

**MULTIGARD[®] 5000 GAS SAMPLING SYSTEM
DOCUMENTATION PACKAGE**

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Section 1

**MULTIGARD[®] 5000 SYSTEM
CONFIGURATION DATA**

**Instrument Division 1-800-MSA-INST or FAX (724) 776-8783
MSA International (412) 967-3354 or FAX (412) 967-3451
In Canada 1-800-267-0672 or FAX (416) 663-5908**

**Manufactured by
MSA North America
1000 Craberry Woods Drive Cranberry Township, PA 16066**



MSA CORPORATE CENTER
1000 Cranberry Woods Drive
Cranberry Township, Pennsylvania 16066

MultiGard[®] 5000
System Configuration Data

Contents

1. Custom System Definition
2. Factory Configured Parameters
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MultiGard Custom System Definition

System Serial Number: End User: Job Number: ATO: Model: Processor Version: Display Version:		H17-400913267-11-001 & H17-400913267-11-002 Thermal Equipment Corp 400913267 A-MG5000-C-B-A-B-0-0-A-A-A-B-C Single 32 3102-20 Rev 0 3102-21 Rev 0	
		System A	System B
Calibration Gases	Zero Comb CO	Instrument Air Propane .6% Span Value 20 CO 60 PPM	
Nominal Sensor Flow Rate Minimum Sensor Flow Rate Minimum Sample Line Flow Rate		3 SCFH +/- .5 SCFH 2 SCFH +/- .5 SCFH 8 SCFH +/- .5 SCFH	
UCO Option # 1 (User Configured Outputs)	X	Not Installed Form C Relays Solid State Outputs	
UCO Option # 2 (User Configured Outputs)	X	Not Installed Form C Relays Solid State Outputs	
System Drawings		Drawing Number	DSK3103- 1045
Notes: System is configured for BACNet WAN side admin IP is 192.168.1.110:8080 LAN 10.10.79.103 BACNet, Processor 10.10.79.102, Display 10.10.79.101, Router 10.10.79.1 Panelview Plus 7, V9.0			

MultiGard **Factory** Configured Parameters

	Sensor 1	Sensor 2	Sensor 3	Sensor 4
Sensor Type (5 characters max)	Comb	CO	NA	NA
Engineering Units	%LEL	PPM		
Low Engineering Unit	0	0		
High Engineering Unit	100	100		
Analog Signal Interface Type	Current	Current		
Analog Input Signal Maximum	20	20		
Analog Input Signal Minimum	4	4		
Warning Direction	Increasing	Increasing		
Alarm Direction	Increasing	Increasing		
Auto Standardize	Disabled	Disabled		
ASTD Tolerance in EGU's, Low	NA	NA		
ASTD Tolerance in EGU's, High	NA	NA		
Synthetic Span Gas in Use	No	No		
Combustible Sensor?	Yes	No		
Warning & Alarm Limit in %LEL	60	NA		
Purge Operation (comb. sensor)	Yes	No		
Purge valve selection (none, zero,span1,span2)	Zero	NA		
Purge Set Point in %LEL	30	NA		
	Zero	Span 1	Span 2	Sample Purge
Auto Standardize Duration	NA	NA	NA	NA
Auto Standardize Duration System B	NA	NA	NA	NA
Purge Duration (sec.)	30			
Purge Duration, System B (sec.)	NA			
Manual Control of Span 1 Valve	Yes			
Manual Control of Span 2 Valve	Yes			
System B Control of Span 1 Valve	NA			
System B Control of Span 2 Valve	NA			
PIR Ready Enabled	No			
PIR Ready Enabled System B	NA			

MultiGard Default **User** Parameters

Password	1 (Open System)			
	Sensor 1	Sensor 2	Sensor 3	Sensor 4
Trouble Set Points (all points)	-5	-5		
Warning Set Points (all points)	20	20		
Alarm Set Points (all points)	30	30		
Extended Analysis (time rate trigger, inc. & dec.)	100	100		
Extended Analysis (increasing level trigger)	100	100		
Extended Analysis (decreasing level trigger)	-100	-100		
Hysteresis (in sensor EGU units)	2	2		
Analysis Time (sec.) (based on slowest sensor)	90	Extended Analysis Time (sec.)		30
Analysis Time System B (based on slowest sensor)	NA	Extended Analysis Time Sys. B		NA
	Trouble Relay	Warning Relay	Alarm Relay	Horn Relay
Latched/Non-latched	Latched	Non-Latched	Non-Latched	NA
Fail Safe/Non-Fail Safe	Fail-Safe	Non-Fail Safe	Non-Fail Safe	NA
On Delay (sec.)	0	0	0	0
Off Delay (sec.)	0	0	0	0
System B Latched/Non-latched	NA	NA	NA	NA
System B Fail Safe/Non-Fail Safe	NA	NA	NA	NA
System B On Delay (sec.)	NA	NA	NA	NA
System B Off Delay (sec.)	NA	NA	NA	NA
	Days	Hours	Minutes	
Timed Auto Standardize # 1	NA	NA	NA	
Timed Auto Standardize # 2	NA	NA	NA	
Timed Auto Standardize # 3	NA	NA	NA	



Section 2

**MULTIGARD® 5000 SYSTEM
OPERATION AND MAINTENANCE MANUAL**

 **WARNING**

THIS MANUAL MUST BE CAREFULLY READ BY ALL INDIVIDUALS WHO HAVE OR WILL HAVE THE RESPONSIBILITY FOR USING OR SERVICING THE PRODUCT. Like any piece of complex equipment, this instrument will perform as designed only if it is used and serviced in accordance with the manufacturer's instructions. OTHERWISE IT COULD FAIL TO PERFORM AS DESIGNED AND PERSONS WHO RELY ON THIS PRODUCT FOR THEIR SAFETY COULD SUSTAIN SEVERE PERSONAL INJURY OR DEATH.

The warranties made by Mine Safety Appliances Company with respect to this product are voided if the product is not installed, used and serviced in accordance with the instructions in this manual. Please protect yourself and others by following them. We encourage our customers to write or call regarding this equipment prior to use or for any additional information relative to use or repairs.

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1. General Information

1.1 Introduction

The MultiGard 5000 Gas Sampling System family consists of six distinct configurations; four **single** system configurations (an 8 point system, a 16 point system, a 24 point system and a 32 point system) and two **dual** system configurations [a dual 8 (“D8”) point system and a dual 16 (“D16”) point system]. A dual system system uses a single operator interface to run two otherwise independent flow systems identified as System A and System B.

Dual system systems may require additional explanation and therefore, in the appropriate section, the information provided will be visually distinguished by the text box style as shown below.

Sample text related to the dual MultiGard 5000 Systems.

This information can be ignored by users of single MultiGard 5000 Systems.

The MultiGard 5000 Gas Sampling System draws gas samples from multiple sample points, and then passes the gas across up to four sensors/analyzers. The sensors/analyzers may be any variety of sensors/analyzers manufactured by MSA. Depending on the quantity and type of sensors/analyzers, they may be mounted internally or externally. At the same time the unit is drawing gas from a sample point, it is also drawing gas from the next sample point to be sampled. This is decrease the sample time necessary to achieve an accurate sample reading.

The controller for the MultiGard 5000 Gas Sampling System is the Allen Bradley CompactLogix L24ER controller. It performs all the necessary tasks associated with sequencing, alarming, fault conditions, etc.

