monitor — Will show the same screen the touchscreen is showing. Does not allow for remote control, just monitoring only.

Control — Will allow the touchscreen to be controlled from the web browser window.

15.4 Remote Data Upload

The TE-Wilbur sampler allows for remote uploading of the data log and history log using a software tool called Downloader which is produced and supported by IDEC Corporation.

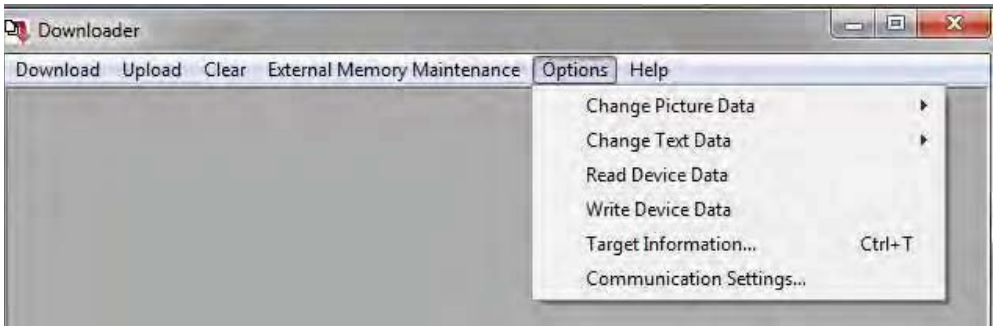
The downloader tool can be found and downloaded at this address:

http://www.idec.com/caen/products/Catalogs/Software/WindOI_NV2/document.html

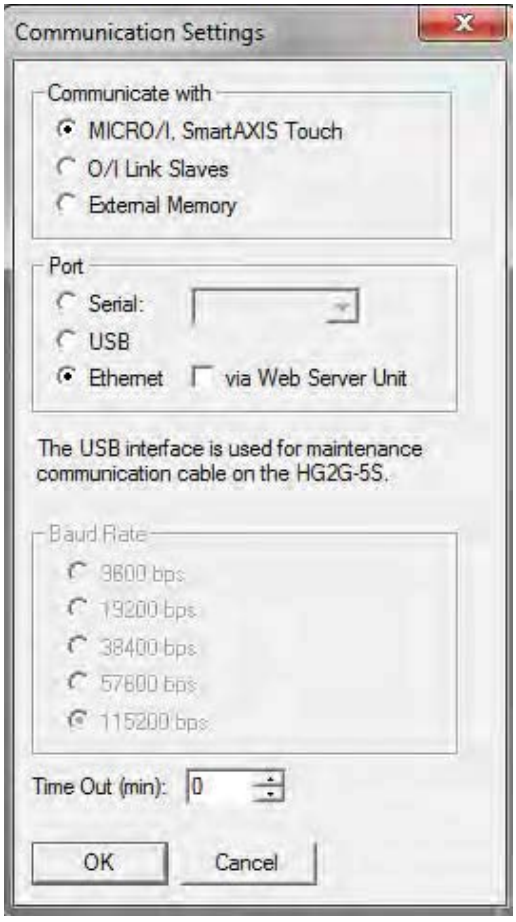
NOTE: The downloader tool can cause unrecoverable loss of data and can render the system disabled if the wrong functions are performed.

After installation of the downloader tool, click on the icon and launch the program.

Click on Options and select 'Communication Settings…'

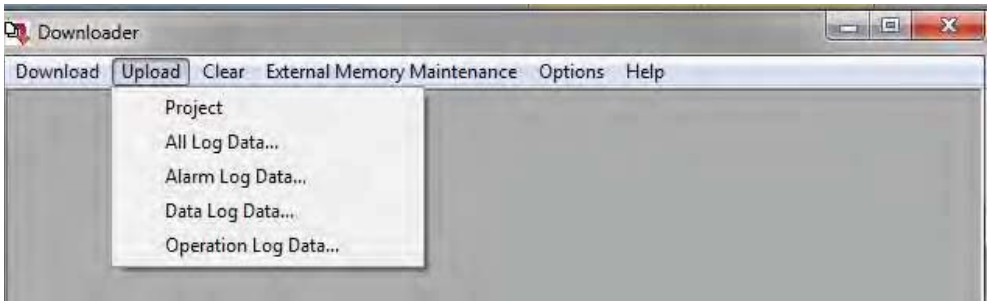


The following window will open. Select to communicate with a MICRO/I and set the port to Ethernet.



To upload the data log or history log to your PC perform the following:

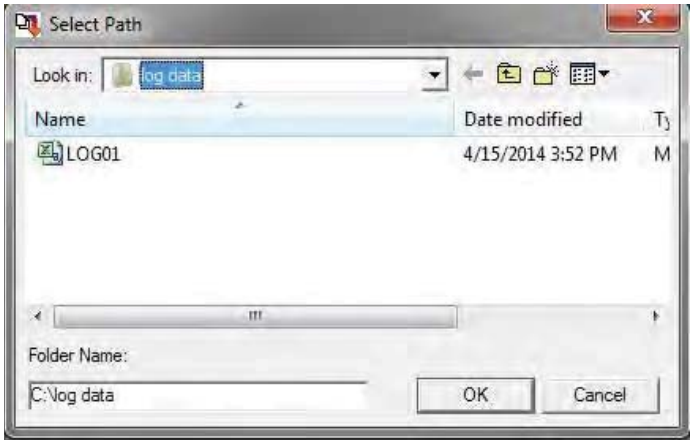
Click on Upload



Then click:

All Log Data	To download all logs
Data Log Data	To download the data log or run summary log
Alarm Log Data	To download the history log

The software will then ask for a path to save the data, select a path and click OK to save the file.



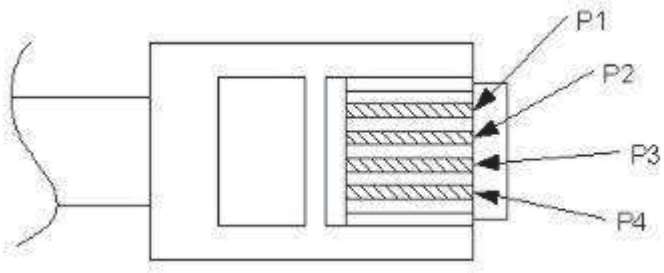
15.5 MODBUS Configuration

The TE-Wilbur MODBUS port is located on the side box and is configured as an RS485 RJ-11 plug. The communication parameters for MODBUS are configured as follows:

Modbus Serial Protocol – RS485 SLAVE

Baud Rate (bps)	9600
Data Bits	8
Parity	Even
Stop Bits	1
Slave Number	1 (default)

The cable needed for connection to the Modbus is a Tisch Environmental part number TE-W-217 and has the following RS-485 pin connections:

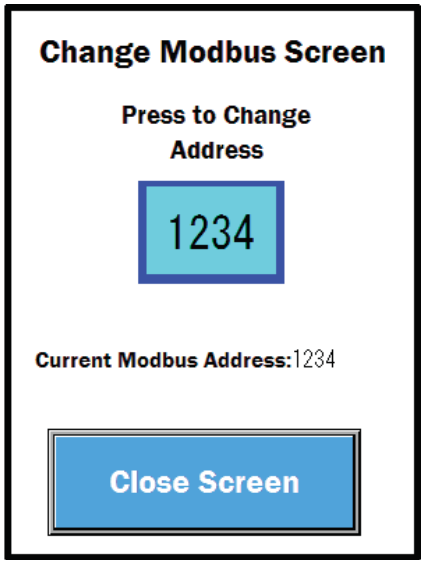


P1	A(+)
P2	Not Used
P3	Not Used
P4	B(-)

The Slave address of the sampler can be set by following these keystrokes:

MAIN MENU ➔ **MAINTENANCE MENU** ➔ **MORE MAINTENANCE MENU** ➔ **CHANGE MODBUS ADDRESS**

Change MODBUS Screen



The MODBUS valid addresses are 1 thru 1000

15.6 MODBUS Data Map

The following MODBUS Data registers are used:

MODBUS Address	Comm Frame	Data Type	TE-Wilbur Internal Address	Description
413001	32C8	Float32	D13000	30 second Average Volumetric Flow
413003	32CA	Float32	D13002	30 second Max Volumetric Flow
413005	32CC	Float32	D13004	30 second Min Volumetric Flow
413007	32CE	Float32	D13006	30 second Average Baro Pressure
413009	32D0	Float32	D13008	30 second Max Baro Pressure
413011	32D2	Float32	D13010	30 second Min Baro Pressure
413013	32D4	Float32	D13012	30 second Average Filter Temp
413015	32D6	Float32	D13014	30 second Max Filter Temp
413017	32D8	Float32	D13016	30 second Min Filter Temp
413019	32DA	Float32	D13018	30 second Average Ambient Temperature
413021	32DC	Float32	D13020	30 second Max Ambient Temperature
413023	32DE	Float32	D13022	30 second Min Ambient Temperature
413025	32E0	Float32	D13024	30 second Average System Pressure
413027	32E2	Float32	D13026	30 second Max System Pressure
413029	32E4	Float32	D13028	30 second Min System Pressure
413031	32E6	Float32	D13030	Data Log Average Volumetric Flow
413033	32E8	Float32	D13032	Data Log Max Volumetric Flow
413035	32EA	Float32	D13034	Data Log Min Volumetric Flow
413037	32EC	Float32	D13036	Data Log Average Baro Pressure
413039	32EE	Float32	D13038	Data Log Max Baro Pressure
413041	32F0	Float32	D13040	Data Log Min Baro Pressure
413043	32F2	Float32	D13042	Data Log Average Filter Temp
413045	32F4	Float32	D13044	Data Log Max Filter Temp
413047	32F6	Float32	D13046	Data Log Min Filter Temp
413049	32F8	Float32	D13048	Data Log Average Ambient Temperature
413051	32FA	Float32	D13050	Data Log Max Ambient Temperature
413053	32FC	Float32	D13052	Data Log Min Ambient Temperature
413055	32FE	Float32	D13054	Data Log Average System Pressure
413057	3300	Float32	D13056	Data Log Max System Pressure
413059	3302	Float32	D13058	Data Log Min System Pressure
413061	3304	Float32	D13060	Data Log Average Temp Variance
413063	3306	Float32	D13062	Data Log Max Temp Variance
413065	3308	Float32	D13064	Data Log Min Temp Variance
413067	330A	Float32	D13066	Flow total

MODBUS Address	Comm Frame	Data Type	TE-Wilbur Internal Address	Description
413069	330C	Float32	D13068	Flow CV
413071	330E	Float32	D13070	Sample Time
413073	3310	BIN32	D13072	Filter ID
413075	3312	BIN32	D13074	Site ID
413077	3314	BIN32	D13076	Serial Number
413079	3316	Float32	D13078	Instantaneous Flow Reading
413081	3318	Float32	D13080	Instantaneous Baro Pressure Reading
413083	331A	Float32	D13082	Instantaneous Filter Temp Reading
413085	331C	Float32	D13084	Instantaneous Ambient Temp Reading
413087	331E	Float32	D13086	Instantaneous System Pressure Reading
002604	0A2B	Binary	M2003	10% Flow Variance Alarm
002606	0A2D	Binary	M2005	High Pressure Alarm
002616	0A37	Binary	M2017	5% Flow Variance Alarm
002617	0A37	Binary	M2020	Sample time <23 or >25 hours
002612	0A33	Binary	M2013	Ambient Temperature Failure
002613	0A343	Binary	M2014	Filter Temperature Failure
002609	0A30	Binary	M2010	Flowmeter Failure
002611	0A32	Binary	M2012	Barometric Pressure Failure
002610	0A31	Binary	M2011	Pressure Sensor Failure
002627	0A42	Binary	M2032	Temperature Variance Alarm
002628	0A43	Binary	M2033	Sample Warning Alarm
002630	0A45	Binary	M2035	Battery Discharge Alarm
002631	0A46	Binary	M2036	Battery Failure Alarm
001512	05E7	Binary	M0637	Shut Down Sample Alarm
001529	05F8	Binary	M0660	Screen Battery Failure
001652	0673	Binary	M0813	Power Fail
001772	06EB	Binary	M0963	Mains Power Lost
001497	05D8	Binary	M0620	Custom Sample Set
001501	05DC	Binary	M0624	1 in 3 Sample Set
001502	05DD	Binary	M0625	1 in 6 Sample Set
001503	05DE	Binary	M0626	1 in 12 Sample Set
001500	05DB	Binary	M0623	Sample Running

Appendix A: Parts List

Appendix A is a complete parts listing of the TE-Wilbur sampler, accessories and optional equipment.

A.1 Parts List

The TE-Wilbur can be ordered with (3) configurations for the collection of particulate matter.

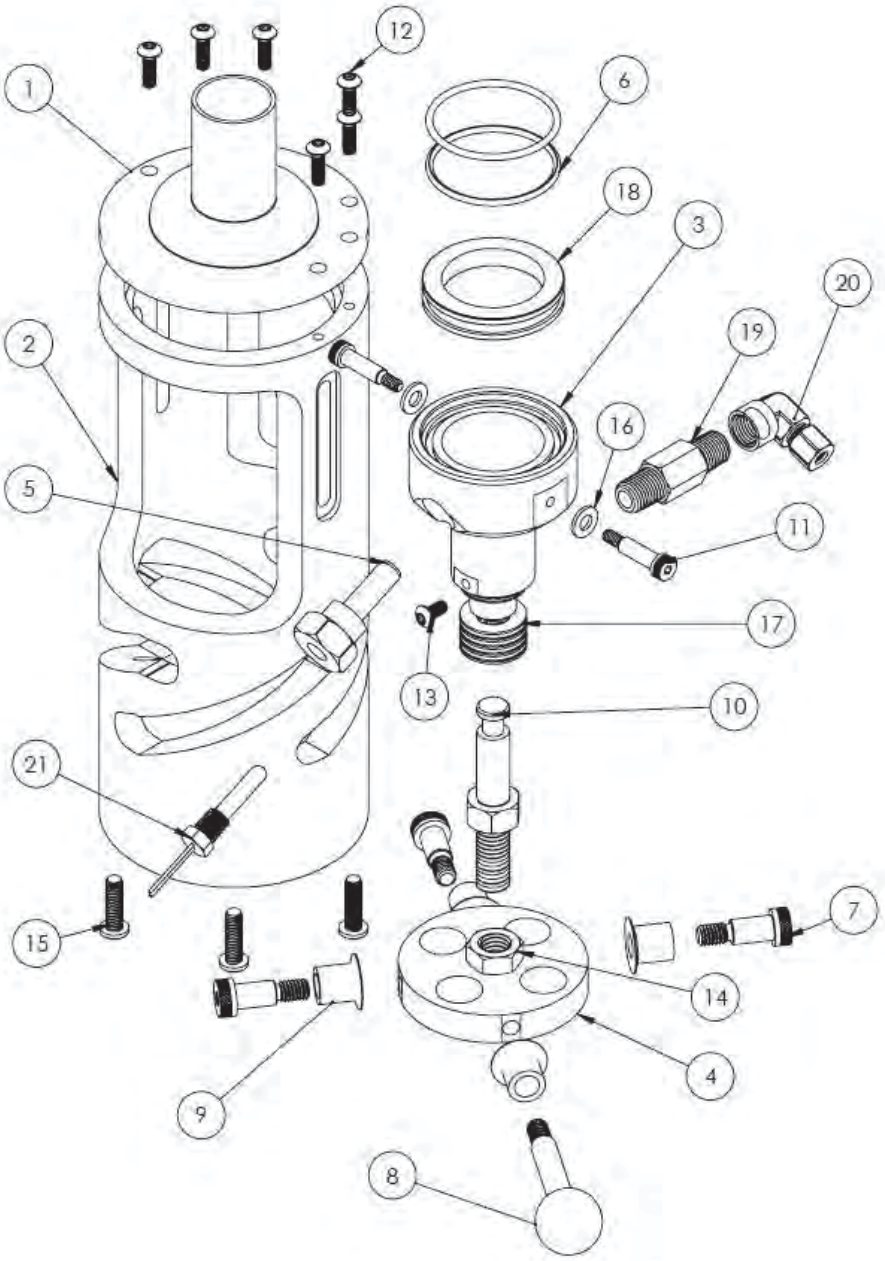
TE-Wilbur10	Includes the TE-PM10 10µm collection head.
TE-Wilbur2.5	Includes the TE-PM10 10µm collection head and the TE-PM2.5C $PM_{2.5}$ cyclone fractionator.
TE-WilburTSP	Includes the TE-TSP collection head.
TE-FRM-CAL	Advanced automatic calibrator for the TE-Wilbur air sampling platform

Part Number	Description
TE-PM-10	PM_{10} 10µ collection head
TE-PM2.5C	$PM_{2.5}$ cyclone fractionator
TE-W-STAND	TE-Wilbur stand (complete)
TE-FH	TE-Wilbur Filter Holder (complete)
TE-FH47	Filter cassette top, bottom with screen
TE-W-001	Inlet downtube
TE-W-002	Downtube adapter (black delrin) w/ o-rings
TE-W-003	Silicone gasket for downtube adapter
TE-W-004	Internal leak check disk (solid black disk)
TE-W-005	TE-Wilbur instruction manual
TE-W-050	TE-Wilbur enclosure (complete)
TE-W-051	Left internal side plate with opening
TE-W-052	Left back mounting plate
TE-W-053	Battery case
TE-W-054	Side box connection internal plate

Part Number	Description
TE-W-055	Filter holder mounting plate
TE-W-056	Pump mounting plate
TE-W-057	Left touch screen panel
TE-W-058	Left, bottom plate
TE-W-059L	LED strip 10” long with wires
TE-W-059R	LED strip 8” long with wires
TE-W-060	(4) Rubber feet
TE-W-061	Black Polycarbonate Handle
TE-W-100	Main color touchscreen
TE-W-101	Main controller module
TE-W-102	Analog input card
TE-W-103	Analog input / output card
TE-W-104	Modbus communication module
TE-W-105	Screen to controller communication cable
TE-W-106	32M SD Card for touchscreen
TE-W-107	USB stick for touchscreen
TE-W-150	Thermal mass flowmeter 0-25 Lpm range
TE-W-151	Ambient temperature RTD with radiation shield
TE-W-152	Filter temperature RTD
TE-W-153	Vacuum pressure sensor
TE-W-154	Barometric pressure sensor
TE-W-200	TE-Wilbur 24VDC Battery Pack
TE-W-201	UPS Module
TE-W-202	24VDC 60 watt power supply
TE-W-203	24VDC Enclosure fan
TE-W-204	Fan guard
TE-W-205	Enclosure louvers
TE-W-206	Power button with green LED

Part Number	Description
TE-W-207	USB interconnection cable
TE-W-208	24VDC Main fuse
TE-W-209	Power cord with US end to IEC320 connection
TE-W-210	AC inlet socket
TE-W-211	Ethernet connector for side box
TE-W-212	24VDC Solenoid
TE-W-213	Side box for external connections
TE-W-214	Power fail relay
TE-W-215	3.3V Lithium Ion battery for screen
TE-W-216	Ethernet patch cable
TE-W-217	Modbus connector for side box
TE-W-223	1Amp Mains Pushbutton Circuit Breaker
TE-W-300	Brushless 24VDC pump
TE-W-301	Pump control circuit board
TE-W-302	Cable for pump control board
TE-W-303	Pump rebuild kit
TE-W-304	Pump muffler 1/8” NPT
TE-W-F01	Pump suction fitting – pushfit 3/8 tube
TE-W-F02	Solenoid to pump connection pushfit 3/8 tube
TE-W-F03	Solenoid fitting to flowmeter 1/4 compression
TE-W-F04	Flowmeter fittings 1/4 compression
TE-W-F05	Pressure sensor tee
TE-W-F06	1/4 OD polyurethane tubing
TE-W-F07	3/8 OD PUR tubing

A.2 Filter Holder Parts List



Number	Part Number	Description
1	TE-W-FH1	Top mate
2	TE-W-FH2	Helix Lever Base
3	TE-W-FH3	Bottom mate
4	TE-W-FH4	Cam lever plate
5	TE-W-FH5	Thermowell
6	TE-W-FH6	Bottom and top mate o-rings (Qty 2)
7	TE-W-FH7	5/16-18 shoulder bolt (Qty 3)
8	TE-W-FH8	Lever handle with ball (stainless steel)
9	TE-W-FH9	Cam bushing (Qty 4)
10	TE-W-FH10	Drive rod
11	TE-W-FH11	10-24 shoulder bolt (Qty 2)
12	TE-W-FH12	10-32 socket cap screw (Qty 6)
13	TE-W-FH13	Set screw
14	TE-W-FH14	Drive rod nut
15	TE-W-FH15	1/4-20 mounting bolts (Qty 4)
16	TE-W-FH16	PTFE washer (Qty 2)
17	TE-W-FH17	Belleville washers (Qty 10)
18	TE-FH47	Filter Cassette
19	TE-W-FH19	Filter holder hex nipple
20	TE-W-FH20	Compression fitting elbow
21	TE-W-152	PT100 RTD Filter Holder Temperature Probe

A.3 Optional Accessories

Part Number	Description
TE-W-500	Filter Cassette Separator tool
TE-W-501	Modbus cable – RJ9 2-wire 25’ long
TE-W-502	External 24VDC connection cable 25’ long
TE-W-503	Ethernet cable RJ45 25’ long

A.4 Solar Option Parts List

Part Number	Description
TE-W-600	Solar control system panel complete w/o Batteries
TE-W-601	Solar controller
TE-W-602	250 watt 24VDC Solar panel
TE-W-603	MC cables 10’ long
TE-W-606	Solar Mounting Kit
TE-W-608	External connection cable 25’ long

A.5 O-Ring Replacement Part Numbers

PM_{10} Head replacement o-rings P/N: TE-W-020 for complete kit

Quantity	Description	Part Number
2	Exit Adapter O-Rings	TE-W-022
1	Impactor Nozzle O-Ring	TE-W-023
2	Downtube O-Rings	TE-W-021

TE-PM2.5C replacement o-rings P/N: TE-W-030 for complete kit

Quantity	Description	Part Number
2	Exit Nozzle O-Rings	TE-W-031
1	Collector Cup O-Ring	TE-W-032
1	Threaded Insert O-Ring	TE-W-033
4	Connector tube O-Rings	TE-W-034
2	Stainless bolt O-Rings	TE-W-035

Appendix B: Drawings

Appendix B includes detailed drawings on the TE-Wilbur sampler.

B.1 Electrical Terminal TB1 connections

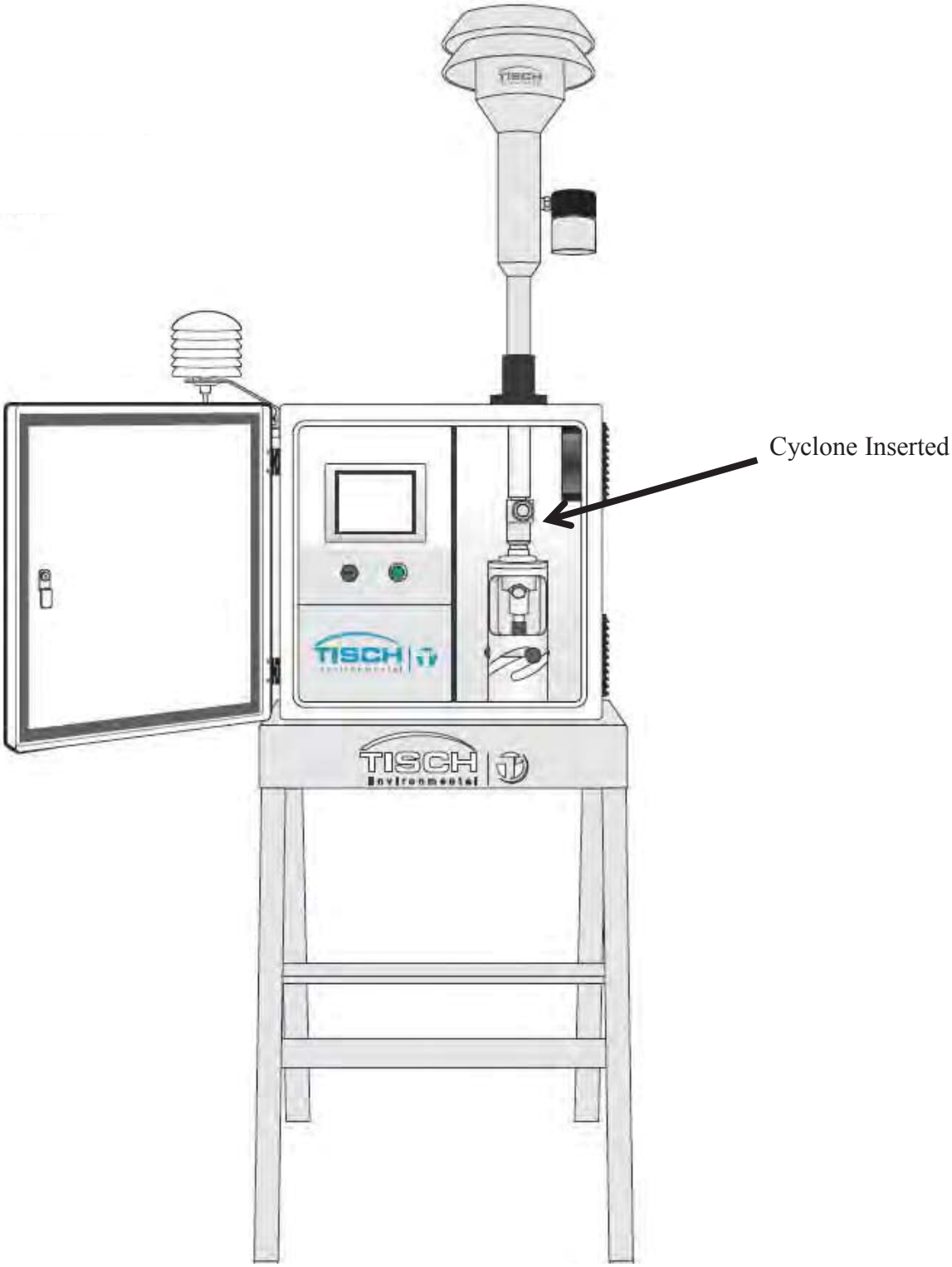
Terminal Number	Description
1	(+) terminal for LED lighting strips Blue/Green wire
2	(+) terminal for ventilation fan Brown wire
3	(+) terminal for solenoid valve
4	black wire – (+) signal output from flowmeter
5	brown wire – (+) supply voltage to flowmeter
6	blue wire – (-) supply voltage to flowmeter
7	(+) Supply and signal to pressure sensor
8	(-) supply and signal to pressure sensor
9	white wire – (+) signal from barometric pressure sensor
10	black wire – (-) supply to barometric pressure sensor
11	red wire – (+) supply to barometric pressure sensor
12	(+) signal for pump speed control
13	(-) signal for pump speed control
14	ambient temperature connection (no polarity)
15	ambient temperature connection (no polarity)
16	filter temperature connection (no polarity)
17	filter temperature connection (no polarity)
18	(+) connection for battery pack
19	(-) connection for battery pack

B.2 TE-Wilbur Drawings

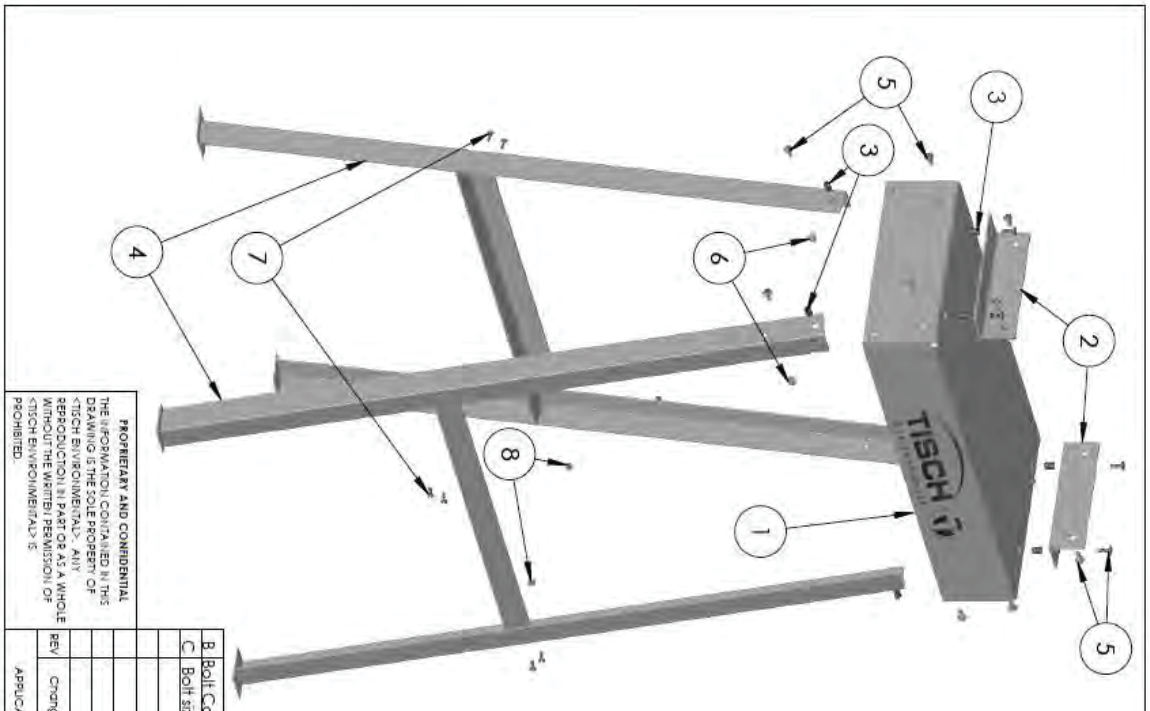
Illustration of sampler with enclosure shut

Illustration of sampler setup for PM_{10} collection

Illustration showing sampler setup for $PM_{2.5}$ collection



B.3 Enclosure Stand Drawing



ITEM NO.	PART NUMBER	QTY.
1	TischHolderStand041214	1
2	TischHolderStandBoxMountAngles	2
3	1/4-20 Nut Inserts	8
4	TischHolderStandLegAssembly	2
5	1/4-20 X 1 Screw	16
6	1/4-20 Nylon Nut	4
7	# 10-32 x 1/2 Screw	8
8	#10-32 Nylon Nut	8

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B Bolt Config
C Bolt sizes

REV	change	APPLICATION

DO NOT SCALE DRAWING

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± 1 BEND ±1
TWO PLACE DECIMAL ±.010
THREE PLACE DECIMAL ±.005

MATERIAL: ALUMINUM per Tisch
FINISH: --
COMMENTS:

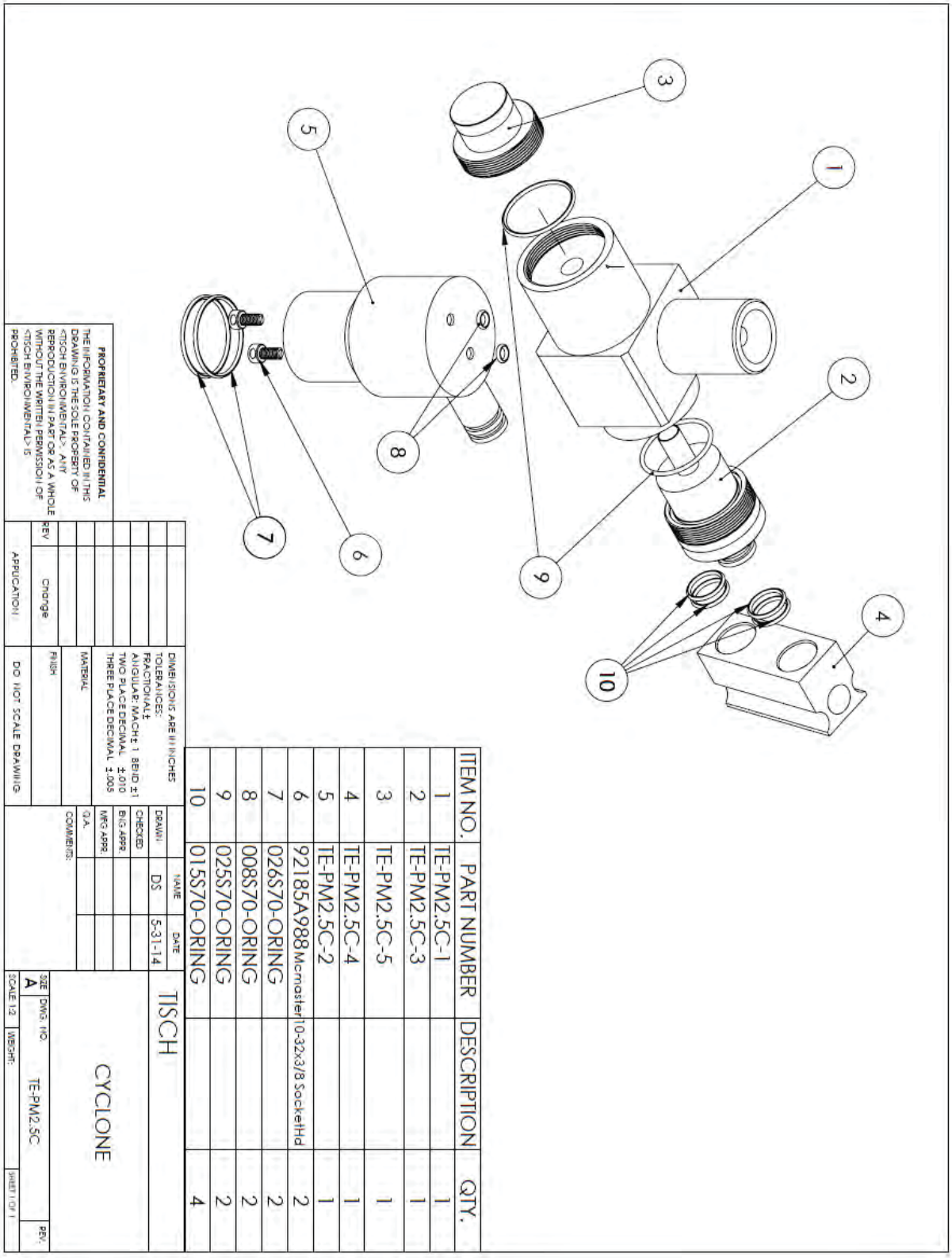
	NAME	DATE
DRAWN	DS	9-15-14
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

TISCH

STAND ASSEMBLY

SIZE A | DWG. NO. TischHolderStandAssemblyOpen | REV. C
SCALE:1/8 | WEIGHT: | SHEET 1 OF 1

B.4 TE-PM2.5C Drawing



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	TE-PM2.5C-1		1
2	TE-PM2.5C-3		1
3	TE-PM2.5C-5		1
4	TE-PM2.5C-4		1
5	TE-PM2.5C-2		1
6	92185A988 Mcmaster	10-32x3/8 SocketHd	2
7	026S70-ORING		2
8	008S70-ORING		2
9	025S70-ORING		2
10	015S70-ORING		4

CYCLONE

TISCH

TE-PM2.5C

SIZE A | DWG. NO. | REV.

