



FirstCall™ VacuGuard+ Medical Vacuum Oxidizer Monitor & Mitigation Operating & Maintenance Manual

Please read and save these instructions. Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage! Retain instructions for future reference.



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Responsibilities

Information contained in this manual pertains to the VacuGuard+ Medical Vacuum Oxidizer Monitor (Part Number VacuGuard+). The system will operate as described when operated and serviced in compliance with these instructions.

Installer Responsibilities

The VacuGuard+ must be handled, installed, and tested per the recommended practices described within this manual. Installation must be performed by a qualified technician.

User Responsibilities

The monitor should be tested and examined periodically according to facility codes and NFPA 99 requirements. Any parts found to be damaged or contaminated must be replaced immediately using original equipment or replacement parts from Powerex.

Introduction

Product Line Overview

The VacuGuard+ Total Oxidizer Monitor is a gas monitoring and mitigation system designed to maintain oxygen concentrations below the 23.6% threshold required by NFPA 99 for combined-use medical vacuum/WAGD systems. The system utilizes a PLC to interface with an oxygen sensor, vacuum transducer, and control valve to automatically dilute high oxygen levels while prioritizing system vacuum pressure.

Features and Benefits

- **Continuous Compliance Monitoring:** Real-time monitoring and data logging of total oxygen concentration to provide periodic reports for NFPA 99 compliance.
- **Long-Life Sensor Technology:** Features a zirconium oxide O2 sensor with a 10-year continuous lifespan.
- **Automated Mitigation:** Integrated PLC commands a mitigation valve (utilizing ambient air, CO2, or Nitrogen) to maintain safe levels without manual intervention.

- **Integrated Alarm Output:** Includes a dry contact alarm relay that triggers if oxygen levels exceed 23.6%, suitable for connection to facility master alarm panels.
- **Durable NEMA Enclosure:** Housed in a NEMA 1, 2, 4, 4X rated polycarbonate enclosure suitable for both indoor and outdoor use.

System Equipment

Included System Components

The following materials are included in the VacuGuard+ package to support standard installation:

Part	Part Description	Qty
VacuGuard+ Control Unit	Programmed PLC with dry contact alarm relay, 24VDC power supply, and 1A circuit breaker in a polycarbonate enclosure. Includes 5m cables for O2 sensor, vacuum sensor, and solenoid valve.	1
Oxygen Sensor PE004133AV	Zirconium oxide sensor with M8 connector.	1
Vacuum Pressure Sensor PE000436AV	Vacuum pressure sensor with M12 connector.	1
Solenoid Valve ST981249AV	24VDC solenoid valve with ½" NPT female connections.	1
Filter/Muffler	½" NPT male connection for ambient air intake.	1
Installation Hardware	Includes LB junction box, close nipples, brass NPT adapter for O2 sensor, and wire nuts.	1 set

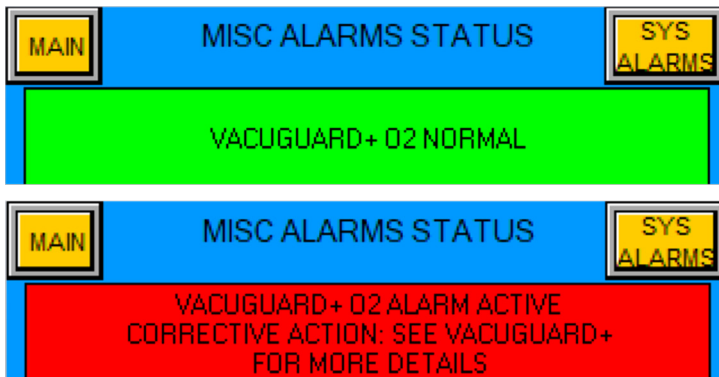
Note: Installers must provide their own tools, mounting screws, and drywall anchors specific to the facility's wall type.

System PLC + HMI Integration
(Primary Control Panel)

The VacuGuard+ arrives from the factory fully integrated into the medical vacuum packages. The VacuGuard+ alarm status is hardwired to the primary system PLC, allowing for centralized monitoring and visual alerts via the system's HMI. VacuGuard+ O2 alarm status is wired back into the overall system panel, providing visual display of alarm status.

If high oxygen concentration is detected, an alarm notification will appear on the system's HMI, directing facility personnel to the VacuGuard+ unit for detailed status information (see screens below).

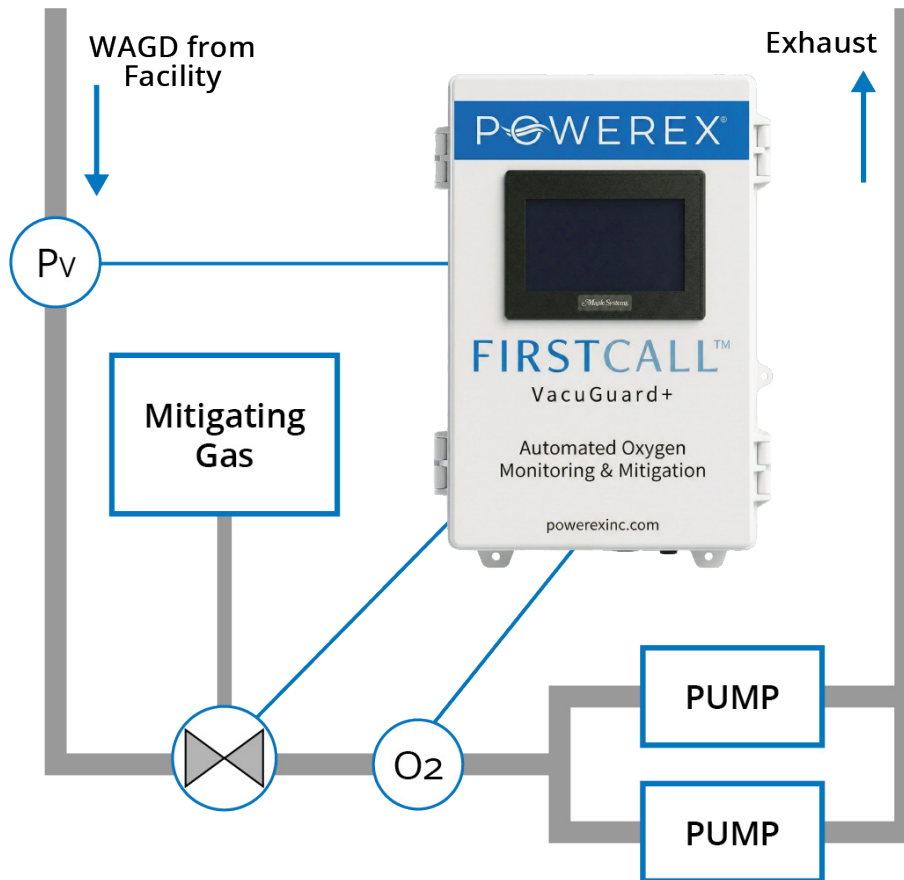
The VacuGuard+ O2 alarm status is provided to the facility via BACnet© and hardwired dry contacts.



