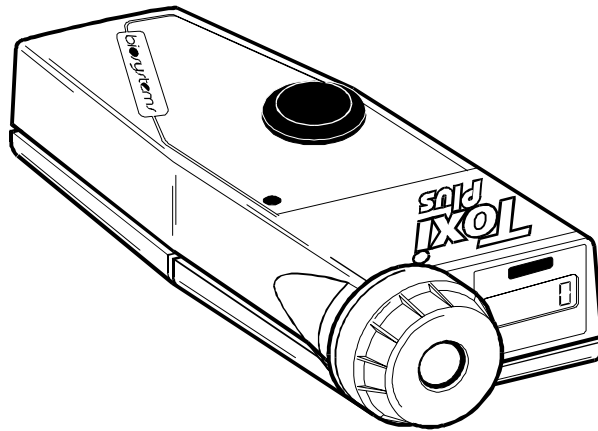


Reference Manual

Toxi Plus

Single Sensor Gas Detector



biosystems[®]

No one makes it easier[™]

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WARNING

THE TOXI PLUS PERSONAL PORTABLE GAS DETECTOR HAS BEEN DESIGNED FOR THE DETECTION AND MEASUREMENT OF POTENTIALLY HAZARDOUS ATMOSPHERIC CONDITIONS

IN ORDER TO ASSURE THAT THE USER IS PROPERLY WARNED OF POTENTIALLY DANGEROUS CONDITIONS, IT IS ESSENTIAL THAT THE INSTRUCTIONS IN THIS MANUAL BE READ, FULLY UNDERSTOOD, AND FOLLOWED.

AVERTISSEMENT: LIRE ATTENTIVEMENT LES INSTRUCTIONS AVANT DE METTRE EN MARCHE.

**Toxi Plus Operation Manual
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Introduction

The Toxi Plus is a personal, portable, microprocessor controlled, single sensor gas detector. The hazard the Toxi Plus is designed to detect is determined by the type of sensor installed at the time of purchase. The Toxi Plus may be configured for the detection of carbon monoxide (CO), hydrogen sulfide (H₂S), sulfur dioxide (SO₂), or may be equipped with a dual purpose "CO Plus" sensor for the simultaneous measurement of both CO *and* H₂S.

The Toxi Plus uses a top-mounted LCD (liquid crystal display) to show readings of the gas being measured as well as other messages. An audible alarm and alarm light warn users of hazardous conditions. An optional vibrator type alarm is also available for use in high noise or other environments requiring additional warnings. A manually activated display back-light insures that the LCD may be easily read even in dim light conditions. The Toxi Plus offers a choice of three modes of operation, ("OK", Basic and Technician) providing the right amount of information for users with different skill levels. Biosystems' "One Button" operating logic allows all procedures necessary for normal day-to-day operation, including fully automatic calibration adjustment, through use of the single on/off "Mode" button.

The Toxi Plus is Classified by Underwriters Laboratories, Inc. and the Canadian Standards Association (pending) as to Intrinsic Safety for use in Hazardous Locations Class I, Division 1, Groups A, B, C, and D. Classification for intrinsic safety is based on tests conducted in explosive gas / air (21 % Oxygen) mixtures only.

WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.

AVERTISSEMENT: LA SUBSTITUTION DE COMPOSANTS PEUT COMPROMETTRE LA SÉCURITÉ INTRINSÈQUE.

CAUTION: FOR SAFETY REASONS THIS EQUIPMENT MUST BE OPERATED AND SERVICED BY QUALIFIED PERSONNEL ONLY. READ AND UNDERSTAND THE INSTRUCTION MANUAL COMPLETELY BEFORE OPERATING OR SERVICING.

ATTENTION: POUR DES RAISONS DE SÉCURITÉ, CET ÉQUIPEMENT DOIT ÊTRE UTILISÉ, ENTRETENU ET RÉPARÉ UNIQUEMENT PAR UN PERSONNEL QUALIFIÉ. ÉTUDIER LE MANUEL D'INSTRUCTIONS EN ENTIER AVANT D'UTILISER, 'ENTRETENIR OU DE RÉPARER L'ÉQUIPEMENT.

CAUTION: ANY RAPID UP-SCALE READING FOLLOWED BY A DECLINING OR ERRATIC READING MAY INDICATE A GAS CONCENTRATION BEYOND UPPER SCALE LIMIT WHICH MAY BE HAZARDOUS.

Avertissement: Toute lecture rapide et positive, suivie d'une baisse subite au erratique de la valeur, peut indiquer une concentration de gaz hors gamme de détection qui peut être dangereuse.

Warnings and Cautions

A. Signal Words

The following signal words, as defined by ANSI Z535.4-1998, are used in the Toxi Plus Operator's Guide.

⚠ DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

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

⚠ CAUTION indicates a potentially hazardous situation, which if not avoided, may result in moderate or minor injury.

CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.

B. Warnings

1. **⚠ WARNING** The Toxi Plus personal, portable gas detector has been designed for the detection of specific toxic gas accumulations. An alarm condition indicates the presence of a potentially life-threatening hazard and should be taken very seriously.
2. **⚠ WARNING** In the event of an alarm condition it is important to follow established procedures. The safest course of action is to immediately leave the affected area, and to return only after further testing determines that the area is once again safe for entry. Failure to immediately leave the area may result in serious injury or death.
3. **⚠ WARNING** Hand aspirated remote sampling only provides continuous gas readings as long as the bulb is being squeezed.
4. **⚠ WARNING** The accuracy of Toxi Plus instruments should be checked periodically with known concentration calibration gas. Failure to check accuracy can lead to inaccurate and potentially dangerous readings.
5. **⚠ WARNING** A sensor that cannot be calibrated or is found to be out of tolerance must be replaced immediately. An instrument equipped with a sensor that fails calibration may not be used until testing with known concentration test gas determines that accuracy has been restored, and the instrument is once again fit for use.
6. **⚠ WARNING** Do not reset the calibration gas concentration setpoints in the Toxi Plus unless the concentration of your calibration gas differs from the concentration of the calibration gas that is normally supplied by Biosystems for use in calibrating the Toxi Plus.
7. **⚠ WARNING** Use of non-standard calibration gas and/or calibration kit components when calibrating the Toxi Plus can lead to dangerously inaccurate readings and may void the standard Biosystems warranty. Biosystems offers calibration kits and long-lasting cylinders of test gas specifically developed for easy calibration. Customers are strongly urged to use only Biosystems calibration materials when calibrating the Toxi Plus.
8. **⚠ WARNING** Substitution of components may impair intrinsic safety.
9. **⚠ WARNING** For safety reasons the Toxi Plus must be operated by qualified personnel only. Read, understand and follow the directions set forth in this reference manual before operating the Toxi Plus.
10. **⚠ WARNING** The Toxi Plus has been tested for intrinsic safety in Explosive Gas/AIR(21.0% O2) Only.

Chapter 1 Toxi Plus Description

1.1 Toxi Plus capabilities

The Toxi Plus gas detector can be customized to meet specific customer requirements. This chapter discusses some of these special features as well as basic capabilities used on a day-to-day basis.

1.2 Methods of sampling

The Toxi Plus may be used as either a "Diffusion" or "Sample-Draw" type monitoring device.

In normal operation, the Toxi Plus detector is worn on the belt, clipped into the user's shirt pocket, suspended on the neck lanyard, or held in the hand. Once turned on, the Toxi Plus monitors continuously. The atmosphere reaches the sensor by diffusing through a dust and water-resistant protective filter directly into the sensor. Normal air movements are enough to carry the sample to the sensor. The sensor reacts to changes in the concentration of the hazard being measured. Values are constantly updated and displayed on the Toxi Plus LCD.

This type of "diffusion" operation monitors only the atmosphere that immediately surrounds the detector.

It is possible to use a sample draw kit to obtain readings from remote locations with a hand-operated squeeze-bulb, which is used to draw the sample in through a probe assembly and a length of hose back to the instrument. **Use of the sample draw kit is covered in section 2.4.**

1.3 Sensor options

The Toxi Plus can be configured to monitor for any one of several different atmospheric hazards. The hazard the Toxi Plus is designed to detect is determined by the sensor. The type of sensor must be

specified at the time the instrument is purchased. The types of sensors currently available include substance-specific electrochemical sensors for the detection of carbon monoxide (CO), hydrogen sulfide (H₂S), and sulfur dioxide (SO₂). In addition, a dual purpose "CO Plus" sensor for the simultaneous detection of both CO *and* H₂S is also available for occasions when a single sensor detector must be used to monitor for the presence of multiple hazards.

Toxic gas readings are given in PPM (parts per million) concentrations.

1.3.1 Electrochemical toxic sensors

The Toxi Plus uses highly specific, electrochemical toxic sensors that have been designed to minimize the effects of common interfering gases. Biosystems uses substance specific sensors to provide accurate, dependable readings for carbon monoxide (CO), hydrogen sulfide (H₂S), and sulfur dioxide (SO₂). In addition to these substance specific sensors, Biosystems also offers the "CO Plus" electrochemical sensor. The CO Plus sensor is a dual purpose sensor designed to simultaneously respond to both to CO *and* H₂S.

Contact Biosystems for additional information concerning the appropriateness of the "CO Plus" sensor for specific applications.