SCALE 1:2 | WEIGHT: | SHEET 1 OF 1

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± 1 BEND ±1
TWO PLACE DECIMAL ±.010
THREE PLACE DECIMAL ±.005
MATERIAL
FINISH
DO NOT SCALE DRAWING
COMMENTS:

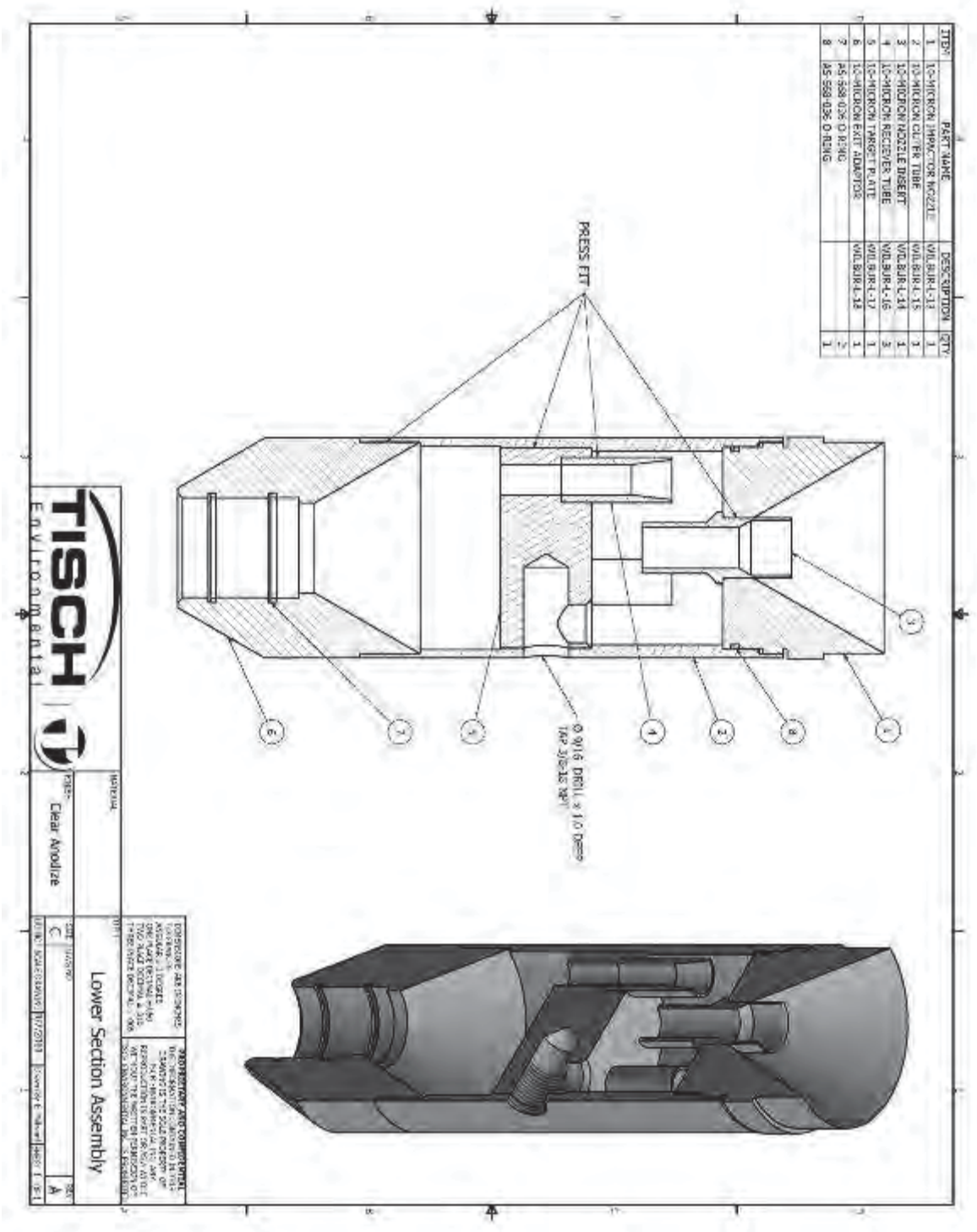
	NAME	DATE
DRAWN	DS	5-31-14
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

APPLICATION | REV

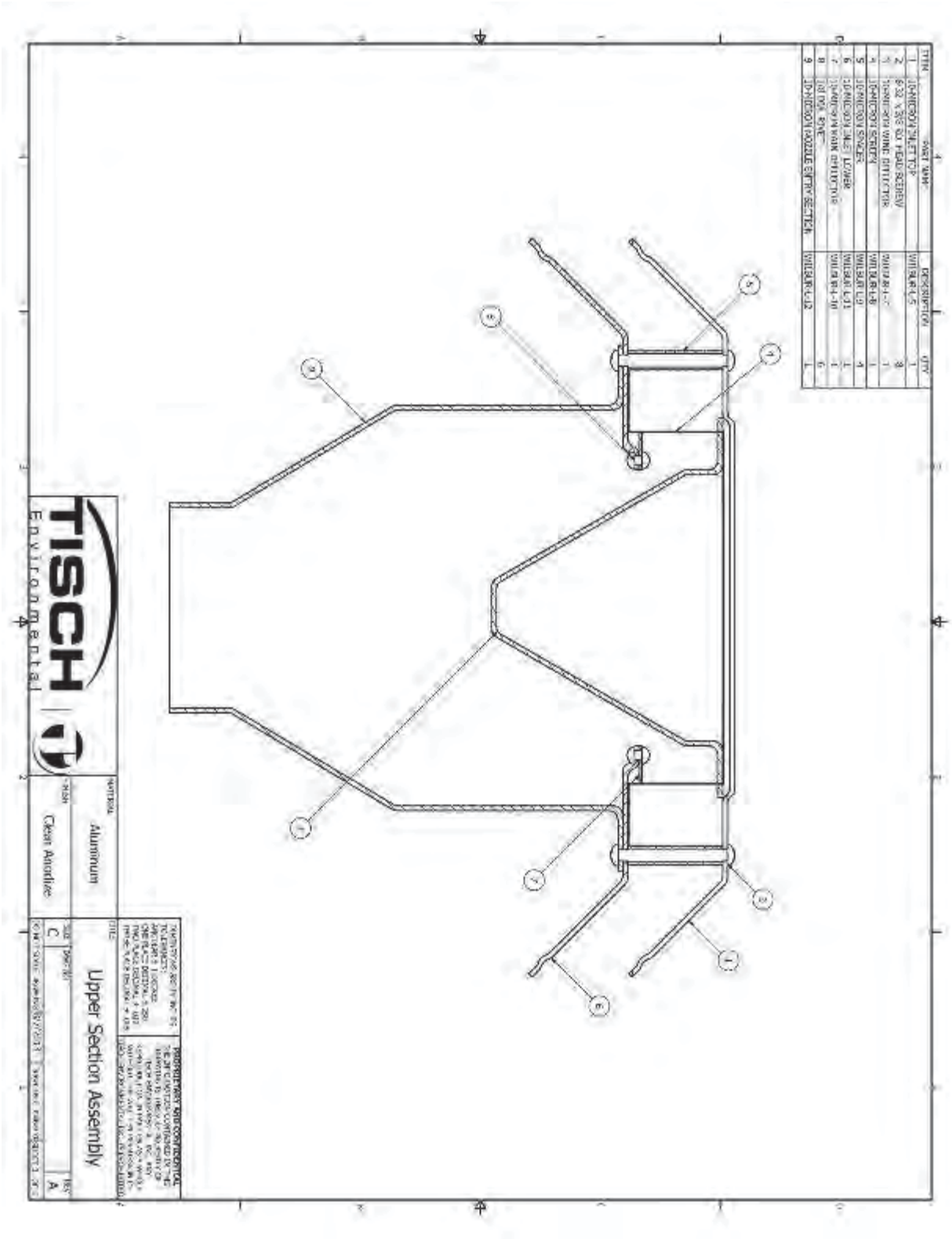
Change

B.5 TE-PM10 Drawings

TE-PM10 Lower Assembly Drawing



TE-PM10 Upper Assembly Drawing



Appendix C: Revision History

Revision No.	Date	Description
REV001	5-3-14	Manual created
REV002	5-5-14	Added quick start guide as Section 3.0
REV002.1	5-24-14	Added TE-Wilbur Calibration Worksheet and worksheet instructions to section 7.0 Calibration – created new section 7.9
REV002.2	6-2-14	Added TE-PM2.5C exploded view drawing
REV002.3	6-18-14	Updated MODBUS addressing, added updated pictures for connection plate and TE-PM2.5C, added TE-PM10 drawings and updated stand drawing, filter cassette drawing and pneumatic diagram
REV002.4	7-10-14	Updated several punctuation comments from USEPA designation and added several alerts
REV002.5	7-26-14	Added instructions 2.8 for changing language
REV002.6	8-23-14	Added USEPA Reference designation number
REV002.7	9-11-14	Added instructions and illustrations for unpacking of the unit Updated dimensions for PM2.5 and PM10 Updated fuse information
REV002.8	9-15-14	Updated USEPA Federal Reference Method designation and Federal Equivalency Method designation
REV002.9	10-3-14	Added louver filter maintenance section 13.20 Updated calibration worksheet with new version
REV002.10	11-1-14 11-4-14	Added warning about use of outdoor-rated cords Added USEPA FRM Designation numbers Updated screen for V1.80 of software. Changed last sample completed to sample summary screen
REV002.11	11-11-14	Added part number for TE-FRM-CAL calibrator
REV002.12	11-27-14	Updated electrical drawings in section 13.0 Added software revision history Appendix D

REV002.13	2-19-15	Updated manual to reflect flow setpoint changes of 90/95/100/105% of setpoint Updated solar panel configuration to include (2) panels
REV002.14	3-7-15	Added section 6.6 and documentation for new sample information screens that will give the user information for the last 5 samples completed
REV002.15	6-11-15	Added USEPA designations for using the TE-PM2.5C $PM_{2.5}$ fractionator
REV002.2	1-07-2016	Added updates to the sample summary log for version 3.5 of the firmware

Appendix D: Software Revision History

Screen Revision History

Date	Version	Comments
9/28/14	1.10	Production version
10/9/14	1.70	Production version – changed version for USEPA FRM designation
10/29/14	1.80	Changed sample completed button and screens to sample summary
11/10/14	1.90	Changed ability for the screen to have its own software version
2/19/15	2.1	Changed the calibration system to be 90/95/100/105% of setpoint to ease calibration and allow setpoints to be closer to the system setpoint of 16.67Lpm. Skipped version 2.0 to allow screen to be the same revision level of the PLC
3/6/15	2.2	Added the ability for the user to view the last 5 sampling events onto the touchscreen
7/20/15	3.0	Added another datalog on the sample summary folder – new datalog is called sample summary and will record every sampling event that takes place.
1/6/15	3.5	Combined time into HHMM and date into MMDDYYYY in the sample summary log Added a sample warning bit in the sample log. If set to a 0, there is no sample warning. If set to 1 there was a sample warning and the history log needs to be examined to determine the warning.

PLC Revision History

Date	Version	Comments
9/28/14	1.10	Production version
10/9/14	1.70	Production version – changed version for USEPA FRM designation
10/29/14	1.80	Changed sample completed button and screens to sample summary
11/18/14	1.90	Multiplied CV by 100 to represent into percent. Changed maximum CV timer to 90 seconds from 60 seconds to allow sample flow to get up to speed more effectively Changed sensor failure alarm timer from 30 seconds to 60 seconds to allow barometric pressure sensor time to boot up when plc firmware is updated
12/11/14	2.0	Changed battery discharge and battery fail alarms so they must stay maintained for 5 seconds before declaring a valid alarm
2/19/15	2.1	Changed the calibration system to be 90/95/100/105% of setpoint to ease calibration and allow setpoints to be closer to the system setpoint of 16.67Lpm.
3/6/15	2.2	Added the ability for the user to view the last 5 sampling events onto the touchscreen
7/20/15	3.0	Added another datalog on the sample summary folder – new datalog is called sample summary and will record every sampling event that takes place.
1/6/15	3.5	Combined time into HHMM and date into MMDDYYYY in the sample summary log Added a sample warning bit in the sample log. If set to a 0, there is no sample warning. If set to 1 there was a sample warning and the history log needs to be examined to determine the warning.

APPENDIX G

OPERATIONS MANUAL

TE-1000 PUF Poly-Urethane Foam
High Volume Air Sampler

Tisch Environmental, Inc.
145 South Miami Avenue
Village of Cleves, Ohio 45002

Toll Free: (877) 263 -7610 (TSP AND-PM10)
Direct: (513) 467-9000
FAX: (513) 467-9009

sales@tisch-env.com
www.tisch-env.com

TE-1000 PUF

Welcome

We are the experts in high volume air sampling, lead sampling, lead samplers, particulate monitoring, particulate emissions, pesticide monitoring, pesticide sampling, total suspended particles, particulate sampler, Federal Reference Method PM-10, Federal Reference Method PM2.5, EPA Method TO-4A, EPA Method TO-9A, EPA Method TO-13A. TEI is a family business located in the Village of Cleves, Ohio. TEI employs skilled personnel who average over 20 years of experience each in the design, manufacture, and support of air pollution monitoring equipment. Our modern well-equipped factory, quality philosophy and experience have made TEI the supplier of choice for air pollution monitoring equipment. Now working on the fourth generation, TEI has state-of-the-art manufacturing capability and is looking into the future needs of today's environmental professionals.

Assistance

If you encounter problems or require detailed explanations, do not hesitate to contact Tisch Environmental offices by e-mail or phone.

Toll Free: (877) 263 -7610 (TSP AND-PM10)
Direct: (513) 467-9000
FAX: (513) 467-9009

sales@tisch-env.com
www.Tisch-Env.com

Table of Contents

Introduction

EPA Standards

The following manual will instruct you in the unpacking, assemblage, operation, calibration, and usage of the corresponding Tisch Environmental product. For information on air sampling principles, procedures and requirements and to ensure compliance with government regulations please contact the local Environmental Protection Agency Office serving your area or visit www.epa.gov.

Safety Precautions

Before using Tisch Environmental products, always be sure to review the corresponding operations manuals and take all necessary safety precautions. Tisch Environmental products are to be used only for the purposes specified by operations manuals and by Tisch Environmental personnel. Tisch Environmental cannot guarantee the safe usage of its instruments in procedures that do not adhere to Tisch Environmental guidelines and standards. If you have concerns about the safety of your product or questions about safe practices, contact Tisch Environmental by phone or e-mail to speak with a representative.

Important Safety Instructions

Read and understand all instructions. Do not dispose of these instructions. Failure to follow all instruction listed in this manual may result in electric shock, fire, and/or personal injury. When using an electrical device, basic precautions must always be followed, including the precautions listed in the safety section of this manual. Never operate this unit in the presence of flammable materials or vapors are present as electrical devices may produce arcs or sparks that can cause fire or explosions. Always disconnect power supply before attempting to service or remove any components. Never immerse electrical parts in water or any other liquid. Always avoid body contact with grounded surfaces when plugging or unplugging this device is wet or dangerous conditions.

Electrical Installation

Installation must be carried out by specialized personal only, and must adhere to all local safety rules. This unit can be used for different power supply versions; before connecting this unit to the power line, always check if the voltage shown on the serial number tag corresponds to the one on your power supply. This product does use grounded plugs and wires. Grounding provides the path of least resistance for electrical currents, thereby reducing the risk of electric shock to users. This system is equipped with electrical cords with internal ground wires and a 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 the plug provided. If plug will not fit outlet, have the proper corresponding outlet installed by a professional, qualified electrician.

Do Not Abuse Cords

In the event that any electrical component of this system needs to be transported, **DO NOT** carry the unit by its power cord or unplug the unit by yanking the cord from the outlet. **Pull the plugs, not the cords**, to reduce risk of damage to unit. Keep all cords away from heat, oil, sharp objects, and moving parts.

Extension Cords

It is always advisable to use the shortest extension cord possible. Grounded units require a three-wire extension cord. As the distance from the supply outlet increases, you must use a heavier gauge extension cord. Using extension cords with inadequately sized wires results in serious changes in voltage, resulting in a loss of power and possible damage to equipment. It is recommended to only use 10-gauge extension cords for this product. Never use cords that exceed one hundred feet. Outdoor extension cords must be marked with the suffix “W-A” (or “W” in Canada)to indicate that it is suitable for outdoor usage. Always ensure that extension cords are properly wired and in good electrical condition. Always replace damaged extension cords immediately, or seek repair from qualified electricians before further use. Remember to protect extension cords from sharp objects, excessive heat, and damp or wet conditions.

Product Description

Introduction

TE-1000-PUF Poly-Urethane Foam sampler is a complete system designed to simultaneously collect suspended airborne particulates as well as trap airborne pesticide vapors at flow rates up to 280 liters per minute. The TE-PUF features the latest in technological advances for accurately measuring airborne particulates and vapors.

A dual chambered aluminum sampling module contains both filtering systems. The upper chamber supports the airborne particulate filter media in a circular filter holder. The lower chamber encapsulates a glass cartridge which contains the PolyUrethane Foam for vapor entrapment.

A wide variety of sorbents can be used in a manner that permits their continual use. Poly urethane foam or wet/dry granular solid media can be used individually or in combination. The dual chambered sampling module is designed for easy access to both upper and lower media. The threaded lower canister is removed with the cartridge intact for immediate exchange. Filter support screens and module components are equipped with gaskets providing a leak proof seal during the sampling process. Air flow rates are infinitely variable up to 280 liters per minute. The voltage variator adjusting screw alters the blower motor speed to achieve the flow rate desired. Air flow rate is measured through the flow venturi utilizing a 0-100" Magnehelic Gage. Periodic calibration is necessary to maintain on-site sampling accuracy. A Seven Day Mechanical Timer (TE-5007) is included as standard equipment and permits weekly scheduling with individual settings for each day and 14 trippers to turn the sampler On and Off as desired. Any day or days may be omitted. Day and night periods are distinctly marked. Other timers and programmers are available optionally to suit any sampling requirement.

Applications

- Meets US EPA methods TO-4A, TO-9A, and TO-13A.
- Samples semi-volatile organic compounds.
- Especially designed for sampling airborne particulates and vapor contamination from pesticide compounds.
- Successfully demonstrated to efficiently collect a number of organochlorine and organophosphate pesticides.
- By-pass blower motor design permits continuous sampling for extended periods at rates to 280 liters per minute.
- Proven sampler components housed in an anodized aluminum shelter for outdoor service.
- Samples in accordance with U.S. EPA Method TO-4A, "Method for the Determination of Organochlorine Pesticides and Polychlorinated Biphenyls in Ambient Air using high volume polyurethane foam (PUF) sampler."

Calibration Requirements

The TE-1000 PUF Sampler should be calibrated:

- Upon installation
- After motor maintenance
- At least once every three months
- After 360 sampling hours

Parts

1. Shelter Box - 48" x 20" x 20" 74 lbs

PUF Anodized Aluminum Shelter
TE-1000 110volt, 60hz
TE-1000X 220volt, 50hz
TE-1000XZ 220volt, 60hz

7-Day Mechanical Timer
TE-5007 110volt, 60hz
TE-5007X 220volt, 50hz
TE-5007XZ 220volt, 60hz

Flow Venturi & Calibration Valve
TE-1003

Motor Voltage Control
TE-5010 110volt, 60hz
TE-5010X 220volt, 50hz
TE-5010XZ 220volt, 60hz

PUF Blower Motor Assembly
TE-1004 110volt
TE-1004X 220volt

Dual Sampling Module
TE-1002

Exhaust Hose
TE-1023

Magnehelic Gauge
TE-1005

2. Lid Box - 19" x 14" x 14" 9 lbs

TE-5001-10
Gabled Roof

***** Save the shipping containers and packing material for future use.**

Assembly

1. Open shelter box and remove the Anodized Aluminum Shelter.

2. Inside of the shelter is the exhaust hose. Unwrap and insert end with speed clamp on end of blower motor discharge. Tighten with a flat edge screwdriver and put end of hose downwind of sampler.

3. Enclosed in the 13” x 10” x 7” box on the bottom of the shelter is the TE-1002 Dual Sampling Module. Remove it from the box.

4. Take out the rubber plug that is in the quick disconnect on the top pan of the shelter. Insert Dual Sampling Module and lock in place by pushing rings down to seal tightly.

5. Take off the cover that is on top of the 4” filter holder. Turning motor on with cover in place will damage motor.

6. Open lid box and remove 5001-10 roof.

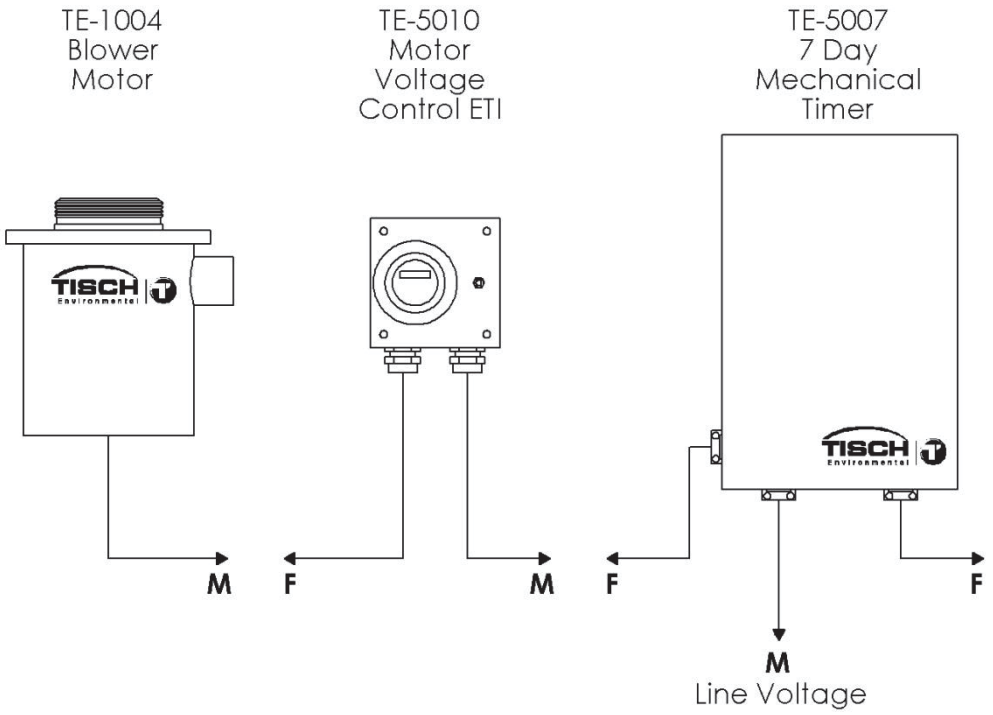
Gabled Roof Assembly

Lid Hardware 5 pcs 10-24 x 1/2 pan head screws 5 pcs 10-24 stop nuts 1 pc 6-32 x 3/8 pan head screw 1 pc 6-32 hex nut 1 pc 20" chain with "S" hook 1 pc TE-5001-10-9 roof back catch 1 pc TE-5001-10-10 front catch 1 pc TE-5001-10-11 rear lid hasp	
Step 1 Secure TE-5001-10-10 front catch to the shelter using 2 10-24 pan head screws with stop nuts. **Do not tighten completely, this may need to be adjusted after final assembly**	
Step 2 Secure TE-5001-10-9 roof back catch to the back of shelter using #6-32 pan head screw with stop nut.	
Step 3 Secure TE-5001-10-11 rear lid hasp inside the lid with the slot angled up using (2) #10-24 pan head screws with stop nuts. **Do not tighten completely, this may need to be adjusted after final assembly**	
Step 4 Remove (4) #10-24 x ½" pan head screws from the rear of the shelter, attach the lid to the shelter by placing the lid hinge plates on the **"OUTSIDE"** of the shelter, line the hinges up with the (4) threaded holes in the back of the shelter. Use the (4) #10-24X ½" pan head screws that were removed preciously to attach the lid hinges to the shelter. **Tighten completely**	

Step 5 Adjust the front and rears catch to be sure that the lid slots lowers over it when closing. Tighten the roof back hasp and front catch completely.	 
Step 6 Attach the chain and "S" hook assembly to the side of the shelter with a #6-32 x 3/8" pan head screw.	
Step 7 The Lid can now be secured in an open or closed position with the "S" hook.	

Electrical Set-Up

TE-1000 Electrical Set-Up



1. The TE-1004 PUF Blower Motor male cord set plugs into the TE-5010 Motor Voltage Control Female cord set.

2. The male cord set of the Motor Voltage Control plugs into the TE-5007 7-Day Mechanical Timer timed female cord set which is on the left side of timer.

3. The other female cord set on timer (on the right) is hot all the time and is an extra plug.

4. The male cord set of timer plugs into the line voltage.

Operations

Calibration Procedure

Visit, www-tisch-env.com/calibration-worksheets, to download calibration worksheets. The calibration worksheets allow the user to input the data and automatically make the calculations. The manual calculation method is described in the following sections for your reference, however, it is highly recommended to download the calibration worksheets.

Proceed with the following steps to begin the calibration:

1. Calibration of the PUF Sampler is performed without a foam plug (TE-1010) or filter paper in the sampling module. However the empty glass cartridge must remain in the module to insure a good seal through the module.

2. Install the TE-5040A Calibrator (orifice) on top of the 4" Filter Holder. Tighten and make sure of no leaks.

3. Open both ports on top of manometer and connect tubing from manometer port to the pressure tap on the TE-5040A Calibrator. Leave the opposite side of manometer port open to the atmosphere.

4. Open ball valve fully (handle should be straight up), this is located inside of shelter directly above the blower motor.

5. Turn the system on by tripping the manual switch on the timer. Allow a few minutes for motor to warm-up.

6. Adjust and tighten the voltage control screw (variac) on the TE-5010 to obtain a reading of 70 inches on the dial of the Magnehelic Gage (or 80 whatever is desired). Do not change until completion of calibration.

7. With 70 inches on the gage as your first calibration point, record this figure and the orifice manometer reading on your data sheet. To read a manometer one side goes up and one goes down, add both sides together, this is your inches of water.

8. Close the ball valve slightly to readjust the dial gage down to 60 inches. Record this figure and the orifice manometer reading on your data sheet.

9. Using the above procedure, adjust the ball valve for readings at 50, 40, and 30 inches and record on data sheet. You should have 5 sets of numbers 10 numbers in all.

10. Manually turn sampler off.

To download the calibration worksheet please visit, www.tisch-env.com/calibration-worksheets and select the *"TE-1000 PUF calibration worksheet."* The TE-1000 PUF Sampler Calibration Data Sheet has been attached with data filled in from a typical calibration. This includes the transfer standard orifice calibration relationship which was taken from the Orifice Calibration Worksheet that accompanies the calibrator orifice. Since this calibration is for a PUF sampler, the slope and intercept for this orifice uses **standard** flows rather than actual flows.

The five orifice manometer readings taken during the calibration have been recorded in the column on the data worksheet titled H_2O (in). The five Magnehelic Gage readings taken during the calibration have been recorded under the column titled FLOW (magn).

The orifice manometer readings need to be converted to the standard air flows they represent using the following equation:

$$\mathbf{Qstd = 1/m[Sqrt((H_20)(Pa/760)(298/Ta))-b]}$$

where:
Qstd = actual flow rate as indicated by the calibrator orifice, m^3/min
H_20 = orifice manometer reading during calibration, in. H_20
Ta = ambient temperature during calibration, K (K = 273 + C^o)
298 = standard temperature, a constant that never changes, K
Pa = ambient barometric pressure during calibration, mm Hg
760 = standard barometric pressure, a constant that never changes, mm Hg
m = *Qstandard slope of orifice* calibration relationship
b = *Qstandard intercept of orifice* calibration relationship.

Once these standard flow rates have been determined for each of the five run points, they are recorded in the column titled Qstd, and are represented in cubic meters per minute.

The Magnehelic Gage readings taken during the calibration need to be corrected to the current meteorological conditions using the following equation:

FLOW (corrected) **= Sqrt((magn)(Pa/760)(298/Ta))**

where:
FLOW (corrected) = Magnehelic Gage readings corrected to current Ta and Pa
magn = Magnehelic Gage readings during calibration
Pa = ambient barometric pressure during calibration, mm Hg
760 = standard barometric pressure, a constant, mm Hg
Ta = ambient temperature during calibration, K (K = 273 +C°)
298 = standard temperature, a constant, K

After each of the Magnehelic Gage readings have been corrected, they are recorded in the column titled FLOW (corrected).

Using Qstd and FLOW (corrected) as the x and y axis respectively, a slope, intercept, and correlation coefficient can be calculated using the least squares regression method. The correlation coefficient should never be less than 0.990 after a five point calibration. A coefficient below .990 indicates a calibration that is not linear and the calibration should be performed again. If this occurs, it is most likely the result of an air leak during the calibration.

The equations for determining the slope (m) and intercept (b) are as follows:

$$m = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sum x^2 - \frac{(\sum x)^2}{n}} \quad ; \quad b = \bar{y} - m\bar{x}$$

where: n = number of observations
$\bar{y} = \sum y/n$; $\bar{x} = \sum x/n$
$\sum$ = sum of

The equation for the coefficient of correlation (r) is as follows:

$$r = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sqrt{\left[\sum x^2 - \frac{(\sum x)^2}{n}\right]\left[\sum y^2 - \frac{(\sum y)^2}{n}\right]}}$$

where: n = number of observations
$\sum$ = sum of

If you wanted to set this sampler at .242 m^3/min (8.5 CFM or 242 LPM) (Make sure the ball valve is open fully, a 4" filter is in place, and the module is loaded) you would turn the voltage control screw or variac until the Magnehelic Gage read 60 inches. By making sure that the sampler is operating at a Magnehelic Gage reading that is within the acceptable range, it can be assumed that valid PUF data is being collected.

Example Problems

The following example problems use data from the attached calibration worksheet.

After all the sampling site information, calibrator information, and meteorological information have been recorded on the worksheet, standard air flows need to be determined from the orifice manometer readings taken during the calibration using the following equation:

1. **Qstd = 1/m[Sqrt((H$_2$0)(Pa/760)(298/Ta))-b]**

where:
Qstd = actual flow rate as indicated by the calibrator orifice, m^3/min
H_20 = orifice manometer reading during calibration, in. H_20
Ta = ambient temperature during calibration, K (K = 273 + C^o)
298 = standard temperature, a constant that never changes, K
Pa = ambient barometric pressure during calibration, mm Hg
760 = standard barometric pressure, a constant that never changes, mm Hg
m = *Qstandard slope of orifice* calibration relationship
b = *Qstandard intercept of orifice* calibration relationship.

Note that the ambient temperature is needed in degrees Kelvin to satisfy the Qstd equation. Also, the barometric pressure needs to be reported in millimeters of mercury. In our case the two following conversions may be needed:

2. **degrees Kelvin = [5/9 (degrees Fahrenheit - 32)] + 273**
3. **millimeters of mercury = 25.4(inches of H_2O/13.6)**

Inserting the numbers from the calibration worksheet run point number one we get:

4. Qstd = 1/9.82823[Sqrt((7.5)(756.9/760)(298/294.8)) - (-.03871)]
5. Qstd = .1017477[Sqrt((7.5)(.996)(1.011)) + .03871]
6. Qstd = .1017477[Sqrt(7.55217) + .03871]
7. Qstd = .1017477[2.7481211 + .03871
8. Qstd = .1017477[2.7868311]
9. Qstd = .284

Throughout these example problems you may find that your answers vary some from those arrived at here. This is probably due to different calculators carrying numbers to different decimal points. The variations are usually slight and should not be a point of concern.

With the Qstd determined, the corrected Magnehelic Gage reading FLOW (corrected) for this run point needs to be calculated using the following equation:

10. **FLOW (corrected) = Sqrt((magn)(Pa/760)(298/Ta))**

where:
FLOW (corrected) = Magnehelic Gage readings corrected to standard
magn = Magnehelic Gage readings during calibration
Pa = ambient barometric pressure during calibration, mm Hg.
760 = standard barometric pressure, mm Hg
Ta = ambient temperature during calibration, K (K = 273 + C^o)
298 = standard temperature, K.

Inserting the data from run point one on the calibration worksheet we get:

11. FLOW (corrected) = Sqrt((70)(756.9/760)(298/294.8))
12. FLOW (corrected) = Sqrt((70)(.996)(1.011))

13. FLOW (corrected) = Sqrt(70.48692)
14. FLOW (corrected) = 8.39

This procedure should be completed for all five run points.

Using Qstd as our x-axis, and FLOW (corrected) as our y-axis, a slope, intercept, and correlation coefficient can be determined using the least squares regression method.

The equations for determining the slope (m) and intercept (b) are as follows:

15. $$m = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sum x^2 - \frac{(\sum x)^2}{n}} \quad ; \quad b = \bar{y} - m\bar{x}$$

where: n = number of observations
$\bar{y} = \sum y/n$; $\bar{x} = \sum x/n$
$\sum$ = sum of.

The equation for the coefficient of correlation (r) is as follows:

16. $$r = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sqrt{\left[\sum x^2 - \frac{\left(\sum x\right)^2}{n}\right]\left[\sum y^2 - \frac{\left(\sum y\right)^2}{n}\right]}}$$

where: n = number of observations
$\sum$ = sum of

Before these can be determined, some preliminary algebra is necessary. $\sum x$, $\sum y$, $\sum x^2$, $\sum xy$, $(\sum x)^2$, $(\sum y)^2$, n, $\bar{y}$, and $\bar{x}$ need to be determined.