The user interface is a 10.4” LCD display screen with touch-screen entry. It allows for operator control of the system. This includes but is not limited to, the entry of user controlled parameters, silencing the horn and acknowledge alarms.

This manual refers to the standard Installation Drawing, Flow Diagram and Field Wiring Diagram of the system. Refer to the MultiGard 5000 Custom System Definition data sheet in Section 1 for a detailed list of the specific drawing numbers that apply to your system.

This manual covers the operation of the MultiGard 5000 Gas Sampling System. Refer to the appropriate manuals in Section 3 for the operation of the individual sensors/analyzers that are a part of the system.

1.2 General Operating Specifications

Table 1.1: MultiGard 5000 System Enclosure Specifications				
Area Classification		General Purpose for Non-Hazardous Areas		
System Configuration		MultiGard 5000 8/16	MultiGard 5000 24/32	MultiGard 5000 Dual 8/Dual 16
Rating		NEMA 1	NEMA 1	NEMA 1
Dimensions* in (mm)	Width	24 (610)	30 (762)	30 (762)
	Height	30 (762)	30 (762)	30 (762)
	Depth	12 (305)	12 (305)	12 (305)
Weight, lbs (kg)		150 (68)	150 (68)	175 (80)

*dimensions less options

Operator Interface:

MultiGard 5000 8 / 16 / 24 / 32 / D8 / D16 - 10.4" Diagonal Color TFT LCD Display

Power Requirements:

MultiGard 5000 8 / 16 / 24 / 32 / D8 / D16 - 15 Amp. @ 115 VAC, 60 Hz

Outputs:

Common Alarms - Form C contacts (SPDT), 250 VAC,

Contact Rating

- 8 Amp. Resistive Load
- 6 Amp Inductive Load

Optional User Configurable Output ("UCO") Discrete Alarms - Form C contacts (SPDT), 250 VAC

Contact Rating

- 10 Amp. Resistive Load
- 7.5 Amp Inductive Load

Optional User Configurable Output ("UCO") Solid State Outputs - 100 mA @ 24 Volts DC, Sinking
(Requires external 24 VDC power supply)

Flow System:

Flow Scheme – “Look-Ahead Bypass”

Connection size and thread:

- Sample Inlets and Exhausts - 1/8" NPTF
- Drain - 1/8" NPTF

Sample Line Tubing - 500' max, with 0.250" OD, 0.175 ID tubing

Sample Line Flow Rate:

- 20 SCFH typical, No Load
- 10 SCFH typical, Full Load

Temperature:

Operating- 35 to 95°F (0 to 35°C)

Non-Operating- 14 to 140°F (-10 to 60°C)

Sample- 0 to 140°F (-17 to 60°C)

Humidity:

5 to 85% RH non-condensing

***** Sensors / Analyzers are not reflected in above specifications. *****

1.3 Terminology

The following terminology is used throughout this manual. Read and become familiar with the definitions.

ACTUAL DWELL TIME - The actual time sample is being drawn from a specific sample line and applied to the sensor(s)/analyzer(s). This value is a function of the dwell time parameters.

ALARM - The indication that a preset alarm level has been exceeded.

ALARMING - The indication of a WARNING, ALARM, or TROUBLE by the MultiGard 5000 unit.

ANALYSIS TIME – the amount of time that a gas sample from the sample location is run past the sensors independent of any associated transport times. This time is dictated by the slowest responding sensor on the common sample path.

BYPASS EXHAUST - In this look-ahead system, the bypass gas volume is drawn from the next area to be sampled and vented.

BYPASS (VALVE, MANIFOLD, PUMP HEAD, FLOW SWITCH) - The plumbing required to draw on the next point to be sampled.

CALIBRATION - The process of zeroing and spanning a sensor/analyzer.

COALESCER - A filter designed to eliminate condensate from the sample stream.

CONDITION ACKNOWLEDGE - Eliminating a Latched alarming condition indicated by the MultiGard 5000 unit by depressing the “Condition Acknowledge” button on the Overview screen after the condition has cleared.

CORRELATION FACTOR - A sensor’s response to a synthetic span-gas in units of sensor reading per concentration of synthetic span gas.

DEFAULTS FORCED - A condition resulting from the loss of the program memory requiring a back-up from flash memory. In this state, the MultiGard 5000 unit reverts to functioning as configured by MSA and all user modifications are nullified.

DRAIN - The volume of sample gas that continuously bypasses the sensor(s) to eliminate condensate from the sample stream.

DWELL TIME PARAMETERS - The parameters that are used to determine the actual dwell time of the system on a sample line; analysis time, extended analysis time, sample transport time and internal transport time.

END OF LINE FILTER - A filter used at the sample entry point to eliminate particulates from the sample stream.

EXHAUST GAS - Sample gas after it passes across the sensor(s).

EXTENDED ANALYSIS TIME - An increase in analysis time triggered by exceeding a preset level or rate of change.

FLOW RATE - Volume of gas drawn through the sample line per unit of time.

FRESH AIR - Air that has no possibility of containing gas.

HORN ACKNOWLEDGE - Silencing the operation of the horn and local buzzer by depressing the horn acknowledge button on the overview screen or an optional remote horn acknowledge switch.

HYSTERESIS - A dead band factor introduced into the warning, alarm and trouble functions to eliminate the relay from responding to small variations in gas level readings in the proximity of its actuation set point.

LOOK-AHEAD BYPASS FLOW SCHEME - A sample flow scheme that draws on the current line being sampled and the next line to be sampled.

MULTIGARD 5000 DUAL SYSTEM – An MSA gas sampling system that uses one MultiGard 5000 controller (PLC) and one MultiGard 5000 operator interface (HMI) to operate two otherwise independent flow systems.

NORMALLY DE-ENERGIZED / NON FAIL-SAFE - A relay that is open when de-energized, and closed when energized due to a warning, alarm, or fault. This style relay will **NOT** alert the user to a loss of power or a failure in the system wiring.

NORMALLY ENERGIZED / FAIL-SAFE - A relay that is open when energized, and closed when de-energized due to a warning, alarm, fault, or loss of power. This style relay will alert the operator when there is a loss of power, or a failure in the system wiring.

NORMAL OPERATING STATE - The absence of any alarming indication.

POINT BYPASS - Removing a point/line number from the sampling sequence.

PURGING (FLOW SYSTEM) -The process of flushing the flow system of residual gas after an auto standardization has occurred or after an indication of possible sensor saturation on a combustible sensor.

RELATIVE HUMIDITY – The percentage of total water saturation in the air for a given temperature.

SAMPLE POINT - The location or area from which a gas sample is drawn. Up to 32 areas (depending on system configuration), sequentially numbered, can be monitored. In dual systems, System A and System B may each have up to 16 points (depending on system configuration), sequentially numbered.

SAMPLE TRANSPORT TIME - The duration of time required to deliver a fresh sample from the sample entry point to the MultiGard 5000 unit.

SENSOR/ANALYZER - A device that generates an electrical signal proportional to the concentration of the specific gas it was calibrated to detect.

SPAN - Full-scale or up-scale reading on the meter display.

SPAN DRIFT - The deviation of sensor output from actual gas concentration applied.

SPAN GAS VALUE - The gas concentration that gives the instrument a full-scale or up-scale value. This value is printed on the cylinder containing the calibration gas.

SPANNING - The process of applying span gas to a sensor/analyzer and placing a full-scale or span gas indication on the unit during calibration.