1.4 One Button Auto Calibration

The Toxi Plus detector has been designed for easy verification of accuracy. Biosystems' "One Button" logic means that all normal day-to-day operating procedures, including automatic calibration adjustment, can be made with the on/off MODE button.

⚠WARNING Accuracy of the Toxi Plus should be checked periodically with known concentration calibration

gas. Failure to check accuracy can lead to inaccurate and potentially dangerous readings.

Calibration is a two step procedure. In the first step the Toxi Plus is taken to an area where the atmosphere is fresh and a "zero" adjustment is made. The second step of the calibration procedure is the sensor response or "span" adjustment. In this step the toxic sensor is exposed to known concentration calibration gas. If the instrument notes there is a deviation from the expected response, it will automatically adjust itself so that the readings match the concentration of the gas being used.

Calibration procedures are discussed in detail in Chapter 3.

1.5 Display backlight

A manually activated display backlight allows the LCD to be read in dim light conditions. Pressing the on/off MODE button once at any time during normal operation causes the backlight to be activated for 10 seconds. In the event of a gas alarm the backlight turns on automatically and remains on until the alarm condition clears.

1.6 Alarm logic

Toxi Plus alarms are user adjustable and may be set anywhere within the range of the sensor. When an alarm set point is exceeded a two-toned audible alarm sounds, a bright red LED alarm light flashes, and (if equipped) the optional vibrator type alarm is activated.

Toxi Plus alarms are normally self-resetting. When readings drop back below the pre-set alarm levels, the instrument returns to normal operation, and the visual and audible alarms cease.

Toxi Plus alarms may also be set so that they "latch." With the alarms latched, once an alarm occurs both visual and audible alarms continue to sound even after the atmospheric hazard has cleared. The

instrument must be manually reset to silence the alarms.

Procedures for latching Toxi Plus alarms are given in Chapter 4.

1.6.1 Atmospheric hazard alarms

⚠WARNING The Toxi Plus personal, portable gas detector has been designed for the detection of dangerous atmospheric conditions. An alarm condition indicates the presence of a potentially life-threatening hazard and should be taken very seriously.

⚠WARNING In the event of an alarm condition it is important to follow established procedures. The safest course of action is to immediately leave the affected area, and to return only after further testing determines that the area is once again safe for entry. Failure to immediately leave the area may result in serious injury or death.

Three alarm set-points have been provided for Toxi Plus detectors: TWA (Time Weighted Average), STEL (Short Term Exposure Limit), and Ceiling. Toxi Plus alarm settings are set at the factory in the most conservative way possible.

The procedures for adjusting alarm set points or restoring the factory default settings are given in Chapter 4.

1.6.2 Low battery alarms

The Toxi Plus uses 3 AAA alkaline batteries for power. A fresh set of batteries should provide up to 1,500 hours of normal operation.

When it is time to replace the batteries a "B" will appear in the lower left hand corner of the display screen, and the audible alarm will "beep" once per minute until the battery is replaced. The user should have approximately one to two weeks of useful life remaining. Batteries should be replaced as soon as possible after any low battery message is displayed.

See section 2.3 of this manual for battery replacement procedures.

1.7 Special microprocessor features

Several automatic programs prevent tampering and misuse of the Toxi Plus. Each time the detector is turned on, an electronic self-test is performed. The sensor, LED alarm light, and audible alarm are automatically evaluated, and the battery is monitored continuously for proper voltage.

Optional setup choices include adding a security beep, latching the alarms, changing the concentration of the gas that is used during Auto Calibration adjustment, as well as changing or restoring the factory alarm settings by using the 4 push-buttons on the instrument keypad.

Chapter 4 describes advanced technical features and setup choices in detail.

1.8 Classification for intrinsic safety

The Toxi Plus is Classified by Underwriters Laboratories, Inc., and the Canadian Standards Association (pending) as to Intrinsic Safety for use in Hazardous Locations Class I, Division 1, Groups A, B, C, & D.

Classification for intrinsic safety is based on tests conducted in explosive gas / air (21 % Oxygen) mixtures only.

1.9 Options

1.9.1 Sensors

Toxi Plus detectors may be configured for the detection of carbon monoxide (CO), hydrogen sulfide (H₂S), sulfur dioxide (SO₂), or equipped with a "CO Plus" sensor for the simultaneous measurement of both CO and H₂S. The sensor selected must be specified at the time of purchase.

1.9.2 Vibrator alarm

An internally mounted vibrating alarm is optionally available for use in high noise or other environments requiring additional warnings. The vibrator alarm option must be specified at the time the instrument is purchased.

1.9.3 Remote sample draw assembly

An optional hand aspirated (squeeze bulb) sample draw kit is available for use in situations where the sample must be obtained from remote locations. The sample draw kit consists of a sample draw adaptor, squeeze bulb, sample probe assembly, spare filters, and 10 feet of sample tubing.

1.9.4 Weather cover

An optional leather weather cover is available for use in environmentally harsh locations, or where additional protection is desired.

1.9.5 Training video

A comprehensive 25-minute training video is available to augment and support the written Owner's Manual.

1.10 Toxi Plus design components

(1) Case: The instrument is enclosed in a durable, gasketed case constructed of a metal plated ABS / polycarbonate material.

(2) LCD display: A top mounted liquid crystal display (LCD) meter allows display of readings, messages, and other information. A manually activated back-light insures that the LCD may be easily read even in dim light conditions.

(3) Alarm light: A bright red top-mounted LED (light emitting diode) alarm light visually warns users when an alarm level is exceeded.

(4) Audible alarm: A loud two-toned audible alarm is also provided to warn users of hazardous conditions.

(5) **MODE button:** The on/off "Mode" button is used to turn the instrument on and off as well as control most day-to-day functions.

(6) **Protective cap:** A protective O-ring sealed cap and moisture barrier filter are protect the sensor from damage.

(7) **Sensor:** The top-mounted sensor may be easily accessed for replacement or repair.

(8) **Bottom surface:** The stainless steel belt clip may be removed to allow access to the 4 hidden push-buttons ("CAL", "ALM", "+" and "-") used to control advanced functions.

1.11 Toxi Plus accessories

Toxi Plus detectors are shipped complete with sensor, set of three AAA alkaline batteries (installed), calibration adaptor, owner's manual and quick reference card.

Optional Toxi Plus accessories include sample draw kit, weather cover, training video, and internally mounted vibrator alarm (vibrator option must be specified at time of purchase).

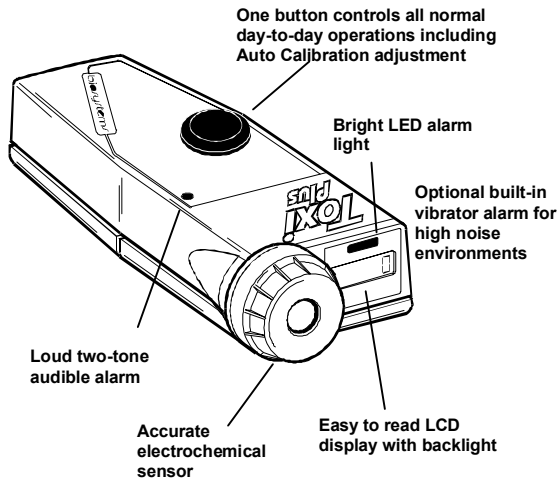


Figure 1.1: Toxi Plus external features

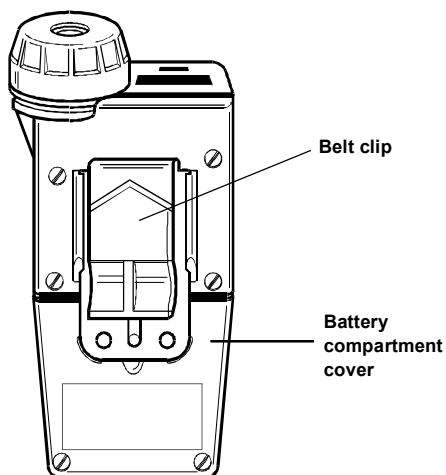


Figure 1.2: Toxi Plus bottom surface

Chapter 2 Basic operation

2.1 Overview of Toxi Plus operation

The Toxi Plus offers a choice of three modes of operation, "Text Only," "Basic," and "Technician". Operating mode selection should be based on how much information is required, the skill level of the user, and the nature of the job.

2.1.1 Operational warnings and cautions

The full list of operational warnings and cautions are contained at the front of this manual immediately preceding chapter 1.

2.1.2 Turning the Toxi Plus on

The black switch on the top of the Toxi Plus case is called the MODE button. It is used to turn the Toxi Plus on and off, as well as to control most other operations of the instrument. Press and hold the MODE button for one second to turn the Toxi Plus on.

2.1.3 Turning the Toxi Plus off

Turn the Toxi Plus off by pressing and holding the MODE button down for 3 seconds.

2.1.4 Start-up sequence

After the detector has been turned on, it will automatically go through an electronic self test and start up sequence that takes approximately twenty seconds. During the self test sequence the LCD backlight will be activated, the visual LED alarm light will flash, the audible alarm will sound, and (if equipped) the optional vibrator alarm will briefly activate. During start-up the LCD display will also show several messages or "screens" in sequence. The first screen displays the software version number:

TP3.7

(Note: The software version installed may differ with that shown above.) The second shows the type of sensor installed:

H2S

Additional screens will briefly appear indicating the current Peak, STEL, and TWA alarm set-points. For instance, a hydrogen sulfide Toxi Plus with default alarm settings being operated in the Technician mode would show the following sequence of factory installed (default) alarm set points when the instrument is first turned on:

PEAK → ALARM → 10 →
STEL → ALARM → 15 →
TWA → ALARM → 10

The current gas reading screen for the gas being measured will then be shown alternating with the sensor identifier screen.