17. $\Sigma x = .284 + .266 + .249 + .230 + .200 = 1.229$
18. $\Sigma y = 8.39 + 7.77 + 7.09 + 6.35 + 5.50 = 35.1$
19. $\Sigma x^2 = (.284)^2 + (.266)^2 + (.249)^2 + (.230)^2 + (.200)^2 = .306313$
20. $\Sigma y^2 = (8.39)^2 + (7.77)^2 + (7.09)^2 + (6.35)^2 + (5.50)^2 = 251.6056$

21. $\Sigma xy = (.284)(8.39) + (.266)(7.77) + (.249)(7.09) + (.230)(6.35) + (.200)(5.50) = 8.77549$

22. $n = 5$

23. $\bar{x} = \Sigma x/n = .2458$

24. $\bar{y} = \Sigma y/n = 7.02$

25. $(\Sigma x)^2 = (1.229)^2 = 1.510441$

26. $(\Sigma y)^2 = (35.1)^2 = 1232.01$

Inserting the numbers:

27. $\text{slope} = \dfrac{8.77549 - \frac{(1.229)(35.1)}{5}}{0.306313 - \frac{1.510441}{5}}$

28. $\text{slope} = \dfrac{8.77549 - \frac{35.36543.1379}{5}}{0.306313 - \frac{1.510441}{5}}$

29. $\text{slope} = \dfrac{8.77549 - 8.62758}{0.306313 - 0.302}$

30. $\text{slope} = \dfrac{0.14791}{0.004313}$

31. slope = 34.293994

32. intercept = 7.02 - (34.293994)(. .2458)

33. intercept = 7.02 - 8.4294637

34. intercept = -1.4094637

35. correlation coeff. = $\dfrac{8.77549 - \frac{(1.229)(35.1)}{5}}{\sqrt{\left[.306313 - \frac{(1.229)^2}{5}\right]\left[251.6056 - \frac{(35.1)^2}{5}\right]}}$

36. correlation coeff. = $$\frac{8.77549 - \frac{(43.1379)}{5}}{\sqrt{[(.306313 - .3020882)]\ [(251.6056 - 246.402)]}}$$

37. correlation coeff. = $$\frac{(8.77549 - 8.62758)}{\sqrt{[(.306313 - .3020882)][(251.6056 - 246.402)]}}$$

38. correlation coeff. = $$\frac{.14791}{\sqrt{(.0042248)(5.2036)}}$$

39. correlation coeff. = $$\frac{.14791}{\sqrt{..0219841}}$$

40. correlation coeff. = $$\frac{.14791}{.1482703}$$

41. correlation coeff. = .9975699

A calibration that has a correlation coefficient of less than .990 is not considered linear and should be re-calibrated. Since the correlation coeff. is > .990 , we have a good calibration.

Unit Operation

1. The PUF Sampler may be operated at ground level or on roof tops. In urban or congested areas, it is recommended that the sampler be placed on the roof of a single story building. The sampler should be located in an unobstructed area, at least two meters from any obstacle to air flow. The exhaust hose should be stretched out in a down wind direction if possible.

2. The sampler should be operated for 24 hours in order to obtain average daily levels of airborne pesticides.

3. On and off times and weather conditions during sampling periods should be recorded. Air concentrations may fluctuate with time of day, temperature, humidity, wind direction and velocity and other climatological conditions.

4. Magnehelic Gage readings should be taken at the beginning and end of each sampling period to obtain an average magnehelic gage reading.

5. Blower motor brushes should be inspected frequently and replaced before expending. An electrical source of 110 volts, 15 amps is required.

Sampling Module

1. Release the three (3) swing bolts on the 4" filter holder (FH-2104) and remove the triangle cover (cover must be off when sampler is **"ON"**) and hold down ring.

2. Install a clean 102mm dia.(4") quartz fiber filter (TE-QMA4) on the support screen in between the teflon gaskets and secure it with the hold down ring and swing bolts.

3. Unscrew together the 4" filter holder and the sampling module cap leaving the module tube in place with the glass cartridge exposed.

4. Load the glass cartridge with foam and or foam/granular solids and replace in the module tube. Fasten the glass cartridge with the module cap and 4" filter holder assembly while making sure that the module assembly, 4" filter holder and all fittings are snug.

5. The glass cartridge and quartz fiber filter should be removed from the sampler with forceps and clean gloved hands and immediately placed in a sealed container for transport to the laboratory. Similar care should be taken to prevent contamination of the filter paper and vapor trap (foam) when loading the sampler.

6. **It is recommended to have two (2) sampling modules (TE-1002) for each sampling system so that filter and foam exchange can take place in the laboratory.**

Sorbents

Two types of sampling media are recommended for use with the PUF Sampler: polyurethane foams and granular solid sorbents. Foams may be used separately or in combination with granular solids. The sorbent may be extracted and reused (after drying) without unloading the cartridge.

1. Polyurethane Foam (PUF):
    - Part number TE-1010 three inch plug is recommended. Also available are two inch (TE-1011) and one inch (TE-1012). This type of foam is white and yellows on exposure to light. Color does not effect the collection efficiency of the material.

2. Granular Solids
    - Porous (macroreticular) chromatography sorbents recommended. Pore sizes and mesh sizes must be selected to permit air flow rates of at least 200 liters/minute. Approximately 200 g of sorbent is recommended. ***If too much sorbent is used, the sampler flow rate may be affected.*** The granular solids may be sandwiched between two layers of foam to prevent loss during sampling and extraction.

Determination of Flow Rate

To figure out the total volume of air that flowed through the PUF sampler during your sampling run take a set-up magnehelic gage reading (when you set the sampler up manually turn it on and take a magnehelic gage reading; in our example it should be 60 inches) and a pick-up reading (after the sample has been taken again manually turn sampler on and take a magnehelic gage reading; for our example let's say it read 54 inches). Take 60 + 54 = 114 114/2 = 57 so the magnehelic gage reading you would use is 57 inches. Put that into the formula (on bottom of worksheet):

1/m([Sqrt(magn)(Pav/760)(298/Tav)]- b)

m = sampler slope
b = sampler intercept
magn = average magnehelic gage reading
Tav = daily average temperature
Pav = daily average pressure
Sqrt = square root

Example:

m^3/min = 1/35.3693([Sqrt(57)(751.3/760)(298/293.2)]-(-1.6711))
m^3/min = .0282731 ([Sqrt(57)(.9885526)(1.016371)] + 1.6711)
m^3/min = .0282731 ([Sqrt(57.269962)] + 1.6711)
m^3/min = .0282731 ([(7.5676919)] + 1.6711)
m^3/min = .0282731 (7.5676919 + 1.6711)
m^3/min = .0282731 (9.2387919)
m^3/min = .2612092
lpm = 261.2092

Total liters of air = lpm x 60 x hours that sampler ran

Let's say our sampler ran 23.9 hours
(end ETI reading - start ETI reading)

** Make sure ETI is in hours otherwise convert to hours **

Total liters of air = 261.2092 x 60 x 23.9 = 374,573.99 liters of air.

Troubleshooting

note: this is a general troubleshooting guide, not all problem may apply to every sampler

Problem	Solution
Brush Motor Won't Turn On	-Check Motor brushes(Change every 500 hours) -Check Motor(Should be replaced after 2 brush changes about 1500 hours) -Check power supply -Ensure that all electrical connections are secure -Make sure timer is on -Make sure flow controller(if applicable) is adjusted properly -Check for loose or damaged wires -Check speed on TE-5010, ensure adjustment screw is turned clockwise to increase motor speed.
Brushless Motor Won't Turn On	-Ensure that all electrical connections are secure -Make sure flow controller(if applicable) is adjusted properly -Check power supply -Make sure timer is on -Check for loose or damaged wires
Mechanical timer not working	-Make sure trippers are set properly -Make sure that trippers are not pressed against switch at start up, the timer need to rotate a few degrees before the trippers hit the switch -Check for loose or damages wires -Check power supply -Check electrical hook up diagram to ensure correct installation -Check Motor
Digital timer not working	-Check timer settings -Make sure current date and time are correct -Make sure power cords are properly connected -Check fuse on main PC board (F3) -Check Power Supply -Check Motor

Mass Flow Controller not working	-Make sure timer is on -Check Motor/Motor brushes -Make sure 8 amp breaker is not popped -Make sure flow probe is installed correctly -Check all electrical connections -Check power supply
Elapsed Time Indicator not working	-Check Power Supply -Check electrical connections
Voltage Variator with ETI not working	-Check Power Supply -Check Electrical Connections -Check Motor
Flow Rate Too Low	-Check for leaks -Check filter media placement -Ensure only one piece of filter paper is installed -Check Flow Controller -Check flow valve(TE-1000PUF samplers only) -Ensure proper voltage is being supplied -Check calibration
Chart Recorder not working	-Replace pen point -Make sure pen point is touching chart -Make sure pen point is on “0” -Make sure tubing from motor is in place -Check Power Supply -Check motor
Air Leaks	-Make sure all gaskets are in place -Make sure all connections are secure -Makes sure connections are not over tightened -Check for damaged components: Filter holder screen, gaskets, motor flanges

Maintenance and Care

A regular maintenance schedule will allow a monitoring network to operate for longer periods of time without system failure. Our customers may find that the adjustments in routine maintenance frequencies are necessary due to the operational demands on their sampler(s). We recommend that the following cleaning and maintenance activities be observed until a stable operating history of the sampler has been established.

TE-1000 PUF

1. Make sure all gaskets (including motor cushion) are in good shape and that they seal properly.

2. The power cords should be checked for good connections and for cracks (replace if necessary).

   CAUTION: DO NOT allow power cord or outlets to be immersed in water!

3. Inspect the filter screen and remove any foreign deposits.

4. Inspect the filter holder frame Teflon gasket each sample period and make sure of an airtight seal.

5. Check or replace TE-33384 or TE-33378 motor brushes every 400 to 500 running hours.

6. After replacing brushes two times, a new motor (TE-116336 or TE-116125) must be used.

7. Make sure elapsed time indicator is working properly.

Motor Brush Replacement

(**110 volt** Brush part #TE-33384)
(**220 volt** Brush part #TE-33378)

CAUTION: Ensure that all electrical power to the TE-PUF Sampler is disconnected prior to opening the motor housing. Unplug the motor power cord.

The following steps are accompanied by pictures to aid your understanding of motor brush replacement procedures. Please be aware that the pictures are standardized and may not match the equipment that you are using. Motor brush removal and replacement does not change based on motor or brush type, so do not be confused if your equipment differs from what is pictured.

1. Remove the motor mounting cover by removing the four bolts. This will expose the flange gasket and the motor. Turn motor over.

2. Remove ground wires from backplate and carefully lift the metal housing from the motor.

3. With a screwdriver, carefully remove the plastic fan cover by prying in between the brush and cover until both sides pop loose.

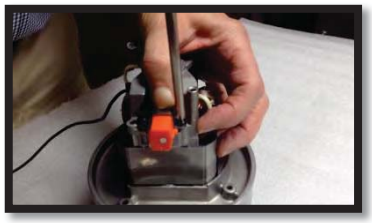
4. With a screwdriver, carefully pry the brass quick disconnect tabs away from the expended brushes.

5. With a screwdriver remove brush holder and release **TE-33384** brushes.

6. With new **TE-33384** brushes, carefully slide quick disconnect tabs firmly into tab slot until seated.

7. Push brush carbon against commutator until plastic brush housing falls into place on commutator end bracket.

8. Replace brush holder clamps onto brushes.



9. Assemble motor after brush replacement: snap plastic fan cover back into place, feed ground wires back through backplate, put housing back on to motor, pull cord set back to normal postion, (**make sure wires do not get smashed between metal ring and housing.** fasten ground wires to backplate, turn motor over, tighten flange on top of housing and gasket.

10. Replace motor mounting cover on top of motor making sure to center gasket.

****WARNING** Change Brushes Before Brush Shunt Touches Commutator!**

TE-116336
110v Motor

TE-33384(green)
110v Motor Brush

TE-116125
220v Motor

TE-33378(brown)
220v Motor Brush

Seating Procedure

CAUTION: Direct application of full voltage after changing brushes will cause arcing, commutator pitting, and reduce overall life.

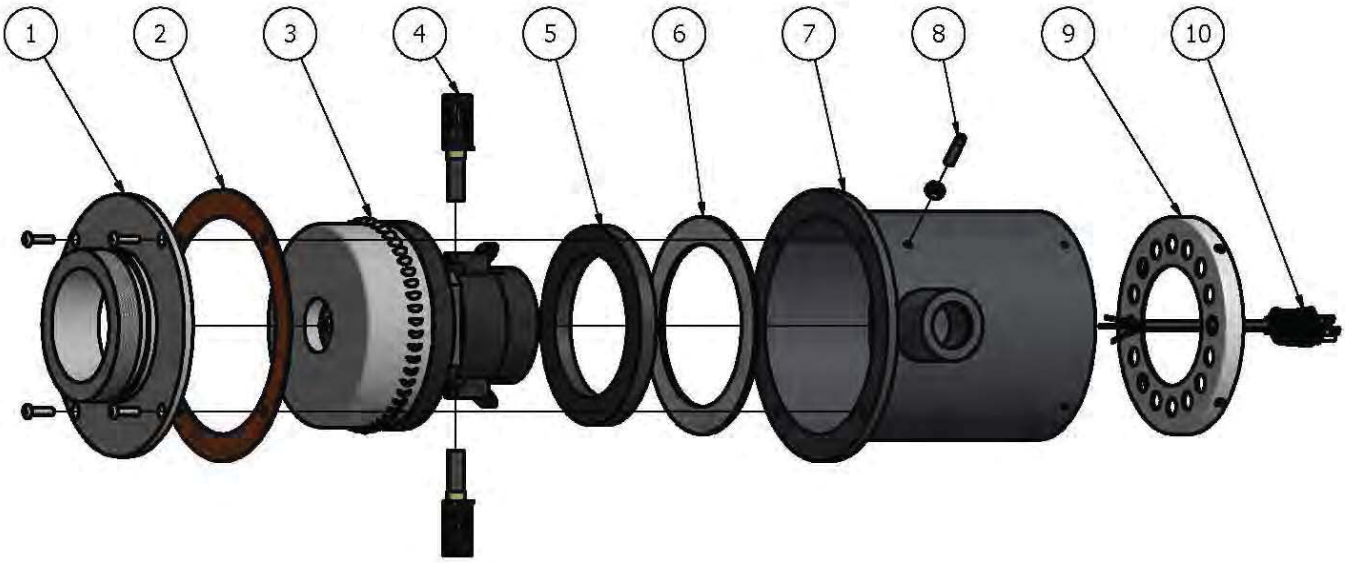
To achieve best performance from new **TE-33384** brushes they must be seated on the commutator before full voltage is applied. After brush change apply 50% voltage for fifteen to twenty minutes to accomplish this seating. Use of **TE-5010** Flow Selector on system provides the reduced voltage for brush seating.

Warranty

Instruments manufactured by Tisch Environmental, Inc. are guaranteed by warranty to be free of defects in materials and workmanship for one year after shipment from Tisch Environmental factories. The liability of Tisch Environmental, Inc. is limited to servicing or replacing any defective part of any instrument returned to the factory by the original purchaser. All service traceable to defects in original material or workmanship is considered warranty service and is performed free of charge. The expense of warranty shipping charges to and from our factory will be borne by Tisch Environmental. Service performed to rectify an instrument malfunction caused by abuse, acts of god or neglect, and service performed after the one-year warranty period will be charged to the customer at the current prices for labor, parts, and transportation. Brush-type and brushless motors will carry a warranty as far as the original manufacture will pass through its warranty to Tisch Environmental, Inc. The right is reserved to make changes in construction, design specifications, and prices without prior notice.

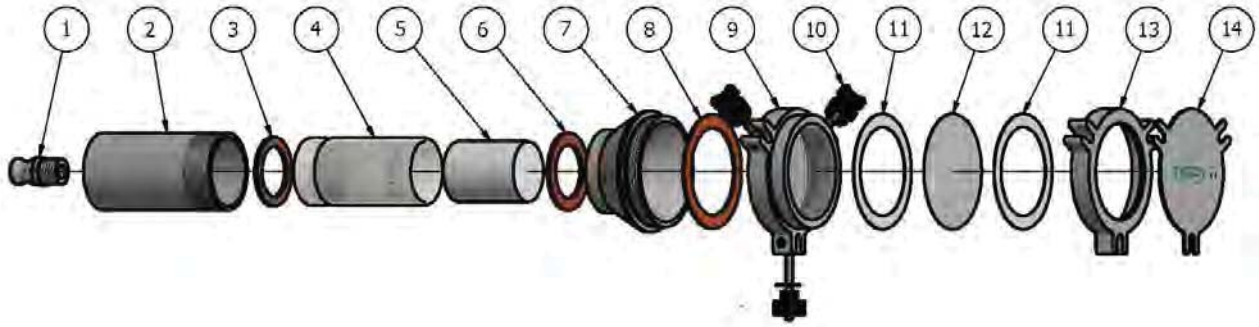
Assembly Drawings

TE-1004 Blower Motor Assembly



TE-1004 PUF Blower Motor Assembly			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	TE-1004-1	Blower Motor Flange
2	1	TE-1004-2	Flange Gasket
3	1	TE-116336 TE-116125	Motor for 110V PUF System Motor for 220V PUF System
4	1	TE-33384 TE-33378	Motor Brushes for 110V Motor Motor Brushes for 220V Motor
5	1	TE-5005-4	Motor Cushion
6	1	TE-1004-8	Motor Spacer Ring
7	1	TE-1004-3	Aluminum Blower Motor Housing w/ Integral Side Exhaust
8	1	TE-1004-15	PUF Pressure Tap w/ Nut
9	1	TE-1004-7	Back Plate
10	1	TE-5010-4	Power Cord

TE-1002 Vapor/Particulate Module



TE-1002 Particulate/Vapor Sampling Module			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	TE-1002-4	Module Plug Coupler
2	1	TE-1002-3	Module Body
3	1	TE-1002-8	Lower Module Gasket, Silicone 2 9/16" OD
4	1	TE-1009	Glass Cartridge w/ Stainless Steel Screens
5	1	TE-1010 TE-1011 TE-1012	3" Long Polyurethane Vapor Collection Substrate (Unwashed) 2" Long Polyurethane Vapor Collection Substrate (Unwashed) 1" Long Polyurethane Vapor Collection Substrate (Unwashed)
6	1	TE-1002-6	Upper Module Gasket, Silicone 2 7/8' OD
7	1	TE-1002-2	Module Reducer
8	1	TE-1008-8	Filter Holder Gasket, Silicone 4 1/2" OD
9	1	TE-1008-2	4" Filter Holder Body w/ Stainless Steel Screens
10	3	TE-1002-14	Plastic Thumb Nut, Brass Bolt, Washer, and S/S Bolt
11	2	TE-1008-5	Teflon Gasket
12	1	TE-QMA4	Micro-Quartz Filter Media 4" Round for PUF
13	1	TE-1008-1	4" Hold Down Frame
14	1	TE-1008-9	Aluminum Cover for 4" Filter Holder

Calibration Worksheet

TE-1000 PUF Calibration Worksheet

Site Information

Location: Cleves Oh.	**Site ID:** 145	**Date:** 1-Jul-15
Sampler: TE-1000	**Serial No:** 1116	**Tech:** Jim Tisch

Site Conditions

Barometric Pressure (in Hg):	29.80	**Corrected Pressure (mm Hg):**	756.9
Temperature (deg F):	71.0	**Temperature (deg K):**	294.8
Average Pressure (in Hg):	29.58	**Corrected Average Pressure (mm Hg):**	751.3
Average Temperature (deg F):	68.0	**Average Temperature (deg K):**	293.2

Calibration Orifice

Make: Tisch	**Qstd Slope:** 9.82823
Model: TE-5040A	**Qstd Intercept:** -0.03871
Serial#: 1185	**Calibration Due Date:** 15-Oct-14

Calibration Information

Plate or Test #	Pressure (in H_2O)	Qstd (m3/min)	Flow (magn)	Flow (corrected)
1	7.50	0.284	70.0	8.39
2	6.60	0.266	60.0	7.77
3	5.75	0.249	50.0	7.09
4	4.90	0.230	40.0	6.35
5	3.70	0.200	30.0	5.50

Linear Regression

Slope: 35.3693
Intercept: -1.6711
Corr. Coeff: 0.9978
# of Observations: 5

Calculations

Qstd = 1/m[Sqrt((H20)(Pa/760)(298/Ta))-b]
Flow (corrected)=Sqrt((magn)(Pa/Pstd)(Tstd/Ta))

Qstd = standard flow rate
Flow (magn)= reading from magnehelic gauge
Flow (corrected)= corrected flow rate
m = calibrator Qstd slope
b = calibrator Qstd intercept
Ta = actual temperature during calibration (deg K)
Pa = actual pressure during calibration (mm Hg)
Tstd = 298 deg K
Pstd = 760 mm Hg
For subsequent calculation of sampler flow:
Qstd = 1/m[Sqrt((H20)(Pa/760)(298/Ta))-b]

m = sampler slope
b = sampler intercept
(magn) = magnehelic reading
Tav = daily average temperature
Pav = daily average pressure

Average Flow (magn): 36.0
Average Flow Over Sample (m3/min)
0.217306
Enter Total Time (hrs): 23.9
Total Flow Over Sample (m3/min)
311.6161029
Total Flow Over Sample (LPM)
311616.1029

NOTE: Ensure calibration orifice has been certified within 12 months of use

Tisch Environmental 145 South Miami Ave, Cleves OH 45002 • 877.263.7610 • sales@tisch-env.com • www.tisch-env.com

Calibrator Certificate

TISCH ENVIRONMENTAL, INC.
145 SOUTH MIAMI AVE
VILLAGE OF CLEVES, OH
45002
513.467.9000
877.263.7610 TOLL FREE
513.467.9009 FAX

ORIFICE TRANSFER STANDARD CERTIFICATION WORKSHEET TE-5040A

Date - May 04, 2015 Rootsmeter S/N 0438320 Ta (K) - 294
Operator Jim Tisch Orifice I.D. - 2959 Pa (mm) - 755.65

PLATE OR VDC #	VOLUME START (m3)	VOLUME STOP (m3)	DIFF VOLUME (m3)	DIFF TIME (min)	METER DIFF Hg (mm)	ORFICE DIFF H2O (in.)
1	NA	NA	1.00	6.7000	3.6	2.00
2	NA	NA	1.00	4.1130	10.0	5.50
3	NA	NA	1.00	3.2710	15.5	8.50
4	NA	NA	1.00	2.8040	21.0	11.50
5	NA	NA	1.00	2.4730	26.5	14.50
6	NA	NA	1.00	2.3050	30.2	16.50

DATA TABULATION

Vstd	(x axis) Qstd	(y axis)		Va	(x axis) Qa	(y axis)
1.0029	0.1496	1.4197		0.9951	0.1485	0.8821
0.9944	0.2417	2.3543		0.9867	0.2399	1.4628
0.9871	0.3017	2.9268		0.9794	0.2994	1.8185
0.9797	0.3494	3.4044		0.9721	0.3467	2.1153
0.9724	0.3932	3.8227		0.9649	0.3901	2.3752
0.9675	0.4197	4.0778	-	-0.9600	0.4165	2.5337
Qstd slope (m) =		9.82823		Qa slope (m) =		6.15427
intercept (b) =		-0.03871		intercept (b) =		-0.02405
coefficient (r) =		0.99988		coefficient (r) =		0.99988
y axis = SQRT[H2O(Pa/760)(298/Ta)]				y axis = SQRT[H2O(Ta/Pa)]		

CALCULATIONS

Vstd = Diff. Vol[(Pa-Diff. Hg)/760](298/Ta)
Qstd = Vstd/Time

Va = Diff Vol [(Pa-Diff Hg)/Pa]
Qa = Va/Time

For subsequent flow rate calculations:

Qstd = 1/m{[SQRT(H2O(Pa/760)(298/Ta))]- b}
Qa = 1/m{[SQRT H2O(Ta/Pa)]- b}

APPENDIX H

HEALTH AND SAFETY PLAN

AIR MONITORING METAL SHREDDING FACILITIES STATEWIDE

SA RECYCLING - BAKERSFIELD
2000 E. BRUNDAGE LANE
BAKERSFIELD, CALIFORNIA 93307-2734

PREPARED FOR
CALIFORNIA DEPARTMENT OF TOXICS SUBSTANCES CONTROL
P.O. BOX 806
SACRAMENTO, CALIFORNIA 95812-0806

PREPARED BY

GEOCON CONSULTANTS, INC.
3160 GOLD VALLEY DRIVE, SUITE 800
RANCHO CORDOVA, CALIFORNIA 95742

PROJECT NO. S9850-03-21

SEPTEMBER 2016

GEOCON
CONSULTANTS, INC.

GEOTECHNICAL
ENVIRONMENTAL
MATERIALS

TABLE OF CONTENTS

HEALTH AND SAFETY PLAN SUMMARY

Site Name & Contact: SA Recycling - Metal Shredding Facility
Elio Torrealba, Director, Air Quality Compliance
Cell No.: 714.371.6535

Site Locations/Addresses: 2000 E. Brundage Lane, Bakersfield, California 93307-2734

Project Representatives:

• Program Manager:	**Jim Brake**	**916.870.1180** - Cell No.
• Project Manager:	**Josh Ewert**	**916.212.5168** - Cell No.
• Project Safety Officers:	**Cord Dennig**	**916.397.6413 –** Cell No.
	David Watts	**925.785.5340 –** Cell No.
	Chris Giuntoli	**775.685.6116 –** Cell No.
	Geocon Office No.:	**916.852.9118**
• Certified Industrial Hygienist:	**Doug Krause**	**530.848.9232** - Cell No.
	Geocon Office No.:	**530.758.6397**
• DTSC Project Manager:	**Ed Benelli**	**916.324.6564**

Scope:

- General survey activities
- Ambient perimeter air monitoring

Hazard Summary:

- Mechanical - material handling, slip/trip, struck-by injuries
- Noise – Air monitoring & facility equipment
- Overhead Utilities
- Biological – poison oak, biting insects (vectors) or animals
- Thermal Extremes – heat stress
- Chemical – T22 (CAM 17) Metals, petroleum hydrocarbons

Control Summary:

- Personal Protection Equipment - Safety vests/hard hats/safety glasses/steel-toed boots
- Hearing Protection – plugs or muffs
- Site Inspection - utility identification
- Site inspection/awareness, appropriate dress (long pants), repellent, wasp spray
- Appropriate dress, shaded rest breaks, fluids
- De minis exposure risk; sanitation

Hospital Reference: Kern Medical **661.326.2000**
1700 Mount Vernon Avenue
Bakersfield, California 93306

Hospital Directions: From the Site, proceed east on E Brundage Lane for 0.2 mi. Turn left onto Mt. Vernon Avenue (2.0 mi). Make a U-turn at College Avenue and hospital will be on the right (see Vicinity Map, Figure 2).

Emergency Assistance:

Fire/Police/Medical Assistance: **911**
Poison Control: **(800) 222-1222 (Statewide)**

1.0 INTRODUCTION

This Health and Safety Plan (HSP) is a compilation of health and safety guidelines, policies and/or performance protocols that, when exercised, are intended to reduce or eliminate the potential for injury and exposure during the performance of the activities at the site described below. Conformance with its contents does not warrant that injuries or exposures will not occur.

This HSP is not a training tool and does not contain the degree of detail necessary to train an employee on the appropriate performance, approach and/or equipment-use protocols referenced, herein. Persons working on this project and referring to this HSP shall meet the minimum training requirements described in Section 2.2.

This HSP has been prepared to specifically support the field activities described herein. The provisions described herein apply to employees of Geocon Consultants, Inc. and its subcontractors, only. Representatives of the Client, Client-retained subcontractors, and representatives of State or local government agencies are expected to observe the safety rules and requirements established by their respective organizations, provided they do not conflict with this HSP. However, Geocon will not be responsible for enforcing the conditions of this HSP on these representatives.

The contents of this HSP are based on factors and conditions understood prior to the start of the field activities. If those factors and conditions change during the performance of the activities, including the service scope, or if conditions exist that were not considered in the preparation of this HSP, then such shall be brought to the immediate attention of the person approving this HSP, and the HSP shall be modified, accordingly.

All project personnel, will review and become familiar with the elements of the Plan prior to site work. A copy of the Plan will be provided to all subcontractors and the Client or designees involved with project activities.

A pre-job conference will be held to delineate roles and responsibilities, discuss key elements of the Plan, and coordinate activities. This Plan is a "working document" to be used by affected personnel. The Plan may be modified at any time in accordance with Section 1.4 to adequately address changing conditions or previously unrecognized exposure hazards which may be encountered during the project. An updated, current copy of the Plan will be maintained at the project site during and be available to all affected personnel.

This Plan expires 6 months from the date of CIH approval unless updated or amended; ref. T8 CCR §1532.1(e)(2)(E) Lead: “Written programs shall be revised and updated at least every 6 months.”

1.1 Project Location

Site Addresses: SA Recycling – Bakersfield
2000 E. Brundage Lane
Bakersfield, California 93307-2734

1.2 Project Description

Metal shredding facilities process end-of-life vehicles, appliances, and other forms of scrap metal to recover iron, steel, aluminum, and copper for re-use in new metal products. The metal shredding process generates large amounts of metal shredder waste, which consists of plastics, rubber, glass, foam, fabrics, automobile fluids, dirt, and residual metals. The metal shredding process can also potentially create significant amounts of environmental contamination in the forms of storm water runoff, contaminated soil, contaminated groundwater, and fugitive air emissions. The focus of the scope of services described in this SAP is on fugitive air emissions from facilities generating and/or receiving metal shredding waste.

Although metal shredding waste typically does not exceed the federal regulatory levels established by the Resource Conservation and Recovery Act (RCRA), metal shredder waste has been regulated as a California-only, non-RCRA hazardous waste since 1984 because residual levels of copper, lead, and zinc often exceed California's more stringent regulatory thresholds. Six large metal shredding facilities are currently authorized by DTSC to conduct metal shredding operations. Five of the facilities treat the metal shredding waste with a cement product which is intended to reduce the solubility of the metals and render the waste less hazardous. The sixth facility transfers their waste out of state for further processing. The treated waste is then disposed of in Class II or Class III landfills, where it is largely used as alternative daily cover.

Senate Bill (SB) 1249 (Hill, Chapter 756, Statutes of 2014) became law on January 1, 2015 and requires the DTSC to evaluate the risks and threats posed by the production and management of metal shredding waste. SB 1249 authorizes the DTSC to develop alternative management standards for metal shredding facilities. The DTSC has developed a 3-year plan to conduct the evaluation required by SB 1249, which includes an assessment of the potential impacts of off-site migration of air emissions.

1.3 Project Objectives

The project task is to assess the airborne concentrations of the following constituents of potential concern (COPCs) from the perimeters of a cross-section of metal shredding facilities in a variety of geographic conditions across the state of California:

- particulate matter (PM) in the form of total suspended particulates (TSP);
- PM less than 10 micrograms (μm) (PM_{10});
- PM less than 2.5 μm ($PM_{2.5}$);

- asbestos;
- metals including aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, tin, vanadium, and zinc; and
- toxic organic species (TOS) including benzene, chloromethane, 1,1-dichloroethene, ethylbenzene, 4-ethyltoluene, dichlorodifluoromethane [also known as (aka) Freon 12], trichlorofluoromethane (aka Freon 11), 1,2,4-trimethylbenzene, toluene, 1,3,5-trimethylbenzene, xylenes, vinyl chloride, poly-chlorinated biphenyls (PCB), and formaldehyde.

The DTSC intends to use the data generated from air monitoring to determine the potential for emissions from facilities generating and/or receiving metals shredding waste and evaluate the risk to sensitive populations using the criteria developed for the California Air Resources Board (ARB) Air Toxic Hot Spots Program Air Toxics "Hot Spot" Program [the Air Toxics Hot Spots Information and Assessment Act, Assembly Bill 288 (Connelly) as amended by SB 1731 (Calderon)].

1.4 Planned Scope of Services

- General non-intrusive survey activities
- Facility perimeter ambient air monitoring

1.5 Schedule

Anticipated Period of Performance:	September-October 2016
Anticipated Weather/Temperature:	Moderate to hot and dry; daytime temperatures may exceed 85 – 90 degrees F.

2.0 ADMINISTRATIVE REQUIREMENTS/CONTROLS

2.1 Personnel

Personnel responsible for project safety include the Project Manager, the Project Safety Officer (PSO), the Certified Industrial Hygiene (CIH) consultant, and participating project personnel.

2.1.1 Project Manager

The Project Manager is responsible for development, or assigning development of the HSP, and auditing compliance with the provisions of this HSP. The Project Manager is also responsible for ensuring the HSP is reviewed and approved by the Site Safety Officer and for distributing the Plan to the client and authorized representative of each project subcontractor. In addition, the Project Manager is responsible for:

- Reviewing the HSP requirements (if prepared by another project member);
- Designating/identifying a qualified project member as the PSO;

- Providing the safety equipment specified herein;
- Collecting and submitting the requisite health and safety documentation (training rosters/certificates, air monitoring records (exposure assessments); site personnel logs, medical approvals), and copying them to the PSO, if appropriate; and,

  Note: Air monitoring and exposure assessment records will be maintained in accordance with the provisions of T8 CCR §3204, Access to Employee Exposure and Medical Records as well as requirements in T8 CCR T8 CCR Article 110 Regulated Carcinogens and §1532.1 Lead.
- Reporting all Plan amendments to the Certified Industrial Hygiene (CIH).

2.1.2 Project Safety Officer

The designated PSO has ultimate authority and responsibility for project health and safety, including approval and implementation of this Health and Safety Plan any applicable addenda. Accordingly, he/she has authority to: suspend project activities or modify service practices for health and safety reasons; and, to dismiss from a project site subcontractors or individuals whose onsite conduct either endangers the health and/or safety of others or is judged not to comply with the provisions of this Plan. Implementation of the Plan includes:

- Presenting an overview of the provisions of the HSP with project participants;
- Enforcing the provisions of this HSP;
- Maintaining project safety equipment supplies;
- Performing air monitoring, if and as specified herein, ref: T8 CCR Article 110 Regulated Carcinogens – asbestos, arsenic, cadmium, chromium VI, benzene, vinyl chloride and formaldehyde, and inorganic lead a toxic substance;
- Directing decontamination procedures, as appropriate;
- Setting up Site Controls, if and as specified herein;
- Directing emergency response operations until public emergency personnel arrive; and,
- Reporting all incidents and infractions to the Project Manager.

The PSO has the authority to suspend project activities any time he/she determines that the provisions of the HSP are inadequate to provide a service/project environment conducive to employee safety. Further, the PSO is to inform the Project Manager of any individuals whose onsite actions jeopardize either their health and safety or the health and safety of others.

2.1.3 Certified Industrial Hygienist (CIH)

The Certified Industrial Hygienist (CIH) provides industrial hygiene and safety technical support to the Project Manager and PSO. In this capacity he:

- Reviews and approves this Plan when ready for implementation;
- Provides training, as requested;
- Approves or recommends airborne sampling strategies and monitoring equipment;

- Provides technical support for the selection and use of Personal Protective Equipment (PPE); and,
- Provides arbitration on project health and safety issues.

2.1.4 Air Monitoring Field Staff

All project personnel are responsible for:

- Complying with the provisions of this HSP;
- Performing services in a manner that is consistent with good health and safety practice; and
- Reading and being knowledgeable of the contents of this HSP.

2.2 Personnel Training

2.2.1 General Site Employees

Site employees will attend a project orientation prior to starting the project. The orientation will review all elements of the HSP, including: 1) A review of facility operations and potential health and safety hazards; 2) Personal protective equipment required to be worn/used when working at the facility; 3) Review of the facility workplace safety rules; and 4) Review of the facility emergency response and evacuation procedures.

The training will also address other Cal/OSHA requirements such as the Geocon Hazard Communication Program (T8 CCR §5194), including the potential hazards of exposure to potential airborne contaminants include in the air monitoring protocols.

Anticipated characterization tasks to be performed under this HSP are considered Hazardous Waste Operations as defined by T8 CCR §5192 "Hazardous Waste Operations and Emergency Response." All project personnel will have successfully completed all applicable training requirements outlined in T8 CCR §5192(e), "Training" (40-hour Certificate and current annual Refresher Training).