STANDARDIZATION - The process of compensating for zero-drift and/or span-drift without re-calibrating the sensor.

STANDARDIZATION HIGH TOLERANCE - The amount of correction to sensor output (in sensor engineering units) that will result in a trouble condition indication by the MultiGard 5000 unit and a disabling of the alarm functions.

STANDARDIZATION LOW TOLERANCE - The amount of correction to sensor output (in sensor engineering units) that will result in a trouble condition indication by the MultiGard 5000 unit while continuing to operate.

SYNTHETIC SPAN GAS - A gas that causes an up-scale reading used in place of the original span gas for which the sensor/analyzer was calibrated.

TROUBLE - The indication that a fault condition has occurred.

USER CONFIGURED OUTPUT (UCO) - An output in the form of a solid state output or form C relay contacts whose functionality may be defined by the end user.

WARNING - The indication that a preset warning level has been exceeded.

ZERO - A zero (0) indication on the meter display usually indicates fresh air (no gas present).

ZERO DRIFT - The deviation of sensor output when zero gas is applied.

ZEROING - The process of applying zero gas to a sensor/analyzer and placing a zero gas indication on the unit during calibration.

2. Installation

2.1 Receiving

Upon receipt of the unit, inspect the shipping cartons for signs of visible damage. Report any damage to the carrier and note it on the receipt. The unit must be stored in a dry, secure place prior to its installation and use. Store the unit in its original shipping carton.

2.2 Unpacking

To unpack the equipment, carefully remove the unit from its shipping container(s) in order to prevent damage to sensitive electrical components. **DO NOT** use the coalescing filter assembly to lift the unit as damage may occur. If any damage is found, report it to the shipper immediately. Search through all packing material and containers to avoid inadvertently discarding usable or valuable items. Report any item shortages immediately to MSA.

Using a screwdriver, open the door by turning 1/4 turn latches on the front of the door counter clockwise (see Installation Drawing). Remove any packing material that may be found inside the unit. Carefully inspect components and assemblies inside the unit. If damage or item shortage is evident, advise the carrier. Remove the coalescing filter plug

2.3 Instrument Location Guidelines

The instrument's performance is dependent on its location. Follow the guidelines below when mounting the unit.

1. Acquire the appropriate hardware and locate the unit where personnel will see the display before they enter the area being monitored.
2. Always mount the unit vertically with the display at eye level.
3. Do not mount the unit to structures subject to vibration and/or shock.
4. Do not locate the unit near an excessive heat source or in wet or damp locations.
5. Do not mount the unit in direct sunlight.
6. For proper cooling, allow at least six inches of clearance around all surfaces of the unit. Insure that the cooling intakes on the base of the unit are free from obstructions that could block the flow of air. The cooling exhaust hood on the top of the unit should be unobstructed and positioned off the mounting surface as far as feasible for the installation.
7. Allow for unimpeded operation of the front door (see Installation Drawing) to allow access for service and calibration.

2.4 Wiring

All wiring to the MultiGard 5000 unit should be made via the plate at the bottom of the unit. Wire 120 VAC, 60 Hz single phase power to the MultiGard 5000 input terminals (see Field Wiring Diagram) using a minimum of #16 AWG wire. A separate dedicated power source is recommended to ensure that the unit remains powered when other circuits are shut down for servicing or routine maintenance. The power source should be a “ground neutral” system. When a step down transformer is used, an ungrounded or floating system can result. If an isolation transformer is used, the neutral side of the secondary transformer should be grounded. Always conform to **NEMA** and **NEC** standards pertaining to installations of this type.

Refer to the wiring diagram showing interconnecting wire between the unit and any other devices. Relay wiring should be separate from power wiring. Each relay has contacts for normally open, normally closed and common terminals. Wire to the trouble relays normally closed contact (contact closed due to loss of power) to provide for fail-safe relay activation on loss of power.

WARNING

Wire Trouble Relay to operate an externally powered device (horn, beacon, computer, PLC, etc.) using the common and normally closed contacts for fail-safe operation on loss of power. The Trouble Relay is an important safety device and failure to wire as specified will result in no indication should gas detection system malfunction and/or become disabled.

The horn and local buzzer can be silenced by pressing the HORN ACKNOWLEDGE button on the Overview screen or through an optional remote horn acknowledge switch (see Field Wiring Diagram).

CAUTION

Do not connect any system controlled process shut down circuits until the system has been function checked, calibrated and is ready for normal operation. False alarms may occur if this connection is done before full system startup is completed.

2.5 Plumbing

NOTE: This section specifically applies to the standard MultiGard 5000 system look-ahead bypass flow scheme. Refer to Section 1 if your system employs a custom flow scheme.

Remove all shipping plugs from sample point inlets, exhausts and drain.

Sample point supply lines should be 0.250" OD, 0.175" ID, with a maximum sample line length of 500 ft. As a general rule, sample lines should be kept as short as possible to reduce sample transport time.

Sample point tube entries should be placed in areas that provide the unit with the best representative gas sample to be detected. In large areas where multiple sample point entries are located, air flow patterns must be taken into considered. Ventilation smoke tubes (P.N. 458480) are useful in determining air flow patterns in ambient sampling areas.

The samples must be adequately filtered and free of any liquid contamination before entering the system. End of line particulate filters must be installed at all sample point tube entries (see Flow Diagram). The sample point tube entries must be unobstructed to allow the gas sample to flow freely to the system. Use only materials that are compatible with the gases in the sample flow system to ensure an accurate gas sample is delivered to the system. Ensure that all tubing bends are wide enough to prevent kinking or restriction in sample flow.

When connecting fittings to the sample point inlets, exhaust, and/or drain ports, be sure to not over-tighten the fittings. Overtightening the fittings may cause damage to the sample point manifold. Exhaust and drain gas flow should be properly vented to a safe area. When exhausting outdoors, make sure that rain or water sources cannot enter the exhaust lines. Do not combine any sensor/analyzer exhausts or drain lines. Increase exhaust line diameter by a minimum of 1/8" per 20 ft. of exhaust line. Do not back pressure the exhaust lines by restricting flow. Exhaust lines should also be checked for obstructions. Also, do not connect exhaust lines to a vacuum source.

2.5.1 Sample Line Leak Checking

WARNING

Leak-check all sample lines at start up and regularly thereafter. Leaking sample lines will cause sample dilution and lead to erroneous lower than actual readings. Failure to leak-check the sample lines may result in a hazardous condition.

3. System Start-up / Set-up

3.1 Power-Up Sequence

Remove pump tie down. Activate the pump circuit breaker and then activate the system circuit breaker. Refer to Figure 3.1 for location of components referred to in this section.

Observe the following sequence:

1. Power indicator on controller power supply turns on.
2. Pump turns on.
3. Display turns on.
4. Processor “OK” LED will remain red for a few seconds. The controller will perform a series of internal checks. During this time the controller LED’s will flash on and off. Once the system checks have been completed, the “OK”, “I/O”, “LINK 1” and “RUN” LED’s will become green. “LINK 2” will flash steadily green.
5. Approximately 45 seconds into start-up, the unit will begin to sequence and flow should be observed on the flow meter.

3.2 Flow Adjustment

Use the system control screen to place the unit in manual mode (see section 4.1.6). Step the system to the line with longest length of tubing or least amount of flow as observed on the flowmeter. Adjust the flow meter valve for nominal sensor/analyzer flow (refer to Section 1 for the appropriate value for your specific system). This flow rate is dependent on the sensor(s) installed in the unit. Reset the unit to auto-sequencing mode.