H2S ↔ 0

Note: The alarm set-point screens are omitted when the instrument is turned on while in the "Basic" or "Text Only" modes. In "Text Only" mode, "OK" will be shown unless an alarm condition is present.

2.2 Operating modes

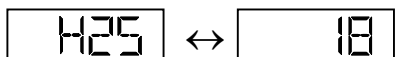
Three operating modes provide Toxi Plus users with the right amount of information to meet their monitoring needs. The Toxi Plus is designed to be as simple or as sophisticated as the job that needs to be done.

2.2.1 Text Only mode

The simplest mode of operation is the "Text Only" mode. In this mode, during normal operation the LCD screen does not display numerical readings, only the indication "OK". This screen alternates with the sensor identifier screen.

OK ↔ H2S

If an alarm condition occurs, that is, when the sensor readings exceed a pre-set alarm level, the indication changes from "OK" to the numerical value, the LED alarm light flashes, the audible alarm sounds, and (if equipped) the optional vibrator alarm is activated.



Toxi Plus alarms are normally self-resetting. When readings drop back below the pre-set alarm levels, the screen reverts to the "OK" indication, and visual and audible alarms cease.

2.2.2 Basic mode

The "Basic" mode of operation is designed for users with a higher level of understanding, and a need for numerical readings, but who are not experts in gas detection.

In the Basic mode, as in the "Text Only" mode, the user has access to only one "screen" of information; the current gas readings. The major difference between the two modes is that in the Basic mode numerical gas level readings are always provided, whereas in the Text Only mode only an indication that conditions are "OK" is provided unless the instrument is in alarm.

Basic mode current gas level screen:



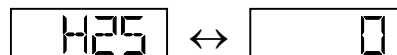
An alarm condition occurs when sensor readings exceed a pre-set alarm level. During an alarm the numerical reading changes to reflect the new value, the LED alarm light flashes, and the audible alarm sounds.



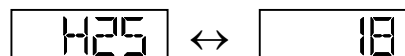
Toxi Plus alarms are normally self-resetting. When readings drop back below the pre-set alarm levels, visual and audible alarms cease, and normal operation of the instrument resumes.

2.2.3 Technician mode

"Technician Mode" provides access to all advanced functions and displays. When the instrument is turned on in the Technician Mode, following the completion of the start-up and self-test sequence, the meter display will show numeric readings for the gas being measured.

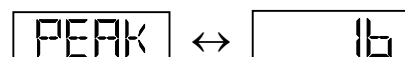


An alarm condition occurs when sensor readings exceed a pre-set alarm level. During an alarm the numerical reading changes to reflect the new value, the LED alarm light flashes, and the audible alarm sounds.



Toxi Plus alarms are normally self-resetting. When readings drop back below the pre-set alarm levels, visual and audible alarms cease, and normal operation of the instrument resumes.

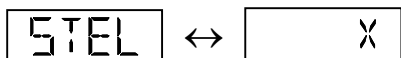
In Technician Mode, press the MODE button to scroll through the additional screens of information. The first screen is the gas level display discussed above. Press the MODE button once to display the peak reading of the gas being measured since the instrument was switched on.



Press the MODE button again to view the STEL (Short Term Exposure Level) of the toxic gas being measured. The STEL (Short Term Exposure Limit) for a particular toxic gas is the maximum average concentration to which an unprotected worker may be exposed in any 15 minute interval during the day. The STEL value displayed is the average concentration for the most recently completed 15 minutes of operation.

Since STEL calculations are made using the most recent fifteen-minute monitoring interval, it is not possible to compute a toxic gas STEL until the Toxi Plus has been

monitoring for at least fifteen minutes. Until the minimum monitoring time has elapsed, the STEL screen will show an "X" where the reading should be.



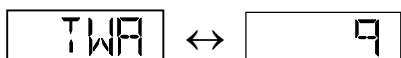
After fifteen minutes have elapsed, the STEL screen will show the appropriate numerical value.



Press the MODE button again to display TWA (Time Weighted Average) exposure levels. Time Weighted Average or TWA values are calculated by taking the sum of exposure to a particular toxic gas in the current operating session in terms of parts-per-million-hours and dividing by an eight-hour period. It is not possible to compute a toxic gas TWA until the Toxi Plus has been monitoring for at least one hour. Until the minimum monitoring time has elapsed, the TWA screen will show an "X" where the reading should be.



After an hour has elapsed, the TWA screen will show the appropriate numerical value.



Pressing the MODE button again to return current gas readings.

Regardless of operating mode selection, anytime the Toxi Plus is on, it is remembering the peak readings of all gases measured, and is calculating both long term Time Weighted Averages and Short Term Exposure Levels (for toxic gas reading detectors) and will go into alarm whenever appropriate.

2.2.4 Changing operating modes

It's possible to change operating modes while the instrument is in use without affecting the on-going calculations used to determine Peak, STEL and TWA alarms. Simply slide the belt clip at the back of the instrument out of the way to expose the

four mini-push-buttons. Then simultaneously press and hold the "+" and "-" buttons until the word "MODE" is displayed. Each time the operating mode is changed the display screen will briefly indicate which operating mode has been selected.

Note: Shifting modes or otherwise reprogramming the instrument should only be done by employees who are authorized to do so.

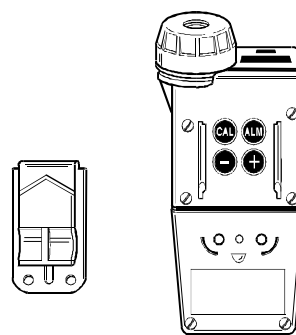


Figure 2.2. Toxi Plus with belt clip removed exposing the four keypad push-buttons

2.3 Toxi Plus batteries

The Toxi Plus uses a set of three AAA disposable alkaline batteries. A fresh set of batteries should power the instrument for up to 1,500 hours of operation.

2.3.1 Low battery voltage alarms

When it is time to replace the batteries a "B" will appear in the lower left hand corner of the display screen, and the audible alarm will "beep" once per minute until the batteries are replaced. Once the "B" is shown, the user should have approximately one to two weeks of useful battery life remaining.

2.3.2 Battery replacement

Toxi Plus batteries should be replaced as soon as possible after a low battery ("B") message has been noticed.

Use the following procedure to change the batteries.

- (1) Turn the instrument off.
- (2) Remove the belt clip from the bottom of the instrument by sliding it completely free of the belt clip mounts.
- (3) Loosen and remove the two screws securing the battery compartment cover to the instrument case. (The screws must be completely removed to detach the battery compartment cover from the instrument case.)
- (4) Gently remove the battery compartment cover by sliding it backwards then lifting it free from the instrument case.
- (5) Remove the old batteries.
- (6) Make sure the battery terminals are clean.
- (7) Install the new batteries. Use high quality alkaline batteries only. (Make sure that the batteries are aligned in the correct directions, and that all battery polarities are correct.)
- (8) Replace the battery compartment cover, screws, and belt clip.
- (9) Accuracy of the Toxi Plus detector must be verified by exposure to known concentration test gas before the instrument is put back into service.**

2.4 Methods of sampling

The Toxi Plus may be used as either a "Diffusion" or "Sample-Draw" type monitoring device.

In normal operation, the Toxi Plus detector is worn on the belt, clipped into a shirt pocket, suspended from the neck lanyard, or held by hand. Once turned on, the Toxi Plus monitors continuously. The atmosphere being measured gets to the sensor by diffusing through a protective moisture barrier filter. Normal air movements are enough to carry the sample to the sensor.

The sensor reacts to changes in the concentration of the gas being measured. Values are quickly updated and displayed on the LCD meter. This type of "diffusion" operation monitors only the atmosphere that immediately surrounds the detector.

It is possible to use the Toxi Plus to sample remote locations by using a sample draw kit. The Toxi Plus kit uses hand-aspirated squeeze bulb to draw a sample-back to the instrument through a hose and probe assembly.

2.4.1 Using the hand aspirated sample draw kit

- (1) Connect the slip-on sample draw cup with the squeeze bulb and hose assembly. (Connect the end of the short length of hose closest to the bulb to the sample draw cup. Connect the other end of the hose to the sample probe.)
- (2) Cover the end of the sample draw probe assembly with a finger, and squeeze the aspirator bulb. If there are no leaks in the sample draw kit components, the bulb should stay deflated for a few seconds.
- (3) Insert the end of the sample probe into the location to be sampled.
- (4) Squeeze the aspirator bulb several times to draw air from the remote location to the sensor compartment. Allow one squeeze of the bulb for every one foot of sampling hose.

Caution: Hand aspirated remote sampling only provides continuous gas readings as long as the bulb is being squeezed.

Each time a reading is desired, it is necessary to squeeze the bulb a sufficient number of times to bring a fresh sample to the sensor.