2.2.2 Supervisors and Managers

Geocon employees whose responsibilities include onsite supervising or managing project tasks as defined under T8 CCR §5192(e)(4) shall hold a Supervisor Certificate documenting at least eight additional hours of specialized hazardous waste operations management training.

2.2.3 "Tailgate" Meetings

During the on-site air monitoring project the Project Manager or designee will conduct regular "tailgate" safety briefings. The briefing will include information on the following topics as applicable:

- Changes to the air monitoring strategy;
- Recognized changes to facility operations or conditions which may present a new or previously unrecognized hazard;

- Feedback from air monitoring staff on hazards, safety suggestions, or concerns; and
- Recognition for compliance, good safety performance or attitude.

Attendance at the tailgate meetings is considered a part of each employee's job responsibilities.

2.3 Medical Surveillance

Potential airborne exposure risk associate with this ambient air monitoring project are considered to be de minimis relative to workplace standards published by Cal/OSHA. For example, Negative Exposure Assessments from industrial hygiene monitoring for arsenic and inorganic lead performed for other field tasks, which is representative of potential exposure risks to other toxic metals, are well below the 5 microgram per cubic meter ($\mu g/m^3$) Action Level for arsenic (ref. T8 CCR §5214) and 30 $\mu g/m^3$ Action Level for inorganic lead (ref. T8 CCR § 1532.1).

Therefore exposure assessments are not justified and Medical Surveillance as specified under T8 CCR §5192 or other applicable Cal/OSHA standards are not required for personnel assigned to this project.

Geocon subcontractor employees who may be required to wear respiratory protection related to facility health and safety requirement shall have a current medical evaluation and approval by a physician or other licensed health care professional (PLHCP). Medical evaluations will be provided in accordance with the Geocon Respiratory Protective Equipment Program (ref. T8 CCR §5144(e) "Medical Evaluation").

3.0 HAZARD AND CONTROL ANALYSIS

The following hazards were assessed to either exist, or have the potential to develop, during the performance of the project activities:

	HAZARDS							
TASKS	MECHANICAL	UNDERGROUND/OVER-HEAD UTILITIES	NOISE	BIOLOGICAL	RADIOLOGICAL	THERMAL	CHEMICAL	OTHER
Work-related driving	**X**							
General non-intrusive activities	**X**	**X**	**X**	**X**		**X**	**X**	
Ambient Perimeter Air Monitoring	**X**	**X**	**X**	**X**		**X**	**X**	

3.1 Safe Driving

Hundreds of workers are injured or die in job-related motor vehicle accidents annually. Motor vehicle accidents are one of the number-one causes of employee injuries and deaths. Most accidents can be avoided by practicing defensive driving. Geocon policies mandate that employees:

- Prepare themselves and their vehicle for the road before travel;
- Drive according to posted speed limits unless adverse conditions necessitate slower speeds, particularly if trailering loads with sampling equipment, portable generators, etc.;
- Never tailgate, employ the three (3) second rule in following vehicles;
- Fully comply with California Vehicle Code and other local laws and regulations regarding the use of cellular phones for communication while driving - talking on a cell phone and/or texting while driving is not only a significant hazard to yourself and others, but also violates Geocon H&S policy; and,
- Use practical driving procedures in cities, on the freeway, and in rural areas.

3.2 Mechanical Hazards

Type(s)/Source:

- Material Handling/Back Injury
- Striking (slips, trips); and
- Struck-by injuries (vehicle traffic)

Qualified Exposure Risk: Moderate

Hazard Control(s):

- Safe Lifting
- Isolation (lane/shoulder closure traffic control/work methods/no work during inclement weather or darkness)
- PPE – ANSI approved yellow-green or orange reflective safety vests; hard hats; safety-toe shoe or boot; safety glasses

3.2.1 Material Handling/Back Injury

Hazard: It is expected that field personnel may be required to lift heavy equipment and supplies and/or perform arduous tasks during this project. Accordingly, back injuries or physical strain may be caused by: routine lifting or one-time-only lifting; the weight of a lifted object; the frequency of lifting; bending, twisting, or rotating during lifting; prolonged sitting; exposure to vibrations; poor arch support in shoes; and, not stretching prior to physical activity. If the following "control" mechanisms are not exercised, debilitating back injury may occur.

Control(s): Before attempting to lift and carry an object, always test its weight first. If it is too heavy, get help. If possible, use mechanical lifting aids. If manageable, the proper method for lifting is:

- Get a good footing;
- Place feet about shoulder width apart;
- Bend knees to pick up load. Never bend from the waist;
- Keep back straight;
- Get a firm hold. Grasp opposite corners of the load, if possible;
- Keep the back as upright as possible;
- Lift gradually by straightening the legs - don't jerk the load;
- Keep the weight as close to the body as possible; and
- When changing directions, turn the entire body, including the feet. Don't twist the body.

If devices are used for handling materials manually (e.g., two-handed lifters, barrel ring clamps, hand trucks, wheelbarrows, etc.), wear protective equipment like gloves and safety shoes to minimize the potential of appendages becoming pinched or smashed between the load and stationary features. Also, avoid overloading the device.

3.2.2 "Striking" Injuries

Hazard: Injuries can, and often, result when a person (a kinetic mass) unexpectedly instigates contact with another kinetic mass. These occurrences typically result from inadvertent slips, trips and falls.

Control(s): To minimize risks of “slip/trip” hazards, personnel shall maintain a constant program of good housekeeping, keeping areas clear of trip hazards and wet and slippery surfaces. All hand tools shall be regularly secured and care shall be taken when entering areas where work is being performed above eye level.

3.2.3 "Struck-by" Injuries

Hazard: Injuries can and often result when workers are the unexpected receptor of contact with another kinetic mass. These occurrences typically result from the worker being struck by a dropped or collapsed mass, a moving piece of equipment, machinery or more possibly industrial trucks or vehicles operating at the facility.

Control(s): Geocon employees will be required to wear hard hats, safety glasses and ANSI approved safety vests, as well as facility required safety equipment and adhere to the facilities safety requirements when operating within facility boundaries.

Air monitoring staff shall maintain a constant awareness of facility operations and traffic patterns of industrial trucks and haul vehicles throughout the duration of on-site monitoring tasks.

3.3 Overhead Utility Hazards

Type(s)/Source: Overhead – electrical and communications cables

Qualified Exposure Risk: Moderate – operating of scissor lifts

Controls: Prior to site work involving extended lift heights using either scissor lifts or portable scaffolds, a site inspection will be conducted to identify potential overhead hazards such as power or communication lines. A clearance of at least 10 feet will be maintained between overhead power lines any lift or air monitoring equipment.

3.4 Noise Hazards

Equipment operated at sampling sites may present a noise hazard to employees. In all cases where the sound pressure levels may exceed a time-weighted average noise dose of 85 decibels (the Action Level), the Project Manager will evaluate exposures according to the Geocon Hearing Conservation Program (ref. T8 CCR §§5095-5100). Selection of hearing protection will be made in accordance with the Geocon Safety Equipment Guide. Only hearing protectors (ear plugs or muffs) with a Noise Reduction Rating of 20 dB, or higher, will be used. When worn, earmuffs will be donned in the "over the head" position with the hair pulled back from the sealing surface.

Note: In general, noise levels in excess of 85 dBA interfere with communication between two individuals speaking in a normal tone of voice at a distance of 3 feet from one another.

3.5 Biological Hazards

Type(s)/Source: Biting insects (mosquitoes, wasps, bees & ticks) and animals; Valley Fever (cocci) inhalation coccidioidomycosis fungal spores.

Qualified Exposure Risk: Low to moderate (cocci – dependent on dry soil conditions)

Primary Control(s):

- Site inspection & isolation/avoidance of poison oak;
- PPE (Gloves/boots/long-sleeve shirts);
- Insect repellent, barrier crèmes, wasp spray;

Hazard: Contact with insects and animals likely to be present at the site should be avoided. Stinging and biting insects, including bees, spiders, and ticks, can cause extreme discomfort and/or serious allergic responses. Insect bites are generally not dangerous, unless they are from a poisonous insect or mosquitoes potentially carrying West Nile and Zika virus.

Valley Fever - San Joaquin (Central) Valley of California has reported cases of “cocci” due to inhalation of dust from soils impacted by coccidioidomycosis fungal spores, which if infected can cause flu-like symptoms or pneumonia. In most people the infection will go away on its own but all

persons with symptoms should see a healthcare provider. Although it is difficult to prevent Valley Fever, the best way to reduce risk is to avoid breathing in airborne dust from dirt in areas where Valley Fever is common; ref Attachment A – Valley Fever (Cocci) Fact Sheet.

The primary concern with animal bites and scratches is the potential for infection and/or rabies. Snake or scorpion bites can also be dangerous, but more from infection or trauma than the toxins injected by the snake or scorpion.

Control(s) – Biting Insects: Before beginning fieldwork each day, inspect the work area for the presence of standing water and inhabitant reptiles and take measures necessary to minimize the potential for contact. Specially prepared topical barriers and insect repellent containing approximately 50% DEET, or picaridin, IR3535, oil of lemon eucalyptus, or para-menthane-diol for long lasting protection for protecting exposed skin from biting insects. These products are commercially available and may minimize the potential for development of skin rashes and/or irritations due to such exposures; apply insect repellent sparingly to exposed skin.

Note: Avoid contacting plastic zippers or other plastic closure mechanisms on clothing, equipment bags, etc., with DEET containing crème which will cause these materials to degrade.

If you are allergic to bee or wasp stings, be sure to have the appropriate first aid available (e.g., an epi-pen) on the project. If you are stung, administer first aid and seek immediate medical attention.
Be sure a reptile or animal bite victim obtains medical attention quickly if a bite or scratch occurs, especially if there is a potential that it was poisonous. In the meantime, administer First Aid by scrubbing the wound with soap and water, and rinsing thoroughly under running water. Dry off and place a clean bandage on the wound. Victims of these bites should lie down and remain calm and motionless; cold packs should be applied and medical attention sought immediately.

3.6 Thermal Hazards – Heat Stress

Type(s)/Source:	Solar load – working outdoors in summer months
Qualified Exposure Risk:	Moderate to high if forecasted daytime temps may exceed 85-90 degrees F
Primary "Control":	Compliance with T8 CCR §3395 Heat Illness Prevention Dress appropriately for the expected weather conditions; Adequate supply of drinking water, fluid consumption.

Hazard: In addition to the chemical, physical and operational hazards referenced above, heat stress may present a potential hazard to onsite personnel during the on-site operations. This hazard can be created when individuals work in warm temperatures while wearing relatively impervious chemical protective clothing (CPC), i.e., Tyvek™ coveralls. When ambient air temperatures at a project site exceed approximately 75 degrees Fahrenheit when CPC is worn, heat stress can result.

Also, when ambient air temperatures at a project site exceed 85 to 95 degrees Fahrenheit, heat stress is a potential risk regardless if CPC is worn or not worn. If these conditions are encountered, the following precautions shall be implemented:

Controls: The PSO will regularly monitor daily weather forecasts and monitor ambient air temperatures. In addition, routinely observe and monitor archaeology field staff for signs and symptoms of heat stress including: dizziness, profuse sweating or lack of perspiration (hot dry skin), and skin color change – flush appearance. If necessary, monitor for increased heart rate and potential vision problems. Personnel who exhibit any of these symptoms will immediately be removed from field work to a shaded location, and required to consume 2 to 4 pints of cool water while resting. Individuals exhibiting symptoms of heat stress should not return to work until the symptoms are no longer recognizable.

Note: If symptoms of hot, dry skin or other critical symptoms appear, immediately implement emergency medical procedures by dialing 911. While awaiting the arrival of emergency medical services attempt to cool the individual's body by saturating their upper clothing (shirt) with cool, but not chilled or cold water.

To control the potential occurrence of heat stress, preventive measures will be evaluated and implemented on a daily basis (ref. T8 CCR §3395 Heat Illness Prevention). These measures will include:

- Schedule periodic cooling and rest (recovery) periods in a shaded area (ref. T8 CCR §3395(d) Heat Illness Prevention);
- Designated shaded rest areas, or portable shade structures must be available when the ambient daily high temperature is predicted to exceed 85 degrees Fahrenheit, or 75 degrees Fahrenheit if CPC will be required to be worn; and,
- Inducement of water intake, the equivalent quantity of 1 quart of water per hour per on-site archaeology staff (2 gallons per person) be available before work begins unless provisions for immediate water replenishments are available (nearby store, plumbed water supply, etc.). Water must always be replenished before running out (ref. T8 CCR §3395(c) Heat Illness Prevention).

The implementation frequency of these measures will be the responsibility of the PSO.

3.7 Chemical Hazards

Potential airborne exposure risk associate with this ambient air monitoring project are considered to be de minimis relative to workplace standards published by Cal/OSHA; ref. Section 2.3 Medical Surveillance.

Detailed information regarding the physical description of asbestos, toxic metals and toxic organic compounds identified in Section 1.3 Project Objectives, including health hazards, routes of entry into the body, signs and symptoms of exposure, target organs, chemical and physical properties are available in Attachments B - Asbestos, C, D, E and F – Toxic Metals , and Attachment G – Toxic Organic Compounds. The chemical guides for representative toxic metals and organic compounds are published by the National Institute for Occupational Safety and Health (NIOSH); the Substance information sheets for Cal/OSHA regulated carcinogens - Asbestos, Arsenic, Cadmium and Lead are Appendices H or A of T8 CCR §§1529, 5214, 1532 and 1532.1 respectively; the hazards of Chromium VI, T8 CCR 1532.2 are covered in the NIOSH Guide.

3.7.1 Asbestos or Asbestos-Containing Materials (ACM)

Types/Source: Airborne asbestos fibers, asbestos containing materials (ACM) and asbestos containing building materials (ACBM) – potential pollutants from metal shredding operations.

Exposure Route: Inhalation; ref. Attachment B - T8 CCR §1529 Asbestos - Appendix H

CHEMICAL NAME CAS #	ROUTES OF ENTRY	PUBLISHED EXPOSURE LIMITS		
		CATEGORY	CONCENTRATION	SOURCE
Asbestos (including actinolite, amosite, anthophyllite, chrysotile, crocidolite and tremolite 1332-21-4	Inhalation Ingestion	PEL-TWA PEL-Excursion Limit	0.1 fiber/cc 1.0 fiber/cc	Cal/OSHA

†PEL – Permissible Exposure Limit; TWA – 8-Hour Time-Weighted Average Exposure

3.7.2 Toxic Metals

Type(s)/Source: Potential pollutants from metal shredding operations.

Aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, tin, vanadium and zinc.

Exposure Route(s): Inhalation and ingestion; ref. Attachment C – Toxic Metals

CHEMICAL NAME AND CAS #	ROUTES OF ENTRY	PUBLISHED EXPOSURE LIMITS		
		CATEGORY	CONCENTRATION	SOURCE
Title 22 Metals, Elemental, Inorganic Compounds	Inhalation, Ingestion, Dermal Contact	PEL-TWA†	0.0005 to 5 mg/m^3	Cal/OSHA

3.7.2.1 Arsenic

T8 CCR GISO Article 110 Regulated Carcinogen §5214

Exposure Route: Inhalation, ingestion, skin contact; ref. Attachment D - T8 CCR §5214 Inorganic Arsenic - Appendix A

CHEMICAL NAME AND CAS #	ROUTES OF ENTRY	PUBLISHED EXPOSURE LIMITS		
		CATEGORY	CONCENTRATION	SOURCE
Arsenic 7440-38-2	Inhalation, Ingestion	PEL-TWA Action Level	10 µg/m^3 5 µg/m^3	Cal/OSHA

3.7.2.2 Cadmium

T8 CCR GISO Article 110 Regulated Carcinogen §1532

Exposure Route: Inhalation, ingestion; ref. Attachment E - T8 CCR §1532 Cadmium - Appendix A

CHEMICAL NAME AND CAS #	ROUTES OF ENTRY	PUBLISHED EXPOSURE LIMITS		
		CATEGORY	CONCENTRATION	SOURCE
Cadmium 7440-43-9	Inhalation, Ingestion	PEL-TWA	5.0 µg/m^3	Cal/OSHA

3.7.2.3 Inorganic Lead

T8 CCR CSO §1532.1

Exposure Route: Inhalation and ingestion; ref. Attachment F - T8 CCR §1532.1 Lead - Appendix A

CHEMICAL NAME CAS #	ROUTES OF ENTRY	PUBLISHED EXPOSURE LIMITS		
		CATEGORY	CONCENTRATION	SOURCE
Lead, Elemental & Inorganic Compounds 7439-92-1	Inhalation & Ingestion	PEL-TWA Action Level	50 µg/m^3 30 µg/m^3	Cal/OSHA
Lead Chromate as Pb Lead Chromate as Cr 7758-97-6	Inhalation & Ingestion	PEL-TWA$_{Pb}$ PEL-TWA$_{Cr}$	20 µg/m^3 5 µg/m^3	

3.7.2.4 Chromium VI (Hexavalent Chromium)

T8 CCR GISO Article 110 Regulated Carcinogen §1532.2

Exposure Route: Inhalation and ingestion; ref. Attachment C - NIOSH Guide Page 5

CHEMICAL NAME & CAS #	ROUTES OF ENTRY	PUBLISHED EXPOSURE LIMITS		
		CATEGORY	CONCENTRATION	SOURCE
Chromium VI 7440-47-3	Inhalation, Ingestion skin contact	PEL-TWA	5.0 µg/m^3	Cal/OSHA

3.7.3 Toxic Organic Compounds

Types/Source: Fuel, lubricants, waste oils, refrigerants as potential pollutants from metal shredding operations

Exposure Route: Inh., skin abs; ref. Attachment G - NIOSH Guides Toxic Organic Compounds

3.7.3.1 Benzene

T8 CCR GISO Article 110 Regulated Carcinogen §5218

Exposure Route: Inhalation and ingestion; ref. Attachment H - T8 CCR §5218

CHEMICAL NAME & CAS#	ROUTES OF ENTRY	PUBLISHED EXPOSURE LIMITS		
		CATEGORY	CONCENTRATION	SOURCE
Benzene 71-73-2	Inhalation Skin Absorption	PEL-TWA STEL‡	1 ppm 5 ppm	Cal/OSHA

‡STEL – Short-Term Exposure Limit (15 minute TWA)

3.7.3.2 Vinyl Chloride

T8 CCR GISO Article 110 Regulated Carcinogen §5210

Exposure Route: Inhalation and ingestion; ref. Attachment G - NIOSH Guides

CHEMICAL NAME & CAS#	ROUTES OF ENTRY	PUBLISHED EXPOSURE LIMITS		
		CATEGORY	CONCENTRATION	SOURCE
Vinyl Chloride 75-01-4	Inhalation Skin Absorption	PEL-TWA STEL Action Level	1 ppm 5 ppm 0.5 ppm	Cal/OSHA

3.7.3.3 Formaldehyde

T8 CCR GISO Article 110 Regulated Carcinogen §5217

Exposure Route: Inhalation and ingestion; ref. Attachment I - T8 CCR §5217 Formaldehyde - Appendix A

CHEMICAL NAME & CAS#	ROUTES OF ENTRY	PUBLISHED EXPOSURE LIMITS		
		CATEGORY	CONCENTRATION	SOURCE
Formaldehyde 50-00-0	Inhalation Skin Sensitizer	PEL-TWA	0.75 ppm	Cal/OSHA

3.7.2.3 Aromatic Petroleum Distillates

T8 CCR GISO §5155 Table AC-1 Permissible Exposure Limits for Airborne Contaminants

CHEMICAL NAME & CAS#	ROUTES OF ENTRY	PUBLISHED EXPOSURE LIMITS		
		CATEGORY	CONCENTRATION	SOURCE
Methyl Chloride (Chloromethane) 74-87-3	Inhalation	PEL-TWA STEL Ceiling	50 ppm 100 ppm 300 ppm	Cal/OSHA
1,1-Dichloroethylene (1,1-Dichloroethene; Vinylidene chloride) 75-34-4	Inhalation	PEL-TWA	1 ppm	Cal/OSHA
Ethylbenzene 100-41-4	Inhalation	PEL-TWA STEL	100 ppm 125 ppm	Cal/OSHA
4-Ethyltoluene 622-96-8	Inhalation	PEL-TWA	Not Established	Cal/OSHA
Dichlorodifluoromethane 75-71-8 (Freon 12)	Inhalation	PEL-TWA	1000 ppm	Cal/OSHA
Trichlorofluoromethane 75-69-4 (Freon 11)	Inhalation	PEL-TWA	1000 ppm	Cal/OSHA
Trimethylbenzene All isomers	Inhalation	PEL-TWA	25 ppm	Cal/OSHA
Toluene 108-88-3	Inhalation Skin Absorption	PEL-TWA STEL Ceiling	10 ppm 150 ppm 500 ppm	Cal/OSHA
Xylenes 1330-20-7	Inhalation	PEL-TWA STEL Ceiling	100 ppm 150 ppm 300 ppm	Cal/OSHA
Chlorodiphenyl (PCB 42%) 53469-21-9	Inhalation Skin Absorption	PEL-TWA	1 mg/m^3	Cal/OSHA
Chlorodiphenyl (PCB 54%) 11097-69-1	Inhalation Skin Absorption	PEL-TWA	0.5 mg/m^3	Cal/OSHA

4.0 GENERAL HEALTH AND SAFETY REQUIREMENTS

4.1 Personal Hygiene

The PSO will establish hand-wash facilities, including clean water, hand soap, waterless hand cleaner, sanitary wipes and clean towels at the facility IF the facility bathrooms are not made available. All Geocon personnel leaving the project site will wash hands prior to leaving the project facility. In addition, the following procedures will be followed to ensure worker protection against potential exposure through ingestion:

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-in-mouth transfer and ingestion of material is prohibited while working in or around the project facility.
- Hands and face must be thoroughly washed upon leaving the facility, and before eating, drinking, or other non-project activities.

4.2 Buddy System

Project personnel are to work with another person when performing ambient air monitoring tasks; a facility representative can serve as the second person while the work is being conducted during regular business hours. Under no circumstances, other than completion of air monitoring documentation paper work are project personnel to work alone at the facility.

4.3 Work Zone Controls

Although formal work zones will not be required for this project, air monitoring stations will be isolated using traffic cones and/or safety/caution sandwich boards.

4.4 Code of Safe Practices

General safe work practices to be utilized by all project personnel are summarized below:

- All nonessential personnel will be kept clear of work areas.
- The use of entertainment and personal communication devices in the work zone shall not be allowed.
- Adequate signs and safety devices will be installed on equipment.
- All site employees will wear assigned personal protective equipment and level of protection as designated by the PSO.
- Eating, drinking, smoking, chewing gum or tobacco, or application of cosmetics is allowed in designated areas only.
- At a minimum, all personnel will wash with soap and water before lunch, using the restroom, and at the end of work. The face and hands shall be washed before eating, drinking, smoking, chewing gum, applying cosmetics, etc.
- Over-the-counter drugs and prescription medications must be reported to the PSO for clearance before an employee is allowed to operate high-volume samplers or associate equipment, i.e., portable generators.
- When portable electric tools and equipment are used, three-wire extension cords are required.
- Employees will advise their supervisors of any malfunctioning equipment immediately.
- An ongoing safety maintenance program for tools and equipment will be instituted. Inspections will occur on a regular basis to ensure parts are secure and intact. Defective equipment will be repaired or replaced.
- Appropriate engineering controls and equipment guards will be installed on tools and equipment. This includes seat belts and backup warning lights and signals.
- A list of names of personnel who are trained in CPR and first aid shall be available.
- Labels shall be placed on containers of hazardous materials.
- No one will work alone; the "buddy system" shall be implemented for all field work.
- Employees shall be trained to identify effects and symptoms of toxic exposure and report them immediately.

- Under no circumstances are Geocon personnel authorized to enter a Permit-Required Confined Space, or unshored trench or excavation.

5.0 PERSONAL PROTECTIVE EQUIPMENT

The use of PPE is intended to provide protection for air monitoring personnel from operational hazards related to tasks performed at the facility that cannot be controlled through other safety procedures or work practices.

PPE required to be onsite for each worker during this project will include:

☒ Hard Hat (without face Shield)	☒ Safety Glasses
☒ Safety Shoes - Boots	☐ Disposable gloves (for sample handling)
☐ Chem. Resistant Boots	☐ Chem. Resistant gloves
☐ Leather Gloves	☐ Air-Purifying Respirator
☒ Ear Plugs/Muffs	☐ APR Cartridges
☒ ANSI Approved Safety Vest	☐ Tyvek® coveralls

☒ Other: PPE required to be worn by the facility operator beyond Geocon required PPE.

Only ANSI-approved PPE and NIOSH-approved respirators will be assigned for use. The use applications for this equipment are summarized in the following matrix. Specific procedures are further described below.

	PPE												
TASKS	Hard Hat	Safety Glasses	Safety Shoes - Boots	Chemical Resistant Boots	Disposable Gloves	Chemical Resistant Gloves	Leather Gloves	Ear Plugs/Muffs	Air-Purifying Respirator	APR Cartridges	ANSI Approved Safety Vest	Tyvek® Coveralls	Other
Perimeter Ambient Air Monitoring	**X**	**X**	**X**					**X**			**X**		**X**

5.1 Respiratory Protection

Respiratory protection will not be required during sampling activities. The PSO, in consultation with the Project Safety Officer, will determine the need for upgrading the level of protection from "D" to "C". If it is determined that respiratory protection is required, personnel shall don a full facepiece or half-mask dual cartridgeair-purifying respirator fitted with a combination organic vapor (Black), or organic vapor-acid gas (Yellow) and HEPA (P100, Magenta) cartridges.

5.2 PPE – Level D Protection

The protective equipment to be donned by personnel working in the Exclusion Zone includes:

- Body Protection: Body protection shall include the use of "work clothing," including long pants and long- or short-sleeved shirts, and Class II ANSI approve safety vest.
- Head Protection: Non-metallic hard hats shall be worn by all personnel; ref. T8 CCR §§1514 & 3385 Head Protection.
- Hearing Protection: Hearing protection shall include the use of foam ear inserts or muffs; ref. T8 CCR §5098.
- Face & Eye Protection: Protective eye wear (i.e., safety glasses) shall be worn by personnel working in direct proximity to operating heavy equipment and highway traffic; ref. T8 CCR §§1514 & 3385 Eye Protection.
- Hand Protection: Appropriate hand protection shall be required for employees whose work involves unusual and excessive exposure of hands to cuts capable of causing injury or impairments; ref. T8 CCR §§1514 & 3384 Hand Protection.
- Foot Protection: foot protection, such as steel toed shoes or boots shall be required for employees who are exposed to foot injuries from electrical hazards, falling objects, or crushing or penetrating actions; ref. T8 CCR §§1514 & 3385 Foot Protection.

5.3 PPE – Level "C" Protection

Level D protection may be up-graded to Level C protection by site personnel with prior notification to the Project Manager. Level C protection shall only be downgraded in consultation with the Geocon Consulting CIH.

5.4 Miscellaneous Safety Equipment

Additional protective equipment to be available to personnel working at the site includes portable radios/walkie-talkies or cell phones shall accompany all personnel.

6.0 EMERGENCY RESPONSE PROCEDURES

6.1 Physical Injury

In the event of an accident resulting in physical injury, call emergency service personnel immediately and perform first aid commensurate with training and seriousness of the injury. Severely injured personnel are to be transported only by emergency service personnel and/or by ambulance personnel, unless a life-threatening condition is judged to exist that must be addressed immediately.

The Project Manager is to be notified by the PSO, as soon after the injury as practical, regarding the nature of the accident. The Project Manager or designee will prepare a written report within 24 hours of the accident.

6.2 Catastrophic Event

In the event of a catastrophic event (e.g., severe personal injury, fire, explosion, and/or property damage), notify the fire/safety and rescue department immediately by dialing 911.

Any accident involving serious injury, illness, or death will require suspension of site activities until the Project Manager (or designee) has completed a review of the events and site conditions and authorized work to resume.

The Project Manager (or designee) will notify the nearest Cal/OSHA District Office immediately (within 8-hours) by phone or fax upon learning of a death or serious injury:

Bakersfield District Office
7718 Meany Avenue
Bakersfield, California 93308

Tel: 661.588.6400
Fax: 661.588.6428

6.3 Emergency Telephone Numbers

Fire/Police/Medical Assistance:	**911**
Poison Control:	**(800) 222-1222**

Other phone numbers may be available or required for emergency response at specific sites. Check with onsite representatives before mobilizing to the job site.

6.4 Project Site Address

Site Addresses: SA Recycling – Bakersfield **661.327.3559**
2000 E. Brundage Lane
Bakersfield, California 93307-2734

6.5 Hospital Addresses and Routes

Hospital Reference: Kern Medical **661.326.2000**
1700 Mount Vernon Avenue
Bakersfield, California 93306

Hospital Directions: From the Site, proceed east on E Brundage Lane for 0.2 mi. Turn left onto Mt. Vernon Avenue (2.0 mi). Make a U-turn at College Avenue and hospital will be on the right (see Vicinity Map, Figure 2).

7.0 PLAN APPROVAL

The undersigned has reviewed and approved this Health and Safety Plan prepared for ambient perimeter air monitoring conducted at the SA Recycling - Metal Shredding Facility in Bakersfield, California, as described herein.

Douglas S. Krause, CIH
Certified Industrial Hygienist
ABIH Certification No. 2123, Exp. June 1, 2020

September 30, 2016
Date

Josh Ewert
Project Manager

September 30, 2016
Date

The following personnel, including subcontractors involved with the project activities have reviewed, or received a copy of this Plan and Attachments A, B, C, D, E, F, G, H & I, and agree to follow the health and safety procedures described herein.

Print Name	Title	Signature	Date

Preventing Work-Related Coccidioidomycosis (Valley Fever)

Valley Fever is an illness that usually affects the lungs. It is caused by the fungus *Coccidioides immitis* that lives in soil in many parts of California. When soil containing the fungus is disturbed by digging, vehicles, or by the wind, the fungal spores get into the air. When people breathe the spores into their lungs, they may get Valley Fever.

Is Valley Fever a serious concern in California? YES!

Often people can be infected and not have any symptoms. In some cases, however, a serious illness can develop which can cause a previously healthy individual to miss work, have long-lasting and disabling health problems, or even result in death.

This fact sheet describes actions employers can take to prevent workers from getting Valley Fever and to respond appropriately if an employee does become ill.

➤ **In October 2007, a construction crew excavated a trench for a new water pipe. Within three weeks, 10 of 12 crew members developed coccidioidomycosis (Valley Fever), an illness with pneumonia and flu-like symptoms. Seven of the 10 had abnormal chest x-rays, four had rashes, and one had an infection that had spread beyond his lungs and affected his skin. Over the next few months, the 10 ill crew members missed at least 1660 hours of work and two workers were on disability for at least five months.**

FACT SHEET HESIS

HAZARD EVALUATION SYSTEM & INFORMATION SERVICE
California Department of Public Health, Occupational Health Branch
850 Marina Bay Parkway, Building P, 3rd Floor, Richmond, CA 94804
510-620-5757 • www.cdph.ca.gov/programs/ohb

JUNE 2013

California Department of Public Health • California Department of Industrial Relations

How do workers get Valley Fever?

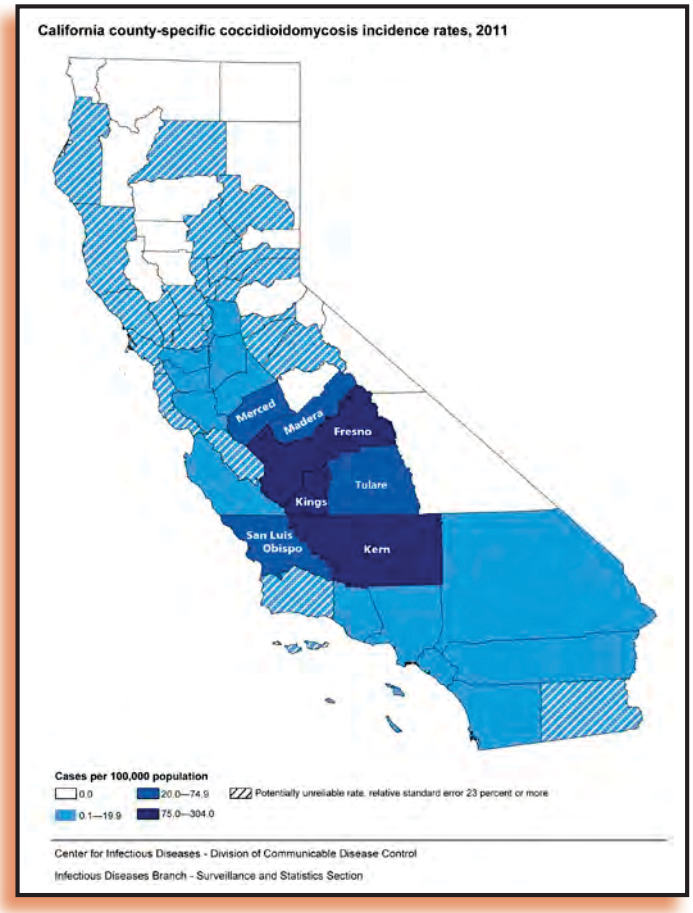
In California, Valley Fever is caused by the fungus *Coccidioides immitis* that lives in the top two to 12 inches of soil in many parts of the state. When soil containing this fungus is disturbed by activities such as digging, vehicles, or by the wind, the fungal spores get into the air. When people breathe the spores into their lungs, they may get Valley Fever. Fungal spores are small particles that can grow and reproduce in the body. The illness is not spread from one person to another.

How do employers know if the fungus is present in soil at their worksites?

The Valley Fever fungal spores are too small to be seen by the naked eye, and there is no reliable way to test the soil for spores before working in a particular place. Some California counties consistently have the Valley Fever fungus present in the soil. In these regions Valley Fever is considered endemic. Health departments track the number of cases of Valley Fever illness that occur. This information is used to map illness rates as seen on the figure above. Employers can contact their local health department for more information about the risk in their counties.

Where do people get Valley Fever?

Highly endemic counties, i.e., those with the highest rates of Valley Fever (more than 20 cases per 100,000 population per year), are Fresno, Kern, Kings, Madera, Merced, San Luis Obispo, and Tulare. Other counties or parts of counties also have the fungus present.



California county-specific coccidioidomycosis incidence rates, 2011

Who is at risk for Valley Fever?

Workers who disturb the soil by digging, operating earth-moving equipment, driving vehicles, or working in dusty, wind-blown areas are more likely to breathe in spores and become infected. Some occupations at higher risk for Valley Fever include:

- Construction workers, including road-building and excavation crews
- Archeologists
- Geologists
- Wildland firefighters
- Military personnel
- Workers in mining, quarrying, gas and oil extraction jobs
- Agricultural workers*

* Cultivated, irrigated soil may be less likely to contain the fungus compared to undisturbed soils.