Installation

VacuGuard+ Control Unit Installation

1. **Mounting:** The enclosure should be mounted vertically on or near the vacuum pump skid.
2. **Brackets:** Use the 4 provided metal standoff brackets. The installer must provide mounting hardware (e.g., Unistrut) to secure the enclosure to the skid.



General Preparation

The VacuGuard+ unit is pre-wired with three 5-meter (16.4 ft) cables: Inside the unit cover, there are six primary connection points used for power, sensor input, and alarm integration:

- **O2 Sensor:** Connectorized
- **Vacuum Pressure Sensor:** Connectorized
- **Solenoid Valve:** 3-wire cable with unterminated leads

Installer Requirements

- **Fittings:** You must provide the appropriate pipe T's, nipples, and reducers for your facility's specific piping configuration.
- **Sealing:** Use Teflon tape or an equivalent sealant on all threaded piping connections.
- **Wiring:** Secure all cables using zip-ties. Any excess wiring should be coiled and secured near the control unit.

VacuGuard+ Sensor & Valve Installation

O2 Sensor Installation

The system includes an O2 sensor with a 0.5" straight-thread interface and an M8 4-pole connector.

1. **Adapter Assembly:** Attach the included brass adapter to the sensor to convert the 0.5" straight-thread to 0.5" NPT.
2. **Placement:** Install the sensor in the common inlet piping as close to the vacuum pump inlets as possible. This placement ensures the sensor accurately monitors the gas mixture (including any mitigation gas) immediately before it enters the pumps.
3. **Connection:** Once the sensor is mechanically installed, route the pre-wired M8 cable from the VacuGuard+ unit and mate it to the sensor connector.



Mitigation Solenoid Valve Installation

The system uses a 24VDC solenoid valve with 0.5" NPT gas interfaces.

1. **Preparation:** If you are using ambient room air for mitigation, install the provided brass filter/muffler onto the inlet side of the valve.
2. **Placement:** Install the valve upstream of the O2 sensor. This allows the mitigation gas to mix thoroughly with the vacuum system gases before they reach the sensor.
3. **Wiring:** Route the 3-wire cable (Red, Black, and White) to the valve. Use the provided Type-LB conduit body and wire nuts to complete the following terminations:
 - **Power:** Connect the **RED (V+)** and **BLACK (V-)** wires from the unit to the **RED** wires on the solenoid.
 - **Ground:** Connect the **WHITE** wire from the unit to the **GREEN** ground wire on the solenoid.



Vacuum Pressure Sensor Installation

The system is supplied with a vacuum pressure sensor featuring a 0.25" NPT gas interface and an M12 4-pole electrical connector.

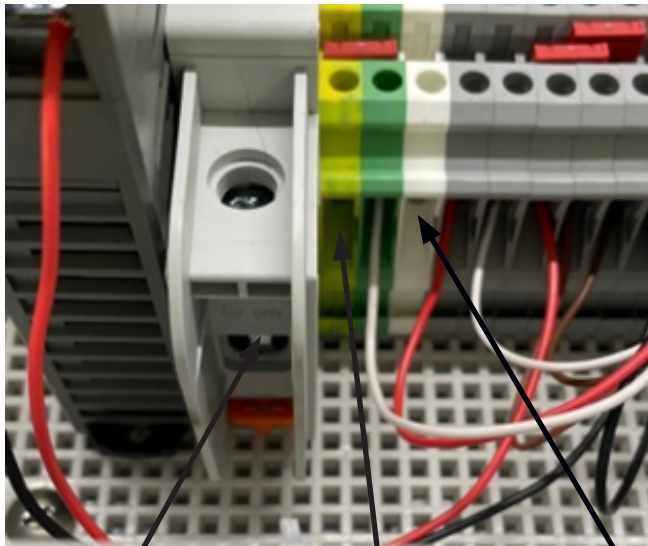
- 1. Placement:** Install the vacuum sensor upstream of the solenoid valve. This specific location allows the unit to monitor patient-side vacuum levels and detect the effects of the mitigation valve when it is open.
 - **Alternative:** If upstream installation is not feasible, install the sensor near the vacuum sensor port used to sense levels for the pump control panel.
- 2. Connection:** Once the sensor is mechanically installed in the piping system, route the pre-wired vacuum sensor cable (M12 connector) from the VacuGuard+ unit to the sensor and mate the connectors.



Facility Interface Wiring – Power Input

Electrical installation must be performed by a qualified electrician.

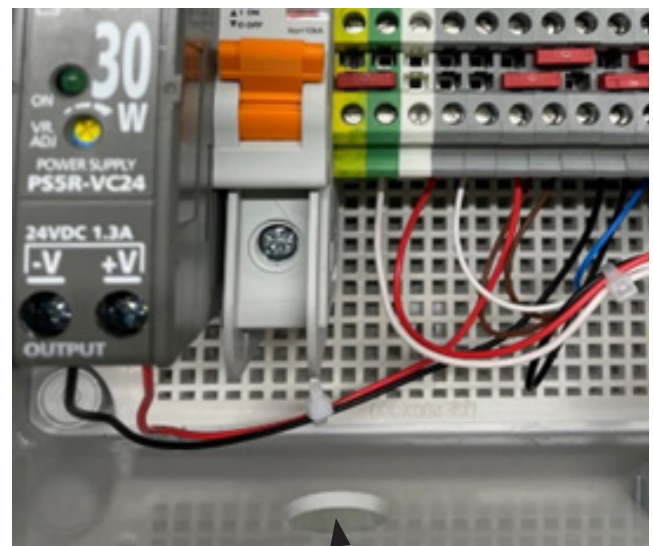
- **Requirements:** The VacuGuard+ requires 120VAC electrical power (2-conductor plus ground).
- **Terminations:** Make all power input connections at the terminal blocks located inside the unit enclosure.
- **Wiring:** The installer is responsible for providing all wiring to interface the unit with an appropriate power source.
- **Recommended Source:** It is typically recommended to connect the unit to a 1A source located within the vacuum pump control panel.