Chapter 3 Calibration

The Toxi Plus detector has been designed for easy calibration. The MODE button is used to enter the “Auto-Calibration” mode, and automatically make all calibration adjustments. It is also possible to manually calibrate the instrument by using simple push-button controls located on the instrument keypad.

“One-Button Auto-Cal” procedures are discussed in Section 3.4. Manual calibration procedures are discussed in Section 3.5.

3.1 Verification of accuracy

⚠WARNING The accuracy of Toxi Plus instruments should be checked periodically with known concentration calibration gas. Failure to check accuracy can lead to inaccurate and potentially dangerous readings.

Verification of accuracy is a two step procedure. In the first step the Toxi Plus is taken to an area where the atmosphere is fresh and the readings are checked. If the readings differ from those expected in fresh air a “zero” adjustment must be made. The second step is to make sure the sensor is accurate by exposing it to known concentration test gas and noting the response. Readings are considered accurate when they are within $\pm 10\%$ of the expected concentration as given on the calibration gas cylinder. If readings are accurate, there is no need to adjust your gas detector. If the readings are inaccurate, the instrument must be span calibrated before further use.

Biosystems offers calibration kits and long lasting cylinders of test gas specifically developed for easy Toxi Plus calibration. Customers are urged to use

Biosystems calibration materials when calibrating their Toxi Plus detectors.

⚠WARNING Use of non-standard calibration gas and/or calibration kit components when calibrating the Toxi Plus can lead to dangerously inaccurate readings and may void the standard Biosystems warranty.

3.1.1 Effect of contaminants on Toxi Plus sensors

The atmosphere in which the Toxi Plus monitor is being used can have an effect on the sensor. Sensors may be poisoned or suffer degraded performance if exposed to certain substances.

⚠WARNING The accuracy of the Toxi Plus should be checked immediately following any known exposure to contaminants by testing with known concentration test gas before further use.

3.1.1.1 Effects of contaminants on toxic gas sensors

Biosystems “substance-specific” electrochemical used to measure CO, H₂S and SO₂ have been carefully designed to minimize the effects of common interfering gases. “Substance-specific” sensors are designed to respond only to the gas that they are supposed to measure. The higher the specificity of the sensor the less likely the sensor will be affected by exposure to other gases which may be incidentally present. For instance, a “substance-specific” carbon monoxide sensor is deliberately designed not to respond to other gases that may be present at the same time, such as hydrogen sulfide or methane.

Although great care has been taken to reduce cross-sensitivity, some interfering gases may still have an effect on toxic

sensor readings. In some cases the interfering effect may be positive and result in readings that are higher than actual. In other cases the interference may be negative and produce readings that are lower than actual or even result in negative gas readings.

Cross sensitivity of Toxi Plus toxic sensors to common interfering gases is listed in Appendix E.

3.1.1.2 Biosystems “CO Plus” dual purpose carbon monoxide / hydrogen sulfide sensor

Carbon monoxide and hydrogen sulfide are the two most widely occurring toxic gases found in the industrial workplace. In addition to “substance specific” sensors designed to measure these toxic hazards, Biosystems also offers a dual purpose sensor designed to simultaneously detect both carbon monoxide *and* hydrogen sulfide. The “CO Plus” sensor is ideal for situations requiring use of a single sensor to monitor simultaneously for both toxic hazards.

The “CO Plus” sensor has been designed to respond to both carbon monoxide and hydrogen sulfide, and can be calibrated for the direct detection of either hazard. Since the sensor has been designed to respond to both hazards at once, it cannot discriminate between or tell which of the two gases is producing the reading. The sensor can’t tell which hazard is present in what specific concentrations, but it will go into alarm if readings exceed the instrument’s alarm level for a CO or H₂S hazard.

Note: When a specific contaminant such as hydrogen sulfide is known to be potentially present the best approach is usually to use a direct reading substance specific sensor. If hydrogen sulfide is known to be potentially present, the sensor

selected should be specifically for the detection of H₂S, and calibrated directly to this hazard.

⚠WARNING Calibration of the CO Plus sensor with multi-component calibration gas mixtures containing both CO and H₂S may lead to inaccurate and potentially dangerous readings.

Biosystems “CO Plus” sensors are designed for the simultaneous detection of both carbon monoxide **and** hydrogen sulfide. The calibration gas used to calibrate “CO Plus” sensors may contain only one of these two gases. If a “CO Plus” sensor is calibrated with a mixture that contains both carbon monoxide and hydrogen sulfide readings may be dangerously low.

Biosystems multi-component calibration gas mixtures which contain both carbon monoxide and hydrogen sulfide are labeled as “Not for use with CO Plus sensors”.

Note: “CO Plus” sensors are normally calibrated to carbon monoxide. The calibration gas normally used contains a mixture of 50 PPM CO.

3.1.1.2.1 Relative response of the “CO Plus” sensor to CO and H₂S gases

A “CO Plus” sensor which has been properly calibrated to carbon monoxide will be exactly accurate for the substance to which it was calibrated. OSHA (1989) permissible exposure limits for carbon monoxide specify an 8 hour TWA limit of 35 PPM. If the “CO Plus” sensor is calibrated to carbon monoxide then exposed to 35 PPM carbon monoxide the reading will be 35 PPM.

The “CO Plus” sensor will also show a “relative response” to other interfering gases. When calibrated on carbon monoxide the relative response of the “CO Plus” sensor to hydrogen sulfide is a ratio of about 3.5 to 1.0. This means a

concentration of about 10 PPM hydrogen sulfide would produce a "CO+" sensor reading of 10 X 3.5 or 35 PPM.

This is a very convenient relative response. The 8 hour TWA permissible exposure limit for hydrogen sulfide is 10 PPM. This means that the "CO+" gas alarms will be tripped any time the concentration of hydrogen sulfide exceeds the permissible exposure limit.

Note: Cross sensitivity of the "CO Plus" sensor to carbon monoxide, hydrogen sulfide and other common interfering gases is listed in Appendix E.

3.2 Fresh air "zero" calibration

The fresh air "zero" must be done in fresh, uncontaminated air. In this procedure the instrument automatically adjusts its readings to match the concentrations present in fresh air. Fresh air contains 0 PPM toxic gas.

If the Toxi Plus cannot be taken to an area where the air is fresh, or if it is not certain whether or not the air is uncontaminated, special procedures are required. These procedures are discussed at greater length in **Appendix C**.

The second step is to verify the accuracy of the sensor by exposing it to known concentration test gas.

3.3 Functional (bump) test

A simple functional (bump) test is all that is needed to verify accuracy.

To perform a functional (bump) test, turn the Toxi Plus on, and wait at least three minutes to allow the readings to fully stabilize. Make sure the instrument is located in fresh air. Check to see that the readings match the concentrations present in fresh air. If the Toxi Plus is operated in either the Basic or Technician mode readings should equal

0 PPM. If the instrument is operated in the Text Only mode all readings should indicate conditions are "OK". If necessary, fresh air zero the instrument using the procedures discussed in **Section 3.4.1**.

Slip on the calibration adapter as discussed in **Section 3.4.2**, and flow calibration gas to the sensor. Wait for the readings to stabilize. (Forty-five seconds to one minute is usually sufficient.) Note the readings. Readings are considered accurate when they are within $\pm 10\%$ of the expected concentration as given on the calibration gas cylinder. If readings are accurate, there is no need to adjust your gas detector. If the readings are inaccurate, the instrument must be span calibrated before further use.

Readings which are more than 10 percent higher or any amount lower than expected indicate the instrument must be adjusted using the "span" calibration procedures discussed in Section 3.4.2 before further use.

Note: It is necessary to be in either the Basic or Technician operating mode in order to make calibration adjustments. When the instrument is operated in the Text Only "OK" mode a functional (bump) test is the procedure used to verify accuracy. If the readings are accurate, it is safe to use the instrument without further adjustment.

3.4 Auto-calibration

Biosystems "One-Button Auto-Calibration" mode may be used to verify accuracy any time during normal operation while the instrument is being used in either the Basic or Technician operating mode.

Press the MODE button 3 times in rapid sequence to place the instrument in the

“Auto-Calibration” mode. Once in the Auto Calibration mode the adjustments are made automatically.

Auto-calibration is a two step procedure. In the first step the Toxi Plus is taken to an area where the atmosphere is fresh and a "zero" adjustment is made automatically by pressing the on / off MODE button. The second step is the sensor response or "span" calibration adjustment. In this step the accuracy of the Toxi Plus sensor is established by exposing it to known concentration calibration gas.

3.4.1 Fresh air "zero" auto-calibration sequence

The fresh air zero procedure may only be done while the instrument is being operated in either the Technician or Basic operating mode.

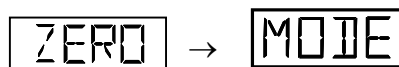
- (1) Turn the instrument on and make sure gas readings are given in numbers.

If readings are given in the form of “OK” text messages the instrument is currently being operated in the “Text Only” mode. It will be necessary to change to either the Basic or Technician operating mode. Switch modes (if necessary) by simultaneously holding down the "+" and "-" keys as discussed in **Chapter 2**. Each time the operating mode is changed, the LCD screen will briefly indicate the current operating mode.