All calibration gases should be equipped with a **dual stage pressure regulator**. Connect the gas to the appropriate calibration port. Refer to Section 1 for the type of gas and port assignment for your specific system. Use the Manual Calibration display screen (see section 4.1.5) to activate the calibration port being adjusted. Adjust the pressure regulator to obtain the required flow as viewed on the flowmeter (approximately **2 PSI**). **DO NOT** adjust the valve on the flowmeter at this point. Repeat this procedure for the other calibration gases used by the system.

3.2.1 Flow Switch

The MultiGard 5000 System is equipped with a sample flow switch to ensure that sufficient sample and calibration gas is applied to the sensor. The function of the bypass flow switch is to ensure that the **sample line** flow rate exceeds the minimum requirements. The sample flow switch and the bypass flow switch have been factory preset to close at the appropriate flow levels.

NOTE: If a flow switch is subjected to excessive flow rates, it may lead to a situation where the flow switch does not respond by opening on loss of flow. Furthermore, a flow switch that is stuck closed will prevent the unit from properly performing an internal flow diagnostic test that will result in an incorrect “Manifold Leaks” error message. This may be corrected by tapping on the flow switch until the desired effect is observed. If this does not correct the problem or the problem reoccurs, this may be an indication of particle or residue accumulation in the flow switch. Under those circumstances, the flow switch should be cleaned in accordance with the manufacturer’s data sheet in Section 4. To clear a “Manifold Leaks” error message after a flow switch problem has been detected and corrected, a leak test must be initiated and lead to a successful resolution. A diagnostic leak test may be activated manually from the Diagnostics screen (see section 4.2.9).

3.3 Sample Transport Time

NOTE: Sections 3.3, 3.4 and 3.5 specifically apply to the standard MultiGard 5000 look-ahead bypass flow scheme. Refer to Section 1 if your system employs a custom flow scheme.

To ensure that the slowest responding sensor is exposed to the gas sample for the entire analysis time, the time it takes for the gas sample to be transported to the Multigard must be considered. To allow for this variance in line length, a sample transport time parameter is entered when calculating dwell time to ensure that a fresh sample is applied to the sensor(s). The sample transport time is a function of the tubing inner diameter, length of tubing and the minimum sample line flow rate. The standard recommended tubing is 0.250" OD, 0.175" ID nylon tubing (MSA part number 029207). The Flow Diagram will indicate the part number for the recommended tubing for your system. Use Table 3.1 or the equation provided below to enter the appropriate sample transport time to the corresponding line number in the Extended Setup and Sample Transport Time screen (see section 4.2.6) .

Table 3.1: Sample Transport Times (0.175" ID Tubing, bypass flow switch set @ 8 CFH)			
50 ft.	4 sec.	300 ft.	23 sec.
100 ft.	8 sec.	350 ft.	27 sec.
150 ft.	12 sec.	400 ft.	30 sec.
200 ft.	15 sec.	450 ft.	34 sec.
250 ft.	19 sec.	500 ft.	38 sec.

Sample Transport Time (sec) = 0.075 X Length of **0.175"** ID Tubing (ft.)

For applications involving gases not compatible with the standard tubing, the recommended tubing is 3/8" OD, 1/4" ID Teflon lined polyethylene tubing (MSA part number 655163). The Flow Diagram will indicate the part number for the recommended tubing for your system.

Sample Transport Time (sec) = 0.173 X Length of **0.250"** ID Tubing (ft.)

When using tubing other than the recommended tubing, use the following formula:

$$\text{Sample Transport Time (sec)} = \frac{\text{Volume of Tubing (cu ft)} \times 3600 \text{ sec/Hr}}{\text{Bypass flow switch trip point (cu ft / Hr)}}$$

NOTE: Sample line tubing with an inner diameter less than 0.175" will restrict flow below the flow rates recommended for this system. Use of this tubing will place additional limitations on the maximum sample line length and is therefore not recommended.

The bypass flow switch is a true indicator that the sample line flow is in excess of the trip point. The bypass flow switch is factory set to close at 8 SCFH increasing.

Use only sample stream compatible materials in the sample flow system to ensure accurate gas samples are delivered to the unit.

3.4 Dwell Time Parameters

NOTE: Sections 3.3, 3.4 and 3.5 specifically apply to the standard MultiGard 5000 look-ahead bypass flow scheme. Refer to Section 1 if your system employs a custom flow scheme.

WARNING

Entering correct Dwell Time Parameters is critical to proper system operation. Incorrect entries may lead to a hazardous situation. Contact MSA if you have any questions related to the MultiGard 5000 Gas Sampling System Dwell Time Parameters.

The components make up the dwell time of the MultiGard 5000 unit on a sample point are referred to as the dwell time parameters. These parameters are the sample transport time for the specific point, the system internal transport time, the sample analysis time, and extended analysis time. The sample analysis time and extended analysis time are entered in the Extended Setup/Sample Transport Time screen (see section 4.2.6). These two factors are to be set in conjunction with the extended analysis time trigger.

Table 3.3 is provided to assist in determining the appropriate dwell parameters. For each sensor indicated, three options are provided; A, B and C. Selecting option A will require a longer cycle time for the system but provide the least wear on the sample and bypass solenoid valves. Selecting option C will allow for a shorter cycle time for the system leading to a quicker response to a leak at the expense of decreasing the life span of the sample and bypass solenoid valves. Option B represents a compromise between options A and C. **Select the option which best suits your gas detection requirements.**

Examine the same row for each sensor to determine the slowest responding sensor in the MultiGard 5000 Gas Sampling System. Select one of option A, B or C for that sensor. Enter the analysis time, extended analysis time and triggers for extended analysis time associated with the option selected. For analysis time, use the column with the sample flow rate recommended for your specific system. The analysis time and extended analysis time are common to all sensors. The triggers for extended analysis time are independent for each sensor.

For the other sensors, select the option that has the longest analysis time that is less than the analysis time for the slowest responding sensor previously determined. Enter the extended analysis triggers for that sensor indicated by that option. Repeat this process for all the other sensors that may be installed.

Refer to Section 1 and/or Section 3 for dwell time for any sensor/analyzer not indicated in Table 3.3.