Anyone, even healthy young people, can get Valley Fever. Once a person has had Valley Fever, their body may develop some immunity against future infections.

How does Valley Fever affect health?

- Experiments on laboratory animals indicate that a very small dose, 10 spores or fewer, may cause an infection.
- After breathing in the spores, the following can happen:
  - In about 60% of cases, symptoms are mild or not present.
  - In about 40% of cases, symptoms vary from moderate to severe. Usually symptoms are those of a flu-like illness that may last up to a month but goes away on its own. However, some people develop pneumonia (at times severe).
  - In a small proportion of cases (about 5%), disease spreads outside of the lungs causing very serious illness. Parts of the body that may be affected include the brain (meningitis), bones, joints, skin, or other organs. This is called ***disseminated Valley Fever*** (or disseminated coccidioidomycosis).
- People who are more likely to have severe or disseminated Valley Fever include those who have weakened immune systems, such as people who are HIV positive, have AIDS, cancer, or diabetes; who smoke; or who are pregnant. People of African and Filipino descent are much more likely to get disseminated disease; however, others can get disseminated disease, too.

Earth-moving equipment may stir up spores

What are signs or symptoms of Valley Fever?

When present, symptoms usually occur between seven to 21 days after breathing in spores, and can include:

- Cough
- Fever
- Chest pain
- Headache
- Muscle aches
- Rash on upper trunk or extremities
- Joint pain in the knees or ankles
- Fatigue.

Symptoms of Valley Fever can be mistaken for other diseases such as the flu (influenza) and TB (tuberculosis), so it is important for workers to obtain medical care for an accurate diagnosis and possible treatment.

Disseminated Valley Fever

Dissemination refers to spread of infection beyond the lungs to other parts of the body. With Valley Fever this usually occurs within the first six to 12 months after the initial illness.

Signs or symptoms of disseminated Valley Fever may vary but usually consist of some combination of the following:

- Fever
- Raised skin lesions with irregular surfaces
- Lymph node swelling, especially in the neck
- Pain and swelling in one or more joints
- Recurrent, persistent, new headaches (may be mild)
- Stiff neck.

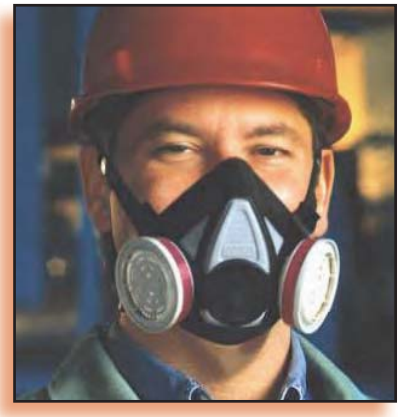
Preventing Valley Fever exposure

There is no vaccine to prevent Valley Fever. Employers can reduce worker exposure by incorporating the following elements into the company's Injury and Illness Prevention Program and project-specific health and safety plans:

1. Determine if the worksite is in an area where Valley Fever is endemic (consistently present). Check with your local health department to determine whether cases have been known to occur in the proximity of your work area. See the map on page 2 to determine whether your company will be working in an endemic county.
2. Train workers and supervisors on the location of Valley Fever endemic areas, how to recognize symptoms of illness (see page 3), and ways to minimize exposure. Encourage workers to report respiratory symptoms that last more than a week to a crew leader, foreman, or supervisor.
3. Limit workers' exposure to outdoor dust in disease-endemic areas. For example, suspend work during heavy wind or dust storms and minimize amount of soil disturbed.
4. When soil will be disturbed by heavy equipment or vehicles, wet the soil before disturbing it and continuously wet it while digging to keep dust levels down.
5. Heavy equipment, trucks, and other vehicles generate heavy dust. Provide vehicles with enclosed, air-conditioned cabs and make sure workers keep the windows closed. Heavy equipment cabs should be equipped with high efficiency particulate air (HEPA) filters. Two-way radios can be used for communication so that the windows can remain closed but allow communication with other workers.
6. Consult the local Air Pollution Control District regarding effective measures to control dust during construction. Measures may include seeding and using soil binders or paving and laying building pads as soon as possible after grading.
7. When digging a trench or fire line or performing other soil-disturbing tasks, position workers upwind when possible.
8. Place overnight camps, especially sleeping quarters and dining halls, away from sources of dust such as roadways.

PAPR with helmet (APF=1000)

Full-face respirator (APF=50)



Half-mask respirator (APF=10)

9. When exposure to dust is unavoidable, provide NIOSH-approved ***respiratory protection*** with particulate filters rated as N95, N99, N100, P100, or HEPA. Household materials such as washcloths, bandanas, and handkerchiefs do not protect workers from breathing in dust and spores.

Respirators for employees must be used within a Cal/OSHA compliant respiratory protection program that covers all respirator wearers and includes medical clearance to wear a respirator, fit testing, training, and procedures for cleaning and maintaining respirators.

Different classes of respirators provide different levels of protection according to their Assigned Protection Factor (APF) (see table below). Powered air-purifying respirators (PAPRs) have a battery-powered blower that pulls air in through filters to clean it before delivering it to the wearer's breathing zone. PAPRs will provide a high level of worker protection, with an APF of 25 or 1000 depending on the model. When PAPRs are not available, provide a well-fitted NIOSH-approved full-face or half-mask respirator with particulate filters.

Fit-tested half-mask or filtering facepiece respirators are expected to reduce exposure by 90% (still allowing about 10% faceseal leakage), which can result in an unacceptable risk of infection when digging where Valley Fever spores are present.

The table below shows the relative effectiveness of various types of respirators for particles of dust and spores.

Respiratory Protection for Reducing Dust and Spore Exposure

	Respirator Type (worn with particulate filters)	**Assigned Protection Factor (APF)**	**Expected Reduction of Exposure to Dust and Spores (%)**
	No respirator	None	0
Increasing Protection ↓	Half-mask respirator (elastomeric or filtering facepiece)	10	90
	Powered air-purifying respirator with loose-fitting face covering	25	96
	Full-face respirator	50	98
	Some powered air-purifying respirators are designed to offer higher protection (check with manufacturer)	1000	99.9

Preventing transport of spores

- **Clean tools, equipment, and vehicles with water to remove soil before transporting offsite** so that any spores present won't be re-suspended in air and inhaled at a later time.
- **Provide workers with coveralls or disposable Tyvek™ daily.** At the end of the work day, require workers to remove their work clothes at the worksite.
- **Keep street clothes and work clothes separate by providing separate lockers or other storage areas.** If possible, store work boots at the worksite; otherwise, have workers use a boot wash before getting into their vehicles.
- **Encourage workers to shower and wash their hair at the workplace** (if at a fixed location) or as soon as they get home.

What should employers do if a worker reports Valley Fever symptoms?

- If the worker disturbed soil or otherwise did dusty work in an endemic area, **the employer should send the worker to their workers' compensation health care provider or occupational medicine clinic**. The employer should provide the health care provider with the details about the dust or soil exposure. The worker should give a copy of this fact sheet to the health care provider.
- When two or more workers report symptoms that suggest Valley Fever, workers should be sent to a single medical provider or occupational medicine clinic for coordinated medical care, if possible. This can facilitate better communication between the medical provider, public health agencies, and employer.
- **Travel through endemic areas has resulted in Valley Fever cases.** When a worker who has traveled through an endemic area reports a respiratory illness that lasts more than a week, the employer should send the worker to their workers' compensation health care provider or occupational medicine clinic.
- **Complete the "Employer's Report of Occupational Injury or Illness" (Form 5020) for each occupational Valley Fever illness** which results in "lost time" or medical treatment beyond first aid.
- **List cases on the Cal/OSHA Form 300,** "Log of Work-Related Injuries and Illnesses".
- **Report immediately any serious injury, illness or death occurring in a place of employment** or in connection with any employment to the local Cal/OSHA district office. A "serious injury or illness" is defined in 8 CCR 330(h) found at **www.dir.ca.gov/title8/330.html**.

What is the treatment for Valley Fever?

Although many people with Valley Fever do not require treatment, those with symptoms should seek medical attention. When Valley Fever is suspected, doctors can order specialized tests to confirm the diagnosis. If treatment is indicated, anti-fungal medications are available. Workers who develop severe or chronic infections may need to stay in the hospital.

It is especially important for people at risk for severe disease, such as people infected with HIV or those with weakened immune systems, to be diagnosed and receive treatment as quickly as possible. People with severe infections need to be treated because advanced Valley Fever can be fatal.

Summary of Controls to Minimize Workers' Dust Exposure and Risk of Valley Fever in Endemic Areas

Type of Control	Actions
Engineering and Work Practice Controls ➤ *to control dust at the source or isolate worker from exposure.*	Minimize exposure to outdoor dust: • Suspend (stop) work in dust storms or high winds. • Minimize the amount of digging by hand. Instead, use heavy equipment with operator in an enclosed, air-conditioned, HEPA-filtered cab. Continuously wet the soil before and while digging or moving the earth. Landing zones for helicopters and areas where bulldozers, graders, or skid steers operate are examples where wetting the soil is necessary. When digging in soil is required, train workers to reduce the amount of dust inhaled by staying upwind when possible.
Administrative Controls ➤ *to increase hazard awareness and knowledge of safe work practices and select safer work practices.*	Train workers and supervisors on: • Distribution of endemic areas • Symptoms and signs, and need to report to supervisor to obtain medical evaluation • People at highest risk of serious disease • Effective controls, including proper use of equipment.
Personal Protective Equipment ➤ *to decrease quantity of fungal spores inhaled.*	Provide respirators when digging or working near earth-moving trucks or equipment: • Powered air-purifying respirator (PAPR) with high efficiency particulate air (HEPA) filter or • Full-face respirator with particulate filter or • Half-mask respirator with particulate filter and • Implement a comprehensive respirator program including medical clearance, training, fit testing, and procedures for cleaning and maintaining respirators. Provide coveralls to prevent street clothes from being contaminated with fungal spores and then taken home.
Clean up ➤ *to decrease quantity of fungal spores inhaled.*	Provide lockers and require change of clothing and shoes at worksite so workers don't take dust and spores home. Wash equipment before moving offsite.
Medical care for disease recognition and prompt, appropriate treatment.	Contract with local medical clinics • Provide prompt evaluation and care • Make sure clinic has a protocol for evaluation, follow-up, and treatment of Valley Fever Make sure in-house physician is aware of work in Valley Fever endemic areas.

Valley Fever in the general population in California (*includes individuals exposed at work*):

- In 2011, 5123 people were diagnosed with new infections.
- The number of new Valley Fever cases reported in California increased dramatically in the past few years. In 2011, there were 20% more cases compared to 2010.
- Every year, about 1,430 people are hospitalized with Valley Fever.
- About 8% (8 out of 100) of people hospitalized with Valley Fever die due to the infection.

RESOURCES

FOR MORE INFORMATION

- **California Department of Public Health,** *"Coccidioidomycosis (Valley Fever) Fact Sheet"* **www.cdph.ca.gov/healthinfo/discond/pages/coccidioidomycosis.aspx** Available in English, Spanish, and Tagalog. Also see *Yearly Summary Report of Coccidioidomycosis in California.*
- **California Department of Public Health, Hazard Evaluation System and Information Service (HESIS).** HESIS answers questions about workplace hazards for California workers, employers, and health care professionals. Call **(510) 620-5817 or (866) 282-5516 (toll free in CA).** HESIS has many free publications available. To request publications, leave a message at **(510) 620-5717 or toll free (866) 627-1586**, or visit our website at **www.cdph.ca.gov/programs/ohb**
- **Centers for Disease Control and Prevention,** *"Coccidioidomycosis, Valley Fever"* **www.cdc.gov/fungal/coccidioidomycosis/.**
- **Centers for Disease Control and Prevention,** *"Increase in Reported Coccidioidomycosis-United States, 1998-2011,"* March 29, 2013 **http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6212a1.htm**
- **Injury and Illness Prevention Program.** This standard (California Code of Regulations (CCR) Title 8, Section 3203), requires employers to implement an injury and illness prevention program (IIPP). For links to publications on IIPPs, see **www.dir.ca.gov/title8/3203.html.**
- **Respiratory Protection.** This standard, CCR Title 8, Section 5144, requires employers to provide respirators when necessary to protect the health of employees. See **www.dir.ca.gov/title8/5144.html**.

To obtain a copy of this document in an alternate format, please contact: (510) 620-5757. (CA Relay Service: 800-735-2929 or 711). Please allow at least ten (10) working days to coordinate alternate format services.

Edmund G. Brown Jr., Governor
State of California

Diana S. Dooley, Secretary
Health and Human Services Agency

Ron Chapman, MD, MPH, Director and
State Health Officer
California Department of Public Health

Marty Morgenstern, Secretary
Labor and Workforce Development Agency

Christine Baker, Director
Department of Industrial Relations

JANE NORLING DESIGN

Substance Technical Information for Asbestos - Non-Mandatory

I. Substance Identification

A. Substance: "Asbestos" is the name of a class of magnesium-silicate minerals that occur in fibrous form. Minerals that are included in this group are chrysotile, crocidolite, amosite, anthophyllite asbestos, tremolite asbestos, and actinolite asbestos.

B. Asbestos is used in the manufacture of heat-resistant clothing, automotive brake and clutch linings, and a variety of building materials including floor tiles, roofing felts, ceiling tiles, asbestos-cement pipe and sheet, and fire-resistant drywall. Asbestos is also present in pipe and boiler insulation materials, and in sprayed-on materials located on beams, in crawlspaces, and between walls.

C. The potential for an asbestos-containing product to release breathable fibers depends on its degree of friability. Friable means that the material can be crumbled with hand pressure and is therefore likely to emit fibers. The fibrous fluffy sprayed-on materials used for fireproofing, insulation, or sound proofing are considered to be friable, and they readily release airborne fibers if disturbed. Materials such as vinyl-asbestos floor tile or roofing felt are considered non-friable if intact and generally do not emit airborne fibers unless subjected to sanding, sawing and other aggressive operations. Asbestos-cement pipe or sheet can emit airborne fibers if the materials are cut or sawed, or if they are broken.

D. Permissible exposure: Exposure to airborne asbestos fibers may not exceed 0.1 fibers per cubic centimeter of air (0.1 f/cc) averaged over the 8-hour workday, and 1 fiber per cubic centimeter of air (1.0 f/cc) averaged over a 30 minute work period.

II. Health Hazard Data

A. Asbestos can cause disabling respiratory disease and various types of cancers if the fibers are inhaled. Inhaling or ingesting fibers from contaminated clothing or skin can also result in these diseases. The symptoms of these diseases generally do not appear for 20 or more years after initial exposure.

B. Exposure to asbestos has been shown to cause lung cancer, mesothelioma, and cancer of the stomach and colon. Mesothelioma is a rare cancer of the thin membrane lining of the chest and abdomen. Symptoms of mesothelioma include shortness of breath, pain in the walls of the chest, and/or abdominal pain.

III. Respirators and Protective Clothing

A. Respirators: You are required to wear a respirator when performing tasks that result in asbestos exposure that exceeds the permissible exposure limit (PEL) of 0.1 f/cc and when performing certain designated operations. Air-purifying respirators equipped with a high-efficiency particulate air (HEPA) filter can be used where airborne asbestos fiber concentrations do not exceed 1.0 f/cc; otherwise, more protective respirators such as air-supplied, positive-pressure, full facepiece respirators must be used. Disposable respirators or dust masks are not permitted to be used for asbestos work. For effective protection, respirators must fit your face and head snugly. Your employer is required to conduct fit tests when you are first assigned a respirator and annually thereafter. Respirators should not be loosened or removed in work situations where their use is required.

B. Protective Clothing: You are required to wear protective clothing in work areas where asbestos concentrations exceed the permissible exposure limit (PEL) of 0.1 f/cc.

IV. Disposal Procedures and Clean-up

A. Wastes that are generated by processes where asbestos is present include:

1. Empty asbestos shipping containers.
2. Process wastes such as cuttings, trimmings, or reject material.
3. Housekeeping waste from wet-sweeping or HEPA-vacuuming.
4. Asbestos fireproofing or insulating material that is removed from buildings.
5. Asbestos-containing building products removed during building renovation or demolition.
6. Contaminated disposable protective clothing.

B. Empty shipping bags can be flattened under exhaust hoods and packed into airtight containers for disposal. Empty shipping drums are difficult to clean and should be sealed.

C. Vacuum bags or disposable paper filters should not be cleaned, but should be sprayed with a fine water mist and placed into a labeled waste container.

D. Process waste and housekeeping waste should be wetted with water or a mixture of water and surfactant prior to packaging in disposable containers.

E. Asbestos-containing material that is removed from buildings must be disposed of in leak-tight 6-mil plastic bags, plastic-lined cardboard containers, or plastic-lined metal containers. These wastes, which are removed while wet, should be sealed in containers before they dry out to minimize the release of asbestos fibers during handling.

V. Access to Information

A. Each year, your employer is required to inform you of the information contained in this standard and appendices for asbestos. In addition, your employer must instruct you in the proper work practices for handling asbestos-containing materials, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to asbestos. Your employer must treat exposure to thermal system insulation and sprayed-on and troweled-on surfacing material as asbestos exposure, unless results of laboratory analysis show that the material does not contain asbestos. You or your representative has the right to observe employee measurements and to record the results obtained. Your employer is required to inform you of your exposure, and, if you are exposed above the permissible exposure limit, he or she is required to inform you of the actions that are being taken to reduce your exposure to within the permissible limit.

C. Your employer is required to keep records of your exposures and medical examinations. These exposure records must be kept for at least thirty (30) years, Medical records must be kept for the period of your employment plus thirty (30) years.

D. Your employer is required to release your exposure and medical records to your physician or designated representative upon your written request.

Aluminum	Formula: Al	CAS#: 7429-90-5	RTECS#: BD0330000	IDLH: N.D.
Conversion:	**DOT:** 1309 170 (powder, coated); 1396 138 (powder, uncoated); 9260 169 (molten)			
Synonyms/Trade Names: Aluminium, Aluminum metal, Aluminum powder, Elemental aluminum				
Exposure Limits: **NIOSH REL:** TWA 10 mg/m^3 (total) TWA 5 mg/m^3 (resp) **OSHA PEL:** TWA 15 mg/m^3 (total) TWA 5 mg/m^3 (resp)			**Measurement Methods (see Table 1):** **NIOSH** 7013, 7300, 7301, 7303 **OSHA** ID121	
Physical Description: Silvery-white, malleable, ductile, odorless metal.				
Chemical & Physical Properties: **MW:** 27.0 **BP:** 4221°F **Sol:** Insoluble **FI.P:** NA **IP:** NA **Sp.Gr:** 2.70 **VP:** 0 mmHg (approx) **MLT:** 1220°F **UEL:** NA **LEL:** NA Combustible Solid, finely divided dust is easily ignited; may cause explosions.	**Personal Protection/Sanitation (see Table 2):** **Skin:** N.R. **Eyes:** N.R. **Wash skin:** N.R. **Remove:** N.R. **Change:** N.R.		**Respirator Recommendations (see Tables 3 and 4):** Not available.	
Incompatibilities and Reactivities: Strong oxidizers & acids, halogenated hydrocarbons [**Note:** Corrodes in contact with acids & other metals. Ignition may occur if powders are mixed with halogens, carbon disulfide, or methyl chloride.]				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Con **SY:** Irrit eyes, skin, resp sys **TO:** Eyes, skin, resp sys			**First Aid (see Table 6):** **Eye:** Irr immed **Breath:** Fresh air	

Antimony	Formula: Sb	CAS#: 7440-36-0	RTECS#: CC4025000	IDLH: 50 mg/m^3 (as Sb)
Conversion:	**DOT:** 1549 157 (inorganic compounds, n.o.s.); 2871 170 (powder); 3141 157 (inorganic liquid compounds, n.o.s.)			
Synonyms/Trade Names: Antimony metal, Antimony powder, Stibium				
Exposure Limits: **NIOSH REL*:** TWA 0.5 mg/m^3 **OSHA PEL*:** TWA 0.5 mg/m^3 [***Note:** The REL and PEL also apply to other antimony compounds (as Sb).]			**Measurement Methods (see Table 1):** **NIOSH** 7301, 7303, P&CAM 261 (II-4) **OSHA** ID121, ID125G, ID206	
Physical Description: Silver-white, lustrous, hard, brittle solid; scale-like crystals; or a dark-gray, lustrous powder.				
Chemical & Physical Properties: **MW:** 121.8 **BP:** 2975°F **Sol:** Insoluble **FI.P:** NA **IP:** NA **Sp.Gr:** 6.69 **VP:** 0 mmHg (approx) **MLT:** 1166°F **UEL:** NA **LEL:** NA	**Personal Protection/Sanitation (see Table 2):** **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contam **Remove:** When wet or contam **Change:** Daily		**Respirator Recommendations (see Tables 3 and 4):** **NIOSH/OSHA** **5 mg/m^3:** 95XQ/Sa **12.5 mg/m^3:** Sa:Cf/PaprHie **25 mg/m^3:** 100F/SaT:Cf/PaprTHie/ScbaF/SaF **50 mg/m^3:** Sa:Pd,Pp **§:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba **Escape:** 100F/ScbaE	
Noncombustible Solid in bulk form, but a moderate explosion hazard in the form of dust when exposed to flame.				
Incompatibilities and Reactivities: Strong oxidizers, acids, halogenated acids [**Note:** Stibine is formed when antimony is exposed to nascent (freshly formed) hydrogen.]				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Ing, Con **SY:** Irrit eyes, skin, nose, throat, mouth; cough; dizz; head; nau, vomit, diarr; stomach cramps; insom; anor; unable to smell properly **TO:** Eyes, skin, resp sys, CVS			**First Aid (see Table 6):** **Eye:** Irr immed **Skin:** Soap wash immed **Breath:** Resp support **Swallow:** Medical attention immed	

Arsenic (inorganic compounds, as As)	**Formula:** As (metal)	**CAS#:** 7440-38-2 (metal)	**RTECS#:** CG0525000 (metal)	**IDLH:** Ca [5 mg/m^3 (as As)]
Conversion:	**DOT:** 1558 152 (metal); 1562 152 (dust)			

Synonyms/Trade Names: **Arsenic metal:** Arsenia
Other synonyms vary depending upon the specific As compound. [**Note:** OSHA considers "Inorganic Arsenic" to mean copper acetoarsenite & all inorganic compounds containing arsenic except ARSINE.]

Exposure Limits:
NIOSH REL: Ca
C 0.002 mg/m^3 [15-minute]
See Appendix A
OSHA PEL: [1910.1018] TWA 0.010 mg/m^3

Measurement Methods (see Table 1):
NIOSH 7300, 7301, 7303, 9102, 7900
OSHA ID105

Physical Description: Metal: Silver-gray or tin-white, brittle, odorless solid.

Chemical & Physical Properties:
MW: 74.9
BP: Sublimes
Sol: Insoluble
FI.P: NA
IP: NA
Sp.Gr: 5.73 (metal)
VP: 0 mmHg (approx)
MLT: 1135°F (Sublimes)
UEL: NA
LEL: NA

Personal Protection/Sanitation (see Table 2):
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contam/Daily
Remove: When wet or contam
Change: Daily
Provide: Eyewash
Quick drench

Respirator Recommendations (see Tables 3 and 4):
NIOSH
¥: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: GmFAg100/ScbaE

See Appendix E (page 351)

Metal: Noncombustible Solid in bulk form, but a slight explosion hazard in the form of dust when exposed to flame.

Incompatibilities and Reactivities: Strong oxidizers, bromine azide
[**Note:** Hydrogen gas can react with inorganic arsenic to form the highly toxic gas arsine.]

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Abs, Con, Ing
SY: Ulceration of nasal septum, derm, GI disturbances, peri neur, resp irrit, hyperpig of skin, [carc]
TO: Liver, kidneys, skin, lungs, lymphatic sys [lung & lymphatic cancer]

First Aid (see Table 6):
Eye: Irr immed
Skin: Soap wash immed
Breath: Resp support
Swallow: Medical attention immed

Barium chloride (as Ba)	**Formula:** $BaCl_2$	**CAS#:** 10361-37-2	**RTECS#:** CQ8750000	**IDLH:** 50 mg/m^3 (as Ba)
Conversion:	**DOT:** 1564 154 (barium compound, n.o.s.)			

Synonyms/Trade Names: Barium dichloride

Exposure Limits:
NIOSH REL*: TWA 0.5 mg/m^3
OSHA PEL*: TWA 0.5 mg/m^3
[***Note:** The REL and PEL also apply to other soluble barium compounds (as Ba) except Barium sulfate.]

Measurement Methods (see Table 1):
NIOSH 7056, 7303
OSHA ID121

Physical Description: White, odorless solid.

Chemical & Physical Properties:
MW: 208.2
BP: 2840°F
Sol: 38%
FI.P: NA
IP: ?
Sp.Gr: 3.86
VP: Low
MLT: 1765°F
UEL: NA
LEL: NA
Noncombustible Solid

Personal Protection/Sanitation (see Table 2):
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contam
Remove: When wet or contam
Change: Daily

Respirator Recommendations (see Tables 3 and 4):
NIOSH/OSHA
5 mg/m^3: 95XQ/Sa
12.5 mg/m^3: Sa:Cf/PaprHie
25 mg/m^3: 100F/SaT:Cf/PaprTHie/ScbaF/SaF
50 mg/m^3: SaF:Pd,Pp
§: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: 100F/ScbaE

Incompatibilities and Reactivities: Acids, oxidizers

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Ing, Con
SY: Irrit eyes, skin, upper resp sys; skin burns; gastroenteritis; musc spasm; slow pulse, extrasystoles; hypokalemia
TO: Eyes, skin, resp sys, heart, CNS

First Aid (see Table 6):
Eye: Irr immed
Skin: Water flush immed
Breath: Resp support
Swallow: Medical attention immed

Beryllium & beryllium compounds (as Be)	**Formula:** Be (metal)	**CAS#:** 7440-41-7 (metal)	**RTECS#:** DS1750000 (metal)	**IDLH:** Ca [4 mg/m^3 (as Be)]
Conversion:	**DOT:** 1566 154 (compounds); 1567 134 (powder)			

Synonyms/Trade Names: **Beryllium metal:** Beryllium
Other synonyms vary depending upon the specific beryllium compound.

Exposure Limits:
NIOSH REL: Ca
Not to exceed 0.0005 mg/m^3
See Appendix A
OSHA PEL: TWA 0.002 mg/m^3
C 0.005 mg/m^3 0.025 mg/m^3 [30-minute maximum peak]

Measurement Methods (see Table 1):
NIOSH 7102, 7300, 7301, 7303, 9102
OSHA ID125G, ID206

Physical Description: Metal: A hard, brittle, gray-white solid.

Chemical & Physical Properties:
MW: 9.0
BP: 4532°F
Sol: Insoluble
FI.P: NA
IP: NA
Sp.Gr: 1.85 (metal)
VP: 0 mmHg (approx)
MLT: 2349°F
UEL: NA
LEL: NA

Personal Protection/Sanitation (see Table 2):
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: Daily
Remove: When wet or contam
Change: Daily
Provide: Eyewash

Respirator Recommendations (see Tables 3 and 4):
NIOSH
¥: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: 100F/ScbaE

Metal: Noncombustible Solid in bulk form, but a slight explosion hazard in the form of a powder or dust.

Incompatibilities and Reactivities: Acids, caustics, chlorinated hydrocarbons, oxidizers, molten lithium

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Con
SY: Berylliosis (chronic exposure): anor, low-wgt, lass, chest pain, cough, clubbing of fingers, cyan, pulm insufficiency; irrit eyes; derm; [carc]
TO: Eyes, skin, resp sys [lung cancer]

First Aid (see Table 6):
Eye: Irr immed
Breath: Fresh air

Cadmium dust (as Cd)	**Formula:** Cd (metal)	**CAS#:** 7440-43-9 (metal)	**RTECS#:** EU9800000 (metal)	**IDLH:** Ca [9 mg/m^3 (as Cd)]
Conversion:	**DOT:** 2570 154 (cadmium compound)			

Synonyms/Trade Names: **Cadmium metal:** Cadmium
Other synonyms vary depending upon the specific cadmium compound.

Exposure Limits:
NIOSH REL*: Ca
See Appendix A
OSHA PEL*: [1910.1027] TWA 0.005 mg/m^3
[***Note:** The REL and PEL apply to all Cadmium compounds (as Cd).]

Measurement Methods (see Table 1):
NIOSH 7048, 7300, 7301, 7303, 9102
OSHA ID121, ID125G, ID189, ID206

Physical Description: Metal: Silver-white, blue-tinged lustrous, odorless solid.

Chemical & Physical Properties:
MW: 112.4
BP: 1409°F
Sol: Insoluble
FI.P: NA
IP: NA
Sp.Gr: 8.65 (metal)
VP: 0 mmHg (approx)
MLT: 610°F
UEL: NA
LEL: NA
Metal: Noncombustible Solid in bulk form, but will burn in powder form.

Personal Protection/Sanitation (see Table 2):
Skin: N.R.
Eyes: N.R.
Wash skin: Daily
Remove: N.R.
Change: Daily

Respirator Recommendations (see Tables 3 and 4):
NIOSH
¥: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: 100F/ScbaE

See Appendix E (page 351)

Incompatibilities and Reactivities: Strong oxidizers; elemental sulfur, selenium & tellurium

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Ing
SY: Pulm edema, dysp, cough, chest tight, subs pain; head; chills, musc aches; nau, vomit, diarr; anos, emphy, prot, mild anemia; [carc]
TO: Resp sys, kidneys, prostate, blood [prostatic & lung cancer]

First Aid (see Table 6):
Eye: Irr immed
Skin: Soap wash
Breath: Resp support
Swallow: Medical attention immed

Calcium oxide	Formula: CaO	CAS#: 1305-78-8	RTECS#: EW3100000	IDLH: 25 mg/m^3
Conversion:	**DOT:** 1910 157			
Synonyms/Trade Names: Burned lime, Burnt lime, Lime, Pebble lime, Quick lime, Unslaked lime				
Exposure Limits: **NIOSH REL:** TWA 2 mg/m^3 **OSHA PEL:** TWA 5 mg/m^3 **Physical Description:** White or gray, odorless lumps or granular powder.			**Measurement Methods (see Table 1):** **NIOSH** 7020, 7303 **OSHA** ID121	
Chemical & Physical Properties: **MW:** 56.1 **BP:** 5162°F **Sol:** Reacts **Fl.P:** NA **IP:** NA **Sp.Gr:** 3.34 **VP:** 0 mmHg (approx) **MLT:** 4662°F **UEL:** NA **LEL:** NA Noncombustible Solid, but will support combustion by liberation of oxygen.	**Personal Protection/Sanitation (see Table 2):** **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contam/Daily **Remove:** When wet or contam **Change:** Daily **Provide:** Eyewash Quick drench		**Respirator Recommendations (see Tables 3 and 4):** **NIOSH** **10 mg/m^3:** Qm **20 mg/m^3:** 95XQ/Sa **25 mg/m^3:** Sa:Cf/PaprHie/100F/ ScbaF/SaF **§:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba **Escape:** 100F/ScbaE	
Incompatibilities and Reactivities: Water (liberates heat), fluorine, ethanol [**Note:** Reacts with water to form calcium hydroxide.]				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Ing, Con **SY:** Irrit eyes, skin, upper resp tract; ulcer, perf nasal septum; pneu; derm **TO:** Eyes, skin, resp sys			**First Aid (see Table 6):** **Eye:** Irr immed **Skin:** Water flush immed **Breath:** Resp support **Swallow:** Medical attention immed	

Chromium metal	Formula: Cr	CAS#: 7440-47-3	RTECS#: GB4200000	IDLH: 250 mg/m^3 (as Cr)
Conversion:	**DOT:**			
Synonyms/Trade Names: Chrome, Chromium				
Exposure Limits: **NIOSH REL:** TWA 0.5 mg/m^3 See Appendix C **OSHA PEL*:** TWA 1 mg/m^3 See Appendix C [***Note:** The PEL also applies to insoluble chromium salts.] **Physical Description:** Blue-white to steel-gray, lustrous, brittle, hard, odorless solid.			**Measurement Methods (see Table 1):** **NIOSH** 7024, 7300, 7301, 7303, 9102 **OSHA** ID121, ID125G	
Chemical & Physical Properties: **MW:** 52.0 **BP:** 4788°F **Sol:** Insoluble **Fl.P:** NA **IP:** NA **Sp.Gr:** 7.14 **VP:** 0 mmHg (approx) **MLT:** 3452°F **UEL:** NA **LEL:** NA Noncombustible Solid in bulk form, but finely divided dust burns rapidly if heated in a flame.	**Personal Protection/Sanitation (see Table 2):** **Skin:** N.R. **Eyes:** N.R. **Wash skin:** N.R. **Remove:** N.R. **Change:** N.R.		**Respirator Recommendations (see Tables 3 and 4):** **NIOSH** **2.5 mg/m^3:** Qm* **5 mg/m^3:** 95XQ*/Sa* **12.5 mg/m^3:** Sa:Cf*/PaprHie* **25 mg/m^3:** 100F/PaprTHie*/ ScbaF/SaF **250 mg/m^3:** SaF:Pd,Pp **§:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba **Escape:** 100F/ScbaE	
	Incompatibilities and Reactivities: Strong oxidizers (such as hydrogen peroxide), alkalis			
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Ing, Con **SY:** Irrit eyes, skin; lung fib (histologic) **TO:** Eyes, skin, resp sys			**First Aid (see Table 6):** **Eye:** Irr immed **Skin:** Soap wash **Breath:** Resp support **Swallow:** Medical attention immed	

Cobalt metal dust and fume (as Co)	**Formula:** Co	**CAS#:** 7440-48-4	**RTECS#:** GF8750000	**IDLH:** 20 mg/m^3 (as Co)
Conversion:	**DOT:**			
Synonyms/Trade Names: Cobalt metal dust, Cobalt metal fume				
Exposure Limits: **NIOSH REL:** TWA 0.05 mg/m^3 **OSHA PEL†:** TWA 0.1 mg/m^3 **Physical Description:** Odorless, silver-gray to black solid.			**Measurement Methods (see Table 1):** **NIOSH** 7027, 7300, 7301, 7303, 9102 **OSHA** ID121, ID125G, ID213	
Chemical & Physical Properties: **MW:** 58.9 **BP:** 5612°F **Sol:** Insoluble **FI.P:** NA **IP:** NA **Sp.Gr:** 8.92 **VP:** 0 mmHg (approx) **MLT:** 2719°F **UEL:** NA **LEL:** NA Noncombustible Solid in bulk form, but finely divided dust will burn at high temperatures.	**Personal Protection/Sanitation (see Table 2):** **Skin:** Prevent skin contact **Eyes:** N.R. **Wash skin:** When contam **Remove:** When wet or contam **Change:** Daily		**Respirator Recommendations (see Tables 3 and 4):** **NIOSH** **0.25 mg/m^3:** Qm **0.5 mg/m^3:** 95XQ*/Sa* **1.25 mg/m^3:** Sa:Cf*/PaprHie* **2.5 mg/m^3:** 100F/ScbaF/SaF **20 mg/m^3:** SaF:Pd,Pp **§:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba **Escape:** 100F/ScbaE	
Incompatibilities and Reactivities: Strong oxidizers, ammonium nitrate				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Ing, Con **SY:** Cough, dysp, wheez, decr pulm func; low-wgt; derm; diffuse nodular fib; resp hypersensitivity, asthma **TO:** Skin, resp sys			**First Aid (see Table 6):** **Eye:** Irr immed **Skin:** Soap wash **Breath:** Resp support **Swallow:** Medical attention immed	

Copper (dusts and mists, as Cu)	**Formula:** Cu	**CAS#:** 7440-50-8	**RTECS#:** GL5325000	**IDLH:** 100 mg/m^3 (as Cu)
Conversion:	**DOT:**			
Synonyms/Trade Names: Copper metal dusts, Copper metal fumes				
Exposure Limits: **NIOSH REL*:** TWA 1 mg/m^3 **OSHA PEL*:** TWA 1 mg/m^3 [***Note:** The REL and PEL also apply to other copper compounds (as Cu) except copper fume.] **Physical Description:** Reddish, lustrous, malleable, odorless solid.			**Measurement Methods (see Table 1):** **NIOSH** 7029, 7300, 7301, 7303, 9102 **OSHA** ID121, ID125G	
Chemical & Physical Properties: **MW:** 63.5 **BP:** 4703°F **Sol:** Insoluble **FI.P:** NA **IP:** NA **Sp.Gr:** 8.94 **VP:** 0 mmHg (approx) **MLT:** 1981°F **UEL:** NA **LEL:** NA Noncombustible Solid in bulk form, but powdered form may ignite.	**Personal Protection/Sanitation (see Table 2):** **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contam **Remove:** When wet or contam **Change:** Daily		**Respirator Recommendations (see Tables 3 and 4):** **NIOSH/OSHA** **5 mg/m^3:** Qm* **10 mg/m^3:** 95XQ*/Sa* **25 mg/m^3:** Sa:Cf*/PaprHie* **50 mg/m^3:** 100F/PaprTHie*/ScbaF/SaF **100 mg/m^3:** SaF:Pd,Pp **§:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba **Escape:** 100F/ScbaE	
Incompatibilities and Reactivities: Oxidizers, alkalis, sodium azide, acetylene				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Ing, Con **SY:** Irrit eyes, nose, pharynx; nasal septum perf; metallic taste; derm; in animals: lung, liver, kidney damage; anemia **TO:** Eyes, skin, resp sys, liver, kidneys (incr risk with Wilson's disease)			**First Aid (see Table 6):** **Eye:** Irr immed **Skin:** Soap wash prompt **Breath:** Resp support **Swallow:** Medical attention immed	

Iron oxide dust and fume (as Fe)	Formula: Fe_2O_3	CAS#: 1309-37-1	RTECS#: NO7400000 NO7525000 (fume)	IDLH: 2500 mg/m^3 (as Fe)
Conversion:	**DOT:** 1376 135 (spent)			
Synonyms/Trade Names: Ferric oxide, Iron(III) oxide				

Exposure Limits:
NIOSH REL: TWA 5 mg/m^3
OSHA PEL: TWA 10 mg/m^3

Physical Description: Reddish-brown solid.
[**Note:** Exposure to fume may occur during the arc-welding of iron.]