- (2) Wait at least three minutes after turning the instrument on to allow sensor readings to stabilize fully **before** initiating auto-calibration procedures.
- (3) Make sure the instrument is located in an area where the air is known to be fresh.
- (4) Press the MODE button 3 times within two seconds. This will "wake up" the instrument from normal

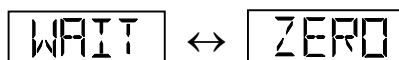
operation, and put it into the “Auto-Calibration” mode.

A screen will briefly display the message “ZERO MODE”.



- (5) Press the MODE button within five seconds to initiate the fresh air adjustment. (If the MODE button is not pushed within 5 seconds, the instrument will return to normal operation.)

The screen will show the message “WAIT ZERO” while the adjustment is being completed.



- (6) Following successful completion of the “zero” auto-calibration, the display will prompt you with the message “SPAN MODE” to continue with a span calibration adjustment.

3.4.1.1 Reading “Too High” or “Too Low” for zero adjust

To reduce the chances of the Toxi Plus being inadvertently zeroed in contaminated air, only small adjustments are allowed through the use of the “One Button” auto-zero sequence. If the necessary adjustments are too large the display will indicate that the reading is too low or too high for zero adjustment. In this case the instrument must be fresh air zeroed using the “Cal” button on the instrument keypad and procedures discussed in **Section 3.5.1** of this manual.

Once the instrument has been successfully zeroed using the “Cal” button, subsequent calibration adjustments may be made using the MODE button and “One Button Auto Cal” logic discussed in this section.

3.4.2 “Span” auto-calibration sequence

After successful completion of the “zero” auto-calibration adjustment the display will show the message “SPAN MODE”.

SPAN ↔ **MODE**

If the MODE button is not pushed within five seconds a span calibration adjustment will not be made, and the instrument will be returned to normal operation.

- (1) Press the MODE button within 5 seconds to initiate “span” auto-calibration. A screen will ask you to “FLOW GAS”. The instrument will continue to display this screen until it determines that calibration gas has been applied.

FLOW ↔ **GAS**

Note: It is possible to exit the auto-calibration mode at any time prior to completion by pressing and holding down the **MODE** button for 3 seconds to turn the instrument off.

- (2) Attach the cylinder of calibration gas, regulator, short section of tubing and calibration adapter to the Toxi Plus detector.

⚠WARNING Make sure the regulator, cylinder seating surfaces and threads are clean and dry before attaching the regulator to the cylinder of gas. Introduction of contaminants through the regulator fittings may alter or degrade the concentration of the gas contained in the cylinder and may lead to inaccurate and potentially dangerous gas readings.

The regulator will automatically begin flowing calibration gas as soon as it is screwed into the cylinder of gas.

- (3) The instrument will display the sensor readings as they rise. When

they have stabilized at their highest value, the instrument will note the response and, if necessary, adjust the readings to match the concentration of gas being used to calibrate the detector. (The instrument will beep as the adjustment is being made.)

⚠WARNING Calibration values shown on the “Span Adjust” screen as the sensor is adjusted must match those appearing on the calibration gas cylinder(s) that will be used to calibrate the Toxi Plus. Non-matching calibration gas and calibration gas value settings will lead to inaccurate and potentially dangerous readings. If the concentration does not match it will be necessary to assign a new calibration gas concentration as discussed in Chapter 4 before continuing with the auto-span adjustment.

- (4) When span adjustment has been completed, the display will show the message “DONE”, after which the instrument will return to the gas indicator mode, and display the current gas readings.

DONE

Note: Make sure the calibration adaptor and all other fittings have been removed from the detector before it is returned to service.

3.5 Manual calibration procedure

It is also possible to calibrate the Toxi Plus manually using the four buttons on the instrument keypad.

3.5.1 “Forced” fresh air “zero” through keypad buttons

⚠WARNING Only perform the “forced” fresh air calibration in an atmosphere that is known to be free

of toxic gases. Performing a “forced” fresh air calibration in a contaminated atmosphere will lead to inaccurate and potentially dangerous readings.

- (1) Turn the instrument on.
- (2) Wait at least three minutes after turning the instrument on to allow sensor readings to stabilize fully **before** initiating the fresh air zero procedure.
- (3) Slide the belt clip towards the rear of the instrument exposing the four buttons on the instrument keypad.
- (4) Verify that the instrument is in the Basic or Technician operating mode. Switch modes (if necessary) by simultaneously holding down the "+" and "-" keys.
- (5) Make sure the instrument is located in an area where the air is known to be fresh.
- (6) Press the keypad button marked "Cal". The “GAS ZERO” calibration message will appear on the instrument LCD.

GAS ↔ ZERO

- (7) Press “Cal” to automatically zero the instrument. The LCD will show the message “ZERO WAIT” while the adjustment is being made.

ZERO ↔ WAIT

- (8) After completion of the zero adjustment the Toxi Plus automatically returns to the gas reading screen display.

0

- (9) Pressing the MODE button causes the calibration values in the memory to remain unchanged from the last time a fresh air adjustment was made. An information screen is displayed briefly which verifies that the zero values have not been changed. The

instrument will then return to normal operation.

NO ↔ SAVE

3.5.2 Span calibration using keypad buttons

Span calibration procedures using buttons on the instrument keypad are only necessary when the adjustment necessary to restore accuracy is outside the permissible window of adjustment for “One Button Auto Calibration” procedures. Span calibration using the keypad buttons may only be done while in the Basic or Technician operating mode.

- (1) Turn the instrument on.
- (2) Remove the belt clip by sliding it free from the belt clip mounts to expose the four mini-push-buttons.
- (3) Verify that the instrument is in the Technician or Basic operating mode. Switch modes (if necessary) by simultaneously holding down the "+" and "-" keys. Each time that the operating mode is changed, the LCD screen will briefly indicate the current operating mode.
- (4) Turn the instrument off by pressing the MODE button for three full seconds.
- (5) With the unit turned off, press and hold down the "Cal" button.
- (6) While holding down the "Cal" button, press the MODE button to turn the Toxi Plus back on. A screen showing the message “SPAN” will be displayed which alternates with the sensor readings.

SPAN ↔ 0

Press and hold the MODE button for three seconds to cancel the calibration.

- (7) Attach the cylinder of gas, regulator, short section of tubing and calibration adaptor to the Toxi Plus. Make sure

the regulator, cylinder seating surfaces, and threads are clean and dry.

- (8) The regulator will automatically begin flowing gas at the correct flow rate as soon as it is fully screwed in. When the readings stabilize, use the "+" and "-" keys to raise or lower the readings to match the concentration printed on the calibration cylinder label.
- (9) Make sure the correct cylinder of gas is attached before attempting to adjust the span! If the concentration of gas reaching the sensor is too low to allow the instrument to be adjusted, or if the wrong type of gas is applied to the sensor being adjusted, the alarms will be activated and a screen will be displayed indicating that the instrument "CANT / SPAN". Pressing the MODE button clears the "CANT SPAN" message and returns the instrument to normal operation.

CANT ↔ **SPAN**

In the event that a "CANT SPAN" message is displayed, verify the type and concentration of the gas being used is correct for the sensor being calibrated, and replace the cylinder if necessary. Verify that the flow rate of the regulator is 1.0 liters per minute. If the "CANT SPAN" message is repeated it may indicate that the sensor is unresponsive, or dead, and requires replacement.

- (11) When span calibration has been completed, press and hold the "Cal" button down until the LCD screen

indicates that calibration is complete by showing the message "DONE". The Toxi Plus will then turn itself off.

DONE

Caution: The "Cal" button must be held down until the screen indicates that span calibration has been successfully completed.

If the button is released before this message is displayed, span values will not be updated, and remain unchanged from the last time a span calibration was successfully completed.

Pressing the MODE button at any time cancels the manual span calibration procedure. A screen will announce "NO SAVE" after which the instrument will turn itself off.

NO ↔ **SAVE**

⚠WARNING A sensor that cannot be calibrated or is found to be out of tolerance must be replaced immediately. An instrument equipped with a toxic gas sensor that fails calibration may not be used until testing with known concentration test gas determines that accuracy has been restored, and the instrument is once again fit for use.

Pressing the MODE button at any time during the span adjustment cancels the procedure, and causes the calibration values in memory to remain unchanged from the last time a span calibration adjustment was made.

Chapter 4 Advanced Functions

The Toxi Plus microprocessor circuitry makes possible a number of advanced features and capabilities. Although this chapter has been designed primarily to be of benefit to "experts" there are several sections that may be of interest to other Toxi Plus users.

The keypad consists of four mini push buttons that are located under the beltclip on the bottom of the detector. The technique for making advanced setup changes requires several buttons to be pressed at the same time.

⚠WARNING Pressing combinations of buttons not explicitly covered in this section may result in unintended changes to the instrument setup.

4.1 Setting alarm levels

Toxi Plus alarms are user adjustable and may be set anywhere within the range of the sensor channel. When an alarm set point is exceeded a loud audible alarm sounds, the bright red LED alarm light blinks, and (if equipped) the optional vibrator alarm is activated.

Toxi Plus alarms are normally self-resetting. When readings drop back below the pre-set alarm levels, visual and audible alarms cease, and normal operation of the instrument resumes. It is possible to set Toxi Plus alarms so that they "latch." In the latched condition, once an alarm occurs both visual and audible alarms continue to sound even after the atmospheric hazard has cleared. Press the MODE button to reset the instrument, silence the alarms and restore normal operation. **Procedures for latching**

Toxi Plus alarms are given in Section 4.2.