Table 3.3: EXAMPLES OF DWELL TIME DATA ENTRIES

SENSOR TYPE CALIBRATION RANGE MSA PART NUMBER WARNING LEVEL ** ALARM LEVEL **		Analysis Time (sec) ++		Extended Analysis Time (sec)	Extended Analysis Time Trigger		
		@ 1.5 SCFH Flow Rate	@ 0.5 SCFH Flow Rate		Sensor Increasing	Sensor Decreasing	Rate Trigger (per sec)
COMBUSTIBLE GAS 0-100% LEL 20 % LEL ** 40 % LEL **	A	24	34	0	20 % LEL (warning level)	-100	3 % (0.16 X warning level)
	B	11	21	13	18 % LEL (0.9 X warning level)	-100	
	C	5	15	19	10 % LEL (0.5 X warning level)	-100	
CARBON MONOXIDE 0-100 PPM 25 PPM ** 50 PPM **	A	60	70	0	25 PPM (warning level)	-100	1.5 PPM (0.06 X warning level)
	B	40	50	20	22 PPM (0.9 X warning level)	-100	
	C	12	22	48	12 PPM (0.5 X warning level)	-100	
CARBON MONOXIDE 0-500 PPM 100 PPM ** 200 PPM **	A	60	70	0	100 PPM (warning level)	-500	6 PPM (0.06 X warning level)
	B	40	50	20	90 PPM (0.9 X warning level)	-500	
	C	12	22	48	50 PPM (0.5 X warning level)	-500	
OXYGEN 0-25%, MEASUREMENT FOR <u>OXYGEN DEFICIENCY</u> 19.5 % ** 18.0 % **	A	40	50	0	25	19.5 % (warning level)	0.3 % (0.22 X (20.8-warning level))
	B	9	19	31	25	19.7 % ((0.9 X warning level) + 2.08)	
	C	5	15	35	25	20.2 % ((0.5 X warning level) + 10.4)	
OXYGEN 0-10%, MEASUREMENT FOR <u>OXYGEN IMPURITY</u> 807071 2.0 % ** 5.0 % **	A	60	70	0	2.0 % (warning level)	-10	0.2 % (0.10 X warning level)
	B	21	31	39	1.8 % (0.9 X warning level)	-10	
	C	11	21	49	1.0 % (0.5 X warning level)	-10	

- TABLE CONTINUED ON FOLLOWING PAGE -

SENSOR TYPE CALIBRATION RANGE MSA PART NUMBER WARNING LEVEL ** ALARM LEVEL **		Analysis Time (sec) ++		Extended Analysis Time (sec)	Extended Analysis Time Trigger		
		@ 1.5 SCFH Flow Rate	@ 0.5 SCFH Flow Rate		Sensor Increasing	Sensor Decreasing	Rate Trigger (per sec)
NITROGEN DIOXIDE 0-10 PPM 2.0 PPM ** 4.0 PPM **	A	NA	100	0	2.0 PPM (warning level)	-10	0.5 PPM (0.50 X warning level)
	B	NA	20	80	1.8 PPM (0.9 X warning level)	-10	
	C	NA	15	85	1.0 PPM (0.5 X warning level)	-10	
MODEL 3800 CARBON MONOXIDE 0-1000 PPM 100 PPM ** 200 PPM **	A	90	NA	0	100 PPM (warning level)	-1000	10 PPM (0.10 X warning level)
	B	70	NA	20	90 PPM (0.9 X warning level)	-1000	
	C	40	NA	50	50 PPM (0.5 X warning level)	-1000	
CHILLGARD RT + REFRIGERANTS 0-1000 PPM 25 PPM ** 50 PPM **	A	90	NA	0	25 PPM (warning level)	-1000	10 PPM (0.10 X warning level)
	B	70	NA	20	22.5 PPM (0.9 X warning level)	-1000	
	C	40	NA	50	12.5 PPM (0.5 X warning level)	-1000	

- REFER TO CAUTIONS AND NOTES ON FOLLOWING PAGE -

WARNING

Typical WARNING and ALARM set-points shown in Table 3.3 are for reference only. The user of this gas sampling system must determine what concentration of a specific gas poses a hazard to the specific site where this equipment is installed and the concentrations where a warning and alarm indication is required. Failure to set appropriate warning and alarm set-points can result in serious personal injury or death.

+ Typical data for units calibrated for the detection of HCFC-123. Other refrigerants may require less stringent set points.

++ Analysis time is a function of the sample flow rate. Refer to the Custom System Definition Data Sheet in Section 1 for the recommended flow rate for your system.

Notes:

Table data entries are based on warning levels selected.

Table data entries are based on readings for 98% sensor accuracy.

A sensor increasing or rate trigger set at sensor full scale effectively disables that trigger.

A sensor decreasing trigger set at minus sensor full scale effectively disables that trigger.

3.5 Actual Dwell Time

NOTE: Sections 3.3, 3.4 and 3.5 specifically apply to the standard MultiGard 5000 look-ahead bypass flow scheme. Refer to Section 1 if your system employs a custom flow scheme.

The purpose of the look ahead bypass is to draw on the next sequential sample line to reduce or in some cases even eliminate the sample transport time. The processor continuously uses the dwell time parameters and the **actual programmed sampling sequence** to determine the actual dwell time. For every line, the actual dwell time is calculated according to the following formula:

Actual Dwell Time (line n) = Sample Transport Time (line n) - Dwell Time of Previous Position in Programed Sequence + Internal Transport Time + Analysis Time + Extended Analysis Time

NOTE: The previous position should be verified in the actual programed sampling sequence.

With precautions taken such that the minimum actual dwell time is never less than the sum of the analysis time, extended analysis time and internal transport time.

The internal transport time is a factory configured constant that is determined to be the time required to transport the sample from the sample manifold to the sensor(s). The internal transport time for this system is 10 seconds.

The extended analysis time is only a factor if triggered by a preset rate or level condition.

The actual dwell time of the current sample point is displayed on the Sequencer Control display screen (see section 4.1.6).

3.6 Auto Standardize Mode

When Auto Standardize is enabled, initial start-up of a MultiGard 5000 System will not proceed correctly without calibration gases available. The “Auto Standardization Not Performed” flag will remain on the MultiGard 5000 Display. MultiGard 5000 System monitoring will proceed with uncorrected analyzer values.

The absence of calibration gases will also result in Zero, Span 1 or 2 “Flow Failure” trouble indications from the MultiGard 5000 System when Auto Standardize is attempted. This indicator is visible on the Manual Calibration screen.

The analog signals from the sensors are scaled and corrected for any possible drift during the MultiGard 5000 Auto Standardize Mode. Failure to have calibration gas available to the MultiGard 5000 System during the Auto Standardize Mode will abort the scaling and correction process. Prior values will be used until a full Auto Standardize cycle can be completed.

CAUTION

When MultiGard 5000 Auto Standardize Mode is enabled calibration gases must be available at all times.

If a calibration gas source is not available during Auto-Standardize Mode MultiGard 5000 monitoring may be adversely affected.

4. Operator Interface

The operator interface for the MultiGard 5000 unit is a 10.4” color touch-screen that provides both information display and user input. This section applies to all unit configurations as well as illustrating the single system versus dual system screen differences.

Throughout this chapter the screens for the MultiGard 5000 24/32 point unit are shown in the figures. Users of MultiGard 5000 8/16 units should note the following rules on using the same operator manual:

- The location of any item is in the same relative position for all system styles.
- The same information content is provided on each screen for all system styles.
- Wherever 32 points of information are shown in the figures, 16 points of information will actually be seen on the screens in a similar format.
- The phrases underlined and in quotes which lead to a description of an item still refer to the figures. Any changes will be noted in the description (see next bullet).
- In the item descriptions point ranges or references to system size may be specified which match the figure. Substitute the numbers in brackets ([]) in place of those in the sentence.
- Any exceptions to these rules will be discussed in the appropriate section.

Below is one example showing the similarity between a MultiGard 5000 8/16 screen and a MultiGard 5000 24/32 screen using the rules described above where appropriate.