Hot/Black Wire to
Circuit Breaker input

Neutral/White Wire
to White Terminal

Insert 120VAC armored
cable (or equivalent) wiring
thru left wiring port

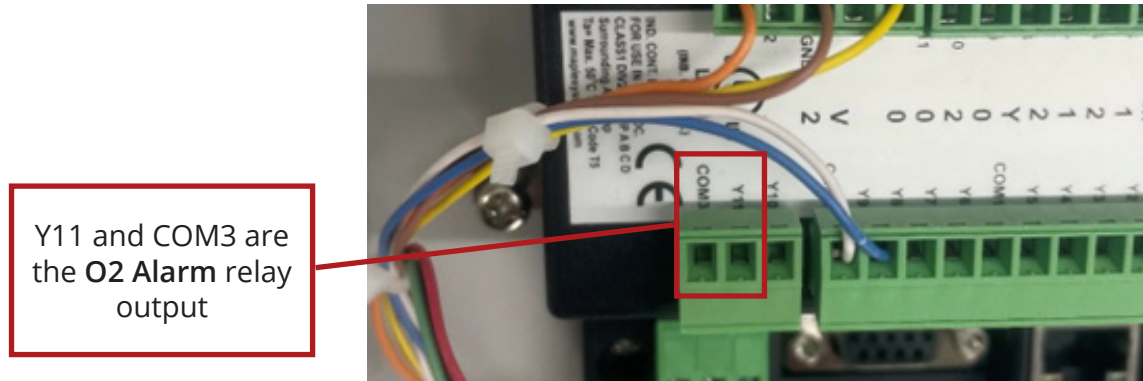


Ground/Green Wire to Green/
Yellow Ground Terminal

Facility Interface Wiring – O2 Alarm Relay Output

The VacuGuard+ includes a dedicated O2 Alarm relay output to facilitate integration with the facility's master alarm panel.

- **Relay Type:** 2-wire dry contact, normally open.
- **Operation Logic:** The relay is commanded closed during normal, safe operation. It will open (triggering the alarm) if:
 1. Oxygen levels exceed the 23.6% safety limit.
 2. The unit loses 120VAC electrical power.
- **Installer Responsibility:** The installer is responsible for providing all necessary wiring to connect this output to the facility's master alarm panel.
- **Connection Location:** Relay terminals are located within the VacuGuard+ enclosure. Refer to the internal labeling for specific terminal termination points.



Mitigating Gas

High oxygen levels can be mitigated using ambient air, carbon dioxide (CO2), or nitrogen gas. The choice of gas depends on the facility type and system volume:

- **In-Patient Facilities:** Due to large system volumes, oxygen spikes are typically diluted easily.
 - **Recommendation:** Use ambient air as the initial mitigating gas. The VacuGuard+ includes an air inlet filter/muffler for the solenoid valve for this purpose.
 - **Note:** If the system experiences recurring O2 alarms after installation, consider switching to carbon dioxide or nitrogen.
- **Out-Patient & Surgery Centers:** Smaller system volumes can lead to much higher and faster oxygen concentration spikes.
 - **Recommendation:** Use carbon dioxide or nitrogen to ensure a more rapid response to increasing O2 levels. Refer to the Specifications section for connection sizing and pressure requirements.
- **Valve Placement:** The mitigation valve must be installed on the consolidated line where all vacuum system inputs meet, upstream of the vacuum pumps.
 - **Optional Hardware:** Larger 3/4" and 1" valves are available for systems requiring higher mitigation flow.

Initial Power Application

Upon the first application of 110 VAC power, the system will boot using factory default settings. The touch screen will illuminate and display the VacuGuard+ MAIN PANEL.

Verification Steps:

1. **Warm-up:** The System Mode should initially display “WARMING UP” (blinking yellow).
2. **Transition:** After approximately 2 minutes, the mode must automatically transition to “MONITORING” (green).
3. **Data Display:** Once in monitoring mode, verify that both the O2% and Vacuum Pressure readings are active on the screen.

Establishing an Installation Baseline

Because altitude and local environmental conditions affect oxygen readings, the installer must baseline the O2 sensor immediately after the unit becomes operational.

1. **Exposure:** Expose the O2 sensor to ambient air for at least **2 minutes**.
2. **Record: Note the concentration reading displayed on the screen.**
3. **Purpose:** This “Installation Baseline” serves as the reference point for all future annual maintenance checks to ensure the sensor has not drifted.
 - *Refer to the “Periodic Sensor Calibration” section for the full calibration procedure.*

O2 STATUS

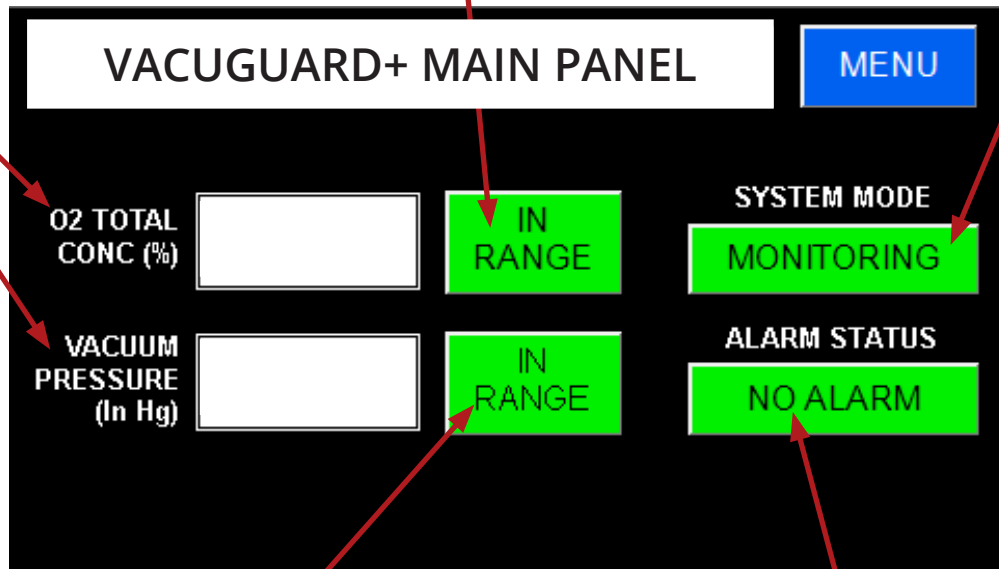
IN RANGE (green) = O2 is in expected range
TOO HIGH (yellow) = O2 is at elevated levels, mitigation is activated

SYSTEM MODE

WARMING UP (blinking yellow) = system is warming up (approx. 2 minutes)
MONITORING (green) = system is monitoring nominal O2 levels
MITIGATING (blinking green) = system is mitigating elevated O2 levels
MONITOR ONLY (yellow) = system is in "monitor only" mode - no mitigation

INPUTS

O2 TOT CONC = absolute oxygen concentration (1 - 95%)
VAC PRESS = vacuum pressure (0 - 29 in Hg)



VACUUM STATUS

IN RANGE (green) = vacuum pressure is in range for mitigation
TOO LOW (yellow) = vacuum pressure is too low for mitigation

ALARM STATUS

NO ALARM (green) = O2 levels are being maintained below alarm limit
ALARM (red) = O2 level has exceeded alarm limit

System Operation

Oxygen Measurement Types

The VacuGuard+ tracks two distinct oxygen metrics to ensure both rapid response and alarm accuracy:

- 1. Instantaneous O2%:** This real-time measurement reflects current O2 concentration. The PLC uses this value to determine exactly when to trigger the mitigation valve. This reading is visible on the MAIN and TREND CHART screens.
- 2. Filtered O2%:** This value is generated by averaging O2 levels over a specific period. It is used to trigger the high-level O2 alarm, preventing “nuisance” alarms from momentary spikes. This measurement can be viewed on the TREND CHART screen.