Measurement Methods (see Table 1):
NIOSH 7300, 7301, 7303, 9102
OSHA ID121, ID125G

Chemical & Physical Properties:
MW: 159.7
BP: ?
Sol: Insoluble
FI.P: NA
IP: NA
Sp.Gr: 5.24
VP: 0 mmHg (approx)
MLT: 2664°F
UEL: NA
LEL: NA
Noncombustible Solid

Personal Protection/Sanitation (see Table 2):
Skin: N.R.
Eyes: N.R.
Wash skin: N.R.
Remove: N.R.
Change: N.R.

Respirator Recommendations (see Tables 3 and 4):
NIOSH
50 mg/m^3: 95XQ/Sa
125 mg/m^3: Sa:Cf/PaprHie
250 mg/m^3: 100F/SaT:Cf/PaprTHie/ScbaF/SaF
2500 mg/m^3: Sa:Pd,Pp
§: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: 100F/ScbaE

Incompatibilities and Reactivities: Calcium hypochlorite

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh
SY: Benign pneumoconiosis with X-ray shadows indistinguishable from fibrotic pneumoconiosis (siderosis)
TO: Resp sys

First Aid (see Table 6):
Breath: Resp support

Lead	Formula: Pb	CAS#: 7439-92-1	RTECS#: OF7525000	IDLH: 100 mg/m^3 (as Pb)
Conversion:	**DOT:**			
Synonyms/Trade Names: Lead metal, Plumbum				

Exposure Limits:
NIOSH REL*: TWA 0.050 mg/m^3
See Appendix C
OSHA PEL*: [1910.1025] TWA 0.050 mg/m^3
See Appendix C
[***Note:** The REL and PEL also apply to other lead compounds (as Pb) -- see Appendix C.]

Physical Description: A heavy, ductile, soft, gray solid.

Measurement Methods (see Table 1):
NIOSH 7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9102, 9105
OSHA ID121, ID125G, ID206

Chemical & Physical Properties:
MW: 207.2
BP: 3164°F
Sol: Insoluble
FI.P: NA
IP: NA
Sp.Gr: 11.34
VP: 0 mmHg (approx)
MLT: 621°F
UEL: NA
LEL: NA
Noncombustible Solid in bulk form.

Personal Protection/Sanitation (see Table 2):
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: Daily
Remove: When wet or contam
Change: Daily

Respirator Recommendations (see Tables 3 and 4):
NIOSH/OSHA
0.5 mg/m^3: 100XQ/Sa
1.25 mg/m^3: Sa:Cf/PaprHie
2.5 mg/m^3: 100F/SaT:Cf/PaprTHie/ScbaF/SaF
50 mg/m^3: Sa:Pd,Pp
100 mg/m^3: SaF:Pd,Pp
§: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: 100F/ScbaE

See Appendix E (page 351)

Incompatibilities and Reactivities: Strong oxidizers, hydrogen peroxide, acids

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Ing, Con
SY: Lass, insom; facial pallor; anor, low-wgt, malnut; constip, abdom pain, colic; anemia; gingival lead line; tremor; para wrist, ankles; encephalopathy; kidney disease; irrit eyes; hypotension
TO: Eyes, GI tract, CNS, kidneys, blood, gingival tissue

First Aid (see Table 6):
Eye: Irr immed
Skin: Soap flush prompt
Breath: Resp support
Swallow: Medical attention immed

Manganese compounds and fume (as Mn)	Formula: Mn (metal)	CAS#: 7439-96-5 (metal)	RTECS#: OO9275000 (metal)	IDLH: 500 mg/m^3 (as Mn)
Conversion:	**DOT:**			

Synonyms/Trade Names: **Manganese metal:** Colloidal manganese, Manganese-55
Synonyms of other compounds vary depending upon the specific manganese compound.

Exposure Limits:
NIOSH REL*: TWA 1 mg/m^3
ST 3 mg/m^3
[***Note:** Also see specific listings for Manganese cyclopentadienyl tricarbonyl, Methyl cyclopentadienyl manganese tricarbonyl, and Manganese tetroxide.]
OSHA PEL*: C 5 mg/m^3
[***Note:** Also see specific listings for Manganese cyclopentadienyl tricarbonyl and Methyl cyclopentadienyl manganese tricarbonyl.]

Measurement Methods (see Table 1):
NIOSH 7300, 7301, 7303, 9102
OSHA ID121, ID125G

Physical Description: A lustrous, brittle, silvery solid.

Chemical & Physical Properties:
MW: 54.9
BP: 3564°F
Sol: Insoluble
Fl.P: NA
IP: NA
Sp.Gr: 7.20 (metal)
VP: 0 mmHg (approx)
MLT: 2271°F
UEL: NA
LEL: NA
Metal: Combustible Solid

Personal Protection/Sanitation (see Table 2):
Skin: N.R.
Eyes: N.R.
Wash skin: N.R.
Remove: N.R.
Change: N.R.

Respirator Recommendations (see Tables 3 and 4):
NIOSH
10 mg/m^3: 95XQ/Sa
25 mg/m^3: Sa:Cf/PaprHie
50 mg/m^3: 100F/SaT:Cf/PaprTHie/ScbaF/SaF
500 mg/m^3: Sa:Pd,Pp
§: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: 100F/ScbaE

Incompatibilities and Reactivities: Oxidizers
[**Note:** Will react with water or steam to produce hydrogen.]

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Ing
SY: Parkinson's; asthenia, insom, mental conf; metal fume fever: dry throat, cough, chest tight, dysp, rales, flu-like fever; low-back pain; vomit; mal; lass; kidney damage
TO: Resp sys, CNS, blood, kidneys

First Aid (see Table 6):
Breath: Resp support
Swallow: Medical attention immed

Molybdenum (soluble compounds, as Mo)	Formula:	CAS#:	RTECS#:	IDLH: 1000 mg/m^3 (as Mo)
Conversion:	**DOT:**			

Synonyms/Trade Names: Synonyms vary depending upon the specific soluble molybdenum compound.

Exposure Limits:
NIOSH REL: See Appendix D
OSHA PEL: TWA 5 mg/m^3

Measurement Methods (see Table 1):
NIOSH 7300, 7301, 7303, 9102
OSHA ID121, ID125G

Physical Description: Appearance and odor vary depending upon the specific soluble molybdenum compound.

Chemical & Physical Properties:
Properties vary depending upon the specific soluble molybdenum compound.

Personal Protection/Sanitation (see Table 2):
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contam
Remove: When wet or contam
Change: N.R.

Respirator Recommendations (see Tables 3 and 4):
OSHA
25 mg/m^3: Qm*
50 mg/m^3: 95XQ*/Sa*
125 mg/m^3: Sa:Cf*/PaprHie*
250 mg/m^3: 100F/SaT:Cf*/PaprTHie*/ScbaF/SaF
1000 mg/m^3: SaF:Pd,Pp
§: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: 100F/ScbaE

Incompatibilities and Reactivities: Varies

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Ing, Con
SY: In animals: irrit eyes, nose, throat; anor; inco; dysp; anemia
TO: Eyes, resp sys, kidneys, blood

First Aid (see Table 6):
Eye: Irr immed
Skin: Water flush
Breath: Resp support
Swallow: Medical attention immed

Nickel metal and other compounds (as Ni)	Formula: Ni (metal)	CAS#: 7440-02-0 (metal)	RTECS#: QR5950000 (metal)	IDLH: Ca [10 mg/m^3 (as Ni)]
Conversion:	**DOT:**			

Synonyms/Trade Names: **Nickel metal:** Elemental nickel, Nickel catalyst
Synonyms of other nickel compounds vary depending upon the specific compound.

Exposure Limits:
NIOSH REL*: Ca
TWA 0.015 mg/m^3
See Appendix A
OSHA PEL*†: TWA 1 mg/m^3
[***Note:** The REL and PEL do not apply to Nickel carbonyl.]

Measurement Methods (see Table 1):
NIOSH 7300, 7301, 7303, 9102
OSHA ID121, ID125G

Physical Description: Metal: Lustrous, silvery, odorless solid.

Chemical & Physical Properties:
MW: 58.7
BP: 5139°F
Sol: Insoluble
FI.P: NA
IP: NA
Sp.Gr: 8.90 (Metal)
VP: 0 mmHg (approx)
MLT: 2831°F
UEL: NA
LEL: NA
Metal: Combustible Solid; nickel sponge catalyst may ignite SPONTANEOUSLY in air.

Personal Protection/Sanitation (see Table 2):
Skin: Prevent skin contact
Eyes: N.R.
Wash skin: When contam/Daily
Remove: When wet or contam
Change: Daily

Respirator Recommendations (see Tables 3 and 4):
NIOSH
¥: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: 100F/ScbaE

Incompatibilities and Reactivities: Strong acids, sulfur, selenium, wood & other combustibles, nickel nitrate

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Ing, Con
SY: Sens derm, allergic asthma, pneu; [carc]
TO: Nasal cavities, lungs, skin [lung and nasal cancer]

First Aid (see Table 6):
Skin: Water flush immed
Breath: Resp support
Swallow: Medical attention immed

Selenium	Formula: Se	CAS#: 7782-49-2	RTECS#: VS7700000	IDLH: 1 mg/m^3 (as Se)
Conversion:	**DOT:** 2658 152 (powder)			

Synonyms/Trade Names: Elemental selenium, Selenium alloy

Exposure Limits:
NIOSH REL*: TWA 0.2 mg/m^3
OSHA PEL*: TWA 0.2 mg/m^3
[***Note:** The REL and PEL also apply to other selenium compounds (as Se) except Selenium hexafluoride.]

Measurement Methods (see Table 1):
NIOSH 7300, 7301, 7303, 9102, S190 (II-7)
OSHA ID121

Physical Description: Amorphous or crystalline, red to gray solid.
[**Note:** Occurs as an impurity in most sulfide ores.]

Chemical & Physical Properties:
MW: 79.0
BP: 1265°F
Sol: Insoluble
FI.P: NA
IP: NA
Sp.Gr: 4.28
VP: 0 mmHg (approx)
MLT: 392°F
UEL: NA
LEL: NA
Combustible Solid

Personal Protection/Sanitation (see Table 2):
Skin: Prevent skin contact
Eyes: N.R.
Wash skin: When contam
Remove: When wet or contam
Change: N.R.
Provide: Quick drench

Respirator Recommendations (see Tables 3 and 4):
NIOSH/OSHA
1 mg/m^3: Qm*/95XQ*/100F/PaprHie*/PaprHie*/Sa*/ScbaF
§: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: 100F/ScbaE

Incompatibilities and Reactivities: Acids, strong oxidizers, chromium trioxide, potassium bromate, cadmium

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Ing, Con
SY: Irrit eyes, skin, nose, throat; vis dist; head; chills, fever; dysp, bron; metallic taste, garlic breath, GI dist; derm; eye, skin burns; in animals: anemia; liver nec, cirr; kidney, spleen damage
TO: Eyes, skin, resp sys, liver, kidneys, blood, spleen

First Aid (see Table 6):
Eye: Irr immed
Skin: Soap wash immed
Breath: Resp support
Swallow: Medical attention immed

Silver (metal dust and soluble compounds, as Ag)	Formula: Ag (metal)	CAS#: 7440-22-4 (metal)	RTECS#: VW3500000 (metal)	IDLH: 10 mg/m^3 (as Ag)
Conversion:	**DOT:**			

Synonyms/Trade Names: **Silver metal:** Argentum
Synonyms of soluble silver compounds such as Silver nitrate ($AgNO_3$) vary depending upon the specific compound.

Exposure Limits:
NIOSH REL: TWA 0.01 mg/m^3
OSHA PEL: TWA 0.01 mg/m^3

Measurement Methods (see Table 1):
NIOSH 7300, 7301, 9102
OSHA ID121

Physical Description: Metal: White, lustrous solid.

Chemical & Physical Properties:
MW: 107.9
BP: 3632°F
Sol: Insoluble
Fl.P: NA
IP: NA
Sp.Gr: 10.49 (metal)
VP: 0 mmHg (approx)
MLT: 1761°F
UEL: NA
LEL: NA
Metal: Noncombustible Solid, but flammable in form of dust or powder.

Personal Protection/Sanitation (see Table 2):
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contam
Remove: When wet or contam ($AgNO_3$)
Change: Daily
Provide: Eyewash

Respirator Recommendations (see Tables 3 and 4):
NIOSH/OSHA
0.25 mg/m^3: Sa:Cf£/PaprHie£
0.5 mg/m^3: 100F/ScbaF/SaF
10 mg/m^3: SaF:Pd,Pp
§: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: 100F/ScbaE

Incompatibilities and Reactivities: Acetylene, ammonia, hydrogen peroxide, bromoazide, chlorine trifluoride, ethyleneimine, oxalic acid, tartaric acid

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Ing, Con
SY: Blue-gray eyes, nasal septum, throat, skin; irrit, ulceration skin; GI dist
TO: Nasal septum, skin, eyes

First Aid (see Table 6):
Eye: Irr immed
Skin: Water flush
Breath: Resp support
Swallow: Medical attention immed

Tin	Formula: Sn	CAS#: 7440-31-5	RTECS#: XP7320000	IDLH: 100 mg/m^3 (as Sn)
Conversion:	**DOT:**			

Synonyms/Trade Names: Metallic tin, Tin flake, Tin metal, Tin powder

Exposure Limits:
NIOSH REL*: TWA 2 mg/m^3
OSHA PEL*: TWA 2 mg/m^3
[***Note:** The REL and PEL also apply to other inorganic tin compounds (as Sn) except tin oxides.]

Measurement Methods (see Table 1):
NIOSH 7300, 7301, 7303
OSHA ID121, ID206

Physical Description: Gray to almost silver-white, ductile, malleable, lustrous solid.

Chemical & Physical Properties:
MW: 118.7
BP: 4545°F
Sol: Insoluble
Fl.P: NA
IP: NA
Sp.Gr: 7.28
VP: 0 mmHg (approx)
MLT: 449°F
UEL: NA
LEL: NA
Noncombustible Solid, but powdered form may ignite.

Personal Protection/Sanitation (see Table 2):
Skin: N.R.
Eyes: N.R.
Wash skin: N.R.
Remove: N.R.
Change: N.R.

Respirator Recommendations (see Tables 3 and 4):
NIOSH/OSHA
10 mg/m^3: Qm*
20 mg/m^3: 95XQ*/Sa*
50 mg/m^3: Sa:Cf*/PaprHie*
100 mg/m^3: 100F/ScbaF/SaF
§: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: 100F/ScbaE

Incompatibilities and Reactivities: Chlorine, turpentine, acids, alkalis

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Con
SY: Irrit eyes, skin, resp sys; in animals: vomit, diarr, para with musc twitch
TO: Eyes, skin, resp sys

First Aid (see Table 6):
Eye: Irr immed
Skin: Soap wash immed
Breath: Resp support
Swallow: Medical attention immed

Vanadium dust	Formula: V_2O_5	CAS#: 1314-62-1	RTECS#: YW2450000	IDLH: 35 mg/m^3 (as V)
Conversion:	**DOT:** 2862 151			

Synonyms/Trade Names: Divanadium pentoxide dust, Vanadic anhydride dust, Vanadium oxide dust, Vanadium pentaoxide dust. Other synonyms vary depending upon the specific vanadium compound.

Exposure Limits:
NIOSH REL*: C 0.05 mg V/m^3 [15-minute]
[***Note:** The REL applies to all vanadium compounds except Vanadium metal and Vanadium carbide (see Ferrovanadium dust).]
OSHA PEL†: C 0.5 mg V_2O_5/m^3 (resp)

Measurement Methods (see Table 1):
NIOSH 7300, 7301, 7303, 7504, 9102
OSHA ID185

Physical Description: Yellow-orange powder or dark-gray, odorless flakes dispersed in air.

Chemical & Physical Properties:
MW: 181.9
BP: 3182°F (Decomposes)
Sol: 0.8%
Fl.P: NA
IP: NA
Sp.Gr: 3.36
VP: 0 mmHg (approx)
MLT: 1274°F
UEL: NA
LEL: NA
Noncombustible Solid, but may increase intensity of fire when in contact with combustible materials.

Personal Protection/Sanitation (see Table 2):
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contam
Remove: When wet or contam
Change: N.R.

Respirator Recommendations (see Tables 3 and 4):
NIOSH (as V)
0.5 mg/m^3: 100XQ*/Sa*
1.25 mg/m^3: Sa:Cf*/PaprHie*
2.5 mg/m^3: 100F/PaprTHie*/ScbaF/SaF
35 mg/m^3: SaF:Pd,Pp
§: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: 100F/ScbaE

Incompatibilities and Reactivities: Lithium, chlorine trifluoride

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Ing, Con
SY: Irrit eyes, skin, throat; green tongue, metallic taste, eczema; cough; fine rales, wheez, bron, dysp
TO: Eyes, skin, resp sys

First Aid (see Table 6):
Eye: Irr immed
Skin: Soap wash prompt
Breath: Resp support
Swallow: Medical attention immed

Zinc oxide	Formula: ZnO	CAS#: 1314-13-2	RTECS#: ZH4810000	IDLH: 500 mg/m^3
Conversion:	**DOT:** 1516 143			

Synonyms/Trade Names: Zinc peroxide

Exposure Limits:
NIOSH REL: Dust: TWA 5 mg/m^3
C 15 mg/m^3
Fume: TWA 5 mg/m^3
ST 10 mg/m^3
OSHA PEL†: TWA 5 mg/m^3 (fume)
TWA 15 mg/m^3 (total dust)
TWA 5 mg/m^3 (resp dust)

Measurement Methods (see Table 1):
NIOSH 7303, 7502
OSHA ID121, ID143

Physical Description: White, odorless solid.

Chemical & Physical Properties:
MW: 81.4
BP: ?
Sol(64°F): 0.0004%
Fl.P: NA
IP: NA
Sp.Gr: 5.61
VP: 0 mmHg (approx)
MLT: 3587°F
UEL: NA
LEL: NA
Noncombustible Solid

Personal Protection/Sanitation (see Table 2):
Skin: N.R.
Eyes: N.R.
Wash skin: N.R.
Remove: N.R.
Change: N.R.

Respirator Recommendations (see Tables 3 and 4):
NIOSH/OSHA
50 mg/m^3: 95XQ/Sa
125 mg/m^3: Sa:Cf/PaprHie
250 mg/m^3: 100F/SaT:Cf/PaprTHie/ScbaF/SaF
500 mg/m^3: Sa:Pd,Pp
§: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: 100F/ScbaE

Incompatibilities and Reactivities: Chlorinated rubber (at 419°F), water
[Note: Slowly decomposed by water.]

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh
SY: Metal fume fever: chills, musc ache, nau, fever, dry throat, cough; lass; metallic taste; head; blurred vision; low back pain; vomit; mal; chest tight; dysp, rales, decr pulm func
TO: Resp sys

First Aid (see Table 6):
Breath: Resp support

I. SUBSTANCE IDENTIFICATION

A. Substance. Inorganic Arsenic.

B. Definition. Copper acetoarsenite, arsenic and all inorganic compounds containing arsenic except arsine, measured as arsenic (As).

C. Permissible Exposure Limit. 0.01 milligrams per cubic meter of air (same as 10 micrograms per cubic meter of air) as determined as an average over an 8-hour period. No employee may be exposed to any skin or eye contact with arsenic trichloride or to skin or eye contact likely to cause skin or eye irritation.

D. Action Level. 0.005 milligrams per cubic meter of air (same as 5 micrograms per cubic meter of air) determined as an average over an 8-hour period.

E. Regulated Areas. Only employees authorized by your employer should enter a regulated area.

II. HEALTH HAZARD DATA

A. Comments. The health hazard of inorganic arsenic is high.

B. Ways In Which Inorganic Arsenic Affects Your Body. Exposure to airborne inorganic arsenic may cause lung cancer, and it can be a skin irritant. Inorganic arsenic may also affect your body if swallowed. One compound in particular, arsenic trichloride, is especially dangerous because it is highly corrosive and it can be absorbed readily through the skin. Because inorganic arsenic is a poison, you should wash your hands thoroughly prior to eating or smoking.

III. PROTECTIVE CLOTHING AND EQUIPMENT

A. Respirators. Respirators will be provided by your employer at no cost to you for routine use if your employer is in the process of implementing engineering and work practice controls or where engineering and work practice controls are not feasible or insufficient. You must wear respirators for non-routine activities or in emergency situations where you are likely to be exposed to levels of inorganic arsenic in excess of the permissible exposure limit. Since how well your respirator fits your face is very important, your employer is required to conduct fit tests to make sure the respirator seals properly when you wear it. These tests are simple and rapid and will be explained to you during training sessions.

B. Protective clothing. If you work in a regulated area, your employer is required to provide at no cost to you, and you must wear, appropriate, clean, protective clothing and equipment. The purpose of this equipment is to prevent you from bringing to your home arsenic-contaminated dust and to protect your body from repeated skin contact with inorganic arsenic likely to cause skin irritation. This clothing should include such items as coveralls or similar full-body clothing, gloves, shoes or coverlets, and aprons. Protective equipment should include face shields or vented goggles where eye injury may occur.

IV. HYGIENE FACILITIES AND PRACTICES

You must not eat, drink, smoke, chew gum or tobacco, or apply cosmetics in the regulated area, except that drinking water is permitted. If you work in a regulated area your employer is required to provide lunch rooms and other areas for these purposes.

If you work in a regulated area, your employer is required to provide showers, washing facilities, and change rooms. You must wash your face and hands before eating and must shower at the end of the work shift. Do not take used protective clothing out of change rooms without your employer's permission. Your employer is required to provide for laundering or cleaning of your protective clothing.

V. SIGNS AND LABELS

Your employer is required to post warning signs and labels for your protection. Signs must be posted in regulated areas. The signs must warn that a cancer hazard is present, that only authorized employees may enter the area, and that no smoking or eating is allowed, and that respirators must be worn.

VI. MEDICAL EXAMINATIONS

If your exposure to arsenic is over the action level at least 30 days per year, or your have been exposed to arsenic for more than 10 years over the action level, your employer is required to provide you with a medical examination. The examination shall be every 6 months for employees over 45 years old or with more than 10 years exposure over the action level and annually for other covered employees. The initial medical examination must include a medical history; a chest X-ray; skin examination; nasal examination and sputum cytology examination for the early detection of lung cancer. In subsequent medical examinations, the chest X-ray is not required unless recommended by the physician. The cytology exams are only included in the initial examination and examinations given after you are either 45 years or older or have 10 or more years employment over the action level. The examining physician will provide a written opinion to your employer interpreting the results of the medical exams. You should also receive a copy of this opinion. The physician must not tell your employer any conditions he or she detects unrelated to occupational exposure to arsenic but must tell you those conditions.

VII.OBSERVATION OF MONITORING

Your employer is required to monitor your exposure to arsenic and you or your representatives are entitled to observe the monitoring procedure. You are entitled to receive an explanation of the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you must also be provided with and must wear the protective clothing and equipment.

VIII. ACCESS TO RECORDS

You or your representative are entitled to records of your exposure to inorganic arsenic upon request to your employer. Your medical examination records can be furnished to you, your physician, or any other individual or organization that you designate if you request your employer to provide them.

IX. TRAINING AND NOTIFICATION

Additional information on all of these items plus training as to hazards of exposure to inorganic arsenic and the engineering and work practice controls associated with your job will also be provided by your employer. If you are exposed over the permissible exposure limit, your employer must inform you of that fact and the actions he or she is taking to reduce your exposures.

Substance Safety Data Sheet Cadmium

I. SUBSTANCE IDENTIFICATION

A. Substance: Cadmium.

B. 8-Hour, Time-weighted-average, Permissible Exposure Limit (TWA PEL):

1. TWA PEL: Five micrograms of cadmium per cubic meter of air 5 $\mu g/m^3$, time-weighted average (TWA) for an 8-hour workday.

C. Appearance: Cadmium metal - soft, blue-white, malleable, lustrous metal or grayish-white powder. Some cadmium compounds may also appear as a brown, yellow, or red powdery substance.

II. HEALTH HAZARD DATA

A. Routes of Exposure.

Cadmium can cause local skin or eye irritation. Cadmium can affect your health if you inhale it or if you swallow it.

B. Effects of overexposure.

1. Short-term (acute) exposure: Cadmium is much more dangerous by inhalation than by ingestion. High exposures to cadmium that may be immediately dangerous to life or health occur in jobs where workers handle large quantities of cadmium dust or fume; heat cadmium-containing compounds or cadmium-coated surfaces; weld with cadmium solders or cut cadmium-containing materials such as bolts.

2. Severe exposure may occur before symptoms appear. Early symptoms may include mild irritation of the upper respiratory tract, a sensation of constriction of the throat, a metallic taste and/or a cough. A period of 1 - 10 hours may precede the onset of rapidly progressing shortness of breath, chest pain, and flu-like symptoms with weakness, fever, headache, chills, sweating and muscular pain. Acute pulmonary edema usually develops within 24 hours and reaches a maximum by three days. If death from asphyxia does not occur, symptoms may resolve within a week.

3. Long-term (chronic) exposure. Repeated or long-term exposure to cadmium, even at relatively low concentrations, may result in kidney damage and an increased risk of cancer of the lung and of the prostate.

C. Emergency First Aid Procedures

1. Eye exposure: Direct contact may cause redness or pain. Wash eyes immediately with large amounts of water, lifting the upper and lower eyelids. Get medical attention immediately.

2. Skin exposure: Direct contact may result in irritation. Remove contaminated clothing and shoes immediately. Wash affected area with soap or mild detergent and large amounts of water. Get medical attention immediately.

3. Ingestion: Ingestion may result in vomiting, abdominal pain, nausea, diarrhea, headache and sore throat. Treatment for symptoms must be administered by medical personnel. Under no circumstances should the employer allow any person whom he retains, employs, supervises or controls to engage in therapeutic chelation. Such treatment is likely to translocate cadmium from pulmonary or other tissue to renal tissue. Get medical attention immediately.

4. Inhalation: If large amounts of cadmium are inhaled, the exposed person must be moved to fresh air at once. If breathing has stopped, perform cardiopulmonary resuscitation. Administer oxygen if available. Keep the affected person warm and at rest. Get medical attention immediately.

5. Rescue: Move the affected person from the hazardous exposure. If the exposed person has been overcome, attempt rescue only after notifying at least one other person of the emergency and

putting into effect established emergency procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the location of the emergency equipment before the need arises.

III. EMPLOYEE INFORMATION

A. Protective Clothing and Equipment

1. Respirators: You may be required to wear a respirator for non-routine activities; in emergencies; while your employer is in the process of reducing cadmium exposures through engineering controls; and where engineering controls are not feasible. If respirators are worn in the future, they must have a joint Mine Safety and Health Administration (MSHA) and National Institute for Occupational Safety and Health (NIOSH) label of approval. Cadmium does not have a detectable odor except at levels well above the permissible exposure limits. If you can smell cadmium while wearing a respirator, proceed immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.
2. Protective Clothing: You may be required to wear impermeable clothing, gloves, foot gear, a face shield, or other appropriate protective clothing to prevent skin contact with cadmium. Where protective clothing is required, your employer must provide clean garments to you as necessary to assure that the clothing protects you adequately. The employer must replace or repair protective clothing that has become torn or otherwise damaged.
3. Eye Protection: You may be required to wear splash-proof or dust resistant goggles to prevent eye contact with cadmium.

B. Employer Requirements

1. Medical: If you are exposed to cadmium at or above the action level, your employer is required to provide a medical examination, laboratory tests and a medical history according to the medical surveillance provisions under paragraph (l) of this standard. (See summary chart and tables in this Appendix A.) These tests shall be provided without cost to you. In addition, if you are accidentally exposed to cadmium under conditions known or suspected to constitute toxic exposure to cadmium, your employer is required to make special tests available to you.
2. Access to Records: All medical records are kept strictly confidential. You or your representative are entitled to see the records of measurements of your exposure to cadmium. Your medical examination records can be furnished to your personal physician or designated representative upon request by you to your employer.
3. Observation of Monitoring: Your employer is required to perform measurements that are representative of your exposure to cadmium and you or your designated representative are entitled to observe the monitoring procedure. You are entitled to observe the steps taken in the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you or your representative must also be provided with, and must wear the protective clothing and equipment.

C. Employee Requirements

You will not be able to smoke, eat, drink, chew gum or tobacco, or apply cosmetics while working with cadmium in regulated areas. You will also not be able to carry or store tobacco products, gum, food, drinks or cosmetics in regulated areas because these products easily become contaminated with cadmium from the workplace and can therefore create another source unnecessary of cadmium exposure.

Some workers will have to change out of work clothes and shower at the end of the day, as part of their workday, in order to wash cadmium from skin and hair. Handwashing and cadmium-free eating facilities shall be provided by the employer and proper hygiene should always be performed before

eating. It is also recommended that you do not smoke or use tobacco products, because among other things, they naturally contain cadmium. For further information, read the labeling on such products.

IV. PHYSICIAN INFORMATION

A. Introduction

The medical surveillance provisions of paragraph (l) generally are aimed at accomplishing three main interrelated purposes: first, identifying employees at higher risk of adverse health effects from excess, chronic exposure to cadmium; second, preventing cadmium-induced disease; and third, detecting and minimizing existing cadmium-induced disease. The core of medical surveillance in this standard is the early and periodic monitoring of the employee's biological indicators of: a) recent exposure to cadmium; b) cadmium body burden; and c) potential and actual kidney damage associated with exposure to cadmium.

The main adverse health effects associated with cadmium overexposure are lung cancer and kidney dysfunction. It is not yet known how to adequately biologically monitor human beings to specifically prevent cadmium-induced lung cancer. By contrast, the kidney can be monitored to provide prevention and early detection of cadmium-induced kidney damage. Since, for non-carcinogenic effects, the kidney is considered the primary target organ of chronic exposure to cadmium, the medical surveillance provisions of this standard effectively focus on cadmium-induced kidney disease. Within that focus, the aim, where possible, is to prevent the onset of such disease and, where necessary, to minimize such disease as may already exist. The by-products of successful prevention of kidney disease are anticipated to be the reduction and prevention of other cadmium-induced diseases.

B. Health Effects

The major health effects associated with cadmium overexposure are described below.

1. Kidney

The most prevalent non-malignant disease observed among workers chronically exposed to cadmium is kidney dysfunction. Initially, such dysfunction is manifested as proteinuria. The proteinuria associated with cadmium exposure is most commonly characterized by excretion of low-molecular weight proteins (15,000 to 40,000 MW) accompanied by loss of electrolytes, uric acid, calcium, amino acids, and phosphate. The compounds commonly excreted include: beta-2-microglobulin ($ß_2$-M), retinol binding protein (RBP), immunoglobulin light chains, and lysozyme. Excretion of low molecular weight proteins are characteristic of damage to the proximal tubules of the kidney (Iwao et al., 1980).

It has also been observed that exposure to cadmium may lead to urinary excretion of high-molecular weight proteins such as albumin, immunoglobulin G, and glycoproteins (Ex. 29). Excretion of high-molecular weight proteins is typically indicative of damage to the glomeruli of the kidney. Bernard et al., (1979) suggest that damage to the glomeruli and damage to the proximal tubules of the kidney may both be linked to cadmium exposure but they may occur independently of each other.

Several studies indicate that the onset of low-molecular weight proteinuria is a sign of irreversible kidney damage (Friberg et al., 1974; Roels et al., 1982; Piscator 1984; Elinder et al., 1985; Smith et al., 1986). Above specific levels of $ß_2$-M associated with cadmium exposure it is unlikely that $ß_2$-M levels return to normal even when cadmium exposure is eliminated by removal of the individual from the cadmium work environment (Friberg, Ex. 29, 1990).