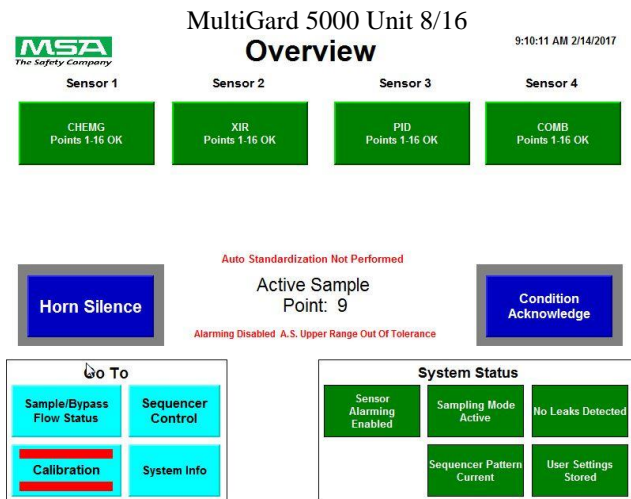


Figure 1: Overview Screen (8 or16 Point System)

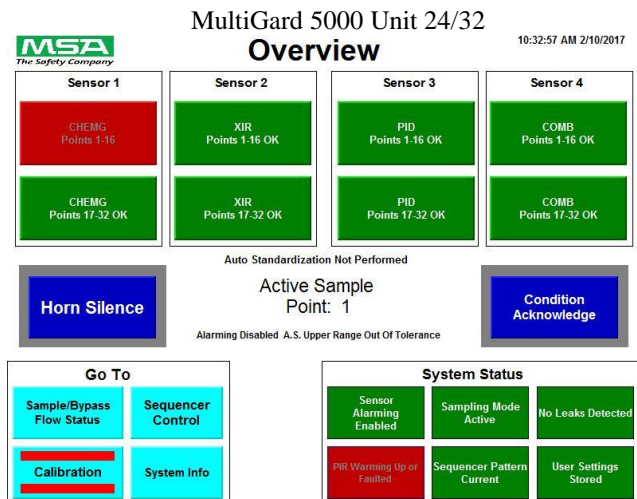


Figure 2: Overview Screen (24 or 32 Point System)

Users of MultiGard 5000 Dual 8 and MultiGard 5000 Dual 16 units should note the following rules on using the same operator manual:

- The same information content is provided on each screen across all models. The location of some items may be different between the single and dual models.
- Wherever dual MultiGard 5000 data is presented based on the number of sample points the quantity will vary between 8 or 16 and be presented in a similar manner.
- The phrases underlined and in quotes which lead to a description of an item still refer to the original figures. In addition these items in the dual MultiGard 5000 system are specifically labeled System A (SYS A) and System B (SYS B) to distinguish between the two separate systems. Items common to the overall assembly do not use this designation.
- When explicit labeling is not used the header text System A: and System B: are used. Everything directly under these headers then applies to the system as labeled.
- The relative position of System A grouped data is on the left. The relative position of System B grouped data is on the right. Data common to the overall assembly is located in the center or where space permits.
- Any special notes and exceptions to these rules will be discussed in the appropriate section and will be visually distinguished by the text box style as shown below.

Sample text related to the dual MultiGard units.

This information can be ignored by users of single MultiGard units.

Below is one example screen using the rules described above where appropriate.

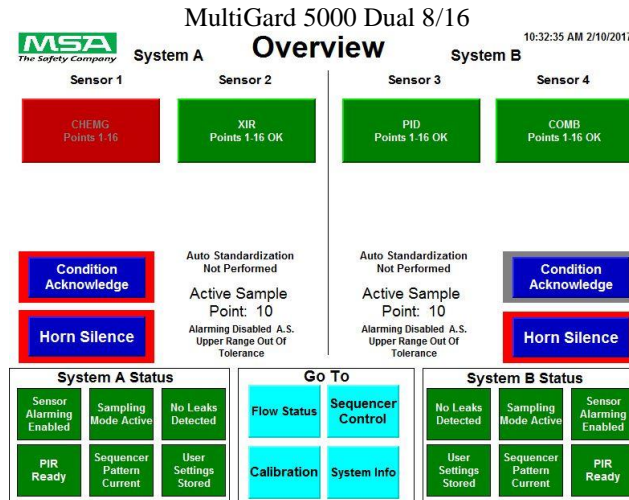


Figure 3: Overview (Dual 16 Point System)

All MultiGard 5000 touchscreen displays have a screen saver feature enabled. The screen will turn off after 30 minutes of touch inactivity. After it turns off, the first touch will restore the screen to normal operation.

The following sections describe the screen package of the MultiGard 5000 unit which is divided into an open access part for use by anyone and a secured access part for the responsible system operator.

4.1 Operational Screens - OPEN ACCESS

The first of two parts which make up the screen package is open access. This part is intended to provide everything an operator needs to know about the gases being monitored and the operation of MultiGard 5000 unit.

The following figure, MultiGard 5000 Screen Hierarchy, Part 1 of 2, summarizes this portion of the package and can be used as a "road map" to system operation.