*Note: Minimum and maximum historical values for both metrics are stored on the **STATS** screen for diagnostic review.*

Mitigation and Alarm Logic

When the system is set to Mitigate Mode, it operates under the following logic:

- **Mitigation Trigger:** If the instantaneous O2 level exceeds the pre-programmed setpoint (configured above nominal levels but below the alarm limit), mitigation is activated.
- **Operational Priority:** Mitigation remains active until O2 levels return to nominal range, provided that the facility’s vacuum pressure is not adversely affected.
- **O2 Alarm Trigger:** If the Filtered O2% exceeds the NFPA-mandated limit of 23.6% for a sustained duration, the system opens the O2 Alarm relay, sending an immediate signal to the facility’s Master Alarm panel.

Post-Alarm Procedures

If an O2 Alarm occurs, the facility should initiate the following safety protocol:

- 1. Direct Monitoring:** Physically inspect the vacuum system pumps for proper operation.
- 2. Verify Levels:** Check the current O2% reading on the VacuGuard+ display.

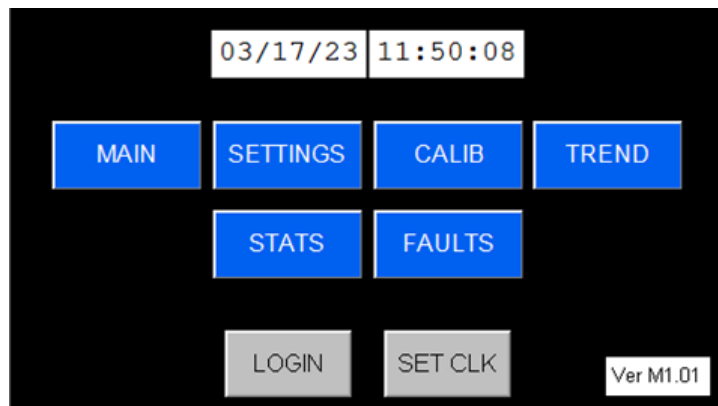
- 3. Clear Alarm:** If the current reading is confirmed to be below the 23.6% limit, reset the O2 alarm on the unit.
- 4. Expert Evaluation:** Contact your VacuGuard+ installation or service agency. A professional evaluation is required to identify the root cause of the excursion and determine if system settings require adjustment.

System Configuration and Navigation

The VacuGuard+ utilizes an intuitive touch screen interface for real-time monitoring and configuration.

- **Main Navigation:** From the MAIN screen, press the MENU button to access the primary system directories, including Settings, Calibrations, Real-Time Data Trending, Statistics, and Fault logs.
- **System Info:** The MENU screen serves as the central information hub, displaying the current date/time and the version of the software currently loaded into the PLC.

MENU Screen



Settings

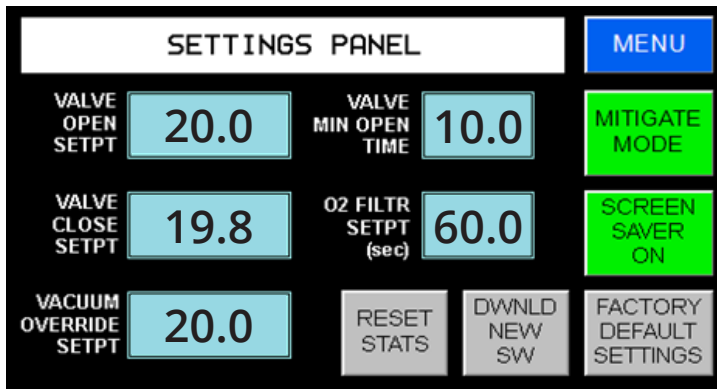
The **SETTINGS** screen allows authorized operators to configure the system's operational parameters. To prevent unauthorized changes after the initial installation, access to this screen is password-protected.

Key Functions:

- **Mitigation Setpoints:** Modify the specific O2 levels at which the solenoid valve opens and closes.
- **Vacuum Override:** Adjust the minimum vacuum pressure threshold required to allow mitigation.
- **System Mode:** Toggle between Monitor Only and Mitigate modes.
- **Statistics Management:** Reset the system's recorded statistics.

The Settings screen (below) enables the operator to modify settings for the mitigation solenoid valve operation setpoints and vacuum override as well as change the VacuGuard+ operating mode (monitor only or mitigate) and reset system statistics.

Settings Screen



Operational Modes

- **Monitor Only Mode:** The system continuously monitors and logs oxygen levels and provides alarm indications. In this mode, only the O2 sensor input is required; the mitigation valve and vacuum sensor are not used.
- **Mitigate Mode:** The system monitors oxygen and vacuum pressure while actively diluting O2 levels via the solenoid valve. This mode requires the O2 sensor, vacuum sensor, and solenoid valve to be

fully installed.

- *Note: Mode selections remain active after a power reset.*

O2 Mitigation Setpoints (Mitigation Mode ONLY)

These settings allow the operator to customize the valve response based on the facility's specific vacuum system design. All adjusted settings are saved to the PLC and will persist even after a power reset.

- **Valve Open Setpoint (Factory Default: 20.0%):** The O2 concentration level that triggers the mitigation valve to open.
- **Valve Close Setpoint (Factory Default: 19.8%):** The O2 concentration level at which the valve will close (provided the minimum open time has elapsed).
- **Valve Min Open Time (Factory Default: 10 Seconds):** The minimum duration the valve will remain open once triggered. This ensures enough mitigating gas is introduced to affect the system levels.

How to Adjust:

1. Touch the value window for the setting you wish to change.
2. A pop-up numeric keypad will appear.
3. Input the new value and press **ENTER**.

Mitigation Valve Operation Logic

When the system is in **Mitigate Mode**, the solenoid valve follows a specific logic sequence to manage oxygen levels safely:

1. **Activation:** When O2% exceeds the Valve Open Setpoint, the System Mode on the MAIN screen flashes MITIGATING (blinking green) and the valve opens.
2. **Duration:** The valve remains open for the duration specified in the Valve Min Open Time setting.
3. **Deactivation:** Once the timer expires, the valve will close only if the O2 concentration is below the Valve Close Setpoint.
4. **Extended Mitigation:** If O2% remains above the close setpoint after the timer expires, the valve

stays open until the levels drop sufficiently.

- **5. Vacuum Priority (Safety Override):** If vacuum pressure falls below the Vacuum Override limit while the valve is open, the solenoid is immediately deactivated. It will remain closed until vacuum pressure rises 0.5 in Hg above the limit (hysteresis).