Some studies indicate that such proteinuria may be progressive; levels of $ß_2$-M observed in the urine increase with time even after cadmium exposure has ceased. See, for example, Elinder et al., 1985. Such observations, however, are not universal, and it has been suggested that studies in which proteinuria has not been observed to progress may not have tracked patients for a sufficiently long time interval (Jarup, Ex. 8-661).

When cadmium exposure continues after the onset of proteinuria, chronic nephrotoxicity may occur (Friberg, Ex. 29). Uremia results from the inability of the glomerulus to adequately filter blood. This leads to severe disturbance of electrolyte concentrations and may lead to various clinical complications including kidney stones (L-140-50).

After prolonged exposure to cadmium, glomerular proteinuria, glucosuria, aminoaciduria, phosphaturia, and hypercalciuria may develop (Exs. 8-86, 4-28, 14-18). Phosphate, calcium, glucose, and amino acids are essential to life, and under normal conditions, their excretion should be regulated by the kidney. Once low molecular weight proteinuria has developed, these elements dissipate from the human body. Loss of glomerular function may also occur, manifested by decreased glomerular filtration rate and increased serum creatinine. Severe cadmium- induced renal damage may eventually develop into chronic renal failure and uremia (Ex. 55).

Studies in which animals are chronically exposed to cadmium confirm the renal effects observed in humans (Friberg et al., 1986). Animal studies also confirm problems with calcium metabolism and related skeletal effects which have been observed among humans exposed to cadmium in addition to the renal effects. Other effects commonly reported in chronic animal studies include anemia, changes in liver morphology, immunosuppression and hypertension. Some of these effects may be associated with co- factors. Hypertension, for example, appears to be associated with diet as well as cadmium exposure. Animals injected with cadmium have also shown testicular necrosis (Ex. 8-86B).

2. Biological Markers

It is universally recognized that the best measures of cadmium exposures and its effects are measurements of cadmium in biological fluids, especially urine and blood. Of the two, CdU is conventionally used to determine body burden of cadmium in workers without kidney disease. CdB is conventionally used to monitor for recent exposure to cadmium. In addition, levels of CdU and CdB historically have been used to predict the percent of the population likely to develop kidney disease (Thun et al., Ex. L-140-50; WHO, Ex. 8-674; ACGIH, Exs. 8-667, 140-50).

The third biological parameter upon which OSHA relies for medical surveillance is Beta-2-microglobulin in urine ($ß_2$-M), a low molecular weight protein. Excess $ß_2$-M has been widely accepted by physicians and scientists as a reliable indicator of functional damage to the proximal tubule of the kidney (Exs. 8- 447, 144-3-C, 4-47, L-140-45, 19-43-A).

Excess $ß_2$-M is found when the proximal tubules can no longer reabsorb this protein in a normal manner. This failure of the proximal tubules is an early stage of a kind of kidney disease that commonly occurs among workers with excessive cadmium exposure. Used in conjunction with biological test results indicating abnormal levels of CdU and CdB, the finding of excess $ß_2$-M can establish for an examining physician that any existing kidney disease is probably cadmium-related (Trs. 6/6/90, pp. 82- 86, 122, 134). The upper limits of normal levels for cadmium in urine and cadmium in blood are 3 µg Cd/gram creatinine in urine and 5 µg Cd/liter whole blood, respectively. These levels were derived from broad-based population studies.

Three issues confront the physicians in the use of $ß_2$-M as a marker of kidney dysfunction and material impairment. First, there are a few other causes of elevated levels of $ß_2$-M not related to cadmium exposures, some of which may be rather common diseases and some of which are serious diseases (e.g., myeloma or transient flu, Exs. 29 and 8-086). These can be medically evaluated as alternative causes (Friberg, Ex. 29). Also, there are other factors that can cause $ß_2$-M to degrade so that low levels would result in workers with tubular dysfunction. For example, regarding the degradation of $ß_2$-M, workers with acidic urine (pH < 6) might have $ß_2$-M levels that are within the "normal" range when in fact kidney dysfunction has occurred (Ex. L-140-1) and the low molecular weight proteins are degraded in acid urine. Thus, it is very important that the pH of urine be measured, that urine samples be buffered as necessary (See Appendix F.), and that urine samples be handled correctly, i.e., measure the pH of freshly voided urine samples, then

if necessary, buffer to pH > 6 (or above for shipping purposes), measure pH again and then, perhaps, freeze the sample for storage and shipping. (See also Appendix F.) Second, there is debate over the pathological significance of proteinuria, however, most world experts believe that $ß_2$-M levels greater than 300 µg/g Cr are abnormal (Elinder, Ex. 55, Friberg, Ex. 29). Such levels signify kidney dysfunction that constitutes material impairment of health. Finally, detection of $ß_2$-M at low levels has often been considered difficult, however, many laboratories have the capability of detecting excess $ß_2$-M using simple kits, such as the Phadebas Delphia test, that are accurate to levels of 100 µg $ß_2$-M/g Cr U (Ex. L-140-1).

Specific recommendations for ways to measure $ß_2$-M and proper handling of urine samples to prevent degradation of $ß_2$-M have been addressed by OSHA in Appendix F, in the section on laboratory standardization. All biological samples must be analyzed in a laboratory that is proficient in the analysis of that particular analyte, under paragraph (l)(1)(iv). [See Appendix F]. Specifically, under paragraph (l)(1)(iv), the employer is to assure that the collecting and handling of biological samples of cadmium in urine (CdU), cadmium in blood (CdB), and beta-2 microglobulin in urine ($ß_2$-M) taken from employees is collected in a manner that assures reliability. The employer must also assure that analysis of biological samples of cadmium in urine (CdU), cadmium in blood (CdB), and beta-2 microglobulin in urine ($ß_2$-M) taken from employees is performed in laboratories with demonstrated proficiency for that particular analyte. (See Appendix F.)

3. Lung and Prostrate Cancer

   The primary sites for cadmium-associated cancer appear to be the lung and the prostate (L-140-50). Evidence for an association between cancer and cadmium exposure derives from both epidemiological studies and animal experiments. Mortality from prostrate cancer associated with cadmium is slightly elevated in several industrial cohorts, but the number of cases is small and there is not clear dose-response relationship. More substantive evidence exists for lung cancer.

   The major epidemiological study of lung cancer was conducted by Thun et al., (Ex. 4-68). Adequate data on cadmium exposures were available to allow evaluation of dose-response relationships between cadmium exposure and lung cancer. A statistically significant excess of lung cancer attributed to cadmium exposure was observed in this study even when confounding variables such as co-exposure to arsenic and smoking habits were taken into consideration (Ex. L-140-50).

   The primary evidence for quantifying a link between lung cancer and cadmium exposure from animal studies derives from two rat bioassay studies; one by Takenaka et al., (1983), which is a study of cadmium chloride and a second study by Oldiges and Glaser (1990) of four cadmium compounds.

   Based on the above cited studies, the U.S. Environmental Protection Agency (EPA) classified cadmium as "B1", a probable human carcinogen, in 1985 (Ex. 4-4). The International Agency for Research on Cancer (IARC) in 1987 also recommended that cadmium be listed as "2A", a probable human carcinogen (Ex. 4- 15). The American Conference of Governmental Industrial Hygienists (ACGIH) has recently recommended that cadmium be labeled as a carcinogen. Since 1984, NIOSH has concluded that cadmium is possibly a human carcinogen and has recommended that exposures be controlled to the lowest level feasible.

4. Non-carcinogenic Effects

   Acute pneumonitis occurs 10 to 24 hours after initial acute inhalation of high levels of cadmium fumes with symptoms such as fever and chest pain (Exs. 30, 8-86B). In extreme exposure cases pulmonary edema may develop and cause death several days after exposure. Little actual exposure measurement data is available on the level of airborne cadmium exposure that causes such immediate adverse lung effects, nonetheless, it is reasonable to believe a cadmium concentration

of approximately 1 mg/m3 over an eight hour period is "immediately dangerous" (55 FR 4052, ANSI; Ex. 8-86B).

In addition to acute lung effects and chronic renal effects, long term exposure to cadmium may cause other severe effects on the respiratory system. Reduced pulmonary function and chronic lung disease indicative of emphysema have been observed in workers who have had prolonged exposure to cadmium dust or fumes (Exs. 4-29, 4-22, 4-42, 4-50, 4-63). In a study of workers conducted by Kazantzis et al., a statistically significant excess of worker deaths due to chronic bronchitis was found, which in his opinion was directly related to high cadmium exposures of 1 mg/m3 or more (Tr. 6/8/90, pp. 156-157).

Cadmium need not be respirable to constitute a hazard. Inspirable cadmium particles that are too large to be respirable but small enough to enter the tracheobronchial region of the lung can lead to bronchoconstriction, chronic pulmonary disease, and cancer of that portion of the lung. All of these diseases have been associated with occupational exposure to cadmium (Ex. 8- 86B). Particles that are constrained by their size to the extra-thoracic regions of the respiratory system such as the nose and maxillary sinuses can be swallowed through mucocillary clearance and be absorbed into the body (ACGIH, Ex. 8-692). The impaction of these particles in the upper airways can lead to anosmia, or loss of sense of smell, which is an early indication of overexposure among workers exposed to heavy metals. This condition is commonly reported among cadmium-exposed workers (Ex. 8-86-B).

I. SUBSTANCE IDENTIFICATION INORGANIC LEAD

A Substance: Pure lead (Pb) is a heavy metal at room temperature and pressure and is a basic chemical element. It can combine with various other substances to form numerous lead compounds.

B Compounds covered by the standard: The word "lead" when used in this standard means elemental lead, all inorganic lead compounds and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds.

C Uses: Exposure to lead occurs in several different occupations in the construction industry, including demolition or salvage of structures where lead or lead-containing materials are present; removal or encapsulation of lead-containing materials, new construction, alteration, repair, or renovation of structures that contain lead or materials containing lead; installation of products containing lead. In addition, there are construction related activities where exposure to lead may occur, including transportation, disposal, storage, or containment of lead or materials containing lead on construction sites, and maintenance operations associated with construction activities.

D Permissible exposure: The permissible exposure limit (PEL) set by the standard is 50 micrograms of lead per cubic meter of air (50 µg/m3) averaged over an 8-hour workday.

E Action level: The standard establishes an action level of 30 micrograms of lead per cubic meter of air (30 µg/m3) averaged over an 8-hour workday. The action level triggers several ancillary provisions of the standard such as exposure monitoring, medical surveillance, and training.

II. HEALTH HAZARD DATA

A Ways in which lead enters your body. When absorbed into your body in certain doses, lead is a toxic substance. The object of the lead standard is to prevent absorption of harmful quantities of lead. The standard is intended to protect you not only from the immediate toxic effects of lead, but also from the serious toxic effects that may not become apparent until years of exposure have passed. Lead can be absorbed into your body by inhalation (breathing) and ingestion (eating). Lead (except for certain organic lead compounds not covered by the standard, such as tetraethyl lead) is not absorbed through your skin. When lead is scattered in the air as a dust, fume or mist it can be inhaled and absorbed through your lungs and upper respiratory tract. Inhalation of airborne lead is generally the most important source of occupational lead absorption. You can also absorb lead through your digestive system if lead gets into your mouth and is swallowed. If you handle food, cigarettes, chewing tobacco, or make-up which have lead on them or handle them with hands contaminated with lead, this will contribute to ingestion. A significant portion of the lead that you inhale or ingest gets into your blood stream. Once in your blood stream, lead is circulated throughout your body and stored in various organs and body tissues. Some of this lead is quickly filtered out of your body and excreted, but some remains in the blood and other tissues. As exposure to lead continues, the amount stored in your body will increase if you are absorbing more lead than your body is excreting. Even though you may not be aware of any immediate symptoms of disease, this lead stored in your tissues can be slowly causing irreversible damage, first to individual cells, then to your organs and whole body systems.

B Effects of overexposure to lead.

1. Short term (acute) overexposure. Lead is a potent, systemic poison that serves no known useful function once absorbed by your body. Taken in large enough doses, lead can kill you in a matter of days. A condition affecting the brain called acute encephalopathy may arise which develops quickly to seizures, coma, and death from cardiorespiratory arrest. A short term dose of lead can lead to acute encephalopathy. Short term occupational exposures of this magnitude are highly unusual, but not impossible. Similar forms of encephalopathy may, however, arise from extended, chronic exposure to lower doses of lead. There is no sharp dividing line between rapidly developing acute effects of lead, and chronic effects which take longer to acquire. Lead adversely affects numerous body systems, and causes forms of health impairment and disease which arise after periods of exposure as short as days or as long as several years.

2. Long-term (chronic) overexposure. Chronic overexposure to lead may result in severe damage to your blood-forming, nervous, urinary and reproductive systems. Some common symptoms of chronic overexposure include loss of appetite, metallic taste in the mouth, anxiety, constipation, nausea, pallor, excessive tiredness, weakness, insomnia, headache, nervous irritability, muscle and joint pain or soreness, fine tremors, numbness, dizziness, hyperactivity and colic. In lead colic there may be severe abdominal pain. Damage to the central nervous system in general and the brain (encephalopathy) in particular is one of the most severe forms of lead poisoning. The most severe, often fatal, form of encephalopathy may be preceded by vomiting, a feeling of dullness progressing to drowsiness and stupor, poor memory, restlessness, irritability, tremor, and convulsions. It may arise suddenly with the onset of seizures, followed by coma, and death. There is a tendency for muscular weakness to develop at the same time. This weakness may progress to paralysis often observed as a characteristic "wrist drop" or "foot drop" and is a manifestation of a disease to the nervous system called peripheral neuropathy. Chronic overexposure to lead also results in kidney disease with few, if any, symptoms appearing until extensive and most likely permanent kidney damage has occurred. Routine laboratory tests reveal the presence of this kidney disease only after about two-thirds of kidney function is lost. When overt symptoms of urinary dysfunction arise, it is often too late to correct or prevent worsening conditions, and progression to kidney dialysis or death is possible. Chronic overexposure to lead impairs the reproductive systems of both men and women. Overexposure to lead may result in decreased sex drive, impotence and sterility in men. Lead can alter the structure of sperm cells raising the risk of birth defects. There is evidence of miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves. Lead exposure also may result in decreased fertility, and abnormal menstrual cycles in women. The course of pregnancy may be adversely affected by exposure to lead since lead crosses the placental barrier and poses risks to developing fetuses. Children born of parents either one of whom were exposed to excess lead levels are more likely to have birth defects, mental retardation, behavioral disorders or die during the first year of childhood. Overexposure to lead also disrupts the blood-forming system resulting in decreased hemoglobin (the substance in the blood that carries oxygen to the cells) and ultimately anemia. Anemia is characterized by weakness, pallor and fatigability as a result of decreased oxygen carrying capacity in the blood.

3. Exposure to lead throughout a working lifetime requires that a worker's blood lead level (BLL, also expressed as PbB) be maintained at or below forty micrograms per deciliter of whole blood (40 µg/dl). The blood lead levels of workers (both male and female workers) who intend to have children should be maintained below 30 µg/dl to minimize adverse reproductive health effects to the parents and to the developing fetus. The measurement of your blood lead level (BLL) is the most useful indicator of the amount of lead being absorbed by your body. Blood lead levels are most often reported in units of milligrams (mg) or micrograms (ug) of lead (1 mg=1000 mg) per 100 grams (100g), 100 milliliters (100 ml) or deciliter (dl) of blood. These three units are essentially the same. Sometime BLLs are expressed in the form of mg% or mg%. This is a shorthand notation for 100g, 100 ml, or dl. (Reference to BLL measurements in this standard are expressed in the form of µg/dl.)

   BLL measurements show the amount of lead circulating in your blood stream, but do not give any information about the amount of lead stored in your various tissues. BLL measurements merely show current absorption of lead, not the effect that lead is having on your body or the effects that past lead exposure may have already caused. Past research into lead-related diseases, however, has focused heavily on associations between BLLs and various diseases. As a result, your BLL is an important indicator of the likelihood that you will gradually acquire a lead-related health impairment or disease.

   Once your blood lead level climbs about 40 µg/dl, your risk of disease increases. There is a wide variability of individual response to lead, thus it is difficult to say that a particular BLL in a given person will cause a particular effect. Studies have associated fatal encephalopathy with BLLs as

low as 150 µg/dl. Other studies have shown other forms of diseases in some workers with BLLs well below 80 µg/dl. Your BLL is a crucial indicator of the risks to your health, but one other factor is also extremely important. This factor is the length of time you have had elevated BLLs. The longer you have an elevated BLL, the greater the risk that large quantities of lead are being gradually stored in your organs and tissues (body burden). The greater your overall body burden, the greater the chances of substantial permanent damage. The best way to prevent all forms of lead-related impairments and diseases -- both short term and long term -- is to maintain your BLL below 40 µg/dl. The provisions of the standard are designed with this end in mind.

Your employer has prime responsibility to assure that the provisions of the standard are complied with both by the company and by individual workers. You, as a worker, however, also have a responsibility to assist your employer in complying with the standard. You can play a key role in protecting your own health by learning about the lead hazards and their control, learning what the standard requires, following the standard where it governs your own actions, and seeing that your employer complies with provisions governing his or her actions.

4. Reporting signs and symptoms of health problems. You should immediately notify your employer if you develop signs or symptoms associated with lead poisoning or if you desire medical advice concerning the effects of current or past exposure to lead or your ability to have a healthy child. You should also notify your employer if you have difficulty breathing during a respirator fit test or while wearing a respirator. In each of these cases, your employer must make available to you appropriate medical examinations or consultations. These must be provided at no cost to you and at a reasonable time and place. The standard contains a procedure whereby you can obtain a second opinion by a physician of your choice if your employer selected the initial physician.

Benzene	**Formula:** C_6H_6	**CAS#:** 71-43-2	**RTECS#:** CY1400000	**IDLH:** Ca [500 ppm]
Conversion: 1 ppm = 3.19 mg/m^3	**DOT:** 1114 130			
Synonyms/Trade Names: Benzol, Phenyl hydride				
Exposure Limits: **NIOSH REL:** Ca TWA 0.1 ppm ST 1 ppm See Appendix A **OSHA PEL:** [1910.1028] TWA 1 ppm ST 5 ppm See Appendix F			**Measurement Methods (see Table 1):** **NIOSH** 1500, 1501, 3700, 3800 **OSHA** 12, 1005	
Physical Description: Colorless to light-yellow liquid with an aromatic odor. [**Note:** A solid below 42°F.]				
Chemical & Physical Properties: **MW:** 78.1 BP: 176°F **Sol:** 0.07% **Fl.P:** 12°F **IP:** 9.24 eV **Sp.Gr:** 0.88 **VP:** 75 mmHg FRZ: 42°F **UEL:** 7.8% **LEL:** 1.2% Class IB Flammable Liquid	**Personal Protection/Sanitation (see Table 2):** **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contam **Remove:** When wet (flamm) **Change:** N.R. **Provide:** Eyewash Quick drench	**Respirator Recommendations (see Tables 3 and 4):** **NIOSH** **¥:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba **Escape:** GmFOv/ScbaE **See Appendix E** (page 351)		
Incompatibilities and Reactivities: Strong oxidizers, many fluorides & perchlorates, nitric acid				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Abs, Ing, Con **SY:** Irrit eyes, skin, nose, resp sys; dizz; head, nau, staggered gait; anor, lass; derm; bone marrow depres; [carc] **TO:** Eyes, skin, resp sys, blood, CNS, bone marrow [leukemia]	**First Aid (see Table 6):** **Eye:** Irr immed **Skin:** Soap wash immed **Breath:** Resp support **Swallow:** Medical attention immed			

Methyl chloride	**Formula:** CH_3Cl	**CAS#:** 74-87-3	**RTECS#:** PA6300000	**IDLH:** Ca [2000 ppm]
Conversion: 1 ppm = 2.07 mg/m^3	**DOT:** 1063 115			
Synonyms/Trade Names: Chloromethane, Monochloromethane				
Exposure Limits: **NIOSH REL:** Ca See Appendix A **OSHA PEL†:** TWA 100 ppm C 200 ppm 300 ppm (5-minute maximum peak in any 3 hours)			**Measurement Methods (see Table 1):** **NIOSH** 1001	
Physical Description: Colorless gas with a faint, sweet odor which is not noticeable at dangerous concentrations. [**Note:** Shipped as a liquefied compressed gas.]				
Chemical & Physical Properties: **MW:** 50.5 **BP:** -12°F **Sol:** 0.5% **Fl.P:** NA (Gas) **IP:** 11.28 eV **RGasD:** 1.78 **VP:** 5.0 atm **FRZ:** -144°F **UEL:** 17.4% **LEL:** 8.1% Flammable Gas	**Personal Protection/Sanitation (see Table 2):** **Skin:** Frostbite **Eyes:** Frostbite **Wash skin:** N.R. **Remove:** When wet (flamm) **Change:** N.R. **Provide:** Frostbite wash	**Respirator Recommendations (see Tables 3 and 4):** **NIOSH** **¥:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba **Escape:** ScbaE		
Incompatibilities and Reactivities: Chemically-active metals such as potassium, powdered aluminum, zinc, and magnesium; water [**Note:** Reacts with water (hydrolyzes) to form hydrochloric acid.]				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Con (liquid) **SY:** Dizz, nau, vomit; vis dist, stagger, slurred speech, convuls, coma; liver, kidney damage; liquid: frostbite; repro, terato effects; [carc] **TO:** CNS, liver, kidneys, repro sys [in animals: lung, kidney & forestomach tumors]	**First Aid (see Table 6):** **Eye:** Frostbite **Skin:** Frostbite **Breath:** Resp support			

Vinylidene chloride	**Formula:** $CH_2=CCl_2$	**CAS#:** 75-35-4	**RTECS#:** KV9275000	**IDLH:** Ca [N.D.]
Conversion:	**DOT:** 1303 130P (inhibited)			
Synonyms/Trade Names: 1,1-DCE; 1,1-Dichloroethene; 1,1-Dichloroethylene; VDC; Vinylidene chloride monomer; Vinylidene dichloride				
Exposure Limits: **NIOSH REL:** Ca See Appendix A **OSHA PEL†:** none			**Measurement Methods (see Table 1):** **NIOSH** 1015 **OSHA** 19	
Physical Description: Colorless liquid or gas (above 89°F) with a mild, sweet, chloroform-like odor.				
Chemical & Physical Properties: **MW:** 96.9 **BP:** 89°F **Sol:** 0.04% **FI.P:** -2°F **IP:** 10.00 eV **Sp.Gr:** 1.21 **VP:** 500 mmHg **FRZ:** -189°F **UEL:** 15.5% **LEL:** 6.5% Class IA Flammable Liquid	**Personal Protection/Sanitation (see Table 2):** **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contam **Remove:** When wet (flamm) **Change:** N.R. **Provide:** Eyewash Quick drench		**Respirator Recommendations (see Tables 3 and 4):** **NIOSH** **¥:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba **Escape:** GmFOv/ScbaE	
Incompatibilities and Reactivities: Aluminum, sunlight, air, copper, heat [**Note:** Polymerization may occur if exposed to oxidizers, chlorosulfonic acid, nitric acid, or oleum. Inhibitors such as the monomethyl ether of hydroquinone are added to prevent polymerization.]				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Abs, Ing, Con **SY:** Irrit eyes, skin, throat; dizz, head, nau, dysp; liver, kidney dist; pneu; [carc] **TO:** Eyes, skin, resp sys, CNS, liver, kidneys [in animals: liver & kidney tumors]			**First Aid (see Table 6):** **Eye:** Irr immed **Skin:** Soap flush immed **Breath:** Resp support **Swallow:** Medical attention immed	

Ethyl benzene	**Formula:** $CH_3CH_2C_6H_5$	**CAS#:** 100-41-4	**RTECS#:** DA0700000	**IDLH:** 800 ppm [10%LEL]
Conversion: 1 ppm = 4.34 mg/m^3	**DOT:** 1175 130			
Synonyms/Trade Names: Ethylbenzol, Phenylethane				
Exposure Limits: **NIOSH REL:** TWA 100 ppm (435 mg/m^3) ST 125 ppm (545 mg/m^3) **OSHA PEL†:** TWA 100 ppm (435 mg/m^3)			**Measurement Methods (see Table 1):** **NIOSH** 1501 **OSHA** 7, 1002	
Physical Description: Colorless liquid with an aromatic odor.				
Chemical & Physical Properties: **MW:** 106.2 BP: 277°F **Sol:** 0.01% FI.P: 55°F IP: 8.76 eV **Sp.Gr:** 0.87 **VP:** 7 mmHg FRZ: -139°F UEL: 6.7% LEL: 0.8% Class IB Flammable Liquid	**Personal Protection/Sanitation (see Table 2):** **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contam **Remove:** When wet (flamm) **Change:** N.R.		**Respirator Recommendations (see Tables 3 and 4):** **NIOSH/OSHA** **800 ppm:** CcrOv*/GmFOv/PaprOv*/Sa*/ScbaF **§:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba **Escape:** GmFOv/ScbaE	
Incompatibilities and Reactivities: Strong oxidizers				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Ing, Con **SY:** Irrit eyes, skin, muc memb; head; derm; narco, coma **TO:** Eyes, skin, resp sys, CNS			**First Aid (see Table 6):** **Eye:** Irr immed **Skin:** Water flush prompt **Breath:** Resp support **Swallow:** Medical attention immed	

Dichlorodifluoromethane	**Formula:** CCl_2F_2	**CAS#:** 75-71-8	**RTECS#:** PA8200000	**IDLH:** 15,000 ppm
Conversion: 1 ppm = 4.95 mg/m^3	**DOT:** 1028 126			
Synonyms/Trade Names: Difluorodichloromethane, Fluorocarbon 12, Freon® 12, Genetron® 12, Halon® 122, Propellant 12, Refrigerant 12				
Exposure Limits: **NIOSH REL:** TWA 1000 ppm (4950 mg/m^3) **OSHA PEL:** TWA 1000 ppm (4950 mg/m^3)			**Measurement Methods (see Table 1):** **NIOSH** 1018	
Physical Description: Colorless gas with an ether-like odor at extremely high concentrations. [**Note:** Shipped as a liquefied compressed gas.]				
Chemical & Physical Properties: **MW:** 120.9 **BP:** -22°F **Sol(77°F):** 0.03% **FI.P:** NA **IP:** 11.75 eV **RGasD:** 4.2 **VP:** 5.7 atm **FRZ:** -252°F **UEL:** NA **LEL:** NA Nonflammable Gas	**Personal Protection/Sanitation (see Table 2):** **Skin:** Frostbite **Eyes:** Frostbite **Wash skin:** N.R. **Remove:** N.R. **Change:** N.R. **Provide:** Frostbite wash		**Respirator Recommendations (see Tables 3 and 4):** **NIOSH/OSHA** **10,000 ppm:** Sa **15,000 ppm:** Sa:Cf/ScbaF/SaF **§:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba **Escape:** GmFOv/ScbaE	
Incompatibilities and Reactivities: Chemically-active metals such as sodium, potassium, calcium, powdered aluminum, zinc & magnesium				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Con (liquid) **SY:** Dizz, tremor, asphy, uncon, card arrhy, card arrest; liquid: frostbite **TO:** CVS, PNS			**First Aid (see Table 6):** **Eye:** Frostbite **Skin:** Frostbite **Breath:** Resp support	

Fluorotrichloromethane	**Formula:** CCl_3F	**CAS#:** 75-69-4	**RTECS#:** PB6125000	**IDLH:** 2000 ppm
Conversion: 1 ppm = 5.62 mg/m^3	**DOT:**			
Synonyms/Trade Names: Freon® 11, Monofluorotrichloromethane, Refrigerant 11, Trichlorofluoromethane, Trichloromonofluoromethane				
Exposure Limits: **NIOSH REL:** C 1000 ppm (5600 mg/m^3) **OSHA PEL†:** TWA 1000 ppm (5600 mg/m^3)			**Measurement Methods (see Table 1):** **NIOSH** 1006	
Physical Description: Colorless to water-white, nearly odorless liquid or gas (above 75°F).				
Chemical & Physical Properties: **MW:** 137.4 **BP:** 75°F **Sol(75°F):** 0.1% **FI.P:** NA **IP:** 11.77 eV **RGasD:** 4.74 **Sp.Gr:** 1.47 (Liquid at 75°F) **VP:** 690 mmHg **FRZ:** -168°F **UEL:** NA **LEL:** NA Noncombustible Liquid Nonflammable Gas	**Personal Protection/Sanitation (see Table 2):** **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** N.R. **Remove:** When wet or contam **Change:** N.R. **Provide:** Eyewash Quick drench		**Respirator Recommendations (see Tables 3 and 4):** **NIOSH/OSHA** **2000 ppm:** Sa/ScbaF **§:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba **Escape:** GmFOv/ScbaE	
	Incompatibilities and Reactivities: Chemically-active metals such as sodium, potassium, calcium, powdered aluminum, zinc, magnesium & lithium shavings; granular barium			
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Ing, Con **SY:** Inco, tremor; derm; card arrhy, card arrest; asphy; liquid: frostbite **TO:** Skin, resp sys, CVS			**First Aid (see Table 6):** **Eye:** Irr immed **Skin:** Water flush immed **Breath:** Resp support **Swallow:** Medical attention immed	

1,2,4-Trimethylbenzene	**Formula:** $C_6H_3(CH_3)_3$	**CAS#:** 95-63-6	**RTECS#:** DC3325000	**IDLH:** N.D.
Conversion: 1 ppm = 4.92 mg/m^3	**DOT:**			
Synonyms/Trade Names: Asymetrical trimethylbenzene, psi-Cumene, Pseudocumene [**Note:** Hemimellitene is a mixture of the 1,2,3-isomer with up to 10% of related aromatics such as the 1,2,4-isomer.]				
Exposure Limits: **NIOSH REL:** TWA 25 ppm (125 mg/m^3) **OSHA PEL†:** none				**Measurement Methods (see Table 1):** **OSHA** PV2091
Physical Description: Clear, colorless liquid with a distinctive, aromatic odor.				
Chemical & Physical Properties: **MW:** 120.2 **BP:** 337°F **Sol:** 0.006% **FI.P:** 112°F **IP:** 8.27 eV **Sp.Gr:** 0.88 **VP(56°F):** 1 mmHg **FRZ:** -77°F **UEL:** 6.4% **LEL:** 0.9% Class II Flammable Liquid	**Personal Protection/Sanitation (see Table 2):** **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contam **Remove:** When wet or contam **Change:** N.R.		**Respirator Recommendations (see Tables 3 and 4):** Not available.	
Incompatibilities and Reactivities: Oxidizers, nitric acid				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Ing, Con **SY:** Irrit eyes, skin, nose, throat, resp sys; bron; hypochromic anemia; head, drow, lass, dizz, nau, inco; vomit, conf; chemical pneu (aspir liquid) **TO:** Eyes, skin, resp sys, CNS, blood			**First Aid (see Table 6):** **Eye:** Irr immed **Skin:** Soap wash **Breath:** Resp support **Swallow:** Medical attention immed	

Toluene	**Formula:** $C_6H_5CH_3$	**CAS#:** 108-88-3	**RTECS#:** XS5250000	**IDLH:** 500 ppm
Conversion: 1 ppm = 3.77 mg/m^3	**DOT:** 1294 130			
Synonyms/Trade Names: Methyl benzene, Methyl benzol, Phenyl methane, Toluol				
Exposure Limits: **NIOSH REL:** TWA 100 ppm (375 mg/m^3) ST 150 ppm (560 mg/m^3) **OSHA PEL†:** TWA 200 ppm C 300 ppm 500 ppm (10-minute maximum peak)			**Measurement Methods (see Table 1):** **NIOSH** 1500, 1501, 3800, 4000 **OSHA** 111	
Physical Description: Colorless liquid with a sweet, pungent, benzene-like odor.				
Chemical & Physical Properties: **MW:** 92.1 BP: 232°F **Sol(74°F):** 0.07% FI.P: 40°F IP: 8.82 eV **Sp.Gr:** 0.87 **VP:** 21 mmHg FRZ: -139°F UEL: 7.1% LEL: 1.1% Class IB Flammable Liquid	**Personal Protection/Sanitation (see Table 2):** **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contam **Remove:** When wet (flamm) **Change:** N.R.		**Respirator Recommendations (see Tables 3 and 4):** **NIOSH** **500 ppm:** CcrOv*/PaprOv*/ GmFOv/Sa*/ScbaF **§:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba **Escape:** GmFOv/ScbaE	
Incompatibilities and Reactivities: Strong oxidizers				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Abs, Ing, Con **SY:** Irrit eyes, nose; lass, conf, euph, dizz, head; dilated pupils, lac; anxi, musc ftg, insom; pares; derm; liver, kidney damage **TO:** Eyes, skin, resp sys, CNS, liver, kidneys			**First Aid (see Table 6):** **Eye:** Irr immed **Skin:** Soap wash prompt **Breath:** Resp support **Swallow:** Medical attention immed	

1,3,5-Trimethylbenzene	**Formula:** $C_6H_3(CH_3)_3$	**CAS#:** 108-67-8	**RTECS#:** OX6825000	**IDLH:** N.D.
Conversion: 1 ppm = 4.92 mg/m^3	**DOT:** 2325 129			
Synonyms/Trade Names: Mesitylene, Symmetrical trimethylbenzene, sym-Trimethylbenzene				
Exposure Limits: **NIOSH REL:** TWA 25 ppm (125 mg/m^3) **OSHA PEL†:** none			**Measurement Methods (see Table 1):** **OSHA** PV2091	
Physical Description: Clear, colorless liquid with a distinctive, aromatic odor.				
Chemical & Physical Properties: **MW:** 120.2 **BP:** 329°F **Sol:** 0.002% **Fl.P:** 122°F **IP:** 8.39 eV **Sp.Gr:** 0.86 **VP:** 2 mmHg **FRZ:** -49°F **UEL:** ? **LEL:** ? Class II Flammable Liquid	**Personal Protection/Sanitation (see Table 2):** **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contam **Remove:** When wet or contam **Change:** N.R.		**Respirator Recommendations (see Tables 3 and 4):** Not available.	
Incompatibilities and Reactivities: Oxidizers, nitric acid				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Ing, Con **SY:** Irrit eyes, skin, nose, throat, resp sys; bron; hypochromic anemia; head, drow, lass, dizz, nau, inco; vomit, conf; chemical pneu (aspir liquid) **TO:** Eyes, skin, resp sys, CNS, blood			**First Aid (see Table 6):** **Eye:** Irr immed **Skin:** Soap wash **Breath:** Resp support **Swallow:** Medical attention immed	

m-Xylene	**Formula:** $C_6H_4(CH_3)_2$	**CAS#:** 108-38-3	**RTECS#:** ZE2275000	**IDLH:** 900 ppm
Conversion: 1 ppm = 4.34 mg/m^3	**DOT:** 1307 130			
Synonyms/Trade Names: 1,3-Dimethylbenzene; meta-Xylene; m-Xylol				
Exposure Limits: **NIOSH REL:** TWA 100 ppm (435 mg/m^3) ST 150 ppm (655 mg/m^3) **OSHA PEL†:** TWA 100 ppm (435 mg/m^3)			**Measurement Methods (see Table 1):** **NIOSH** 1501, 3800 **OSHA** 1002	
Physical Description: Colorless liquid with an aromatic odor.				
Chemical & Physical Properties: **MW:** 106.2 **BP:** 282°F **Sol:** Slight **Fl.P:** 82°F **IP:** 8.56 eV **Sp.Gr:** 0.86 **VP:** 9 mmHg **FRZ:** -54°F **UEL:** 7.0% **LEL:** 1.1% Class IC Flammable Liquid	**Personal Protection/Sanitation (see Table 2):** **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contam **Remove:** When wet (flamm) **Change:** N.R.		**Respirator Recommendations (see Tables 3 and 4):** **NIOSH/OSHA** **900 ppm:** CcrOv*/PaprOv*/ Sa*/ScbaF **§:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba **Escape:** GmFOv/ScbaE	
Incompatibilities and Reactivities: Strong oxidizers, strong acids				
Exposure Routes, Symptoms, Target Organs (see Table 5): **ER:** Inh, Abs, Ing, Con **SY:** Irrit eyes, skin, nose, throat; dizz, excitement, drow, inco, staggering gait; corn vacuolization; anor, nau, vomit, abdom pain; derm **TO:** Eyes, skin, resp sys, CNS, GI tract, blood, liver, kidneys			**First Aid (see Table 6):** **Eye:** Irr immed **Skin:** Soap wash prompt **Breath:** Resp support **Swallow:** Medical attention immed	

Vinyl chloride

Formula:	CAS#:	RTECS#:	IDLH:
CH_2=CHCl	75-01-4	KU9625000	Ca [N.D.]