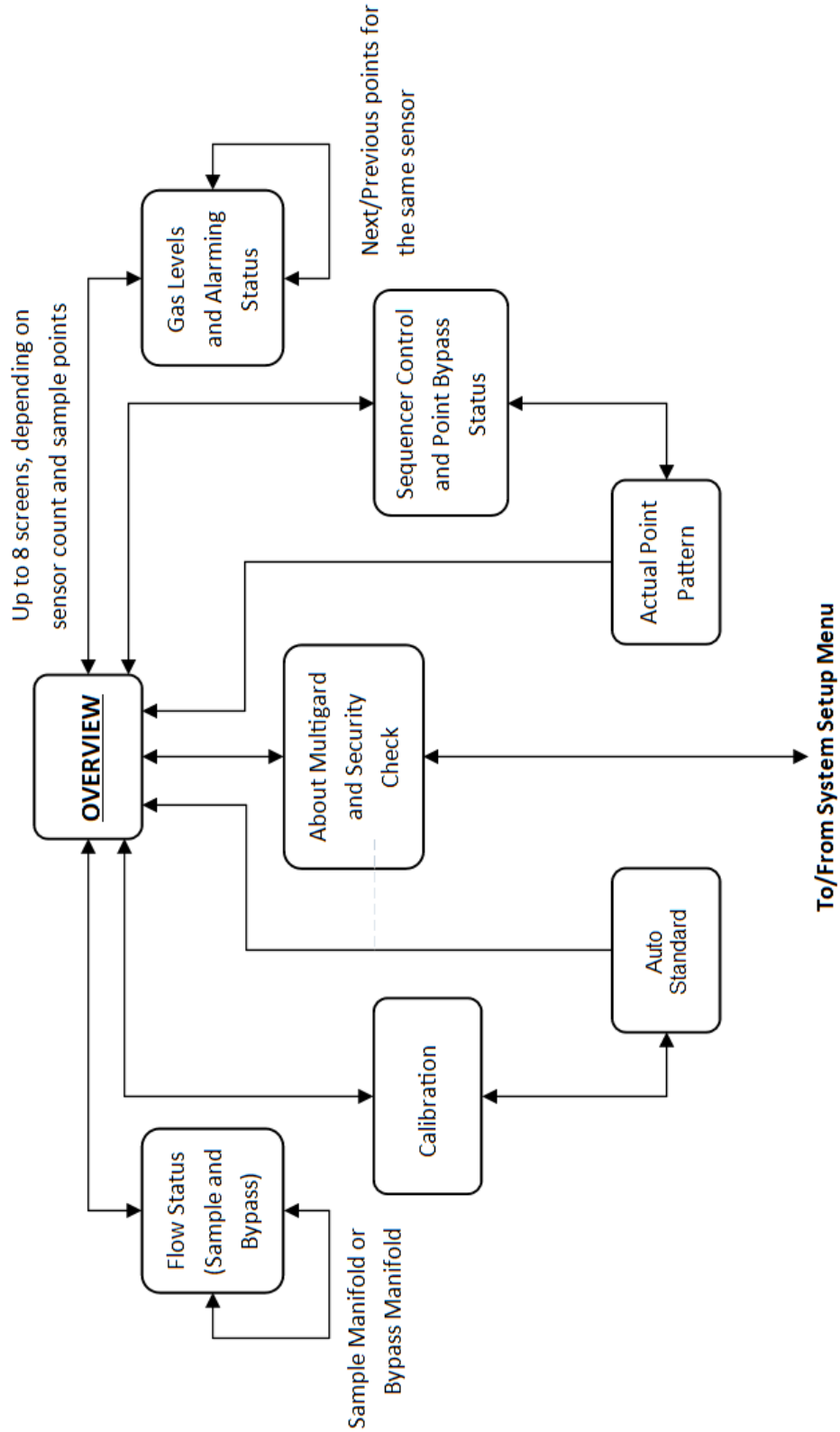


Figure 4: MultiGard Screen Hierarchy, part 1 of 2

Likewise, the following figure, Dual MultiGard 5000 Screen Hierarchy, Part 1 of 2, summarizes the dual MultiGard 5000 units.

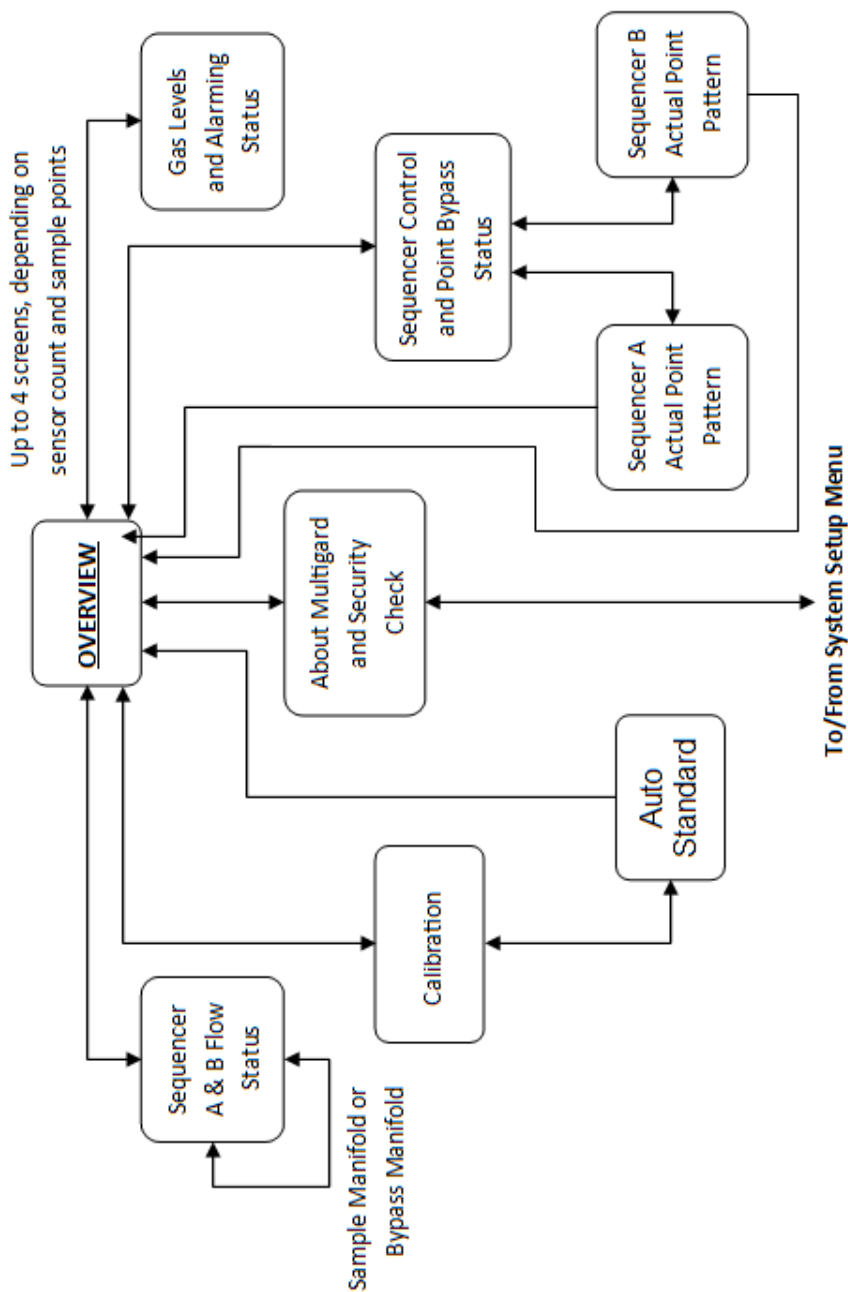


Figure 5: Dual MultiGard Screen Hierarchy, part 1 of 2

4.1.1 Overview

The Overview screen seen in Figures 1 and 2 provide a single place to see anything that is happening within MultiGard 5000 unit. In a summary format, gas alarming and internal system conditions are depicted. Visual annunciators will indicate the subject area where a condition exists and act as "off-page" indicators to lead the operator to other screens for the details.

NOTE: It is intended that this screen be visible most of the time during normal system operation. Any time the local horn sounds the operator should return to and look at the Overview screen to determine what happened. The operator should then proceed to get the details by selecting other appropriate screens as flagged on the Overview.

The Overview screen consists of the following status indicators, annunciators and push buttons:

"User Settings Stored" – Is displayed and green during normal operating conditions. When the system memory has been corrupted, or the system requires booting from the SD card, user-entered parameters are lost and the MSA factory defaults are reinstated, and this indicator becomes red and displays "Factory Defaults Loaded"; this event is classified a trouble condition. If the user entered data has been saved (discussed later in this manual), the user data can be restored, which will cause the indicator to go back to its normal operating condition. The only normal cause for this is battery failure followed by power being turned off long enough for internal capacitors to discharge. This event should be rare assuming the MultiGard 5000 unit is powered up most of the time while in service.

WARNING

If "User Settings Stored" indicator appears red on the Overview screen, all user entered parameters are lost and the MSA factory defaults are reinstated. Immediate action is required to manually re-enter or load all previous user configured parameters to restore MultiGard 5000 unit to its most recent desired operation. If no action is taken the MultiGard 5000 unit will remain in default operation with only common alarming and user configured parameters as defined in Section 1. This results in operation identical to the initial delivery of MultiGard 5000 unit.

"Sampling Mode Active" - This indicator shows that the MultiGard 5000 unit is in sampling mode. When manual calibration is active, the indicator will turn yellow and display "Manual Calibration Active". During auto standardization the indicator will turn yellow and display "Auto Standardization in Progress" until the procedure is completed.

"Sequencer Pattern Current" - Indicates the sequencer pattern currently running is the same as that defined by the Point Bypass and Point Order setup screens. If the operator changed anything on the Point Bypass or Point Order screens, and did not update the pattern, this indicator will change to yellow and display "Update Sequencer Pattern". See Sections 4.2.7 and 4.2.8 for details on point bypass and point order, respectively.