Vacuum Override & O2 Filter Settings (Mitigation Mode ONLY)

- **Vacuum Override (Factory Default: 15.0 in Hg):** This internal safety setting prioritizes facility vacuum pressure over oxygen mitigation. If system pressure falls below this limit, all mitigation is disabled to ensure patient-side vacuum is maintained.
 - **Note:** The VacuGuard+ does not trigger an external alarm for this state, as the primary vacuum pump controller typically handles low-pressure alarms.
- **O2 Filter Setpoint (Factory Default: 60 Seconds):** This setting determines the duration of the “running average” used for the O2 Alarm. By averaging the instantaneous O2 readings over this window (adjustable from 1 to 120 seconds), the system avoids triggering the facility’s master alarm during momentary, non-critical O2 spikes.

Screen Saver Settings

- **Screen Saver ON (Default):** The touchscreen display will go blank after 10 minutes of inactivity.
- **Screen Saver OFF:** The display remains on indefinitely.
- *Note: This setting will automatically revert to ON after a power reset to protect the display hardware.*

Managing System Statistics

The system continuously generates statistical data during operation, which can be viewed on the **STATS** screen.

- **Reset Statistics:** Pressing the RESET STATS button clears all historical data from memory to begin a fresh data collection cycle.

- **When to Reset:** This should only be performed after events that are not representative of normal operations, such as:
 - Initial system installation and commissioning.
 - Post-maintenance checkouts.
 - Initial system installation and commissioning.
 - Post-maintenance checkouts.
- **Safety Confirmation:** To prevent accidental data loss, a warning screen will appear after pressing the button. You must press OK on the warning screen to confirm the reset.

Software and Factory Defaults

- **Download New Software:** This function is currently reserved for future system updates. Please do not attempt to use this button unless specifically instructed by a service representative.
- **Factory Default Settings:** Pressing the FACTORY DEFAULT SETTINGS button will revert all operational setpoints to the original values established during factory testing.
- **When to Use:** This is a troubleshooting step to be used if system setpoints have been modified and the unit is no longer performing as expected.
- **Safety Confirmation:** As with the statistics reset, a warning screen will appear to prevent accidental changes. Press OK on the confirmation screen to proceed with the reset.

Sensor Calibration

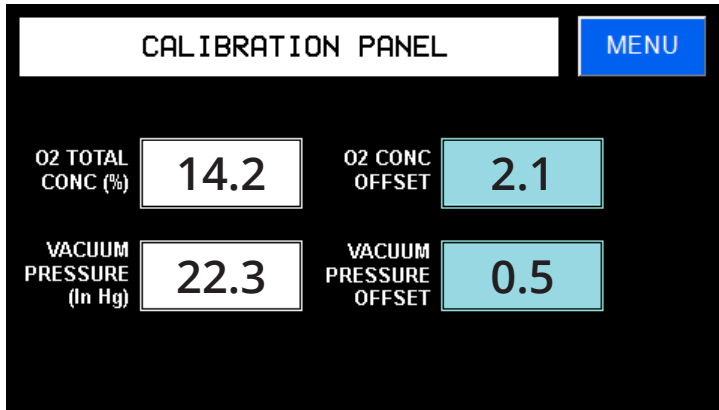
The **CALIBRATION** screen provides the interface for adjusting sensor accuracy through value offsets. Like the Settings menu, access to this screen is password-protected to ensure that only qualified personnel can modify critical system parameters.

Primary Capabilities:

- **Oxygen Offset:** Add or modify offsets for the O2 sensor reading.
- **Vacuum Pressure Offset:** Add or modify offsets for the vacuum pressure sensor reading.

Note: These adjustments are typically made during annual maintenance or when the O2 sensor is verified against an ambient air baseline.

CALIBRATION Screen



Sensor Calibration – Offset Adjustments

These fields allow for precise tuning of sensor readings as part of scheduled system maintenance. Important: Adjustments should only be performed by qualified personnel trained by Powerex-Iwata Air Technology, Inc.

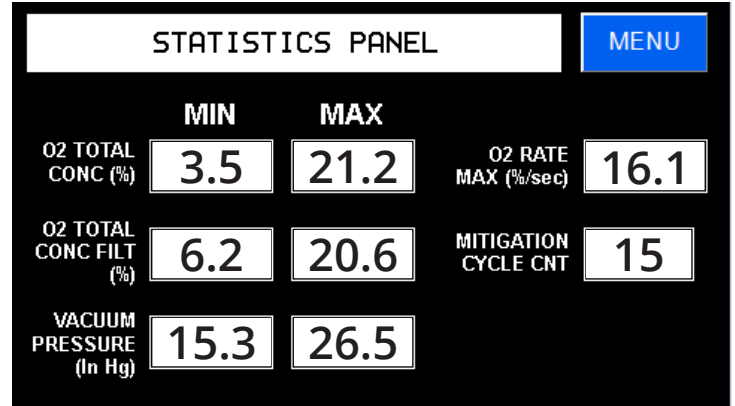
- **O2 Sensor Offset:** This field is used to adjust the oxygen concentration reading up or down. The factory default setting is **0.0**.
- **Vacuum Pressure Offset:** This field is used to adjust the vacuum pressure reading up or down. The factory default setting is **0.0**.

These offsets are typically applied after comparing the unit's readings to a known baseline or calibrated reference device during annual inspections.

Statistics

The **STATS** screen (below) provides a comprehensive overview of system performance during normal facility operations. It serves as a diagnostic tool for operators to verify that the vacuum system and mitigation logic are functioning within expected parameters.

STATS Screen



Statistical Data Points

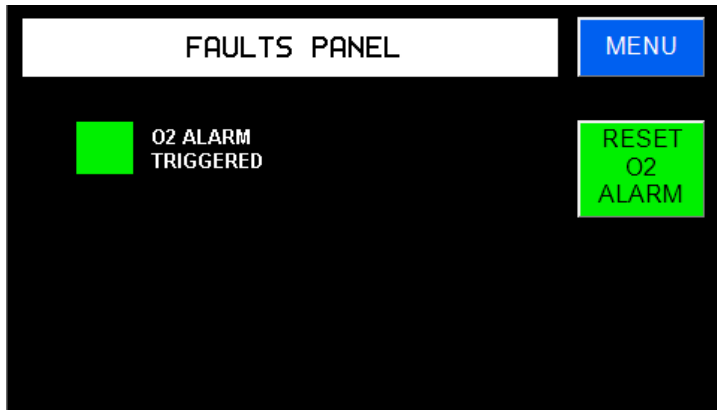
The system tracks and displays the following metrics recorded since the last system startup or the most recent **RESET STATS** command:

1. **O2% Minimum and Maximum:** Records the lowest and highest instantaneous oxygen concentration readings detected by the sensor.
2. **O2% Filtered Minimum and Maximum:** Records the lowest and highest “running average” oxygen readings. These values are particularly useful for reviewing the conditions that lead to O2 alarms.
3. **Vacuum Pressure Minimum and Maximum:** Tracks the extreme high and low points of vacuum pressure, allowing operators to verify system stability.
4. **O2% Rate Maximum:** Displays the fastest rate of oxygen increase detected by the system.
 - *Note: This value is collected for facility diagnostic purposes only and does not currently impact the automated mitigation logic.*
5. **Mitigation Cycle Count:** A running total of every instance the VacuGuard+ has activated the solenoid valve to perform oxygen mitigation. This provides a clear metric of how often the system is required to intervene.