Conversion: 1 ppm = 2.56 mg/m^3 **DOT:** 1086 116P (inhibited)

Synonyms/Trade Names: Chloroethene, Chloroethylene, Ethylene monochloride, Monochloroethene, Monochloroethylene, VC, Vinyl chloride monomer (VCM)

Exposure Limits:
NIOSH REL: Ca
See Appendix A
OSHA PEL: [1910.1017] TWA 1 ppm
C 5 ppm [15-minute]

Measurement Methods (see Table 1):
NIOSH 1007
OSHA 4, 75

Physical Description: Colorless gas or liquid (below 7°F) with a pleasant odor at high concentrations. [**Note:** Shipped as a liquefied compressed gas.]

Chemical & Physical Properties:
MW: 62.5
BP: 7°F
Sol(77°F): 0.1%
FI.P: NA (Gas)
IP: 9.99 eV
RGasD: 2.21
VP: 3.3 atm
FRZ: -256°F
UEL: 33.0%
LEL: 3.6%
Flammable Gas

Personal Protection/Sanitation (see Table 2):
Skin: Frostbite
Eyes: Frostbite
Wash skin: N.R.
Remove: When wet (flamm)
Change: N.R.
Provide: Frostbite wash

Respirator Recommendations (see Tables 3 and 4):
NIOSH
¥: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: GmFS/ScbaE

See Appendix E (page 351)

Incompatibilities and Reactivities: Copper, oxidizers, aluminum, peroxides, iron, steel [**Note:** Polymerizes in air, sunlight, or heat unless stabilized by inhibitors such as phenol. Attacks iron & steel in presence of moisture.]

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Con (liquid)
SY: Lass; abdom pain, GI bleeding; enlarged liver; pallor or cyan of extremities; liquid: frostbite; [carc]
TO: Liver, CNS, blood, resp sys, lymphatic sys [liver cancer]

First Aid (see Table 6):
Eye: Frostbite
Skin: Frostbite
Breath: Resp support

Chlorodiphenyl (42% chlorine)

Formula:	CAS#:	RTECS#:	IDLH:
$C_6H_4ClC_6H_3Cl_2$ (approx)	53469-21-9	TQ1356000	Ca [5 mg/m^3]

Conversion: **DOT:** 2315 171

Synonyms/Trade Names: Aroclor® 1242, PCB, Polychlorinated biphenyl

Exposure Limits:
NIOSH REL*: Ca
TWA 0.001 mg/m^3
See Appendix A
[***Note:** The REL also applies to other PCBs.]
OSHA PEL: TWA 1 mg/m^3 [skin]

Measurement Methods (see Table 1):
NIOSH 5503
OSHA PV2089

Physical Description: Colorless to light-colored, viscous liquid with a mild, hydrocarbon odor.

Chemical & Physical Properties:
MW: 258 (approx)
BP: 617-691°F
Sol: Insoluble
FI.P: NA
IP: ?
Sp.Gr(77°F): 1.39
VP: 0.001 mmHg
FRZ: -2°F
UEL: NA
LEL: NA

Personal Protection/Sanitation (see Table 2):
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contam
Remove: When wet or contam
Change: Daily
Provide: Eyewash
Quick drench

Respirator Recommendations (see Tables 3 and 4):
NIOSH
¥: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: GmFOv100/ScbaE

Nonflammable Liquid, but exposure in a fire results in the formation of a black soot containing PCBs, polychlorinated dibenzofurans & chlorinated dibenzo-p-dioxins.

Incompatibilities and Reactivities: Strong oxidizers

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Abs, Ing, Con
SY: Irrit eyes; chloracne; liver damage; repro effects; [carc]
TO: Skin, eyes, liver, repro sys [in animals: tumors of the pituitary gland & liver, leukemia]

First Aid (see Table 6):
Eye: Irr immed
Skin: Soap wash immed
Breath: Resp support
Swallow: Medical attention immed

Chlorodiphenyl (54% chlorine)	**Formula:** $C_6H_3Cl_2C_6H_2Cl_3$ (approx)	**CAS#:** 11097-69-1	**RTECS#:** TQ1360000	**IDLH:** Ca [5 mg/m^3]
Conversion:	**DOT:** 2315 171			
Synonyms/Trade Names: Aroclor® 1254, PCB, Polychlorinated biphenyl				

Exposure Limits:
NIOSH REL*: Ca
TWA 0.001 mg/m^3
See Appendix A
[***Note:** The REL also applies to other PCBs.]

OSHA PEL: TWA 0.5 mg/m^3 [skin]

Measurement Methods (see Table 1):
NIOSH 5503
OSHA PV2088

Physical Description: Colorless to pale-yellow, viscous liquid or solid (below 50°F) with a mild, hydrocarbon odor.

Chemical & Physical Properties:
MW: 326 (approx)
BP: 689-734°F
Sol: Insoluble
FI.P: NA
IP: ?
Sp.Gr(77°F): 1.38
VP: 0.00006 mmHg
FRZ: 50°F
UEL: NA
LEL: NA

Personal Protection/Sanitation (see Table 2):
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contam
Remove: When wet or contam
Change: Daily
Provide: Eyewash
Quick drench

Respirator Recommendations (see Tables 3 and 4):
NIOSH
¥: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: GmFOv100/ScbaE

Nonflammable Liquid, but exposure in a fire results in the formation of a black soot containing PCBs, polychlorinated dibenzofurans, and chlorinated dibenzo-p-dioxins.

Incompatibilities and Reactivities: Strong oxidizers

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Abs, Ing, Con
SY: Irrit eyes, chloracne; liver damage; repro effects; [carc]
TO: Skin, eyes, liver, repro sys [in animals: tumors of the pituitary gland & liver, leukemia]

First Aid (see Table 6):
Eye: Irr immed
Skin: Soap wash immed
Breath: Resp support
Swallow: Medical attention immed

Formaldehyde	**Formula:** HCHO	**CAS#:** 50-00-0	**RTECS#:** LP8925000	**IDLH:** Ca [20 ppm]
Conversion: 1 ppm = 1.23 mg/m^3	**DOT:**			
Synonyms/Trade Names: Methanal, Methyl aldehyde, Methylene oxide				

Exposure Limits:
NIOSH REL: Ca
TWA 0.016 ppm
C 0.1 ppm [15-minute]
See Appendix A
OSHA PEL: [1910.1048] TWA 0.75 ppm
ST 2 ppm

Measurement Methods (see Table 1):
NIOSH 2016, 2541, 3500, 3800
OSHA ID205, 52

Physical Description: Nearly colorless gas with a pungent, suffocating odor. [**Note:** Often used in an aqueous solution (see specific listing for Formalin).]

Chemical & Physical Properties:
MW: 30.0
BP: -6°F
Sol: Miscible
FI.P: NA (Gas)
IP: 10.88 eV
RGasD: 1.04
VP: >1 atm
FRZ: -134°F
UEL: 73%
LEL: 7.0%
Flammable Gas

Personal Protection/Sanitation (see Table 2):
Skin: N.R.
Eyes: Prevent eye contact
Wash skin: N.R.
Remove: N.R.
Change: N.R.

Respirator Recommendations (see Tables 3 and 4):
NIOSH
¥: ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
Escape: GmFS/ScbaE

See Appendix E (page 351)

Incompatibilities and Reactivities: Strong oxidizers, alkalis & acids; phenols; urea [**Note:** Pure formaldehyde has a tendency to polymerize. Reacts with HCl to form bis-Chloromethyl ether.]

Exposure Routes, Symptoms, Target Organs (see Table 5):
ER: Inh, Con
SY: Irrit eyes, nose, throat, resp sys; lac; cough; wheez; [carc]
TO: Eyes, resp sys [nasal cancer]

First Aid (see Table 6):
Eye: Irr immed
Breath: Resp support

Substance Safety Data Sheet Benzene

I. Substance Identification

A. Substance: Benzene

B. Permissible Exposure: Except as to the use of gasoline, motor fuels and other fuels subsequent to discharge from bulk terminals and other exemptions specified in section 5218(a)(2):

1. Airborne: The maximum time-weighted average exposure limit is 1 part of benzene vapor per million parts of air (1 ppm) for an 8-hour workday and the maximum short-term exposure limit (STEL) is 5 ppm as averaged over a 15-minute sampling period.

2. Dermal: Eye contact must be prevented and skin contact with liquid benzene must be limited.

C. Appearance and odor: Benzene is a clear, colorless liquid with a pleasant, sweet odor. The odor of benzene does not provide adequate warning of its hazard.

II. Health Hazard Data

A. Ways in which benzene affects your health. Benzene can affect your health if you inhale it, or if it comes in contact with your skin or eyes. Benzene is also harmful if you happen to swallow it.

B. Effects of Overexposure.

1. Short-term (acute) Overexposure: If you are overexposed to high concentrations of benzene, well above the levels where its odor is first recognizable, you may feel breathless, irritable, euphoric, or giddy; you may experience irritation in your eyes, nose, and respiratory tract. You may develop a headache, feel dizzy, nauseated, or intoxicated. Severe exposures may lead to convulsions and loss of consciousness.

2. Long-term (chronic) Exposure. Repeated or prolonged exposure to benzene, even at relatively low concentrations, may result in various blood disorders, ranging from anemia to leukemia, an irreversible, fatal disease. Many blood disorders associated with benzene exposure may occur without symptoms.

III. Protective Clothing and Equipment.

A. Respirators. Respirators are required for those operations in which engineering controls or work practice controls are not feasible to reduce exposure to the permissible level. However, where employers can document that benzene is present in the workplace less than 30 days a year, respirators may be used in lieu of engineering controls. If respirators are worn, they must have joint Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (NIOSH) seal of approval, and cartridges or canisters must be replaced before the end of their service life, or the end of the shift, whichever occurs first. If you experience difficulty breathing while wearing a respirator, you may request a positive pressure respirator from your employer. You must be thoroughly trained to use the assigned respirator, and the training will be provided by your employer.

B. Protective Clothing. You must wear appropriate protective clothing (such as boots, gloves, sleeves, aprons, etc.) over any parts of your body that could be exposed to liquid benzene.

C. Eye and Face Protection. You must wear splash-proof safety goggles if it is possible that benzene may get into your eyes. In addition, you must wear a face shield if your face could be splashed with benzene liquid.

IV. Emergency and First-Aid Procedures.

A. Eye and Face Exposure. If benzene is splashed in your eyes, wash it out immediately with large amounts of water. If irritation persists or vision appears to be affected see a doctor as soon as possible.

B. Skin Exposure. If benzene is spilled on your clothing or skin, remove the contaminated clothing and wash the exposed skin with large amounts of water and soap immediately. Wash contaminated clothing before you wear it again.

C. Breathing. If you or any other person breathes in large amounts of benzene, get the exposed person to fresh air at once. Apply artificial respiration if breathing has stopped. Call for medical assistance or a doctor as soon as possible. Never enter any vessel or confined space where the benzene concentration might be high without proper safety equipment and at least one other person present who will stay outside. A life line should be used.

D. Swallowing. If benzene has been swallowed and the patient is conscious, do not induce vomiting. Call for medical assistance or a doctor immediately.

V. Medical Requirements

If you are exposed to benzene at a concentration at or above 0.5 ppm as an 8-hour time weighted average, or have been exposed above 10 ppm in the past while employed by your current employer, your employer is required to provide an initial medical examination and history and laboratory tests and annually thereafter. These tests shall be provided without cost to you. In addition, if you are accidentally exposed to benzene (either by ingestion, inhalation, or skin/eye contact) under emergency conditions known or suspected to constitute toxic exposure to benzene, your employer is required to make special laboratory tests available to you.

VI. Observation of Monitoring

Your employer is required to perform measurements that are representative of your exposure to benzene and you or your designated representative are entitled to observe the monitoring procedure. You are entitled to observe the steps taken in the measurement procedure and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you or your representative must also be provided with, and must wear the protective clothing and equipment.

VII. Access to Records

You or your representative are entitled to see the records of measurements of your exposure to benzene upon written request to your employer. Your medical examination records can be furnished to yourself, your physician or designated representative upon request by you to your employer.

VIII. Precautions for Safe Use, Handling and Storage

Benzene liquid is highly flammable. It should be stored in tightly closed containers in a cool, well ventilated area. Benzene vapor may form explosive mixtures in air. All sources of ignition must be controlled. Use non-sparking tools when opening or closing benzene containers. Fire extinguishers, where provided, must be readily available. Know where they are located and how to operate them. Smoking is prohibited in areas where benzene is used or stored. Ask your supervisor where benzene is used in your area and for additional plant safety rules.

SUBSTANCE TECHNICAL GUIDELINES FOR FORMALIN

The following Substance Technical Guideline for Formalin provides information on uninhibited formalin solution (37% formaldehyde, no methanol stabilizer). It is designed to inform employees at the production level of their rights and duties under the formaldehyde standard whether their job title defines them as workers or supervisors. Much of the information provided is general; however, some information is specific for formalin. When employee exposure to formaldehyde is from resins capable of releasing formaldehyde, the resin itself and other impurities or decomposition products may also be toxic, and employers should include this information as well when informing employees of the hazards associated with the materials they handle. The precise hazards associated with exposure to formaldehyde depend both on the form (solid, liquid, or gas) of the material and the concentration of formaldehyde present. For example, 37-50 percent solutions of formaldehyde present a much greater hazard to the skin and eyes from spills or splashes than solutions containing less than 1 percent formaldehyde. Individual Substance Technical Guidelines used by the employer for training employees should be modified to properly give information on the material actually being used.

SUBSTANCE IDENTIFICATION

Chemical Name: Formaldehyde

Chemical Family: Aldehyde

Chemical Formula: HCHO Molecular Weight: 30.03

Chemical Abstracts Service Number

(CAS Number): 50-00-0

Synonyms: Formalin; Formic

Aldehyde; Paraform; Formol; Formalin

(Methanol-free); Fyde; Formalith;

Methanal; Methyl Aldehyde; Methylene

Glycol; Methylene Oxide;

Tetraoxymethalene; Oxomethane;

Oxymethylene

Components and Contaminants

Percent: 37.0 Formaldehyde

Percent: 63.0 Water

(NOTE: Inhibited solutions contain methanol.)

Other Contaminants: Formic Acid (alcohol free)

Cal/OSHA Exposure Limits:

PEL-TWA 0.75 ppm

STEL 2 ppm

PHYSICAL DATA

Description: Colorless liquid, pungent odor

Boiling Point: 214° F (101° C)

Specific Gravity: 1.08 (H2O = 1@20° C)

pH: 2.8-4.0

Solubility in Water: Miscible

Solvent Solubility: Soluble in alcohol and acetone

Vapor Density: 1.04 (Air = 1@20° C)

Odor Threshold: 0.8-1 ppm

FIRE AND EXPLOSION HAZARD

Moderate fire and explosion hazard when exposed to heat or flame.

The flash point of 37% formaldehyde solutions is above normal room temperature, but the explosion range is very wide, from 7 to 73% by volume in air.

Reaction of formaldehyde with nitrogen dioxide, nitromethane, perchloric acid and aniline, or peroxyformic acid yields explosive compounds.

Flash Point: 1855F (85°C) closed cup

Lower Explosion Limit: 7%

Upper Explosion Limit: 73%

Autoignition Temperature: 806°F (430°C)

Flammability Class (OSHA): III A.

Extinguishing Media: Use dry chemical, "alcohol foam," carbon dioxide, or water in flooding amounts as fog. Solid streams may not be effective. Cool fire-exposed containers with water from side until well after fire is out.

Use of water spray to flush spills can also dilute the spill to produce nonflammable mixtures. Water runoff, however, should be contained for treatment. National Fire Protection Association section 325M Designation:

Health: 2--Materials hazardous to health, but areas may be entered with full-faced mask self-contained breathing apparatus which provides eye protection.

Flammability: 2--Materials which must be moderately heated before ignition will occur. Water spray may be used to extinguish the fire because the material can be cooled below its flash point.

Reactivity: D--Materials which (in themselves) are normally stable even under fire exposure conditions which are not reactive with water. Normal fire fighting procedures may be used. Reactivity

Stability: Formaldehyde solutions may self-polymerize to form paraformaldehyde which precipitates.

Incompatibility (Materials to Avoid): Strong oxidizing agents, caustics, strong alkalies, isocyanates, anhydrides, oxides, and inorganic acids. Formaldehyde reacts with hydrochloric acid to form the potent carcinogen, bischloromethyl ether. Formaldehyde reacts with nitrogen dioxide, nitromethane, perchloric acid and aniline, or peroxyformic acid to yield explosive compounds. A violent reaction occurs when formaldehyde is mixed with strong oxidizers.

Hazardous Combustion or Decomposition Products: Oxygen from the air can oxidize formaldehyde to formic acid, especially when heated. Formic acid is corrosive.

HEALTH HAZARD DATA

Acute Effects of Exposure

Ingestion (Swallowing): Liquids containing 10 to 40% formaldehyde cause severe irritation and inflammation of the mouth, throat, and stomach. Severe stomach pains will follow ingestion with possible loss of consciousness and death. Ingestion of dilute formaldehyde solutions (0.03-0.04%) may cause discomfort in the stomach and pharynx.

Inhalation (Breathing): Formaldehyde is highly irritating to the upper respiratory tract and eyes. Concentrations of 0.5 to 2.0 ppm may irritate the eyes, nose, and throat of some individuals. Concentrations of 3 to 5 ppm also cause tearing of the eyes and are intolerable to some persons. Concentrations of 10 to 20 ppm cause difficulty in breathing, burning of the nose and throat, cough, and heavy tearing of the eyes, and 25 to 30 ppm causes severe respiratory tract injury leading to pulmonary edema and pneumonitis. A concentration of 100 ppm is immediately dangerous to life and health. Deaths from accidental exposure to high concentrations of formaldehyde have been reported.

Skin (Dermal): Formalin is a severe skin irritant and a sensitizer. Contact with formalin causes white discoloration, smarting, drying, cracking, and scaling. Prolonged and repeated contact can cause numbness and a hardening or tanning of the skin. Previously exposed persons may react to future exposure with an allergic eczematous dermatitis or hives.

Eye Contact: Formaldehyde solutions splashed in the eye can cause injuries ranging from transient discomfort to severe, permanent corneal clouding and loss of vision. The severity of the effect depends on the concentration of formaldehyde in the solution and whether or not the eyes are flushed with water immediately after the accident.

NOTE: The perception of formaldehyde by odor and eye irritation becomes less sensitive with time as one adapts to formaldehyde. This can lead to overexposure if a worker is relying on formaldehyde's warning properties to alert him or her to the potential for exposure.

Acute Animal Toxicity:

Oral, rats: LD50 = 800 mg/kg

Oral, mouse: LD50 = 42 mg/kg

Inhalation, rats: LCLo = 250 mg/kg

Inhalation, mouse: LCLo = 900 mg/kg

Inhalation, rats: LC50 = 590 mg/kg

Chronic Effects of Exposure

Carcinogenicity: Formaldehyde has the potential to cause cancer in humans. Repeated and prolonged exposure increases the risk. Various animal experiments have conclusively shown formaldehyde to be a carcinogen in rats. In humans, formaldehyde exposure has been associated with cancers of the lung, nasopharynx and oropharynx, and nasal passages.

Mutagenicity: Formaldehyde is genotoxic in several in vitro test systems showing properties of both an initiator and a promoter.

Toxicity: Prolonged or repeated exposure to formaldehyde may result in respiratory impairment. Rats exposed to formaldehyde at 2 ppm developed benign nasal tumors and changes of the cell structure in the nose as well as inflamed mucous membranes of the nose. Structural changes in the epithelial cells in the human nose have also been observed. Some persons have developed asthma or bronchitis following

exposure to formaldehyde, most often as the result of an accidental spill involving a single exposure to a high concentration of formaldehyde.

Emergency and First Aid Procedures

Ingestion (Swallowing): If the victim is conscious, dilute, inactivate, or absorb the ingested formaldehyde by giving milk, activated charcoal, or water. Any organic material will inactivate formaldehyde. Keep affected person warm and at rest. Get medical attention immediately. If vomiting occurs, keep head lower than hips.

Inhalation (Breathing): Remove the victim from the exposure area to fresh air immediately. Where the formaldehyde concentration may be very high, each rescuer must put on a self-contained breathing apparatus before attempting to remove the victim, and medical personnel should be informed of the formaldehyde exposure immediately. If breathing has stopped, give artificial respiration. Keep the affected person warm and at rest. Qualified first-aid or medical personnel should administer oxygen, if available, and maintain the patient's airway and blood pressure until the victim can be transported to a medical facility. If exposure results in a highly irritated upper respiratory tract and coughing continues for more than 10 minutes, the worker should be hospitalized for observation and treatment.

Skin Contact. Remove contaminated clothing (including shoes) immediately. Wash the affected area of your body with soap or mild detergent and large amounts of water until no evidence of the chemical remains (at least 10 to 20 minutes). If there are chemical burns, get first aid to cover the area with sterile, dry dressing, and bandages. Get medical attention if you experience appreciable eye or respiratory irritation.

Eye Contact: Wash the eyes immediately with large amounts of water occasionally lifting lower and upper lids, until no evidence of chemical remains (at least 15 to 20 minutes). In case of burns, apply sterile bandages loosely without medication. Get medical attention immediately. If you have experienced appreciable eye irritation from a splash or excessive exposure, you should be referred promptly to an ophthalmologist for evaluation.

EMERGENCY PROCEDURES

Emergencies: If you work to an area where a large amount of formaldehyde could be released in an accident or from equipment failure, your employer must develop procedures to be followed in event of an emergency. You should be trained in your specific duties in the event of an emergency, and it is important that you clearly understand these duties. Emergency equipment must be accessible and you should be trained to use any equipment that you might need. Formaldehyde contaminated equipment must be cleaned before reuse.

If a spill of appreciable quantity occurs, leave the area quickly unless you have specific emergency duties. Do not touch spilled material. Designated persons may stop the leak and shut off ignition sources if these procedures can be done without risk. Designated persons should isolate the hazard area and deny entry except for necessary people protected by suitable protective clothing and respirators adequate for the exposure. Use water spray to reduce vapors. Do not smoke, and prohibit all flames or flares in the hazard area.

Special Firefighting Procedures: Learn procedures and responsibilities in the event of a fire in your workplace. Become familiar with the appropriate equipment and supplies and their location. In firefighting, withdraw immediately in case of rising sound from venting safety device or any discoloration of storage tank due to fire.

SPILL, LEAK, AND DISPOSAL PROCEDURES

Occupational Spill: For small containers, place the leaking container in a well ventilated area. Take up small spills with absorbent material and place the waste into properly labeled containers for later disposal. For larger spills, dike the spill to minimize contamination and facilitate salvage or disposal. You may be able to neutralize the spill with sodium hydroxide or sodium sulfite. Your employer must comply with EPA rules regarding the clean-up of toxic waste and notify state and local authorities, if required. If the spill is greater than 1,000 lb/day, it is reportable under EPA's Superfund legislation.

Waste Disposal: Your employer must dispose of waste containing formaldehyde in accordance with applicable local, state, and Federal law and in a manner that minimizes exposure of employees at the site and of the clean-up crew.

MONITORING AND MEASUREMENT PROCEDURES

Monitoring Requirements: If your exposure to formaldehyde exceeds the 0.5 ppm action level or the 2 ppm STEL, your employer must monitor your exposure. Your employer need not measure every exposure if a "high exposure" employee can be identified. This person usually spends the greatest amount of time nearest the process equipment. If you are a "representative employee," you will be asked to wear a sampling device to collect formaldehyde. This device may be a passive badge, adsorbent tube attached to a pump, or an impinger containing liquid. You should perform your work as usual, but inform the person who is conducting the monitoring of any difficulties you are having wearing the device.

Evaluation of 8-hour Exposure: Measurements taken for the purpose of determining time-weighted average (TWA) exposures are best taken with samples covering the full shift. Samples collected must be taken from the employee's breathing zone air.

Short-term Exposure Evaluation: If there are tasks that involve brief but intense exposure to formaldehyde, employee exposure must be measured to assure compliance with the STEL. Sample collections are for brief periods, only 15 minutes, but several samples may be needed to identify the peak exposure.

Monitoring Techniques: OSHA's only requirement for selecting a method for sampling and analysis is that the methods used accurately evaluate the concentration of formaldehyde in employees' breathing zones. Sampling and analysis may be performed by collection of formaldehyde on liquid or solid sorbents with subsequent chemical analysis. Sampling and analysis may also be performed by passive diffusion monitors and short-term exposure may be measured by instruments such as real-time continuous monitoring systems and portable direct reading instruments.

Notification of Results: Your employer must inform you of the results of exposure monitoring representative of your job. You may be informed in writing, but posting the results where you have ready access to them constitutes compliance with the standard.

PROTECTIVE EQUIPMENT AND CLOTHING

(Material impervious to formaldehyde is needed if the employee handles formaldehyde solutions of 1% or more. Other employees may also require protective clothing or equipment to prevent dermatitis.)

Respiratory Protection: Use NIOSH approved full facepiece negative pressure respirators equipped with approved cartridges or canisters within the use limitations of these devices. (Present restrictions on cartridges and canisters do not permit them to be used for a full workshift.) In all other situations, use positive pressure respirators such as the positive pressure air purifying respirator or the self-contained breathing apparatus (SCBA). If you use a negative pressure respirator, your employer must provide you with fit testing of the respirator at least once a year in accordance with the procedures outlined in Appendix E.

Protective Gloves: Wear protective (impervious) gloves provided by your employer, at no cost, to prevent contact with formalin. Your employer should select these gloves based on the results of permeation testing and in accordance with the ACGIH Guidelines for Selection of Chemical Protective Clothing.

Eye Protection: If you might be splashed in the eyes with formalin, it is essential that you wear goggles or some other type of complete protection for the eye. You may also need a face shield if your face is likely to be splashed with formalin, but you must not substitute face shields for eye protection. (This section pertains to formaldehyde solutions of 1% or more.)

Other Protective Equipment: You must wear protective (impervious) clothing and equipment provided by your employer at no cost to prevent repeated or prolonged contact with formaldehyde liquids. If you are required to change into whole-body chemical protective clothing, your employer must provide a change room for your privacy and for storage of your normal clothing.

If you are splashed with formaldehyde, use the emergency showers and eyewash fountains provided by your employer immediately to prevent serious injury. Report the incident to your supervisor and obtain necessary medical support.

Entry Into an IDLH Atmosphere

Enter areas where the formaldehyde concentration might be 100 ppm or more only with complete body protection including a self-contained breathing apparatus with a full facepiece operated in a positive pressure mode or a supplied air respirator with full facepiece and operated in a positive pressure mode. This equipment is essential to protect your life and health under such extreme conditions.

ENGINEERING CONTROLS

Ventilation is the most widely applied engineering control method for reducing the concentration of airborne substances in the breathing zones of workers. There are two distinct types of ventilation.

Local Exhaust: Local exhaust ventilation is designed to capture airborne contaminants as near to the point of generation as possible. To protect you, the direction of contaminant flow must always be toward the local exhaust system inlet and away from you.

General (Mechanical): General dilution ventilation involves continuous introduction of fresh air into the workroom to mix with the contaminated air and lower your breathing zone concentration of formaldehyde. Effectiveness depends on the number of air changes per hour. Where devices emitting formaldehyde are spread out over a large area, general dilution ventilation may be the only practical method of control.

Work Practices: Work practices and administrative procedures are an important part of a control system. If you are asked to perform a task in a certain manner to limit your exposure to formaldehyde, it is extremely important that you follow these procedures.

MEDICAL SURVEILLANCE

Medical surveillance helps to protect employees' health. You are encouraged strongly to participate in the medical surveillance program.

Your employer must make a medical surveillance program available at no expense to you and at a reasonable time and place if you are exposed to formaldehyde at concentrations above 0.5 ppm as an 8-hour average or 2 ppm over any 15-minute period. You will be offered medical surveillance at the time of your initial assignment and once a year afterward as long as your exposure is at least 0.5 ppm (TWA) or 2 ppm (STEL). Even if your exposure is below these levels, you should inform your employer if you have signs and symptoms that you suspect, through your training, are related to your formaldehyde

exposure because you may need medical surveillance to determine if your health is being impaired by your exposure.

The surveillance plan includes:

(a) A medical disease questionnaire.

(b) A physical examination if the physician determines this is necessary.

If you are required to wear a respirator, your employer must offer you a physical examination and a pulmonary function test every year.

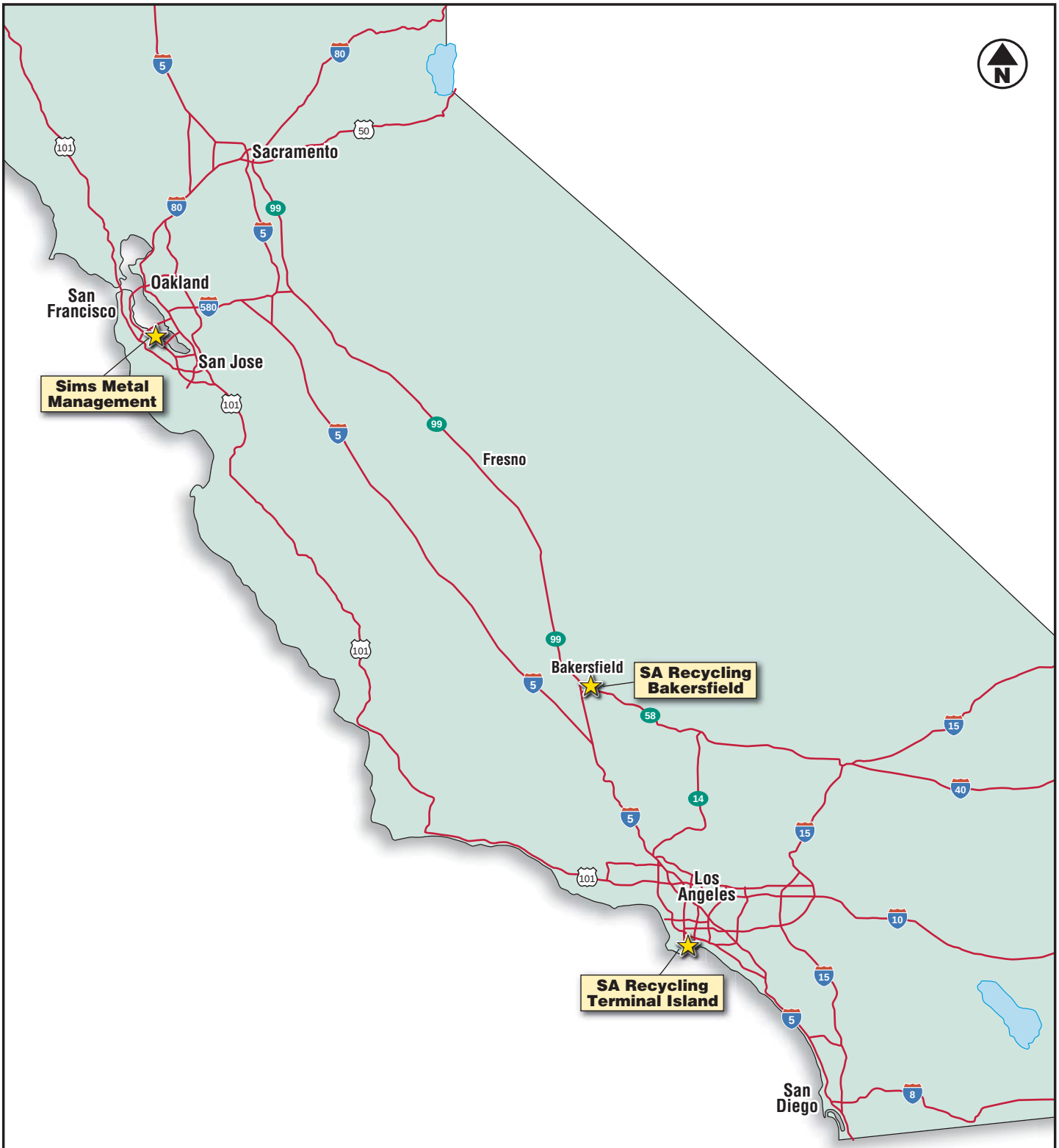
The physician must collect all information needed to determine if you are at increased risk from your exposure to formaldehyde. At the physician's discretion, the medical examination may include other tests, such as a chest X-ray, to make this determination.

After a medical examination, the physician will provide your employer with a written opinion which includes any special protective measures recommended and any restrictions on your exposure. The physician must inform you of any medical conditions you have which would be aggravated by exposure to formaldehyde.

All records from your medical examinations, including disease surveys, must be retained at your employer's expense.

EMERGENCIES

If you are exposed to formaldehyde in an emergency and develop signs or symptoms associated with acute toxicity from formaldehyde exposure, your employer must provide you with a medical examination as soon as possible. This medical examination will include all steps necessary to stabilize your health. You may be kept in the hospital for observation if your symptoms are severe to ensure that any delayed effects are recognized and treated.



GEOCON CONSULTANTS, INC.
3160 GOLD VALLEY DR – SUITE 800 – RANCHO CORDOVA, CA 95742
PHONE 916.852.9118 – FAX 916.852.9132

Various Facilities Generating and/or Receiving Metal Shredding Waste Statewide

Multiple Locations, California

Project Location Map

S9850-03-21	September 2016	Figure 1