4.1.1 Alarm adjustment sequence

To change alarm settings, the instrument must be placed in the "Alarm Adjust" mode. Once in this mode, alarm set points may be adjusted.

In many cases it is possible to comply with OSHA guidelines while using higher alarm points than those used by Biosystems. It is important to note that the default alarm point settings used in the Toxi Plus design are very conservative in order to provide maximum worker safety.

Toxi Plus default alarm setting are listed in Appendix B.

To enter the alarm adjust mode:

- (1) Turn the instrument on.
- (2) Remove the belt clip to expose the four mini-push-buttons.
- (3) Verify that the instrument is in the Technician operating mode. Switch modes (if necessary) by simultaneously holding down the "+" and "-" keys. Each time that the operating mode is changed, the display will briefly indicate the current operating mode.
- (4) Turn the instrument off by pressing and holding the MODE button for three full seconds.
- (5) With the unit turned off, press and hold down the "Alarm" button, then press the MODE button to turn the Toxi Plus back on.
- (6) A screen will appear showing the first alarm point to be adjusted, and the current alarm set point.

ALARM → PEAK → 10

- (7) Press the "Cal" button again to advance to the next available

alarm adjustment option. Press the MODE button at any time to cancel the alarm adjustment and return the instrument to the gas readings screen.

- (9) When the desired alarm adjust option has been reached, the "+" and "-" keys are used to raise or lower the alarm set point.
- (10) When all alarm adjustments have been completed, press and hold the "Alarm" button down until an information screen indicates that alarm adjustment is complete.

DONE

The instrument will display the "ALRM LOCK" screen used to latch or lock Toxi Plus alarms as discussed in **Section 4.2**. Press the MODE button again to turn the Toxi Plus detector off.

4.1.2 "Alarm Latch" command

Toxi Plus alarms are normally self-resetting. When readings drop back below the pre-set alarm levels, visual and audible alarms cease, and normal operation of the instrument resumes. It is possible to set Toxi Plus alarms so that they "latch." In the latched condition, once an alarm occurs both visual and audible alarms continue to sound even after the atmospheric hazard has cleared. Press the MODE button to reset the instrument, silence the alarms and restore normal operation.

Use the following procedure to "latch" the Toxi Plus alarms:

- (1) Make sure the Toxi Plus detector is in the Technician mode (as discussed in **Section 2.2.4**), then turn the instrument off.
- (2) Turn the instrument on while pressing and holding down the "Alarm" button. This will place the

instrument in the "Alarm Adjust Mode".

- (3) Adjust and save the current alarm settings, or press mode to exit without making changes to the current settings. As the instrument leaves the "Alarm Adjust Mode" the unit will display alternating "ALRM / LOCK" messages for 4 seconds. The instrument will then display the current status of the alarm latch feature ("ON" or "OFF").
- (4) Use the "+" or "-" key to change the alarm latch setting.
- (5) Once the proper setting has been selected, press and hold down the "Alarm" button for three seconds. Do not release the "Alarm" button until the LCD displays the message "DONE" to indicate that the new setting has been successfully entered.

Press the MODE button at any time to cancel the procedure. The LCD will show the message "NO SAVE" to indicate that the setting has not been changed.

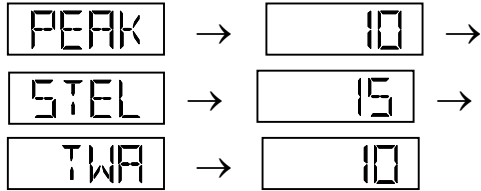
4.1.3 Restoring the factory default alarm settings

Toxi Plus alarm settings are set at the factory in the most conservative way possible. (**See Appendix B**) It is possible to restore these default settings at any time by doing the following.

- (1) Turn the instrument on and make sure it is in the Technician Mode. (**See Section 2.2.4**.)
- (2) Press the "Alarm" button on the instrument key-pad. The display will briefly show the default alarm message, and the type of sensor currently installed.

DEF → **ALRM** → **H2S**

- (3) The specific default alarm settings will then be shown in continuous rotation. In the case of a Toxi Plus with a hydrogen sulfide sensor installed, the following sequence of screens would be shown and repeated.



- (5) Push and hold the "Alarm" button to restore the factory default alarm settings. The display indicates when the settings have been restored:



- (6) If the "Mode" button is pushed, the current alarm settings remain unchanged, and the display shows the following screen:



- (7) After selection of the default or current alarm settings has been made, the display returns to the current gas reading screen.

4.2 Re-setting the calibration gas concentration

During auto calibration adjustment the Toxi Plus adjusts the sensitivity of the sensor to match the concentration of the gas used to calibrate the sensor. The value the instrument uses to adjust the reading is the calibration gas concentration stored in the instrument memory.

For instance, Biosystems normally supplies calibration gas containing 50 PPM carbon monoxide for use in calibrating CO Toxi Plus detectors. This is the default calibration gas concentration stored in the instrument memory. When gas is applied to the

sensor during auto calibration, the instrument automatically adjusts the sensitivity of the carbon monoxide to produce readings that match this 50 PPM concentration.

Sensor	Gas Used	Concentration
CO	CO	50 PPM
CO+	CO	50 PPM
H ₂ S	H ₂ S	25 PPM
SO ₂	SO ₂	10 PPM

Table 5.1. Default Toxi Plus calibration gas concentrations

It is necessary to re-set the calibration gas concentration stored in instrument memory before making use of a different calibration gas concentration.

⚠WARNING Do not reset the calibration gas concentration unless you are using a calibration gas concentration that differs from that normally supplied by Biosystems for use in calibrating your instrument.

Customers are strongly urged to use only Biosystems calibration materials when calibrating their Toxi Plus detector. Use of non-standard calibration gas and/or calibration kit components can lead to dangerously inaccurate readings and may void the standard Biosystems warranty.

Use the following procedure to re-set the calibration gas concentration:

- (1) Make sure the Toxi Plus detector is in the Technician mode (as discussed in **Section 2.2.4**), then turn the instrument off.
- (2) Turn the instrument on while pressing and holding down the "+" button.

The Toxi Plus LCD will display alternating "CAL" and "GAS" messages for 4 seconds. The display will then alternate between

the current concentration stored in memory and the "GAS" message screens.

- (3) Use the "+" and "-" buttons to change the concentration.
- (4) Once the proper new concentration has been selected, press and hold down the "Alarm" button for three seconds. Do not release the "Alarm" button until the LCD displays the message "DONE" to indicate that the new value has been successfully entered.

Pressing the MODE button at any time cancels the procedure. The LCD will show the message "NO SAVE" to indicate that the calibration gas concentration values have not been changed.

4.3 Setting the security beep interval

The security beep screen allows the Toxi Plus to be programmed to emit an audible alarm "beep" on a regular basis while the instrument is in operation. This periodic beep serves as a reminder that the instrument is on. Use the following procedure to turn the security beep on:

- (1) Make sure the Toxi Plus detector is in the Technician mode (as discussed in **Section 2.2.4**), then turn the instrument off.
- (2) Turn the instrument on while pressing and holding down the "-" button.
- (3) The Toxi Plus LCD will display alternating "SEC" and "BEEP" messages for 4 seconds. The display will then alternate between the current security beep interval in minutes and the message "MIN".

- (4) Use the "+" and "-" buttons to set the security beep interval (the time between beeps).

The interval may be set in increments of one minute anywhere between 0 and 60 minutes. Setting the interval to 0 turns the security beep back off.

- (5) Once the proper setting has been selected, press and hold down the "Alarm" button for three seconds. Do not release the "Alarm" button until the LCD displays the message "DONE" to indicate that the new setting has been successfully entered.

Pressing the MODE button at any time cancels the procedure. The LCD will show the message "NO SAVE" to indicate that the setting has not been changed.

Chapter 5 Trouble Shooting and Repair

5.1 Replacing Toxi Plus sensor

⚠WARNING The Toxi Plus must be recalibrated before being returned to service any time the sensor is removed or replaced.

To replace a sensor:

- (1) Make sure the Toxi Plus is turned off.
- (2) Gently unscrew (1/4 turn counter clockwise) and remove the protective sensor cap.
- (3) Gently pry the sensor out of its socket.
- (4) Verify that the type of sensor to be installed matches the label on the front of the Toxi Plus detector.
- (5) Make sure the pins are properly aligned and gently press the replacement sensor into place.
- (6) Make sure the correct color coded filter in the protective sensor cap is replaced along with the new sensor. (A spare filter should have been supplied together with the replacement sensor.) The color of the filter should match the color of the ID ring on the upper surface of the sensor. Use a blunt object to push the old filter out of the sensor cap, and using a finger, press the new filter into place. Be careful not to rip the filter membrane.
- (7) Replace the protective sensor cap.
- (8) Allow at least one to two hours for the sensor to stabilize.
- (9) Recalibrate the new sensor.

5.2 Troubleshooting

There are a few troubleshooting and repair procedures that can be done in the field.

Caution: The following repair procedures should only be performed by authorized personnel.

5.2.1 Unit will not turn on

Possible causes:

Battery discharged, microprocessor / software malfunction.

Solution(s):

Take the instrument to a non-hazardous location. Replace the batteries and attempt to turn on. (Make sure that the batteries are properly aligned, and that all battery polarities are correct.) If the instrument still fails to turn on, return to factory for repair.