Faults

The Faults screen (below) enables the operator to evaluate system faults and alarms that are generated during facility operations.

FAULTS Screen



O2 Alarm Triggered

The O2 alarm limit is fixed at 23.6%, as required by NFPA 99. This safety threshold is factory-set and cannot be modified by the operator.

- **Trigger Logic:** The alarm activates when the O2 concentration exceeds the limit for a sustained period (using the filtered value to avoid nuisance alarms from momentary spikes).
- **Visual Indicators:** When an alarm occurs, the MAIN screen will display ALARM in red, and the FAULTS screen will update the O2 ALARM TRIGGERED status from green to red.
- **Relay Action:** The O2 Alarm relay output will latch in the ON position (relay open) and remain in that state until it is manually reset by an operator.

Resetting the O2 Alarm

Before clearing an alarm, the facility should investigate the cause of the oxygen excursion and ensure the system has stabilized.

1. **Verify Levels:** Confirm that the instantaneous **O2%** reading has returned to a safe level below the 23.6% threshold.
2. **Clear Alarm:** Once levels are nominal, press the **RESET O2 ALARM** button on the interface.
3. **Confirm Status:** Navigate back to the **MAIN** screen via the **MENU**. The **ALARM STATUS** indicator should now display **NO ALARM** in green.

Logging In

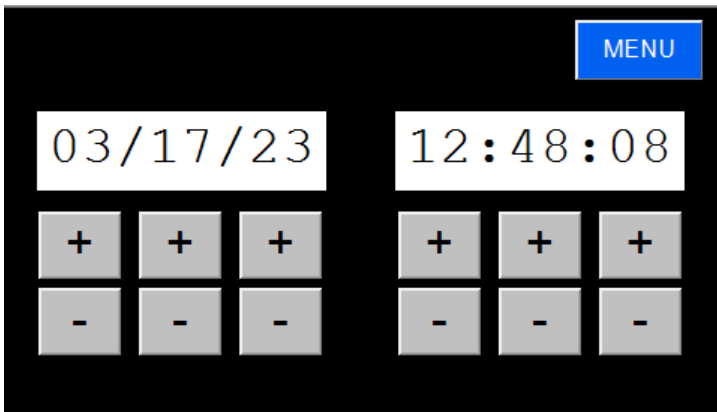
Access to the **SETTINGS** and **CALIB** (Calibration) screens is restricted to authorized personnel. To access these protected menus:

1. **Open Login Screen:** Press the **LOGIN** button on the interface.
2. **Enter Credentials:** * Select the **User ID** field, input your ID, and press the **ENT** button.
 - Select the Password field, input your password, and press the **ENT** button.
3. **Submit:** Once both fields are filled, press the **SUBMIT** button.
4. **Automatic Timeout:** If no errors are detected, access is granted. For security, the PLC will automatically log the user out after 10 minutes of inactivity, requiring credentials to be re-entered.

Adjusting System Date and Time

Maintaining an accurate system clock is essential for the integrity of the data logs used for annual compliance reporting. To update the time:

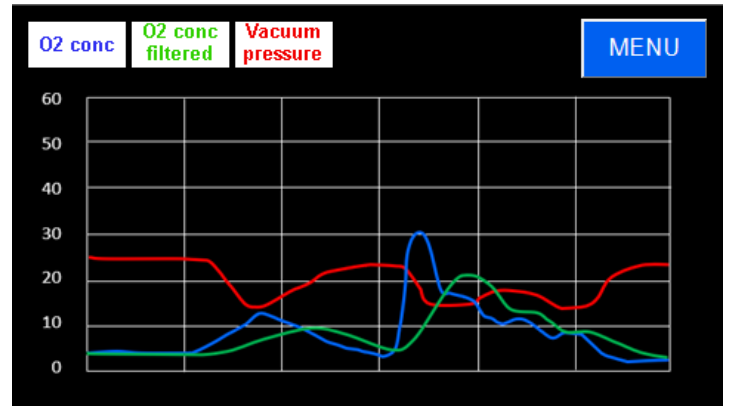
1. **Navigate to Clock Settings:** From the **MENU** screen, press the **SET CLK** button.
2. **Modify Values:** Use the “+” and “-” buttons to adjust the year, month, day, hour, or minute.
3. **Save and Exit:** Once the correct date and time are set, press the **MENU** button to return to the main menu screen and save the changes.



Visualizing Real-Time Data (Trend Chart)

The VacuGuard+ provides a built-in graphical interface to monitor system performance trends as they happen.

- **Accessing the Chart:** From the MAIN screen, press MENU and then select TREND CHART.
- **Monitored Metrics:** The screen automatically populates a real-time graph featuring three key data points:
 1. **O2%: Instantaneous oxygen concentration.**
 2. **O2% Filtered:** The running average used for alarm logic.
 3. **Vacuum Pressure:** Current system pressure levels.
- **Timeframe:** The chart displays a rolling window of 120 seconds of live data.
- **Exiting:** The graph will continue to update and refresh with new data until the MENU button is pressed to return to the previous screen.



Automated Data Logging

The VacuGuard+ system features a real-time logging function that automatically records operational history for compliance and diagnostic review.

- **Storage Media:** Data is written directly to the included USB thumb drive. The provided drive has sufficient capacity to store more than one year’s worth of continuous operational data.
- **Logged Parameters:** The system captures three key metrics:
 1. Instantaneous O2 level
 2. Filtered O2 level
 3. Vacuum Pressure level
- **Logging Frequency:** Data points are recorded every ten (10) seconds, ensuring a high-resolution time history of the system’s performance.

Data Retrieval and Review

Historical data stored on the thumb drive can be accessed and analyzed using a standard computer:

- 1. Extraction:** Remove the thumb drive from the VacuGuard+ unit.
- 2. Connection:** Insert the drive into the USB port of a laptop or PC.
- 3. File Format:** Data is stored as a **.CSV** (Comma Separated Values) file.
- 4. Analysis:** Import the **.CSV** file into a spreadsheet application (such as Microsoft Excel or Google Sheets) to review or graph the data.
 - *Note: Depending on your specific software, some minor data manipulation or formatting may be required to optimize the display of the time-history log.*

Thumb Drive



System Maintenance

Annual Compliance Reporting

To maintain regulatory standards, Powerex-Iwata Air Technology, Inc. recommends downloading the time-history log from the unit's internal thumb drive on an annual basis. This data serves as the facility's official record of oxygen concentration compliance as required by NFPA 99.

Periodic Sensor Accuracy Check

The O₂ sensor should be checked annually to verify its accuracy. This procedure can be performed during the same visit as the annual compliance data download.

1. **Removal:** Carefully unscrew the O₂ sensor from its port in the vacuum system piping.
2. **Ambient Exposure:** Leave the sensor exposed to ambient room air for at least 2 minutes.
3. **Verification:** Confirm that the O₂% reading on the display matches the "Installation Baseline" recorded during the initial system startup.
4. **Recalibration:** If the current reading does not match the baseline, adjust the O₂ Sensor Offset value (refer to the Sensor Calibration section) to re-align the sensor.
5. **Re-installation:** Once the sensor is verified or recalibrated, securely re-install it into the vacuum system port.

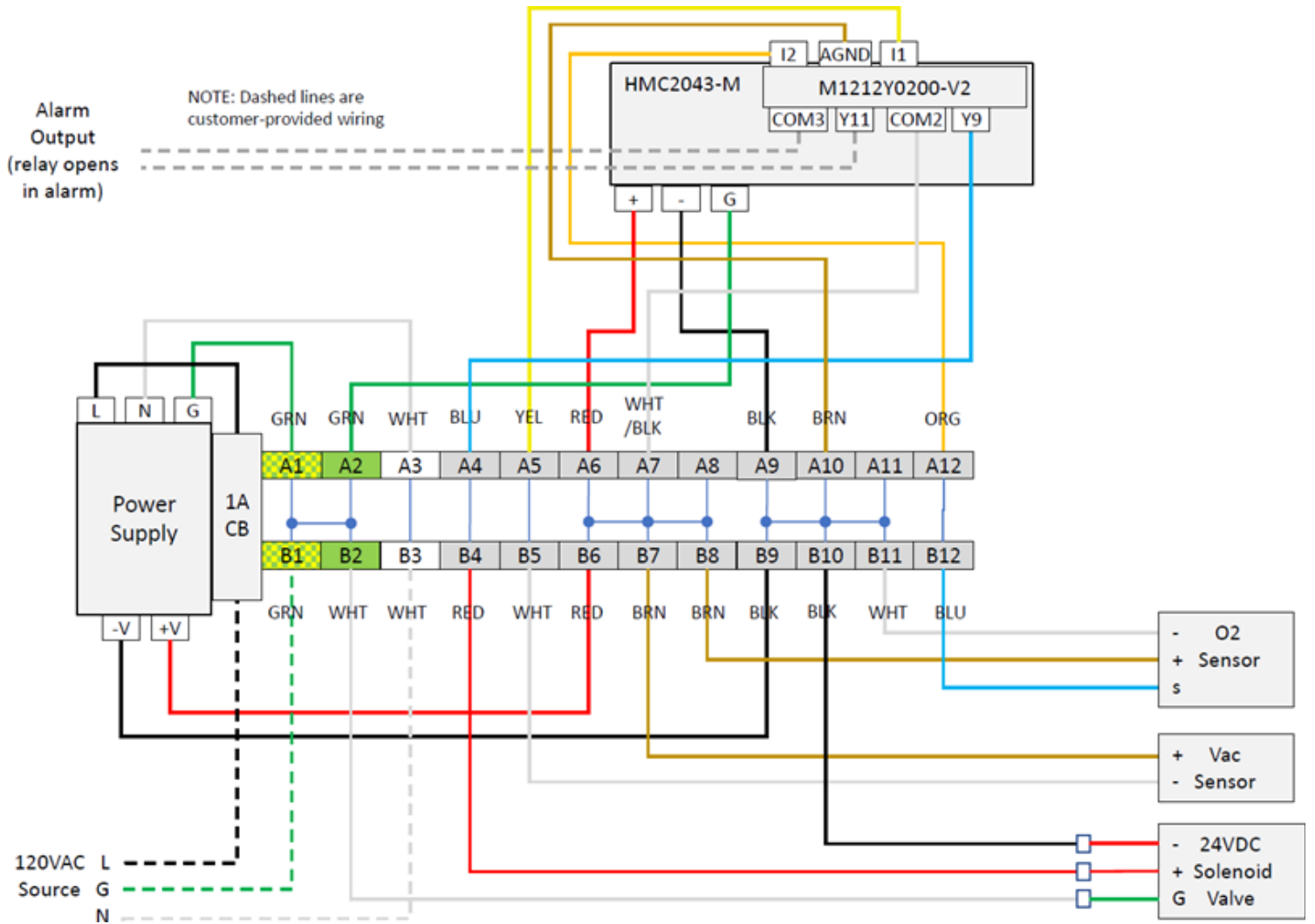
O₂ Concentration and Vacuum Pressure Dynamics

It is important to understand how vacuum pressure affects oxygen concentration readings. The O₂ sensor is designed to measure molecules relative to a sea-level ambient pressure of 14.7 psia.

- **Molecule Density:** When the sensor is exposed to vacuum conditions, there are fewer total gas molecules available to be detected. Because the sensor measures the absolute number of oxygen molecules, the reported concentration will decrease under vacuum even if the ratio of oxygen to other gases remains constant (e.g., 20.9%).

- **Pressure Variance:** The concentration reading will naturally decrease at pressures lower than sea-level (vacuum) and increase at pressures higher than sea-level.
- **Safety Monitoring:** The VacuGuard+ software accounts for these physics to ensure the system accurately monitors oxygen content relative to the absolute safety limits required for pump integrity.

Schematic Diagram



Powerex Limited Warranty

Warranty and Remedies.

(a) Standard Period of Warranty – Parts and Labor. Powerex warrants and represents all Products shall be free from Defects for the first twenty-four (24) months from the date of shipment by Powerex. During such warranty period, Powerex shall be fully liable for all Defects in the Products (the “Product Defects”), i.e., all costs of repair or replacement, which may include “in and out” charges, so long as the Products are located in the United States or Canada, and the Products are reasonably located and accessible by service personnel for removal. “In and out” charges include the costs of removing a Product from buyer’s equipment for repair or replacement.

(b) Additional Period of Warranty – Parts Only (No Labor). In addition to the above, Powerex warrants the products described herein shall be free of Defects for a period of sixty (60) months from the date of shipment by Powerex, with the exception of any components which are recommended to be replaced in less than sixty months in our Installation/Operation manuals. Within said period Powerex will repair or replace any part or component which is proven to be defective in either material or workmanship. This warranty covers parts only. Labor is not included. This warranty is valid only when the product has been properly installed according to Powerex specifications, used in a normal manner and serviced according to factory recommendations. This warranty does not cover failures due to damage which occurs in shipment or failures which result from accidents, misuse, abuse, neglect, mishandling, alteration, misapplication or damage due to acts of nature.