5.2.2 Unit will not turn off

Possible causes:

Microprocessor / software malfunction, low or bad battery, faulty on / off mode switch.

Solution(s):

Take the instrument to a non-hazardous location, replace the batteries, and attempt to turn the detector back on. If the instrument fails to turn on, return to factory for repair.

5.2.3 Sensor readings unstable

Possible causes:

Loose connection, bad sensor, improper calibration, expired calibration gas.

Solution(s):

Check that the sensor is firmly in place. Check calibration gas dating. Re-calibrate sensor. Replace sensor if necessary.

5.2.4 Display is blank

Possible causes:

Battery voltage too low. Operating temperature too low. Bad LCD display assembly. Microprocessor locked-up or "crashed".

Solution(s):

Take the instrument to a non-hazardous location. If cold, allow instrument to warm back up to room temperature. Replace the batteries and attempt to

turn the instrument back on. If the instrument still fails to turn on, return to factory for repair.

5.2.5 No audible alarm

Possible causes:

Loose connection, alarm failure.

Solution(s):

Return to factory for repair.

5.2.6 Keypad buttons don't work

Possible causes:

Not in Basic or Technician mode, microprocessor locked-up or "crashed", loose connection, switch failure.

Solution(s)

Switch to Technician operating mode. Take the instrument to a non-hazardous location. Replace the batteries and attempt to turn the instrument back on. If keypad buttons still fail to operate properly return to factory for repair.

5.2.7 Can't make a "One Button" auto zero adjustment ("Too High" or "Too Low" for zero adjust)

Possible causes:

The atmosphere in which the instrument is located is contaminated (or was contaminated at the time the instrument was last zeroed); instrument is still attached to calibration fittings; a new sensor has just been installed; instrument has been dropped or banged since last turned on.

Solution(s):

Remove any calibration gas fittings, take the instrument to fresh air and allow readings to stabilize. Do a manual fresh air zero adjustment using buttons on the instrument keypad as discussed in **Section 3.5.1**.

5.4 Returning your Toxi Plus to Biosystems for service or repair

Please contact the Biosystems Service Department at (860) 344-1079 to obtain a "Return Authorization" number prior to shipment. A Biosystems Service representative will record all relevant information or special instructions at that time.

To insure safe transport please use the original Toxi Plus packing materials, or other packing materials which similarly protect the instrument and accessories.

Note: The return authorization number must be clearly marked on the outside of the box.

Prominently showing the return authorization number on the outside of the box ensures that it is immediately identified and logged into our system at the time it is received. Proper tracking helps avoid unnecessary delays in completion of service procedures.

Please contact the Biosystems Service Department at (860) 344-1079 or 800 711-6776 if you require any additional information.

**Thank you for choosing
the Toxi Plus, and thank
you for choosing
Biosystems.**

Appendices

Appendix A Toxic gas measurement - Ceilings, TWAs and STELs

Many toxic substances are commonly encountered in industry. The presence of toxic substances may be due to materials being stored or used, the work being performed, or may be generated by natural processes. Exposure to toxic substances can produce disease, bodily injury, or death in unprotected workers.

It is important to determine the amounts of any toxic materials potentially present in the workplace. The amounts of toxic materials potentially present will affect the procedures and personal protective equipment which must be used. The safest course of action is to eliminate or permanently control hazards through engineering, workplace controls, ventilation, or other safety procedures. Unprotected workers may not be exposed to levels of toxic contaminants which exceed Permissible Exposure Limit (PEL) concentrations. Ongoing monitoring is necessary to insure that exposure levels have not changed in a way that requires the use of different or more rigorous procedures or equipment.

Airborne toxic substances are typically classified on the basis of their ability to produce physiological effects on exposed workers. Toxic substances tend to produce symptoms in two time frames.

Higher levels of exposure tend to produce immediate (acute) effects, while lower levels of long-term (chronic) exposure may not produce physiological symptoms for years.

Hydrogen sulfide (H₂S) is a good example of an acutely toxic substance which is immediately lethal at relatively low concentrations. Exposure to a 1,000 PPM (parts per million) concentration of H₂S in

air produces rapid paralysis of the respiratory system, cardiac arrest, and death within minutes.

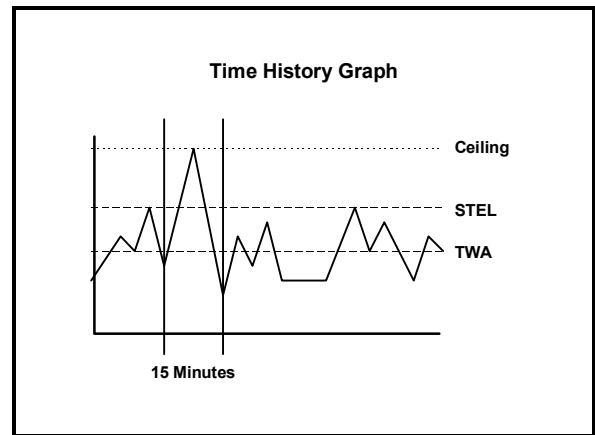
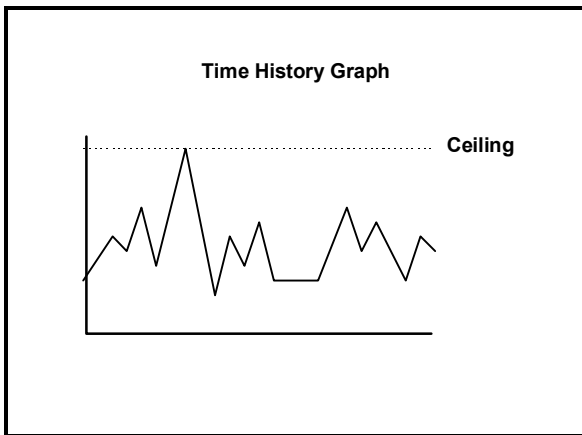
Carbon monoxide (CO) is a good example of a chronically toxic gas. Carbon monoxide bonds to the hemoglobin molecules in red blood cells. Red blood cells contaminated with CO are unable to transport oxygen. Although very high concentrations of carbon monoxide may be acutely toxic, and lead to immediate respiratory arrest or death, it is the long term physiological effects due to chronic exposure at lower levels that take the greatest toll of affected workers. This is the situation with regards to smokers, parking garage attendants, or others chronically exposed to carbon monoxide in the workplace. Exposure levels are too low to produce immediate symptoms, but small repeated doses reduce the oxygen carrying capacity of the blood over time to dangerously low levels. This partial impairment of the blood supply may lead over time to serious physiological consequences.

Because prudent monitoring programs must take both time frames into account, there are three independent exposure measurements and alarm types built into the Toxi Plus design.

1. Ceiling level:

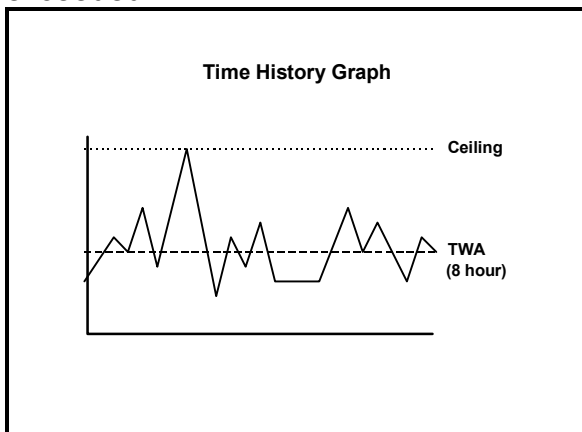
OSHA has assigned some, but not all, toxic substances with a ceiling level. This is the highest concentration of a toxic substance to which an unprotected worker should ever be exposed, even for a very short time.

Never enter an environment even momentarily when concentrations of toxic substances exceed the ceiling level.



2. Time Weighted Average (TWA):

The maximum average concentration to which an unprotected worker may be exposed over an eight hour working day. During this time, STEL and ceiling concentration limits may not be exceeded.



3. Short Term Exposure Limits (STEL):

Toxic substances may have short term exposure limits which are higher than the eight hour TWA. The STEL is the maximum average concentration to which an unprotected worker may be exposed in any fifteen minute interval during the day. During this time, neither the eight hour TWA or the ceiling concentration may be exceeded.

Any fifteen minute periods in which the average STEL concentration exceeds the permissible eight hour TWA must be separated from each other by at least one hour. A maximum of four of these periods are allowed per eight hour shift.

Appendix B How to determine where your alarms should be set

1. Toxic gas alarms

The Toxi Plus has three separate alarm points for toxic gases: Ceiling, STEL, and TWA.

OSHA has assigned some, but not all, toxic substances with a ceiling or "Peak" exposure level. This is the highest concentration of a toxic substance to which an unprotected worker should ever be exposed, even for a very short time. Never enter an environment even momentarily when concentrations of toxic substances exceed the ceiling level.

The Time Weighted Average (or TWA) is the maximum average concentration to which an unprotected worker may be exposed over an eight hour working day. During this time, STEL and ceiling concentration limits may not be exceeded.