(c) General. Powerex warrants each Powerex branded Pipeline Accessory (collectively “Products”, individually each a “Product”) to be free from defects in material and workmanship (“Defects”) at the date of shipment. EXCEPT AS SET FORTH BELOW, NO OTHER WARRANTY, WHETHER EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, SHALL EXIST IN CONNECTION WITH THE SALE OR USE OF SUCH PRODUCTS. TO THE EXTENT PERMITTED BY LAW, ANY AND ALL IMPLIED WARRANTIES ARE EXCLUDED. All warranty claims must be made in writing and delivered to Powerex in accordance with the procedures set forth on its website (www.powerexinc.com), or such claim shall be barred. Upon timely receipt of a warranty claim, Powerex shall inspect the Product claimed to have a Defect, and Powerex shall replace any Product which it determines to have had a Defect; provided, however, that Powerex may elect, upon return of the Product, to refund to buyer any part of the purchase price of such Products paid to Powerex. Freight for returning Products to Powerex for inspection or for shipping warranty parts shall be paid by buyer where permitted by applicable law. Powerex is not responsible for any import fees, taxes, duties, licenses or other fees imposed by any governmental authority upon the production, sale, shipment and/or use of Products covered hereunder. The warranties and remedies herein are the sole and exclusive remedy for any breach of warranty or for any other claim based on any Defect, or non-performance of the Products, whether based upon contract, warranty or negligence.

(d) Coverage. The warranty provided herein applies to Powerex pipeline products only.

(e) Exceptions. Notwithstanding anything to the contrary herein, Powerex shall have no warranty obligations with respect to Products:

- (i)** That have not been installed in accordance with Powerex’s written specifications and instructions;
- (ii)** That have not been maintained in accordance with Powerex’s written instructions;
- (iii)** That have been materially modified without the prior written approval of Powerex; or
- (iv)** That experience failures resulting from operation, either intentional or otherwise, in excess of rated capacities or in an otherwise improper manner.

The warranty provided herein shall not apply to: **(i)** any defects arising from corrosion, abrasion, use of insoluble lubricants, or negligent attendance to or faulty operation of the Products; **(ii)** ordinary wear and tear of the Products; or **(iii)** defects arising from abnormal conditions of temperature, dirt or corrosive matter; **(iv)** any OEM component which is shipped by Powerex with the original manufacturer’s warranty, which shall be the sole applicable warranty for such component.

Limitation of Liability. NOTWITHSTANDING ANYTHING TO THE CONTRARY HEREIN, TO THE EXTENT ALLOWABLE UNDER APPLICABLE LAW, UNDER NO CIRCUMSTANCES SHALL POWEREX BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, PUNITIVE, SPECULATIVE OR INDIRECT LOSSES OR DAMAGES WHATSOEVER ARISING OUT OF OR IN ANY WAY RELATED TO ANY OF THE PRODUCTS OR GOODS SOLD OR AGREED TO BE SOLD BY POWEREX TO BUYER. TO THE EXTENT ALLOWABLE UNDER APPLICABLE LAW, POWEREX'S LIABILITY IN ALL EVENTS IS LIMITED TO, AND SHALL NOT EXCEED, THE PURCHASE PRICE PAID. In the event of breach of any warranty hereunder, Powerex's sole and exclusive liability shall be at its option either to repair or to replace any defective product, or to accept return, transportation prepaid, of such product and refund the purchase price; in either case provided that written notice of such defect is given to Powerex within twenty-four (24) months from date of shipment to Buyer, that the product is found by Powerex to have been defective at the time of such shipment, that the product has been installed and/or operated in accordance with Powerex's instructions, that no repairs, alterations or replacements have been made by others without Powerex's written approval, and that Buyer notifies Powerex in writing within fifteen (15) days after the defect becomes apparent and promptly furnishes full particulars in connection therewith; and provided further that in no event shall the aggregate liability of Powerex in connection with breach of any warranty or warranties exceed the purchase price paid for the product purchased hereunder. Powerex may, at its option, require the return of any product, transportation and duties prepaid, to establish any claim of defect made by Buyer. Unless otherwise agreed in writing **(a)** Powerex will not accept and shall have no responsibility for products returned without its prior written consent, and **(b)** Powerex will not assume any expense or liability for repairs to products made outside of its plant by third parties. In the event Powerex elects to replace a defective product, costs of installation, labor, service, and all other costs to replace the product shall be the responsibility of Buyer.

Powerex shall not, except as set forth above, be otherwise liable to Buyer or to any person who shall purchase from Buyer, or use, any products supplied hereunder for damages of any kind, including, but not limited to, indirect, special or consequential damages or loss of production or loss of profits resulting from any cause whatsoever, including, but not limited to, any delay, act, error or omission of Powerex. Supplier's repair or replacement of any Product shall not extend the period of any warranty of any Product.

Warranty Disclaimer. Powerex has made a diligent effort to illustrate and describe the Products in its literature, including its Price Book, accurately; however, such illustrations and descriptions are for the sole purpose of identification, and do not express or imply a warranty that the Products are merchantable, or fit for a particular purpose, or that the Products will necessarily conform to the illustrations or descriptions.

Product Suitability. Many jurisdictions have codes and regulations governing sales, construction, installation, and/or use of Products for certain purposes, which may vary from those in neighboring areas. While Powerex attempts to assure that its Products comply with such codes, it cannot guarantee compliance, and cannot be responsible for how the product is installed or used. Before purchase and use of a Product, please review the Product applications, and national and local codes and regulations, and be sure that the Product, installation, and use will comply with them.

Claims. Any non-warranty claims pertaining to the Products must be filed with Powerex within (6) months of the invoice date, or they will not be honored. Prices, discounts, and terms are subject to change without notice or as stipulated in specific Product quotations. Powerex shall not be liable for any delay or failure arising out of acts of the public enemy, fire, flood, or any disaster, labor trouble, riot or disorder, delay in the supply of materials or any other cause, whether similar or dissimilar, beyond the control of Company. All shipments are carefully inspected and counted before leaving the factory. Please inspect carefully any receipt of Products noting any discrepancy or damage on the carrier's freight bill at the time of delivery. Discrepancies or damage which obviously occurred in transit are the carrier's responsibility and related claims should be made promptly directly to the carrier. Returned Products will not be accepted without prior written authorization by Powerex and deductions from invoices for shortage or damage claims will not be allowed. **UNLESS OTHERWISE AGREED TO IN WRITING, THE TERMS AND CONDITIONS CONTAINED IN THIS LIMITED WARRANTY WILL CONTROL IN ANY TRANSACTION WITH POWEREX.** Any different or conflicting terms as may appear on any order form now or later submitted by the buyer will not control. All orders are subject to acceptance by Powerex.