OSHA has assigned some, but not all, toxic substances with a Short Term Exposure Limit. The STEL is the maximum average concentration to which an unprotected worker may be exposed in any fifteen minute interval during the day. During this time, neither the eight hour TWA or the ceiling concentration may be exceeded. Any fifteen minute periods in which the average STEL concentration exceeds the permissible eight hour TWA must be separated from each other by at least one hour. A maximum of four of these periods are allowed per eight hour shift.

The table below shows the highest levels at which these alarms should be set. If OSHA has not determined a ceiling value, for greatest safety the Toxi Plus ceiling alarm should be set at the same value as the STEL alarm. If OSHA has not determined a STEL value, the Toxi Plus STEL alarm should be set at the same value as the TWA.

2. U. S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits for select toxic gases:

In the following table "NA" indicates no value has been assigned by OSHA.

Note: Customers should be aware that OSHA permissible exposure limits may be subject to change.

Recent court decisions have affected the enforcement of permissible exposure limits published or modified since the initial enactment of OSHA in 1971. The following table shows the OSHA permissible exposure limits as published in the 1989 edition of the Code of Federal Regulations (29 CFR 1910.1000). It is recommended that customers verify that the values given below are correct and current before using them to update their alarm set-points.

OSHA (1989) Permissible Exposure Limits:

Gas	Ceiling	TWA	STEL
CO	200 PPM	35 PPM	NA
H2S	NA	10 PPM	15 PPM
SO2	NA	2.0 PPM	5.0 PPM

3. Toxi Plus default alarm settings

The most conservative possible way to set alarms is the method used by Biosystems for the Toxi Plus default alarm settings.

The Ceiling alarm is set at the factory at the 8 hour TWA level (when this is given). With this setting, it is unlikely that either the STEL or TWA alarm will ever be activated. For other values, contact Biosystems or your authorized distributor.

Biosystems Toxi Plus default alarm settings:

Gas	Ceiling	TWA	STEL
CO	35 PPM	35 PPM	100 PPM
H2S	10 PPM	10 PPM	15 PPM
SO2	2.0 PPM	2.0 PPM	5.0 PPM

Note: When a “CO Plus” sensor is installed the default alarm settings are automatically assigned on the basis of the calibration gas selected for use. If carbon monoxide is selected as the calibration gas, carbon monoxide alarm settings are automatically assigned. If hydrogen sulfide is selected as the calibration gas, hydrogen sulfide alarm settings are automatically assigned.

Appendix C How to calibrate your Toxi Plus in contaminated air

Calibration of the Toxi Plus is a two-step process. The first step is to expose the sensors to contaminate-free fresh air and perform a fresh air calibration.

Unfortunately, there are some locations which are never completely free of contaminants. An example would be a furnace intensive area which always has a background concentration of a few PPM CO. To make calibration easy in this case, it is necessary to use special calibration "Zero Contaminant" gas. This gas cylinder, Biosystems part number 9039, is used in conjunction with the sample draw calibration adapter. Flow the zero contaminant gas across the sensors for a minute, just as if you were doing a span calibration. Then do the fresh air calibration steps described in Chapter 3 of the owners manual.

Appendix D Suggested Calibration Gases

Warning: Use of non-standard calibration gas and / or calibration kit components when calibrating your Toxi Plus can lead to dangerously inaccurate readings and may void the standard Biosystems warranty.

Biosystems offers calibration kits and long lasting cylinders of test gas specifically developed for easy Toxi Plus

calibration. Customers are strongly urged to use only Biosystems calibration materials when calibrating their Toxi Plus.

Part Number	Calibration gas mixture	Comments
54-9033	Carbon monoxide (CO) (50 PPM in air)	
54-9034	Hydrogen sulfide (H ₂ S) (25 PPM in nitrogen)	
54-9037	Sulfur dioxide (SO ₂) (10 PPM in nitrogen)	
54-9039	Zero air (20.9 % oxygen in nitrogen)	Use for fresh air calibration in contaminated areas.

Appendix E Cross Sensitivity Data¹

The table below lists the cross sensitivity of electrochemical toxic sensors used in the Toxi Plus portable gas detectors to gases other than their target gas. Depending on the nature of the reaction each gas has with the sensor, the effect can either decrease the signal (negative cross sensitivity) or increase the signal; (positive cross sensitivity). Each figure represents the reaction of the sensor to 100 PPM of gas, thus providing a percentage sensitivity to that gas relative to its target gas.

	SENSOR TYPE				
	Carbon monoxide (CO)	Hydrogen sulfide (H2S)	CO Plus (Cal to CO)	CO Plus (Cal to H2S)	Sulfur dioxide (SO2)
CO	100	< 10	100	25	0
H2S	< 10	100	~ 350	100	0
SO2	< 10	~ 20	~ 65	~ 15	100
NO	< 30	< 0	~ 25	~ 6	0
NO2	< 15	~ - 20	~ - 60	- 15	~ - 120
Cl2	< 10	~ - 20	~ - 40	~ - 10	< 5
H2	< 60	< 5	< 60	< 15	0
HCN	< 15	0	~ 40	~ 10	< 50
HCl	< 3	0	~ 5	~ 1	0
NH3	0	0			0
Ethylene	~ 50	0			0

Appendix F Toxi Plus sensor ranges

The following tables display the ranges for currently available sensors for use in the Toxi Plus. Nominal range values indicate the gas-level range which the Toxi Plus can detect over extended periods of operation. "Max overload" values indicate the highest instantaneous reading that the Toxi Plus will be able to attain for a given sensor type.

Toxic Sensor Type	Nominal range (PPM)	Max overload
CO	0-999	999
H2S	0-100	250
SO2	0-100	250
"CO Plus" (Cal. to CO)	0-999	999
"CO Plus" (Cal. to H2S)	0-50	150

¹Data derived in part from City Technology Limited, Product Data Handbook Oct. 1, 1992

Appendix G: Biosystems Standard Warranty Gas Detection Products

General

Biosystems LLC (hereafter Biosystems) warrants gas detectors, sensors and accessories manufactured and sold by Biosystems, to be free from defects in materials and workmanship for the periods listed in the tables below.

Damages to any Biosystems products that result from abuse, alteration, power fluctuations including surges and lightning strikes, incorrect voltage settings, incorrect batteries, or repair procedures not made in accordance with the Instrument's Reference Manual are not covered by the Biosystems standard warranty.

The obligation of Biosystems under this warranty is limited to the repair or replacement of components deemed by the Biosystems Instrument Service Department to have been defective under the scope of this standard warranty. To receive consideration for warranty repair or replacement procedures, products must be returned with transportation and shipping charges prepaid to Biosystems at its manufacturing location in Middletown, Connecticut, or to a Biosystems Authorized Warranty Service Center. It is necessary to obtain a return authorization number from Biosystems prior to shipment.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY AND ALL OTHER WARRANTIES AND REPRESENTATIONS, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE. BIOSYSTEMS WILL NOT BE LIABLE FOR LOSS OR DAMAGE OF ANY KIND CONNECTED TO THE USE OF ITS PRODUCTS OR FAILURE OF ITS PRODUCTS TO FUNCTION OR OPERATE PROPERLY.

Instrument & Accessory Warranty Periods

Product(s)	Warranty Period
PhD ⁵ , PhD Lite, PhD Plus, PhD Ultra Cannonball3, MultiVision, Ex Chek, Toxi, Toxi/Oxy Plus, Toxi/Oxy Ultra	As long as the instrument is in service
Toxi/Oxy Pro	2 years from date of purchase
Toxi/Oxy Limited	2 years after activation or 2 years after the "Must Be Activated By" date, whichever comes first
Mighty-Tox	90 days after activation or 90 days after the "Must Be Activated By" date, whichever comes first
Mighty-Tox 2 Prorated credit is given towards repair or purchase of a new unit of the same type.	0 – 6 months of use 100% credit 6 – 12 months of use 75% credit 12 – 18 months of use 50% credit 18 – 24 months of use 25% credit
IQ Systems, Series 3000, Airpanel, Travelpanel, ZoneGuard, Gas✓Chek1 and Gas✓Chek4	One year from the date of purchase
Battery packs and chargers, sampling pumps and other components, which by their design are consumed or depleted during normal operation, or which may require periodic replacement	One year from the date of purchase

Sensor Warranty Periods

Instrument(s)	Sensor Type(s)	Warranty Period
PhD ⁵ , PhD Lite, PhD Plus, PhD Ultra, Cannonball3, MultiVision, Toxi/Oxy Pro	O ₂ , LEL**, CO, CO+, H ₂ S & Duo-Tox	2 Years
	All Other Sensors	1 Year
Toxi, Toxi/Oxy Plus, Toxi/Oxy Ultra, Ex Chek	LEL**, CO, CO+, H ₂ S	2 Years
	All Other Sensors	1 Year
All Others	All Sensors	1 Year

** Damage to combustible gas sensors by acute or chronic exposure to known sensor poisons such as volatile lead (aviation gasoline additive), hydride gases such as phosphine, and volatile silicone gases emitted from silicone caulks/sealants, silicone rubber molded products, laboratory glassware greases, spray lubricants, heat transfer fluids, waxes & polishing compounds (neat or spray aerosols), mold release agents for plastics injection molding operations, waterproofing formulations, vinyl & leather preservatives, and hand lotions which may contain ingredients listed as cyclomethicone, dimethicone and polymethicone (at the discretion of Biosystems Instrument Service department) void Biosystems' Standard Warranty as it applies to the replacement of combustible gas sensors.