"No Leaks Detected" - This indicator is the result of the sample and bypass manifold leak test performed by MultiGard 5000 unit upon power up and every 8 hours thereafter. This test can also be manually triggered on the Diagnostics screen. If the system leaks this indicator will change to red and display "Leaks Detected".

"Sensor Alarming Enabled" - This indicator follows the state of the manual sensor alarming disable push button on the Diagnostics screen. When disabled, the indicator will turn red and display "Sensor Alarming Disabled".

"Alarming Disabled A.S. Upper Range Out Of Tolerance" – This indicator will appear when an auto standardization was completed and any sensor's upper range is out of tolerance. All alarming will be disabled. This indicator does not follow the manual sensor alarming disable push button on the Diagnostics screen.

"PIR Ready" - This indicator shows the enable/disable and ready/not ready analyzer status in combination as follows: When disabled the message "Analyzers Ready Disabled" is present permanently. When enabled, the indicator will show "PIR Ready" or "PIR Warming Up or Faulted". Note that the analyzers enable/disable is a MSA factory configured parameter that is available only when the MSA analyzers in use provide a ready relay output.

"Auto Standardization Not Performed" – This indicator appears when an auto standardization has never been performed when auto standardization has been factory enabled. The values used in the correction of gas data are unknown and during this time uncorrected data is presented by the MultiGard 5000 unit.

"Sample/Bypass Flow Status" & Annunciator - This push button changes the screen to view the sample and bypass manifold flow status. The annunciator is an "off-page" indicator which is normally invisible. It appears as two flashing red squares when any flow problem exists.

"Calibration" & Annunciator – This push button changes the screen to view and operate calibration features. The annunciator is an "off-page" indicator which is normally invisible. It appears as two flashing red rectangles when problems exist resulting from any auto standardization tolerance being out, or loss of any calibration gas.

"Sequencer Control" - This push button changes the screen to view and operate the Sequencer Control features of MultiGard 5000 unit.

"System Info" – This push button changes the screen to view information about the MultiGard 5000 unit and allows entry of a password to enter the system setup areas (part 2 of the screen package) of the MultiGard 5000 unit.

"Sensor 1 Points 1-16 OK" through "Sensor 4 Points 17-32 OK" - A group of 8 push buttons which changes the screen to view sensor data and alarming status. Whenever a condition exists that requires an operators attention, the button will turn red and indicate "Sensor 1 Point 1-16 [1-8]" through "Sensor 4 Points 17-32".

"Horn Silence" - This is a push button which silences the horn. The frame of the button will flash red during a trouble, warning or alarm condition. See the Chapter 5, Common Alarming for more details.

"Condition Acknowledge" – This is a push button which acknowledges the following conditions when operating in latched mode, trouble, warning, or alarm. The frame of the button will flash red when there is a condition that needs to be acknowledged. If not operating in a latched mode, this button is not required for condition clearing. See Alarming, Chapter 5 for more details.

4.1.2 Gas Levels (And Alarming Status)

The Gas Level screens are used to view the specific details associated with the gas detection features of the MultiGard 5000 unit. It shows sensor values and alarming status on a per point basis for each of the 4 sensors. All point data is stored and can be displayed at any time. The last valid levels are held until the next sequencer update. This screen will look the same for dual systems.

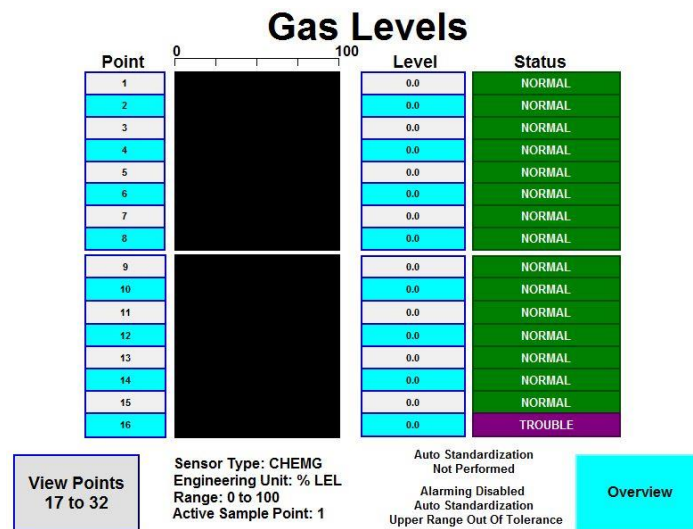


Figure 6: Gas Levels

The Gas Levels screen consists of the following:

"Auto Standardization Not Performed" – This indicator appears when an auto standardization has never been performed. The values used in the correction of gas data are unknown and during this time uncorrected data is presented by the MultiGard 5000 unit.

"Sixteen rows consisting of a Point Number, a Bar Graph, a Level, and a Status Field" – This is the primary data display format in the MultiGard 5000 unit for all gas detection points. The Point Number will be 1-16 or 17-32 depending on which push button on the Overview screen was pushed. The Point Numbers groups will also toggle if the MultiGard 5000 unit is a 32 or 24 point system and

the "View Points 17 to 32" button is pressed. The bar graphs are presented for a visual indication of gas levels and are especially useful in applications where continuous gas levels are present. The Level is the actual gas reading corrected by auto standardization data and displayed in engineering units as indicated at the bottom of the screen. The Status indicators show the alarming states associated with each point.

The Status indicators accurately depict the combined alarming state of each point consisting of trouble, warning, and alarm level detection. All of the possible messages that can appear are as follows: "Normal", "TROUBLE", "WARNING", "TRBL/WARN", "ALARM!", "TRBL/ALARM", "ALARM!/WARN", and "TRBL/W/A". Note that some of these messages may never appear. Which messages are valid is dependent on the sensor type, the MSA factory warning/alarm selection of increasing or decreasing, and the user entered set point values.

When the sequencer is operated in the manual mode the data presentation and status indication described above becomes live after the dwell time has expired for the selected sample point.

"Range:." – This is a text indicator telling the operator the range of sensor. This range should associate with the scale that is above the bar graph.

"Engineering Units:." - This is the engineering units associated with the named sensor.

"Alarming Disabled Auto Standardization Upper Range Out Of Tolerance" - This indicator will appear when an auto standardization was completed and any sensor's upper range is out of tolerance. All alarming will be disabled. This indicator does not follow the manual sensor alarming disable push button on the Diagnostics screen.

WARNING

If "Alarming Disabled Auto Standardization Upper Range Out Of Tolerance" indicator appears on the Overview screen, the alarming is disabled. Immediate action is required to manually calibrate the sensor which caused this condition to occur followed by another auto standardization. See Section 4.1.5, Section 3, and Section 4.1.4 for details. If no action is taken all alarming will stay disabled with the MultiGard 5000 unit only indicating a trouble condition.

"View Points 17 to 32" - This is an HMI navigation push button that switches to the next 16 points associated with the same sensor. Once this button is pushed it will indicate "View Points 1 to 16". This button is not used on MultiGard 5000 unit 8 or 16 point systems.

"Sensor Type:." - This is a text indicator which identifies the type of sensor configured and what data is currently being viewed.

"Active Sample Point:." - Shows the point number that is currently being sampled. In other words, the next point that will get its level and status updated.

"Overview" - This is a button which switches the screen back to the Overview.

4.1.3 Flow Status (Sample and Bypass)

The Flow Status screen shows specifically where a flow problem exists on both the sample and bypass manifolds.

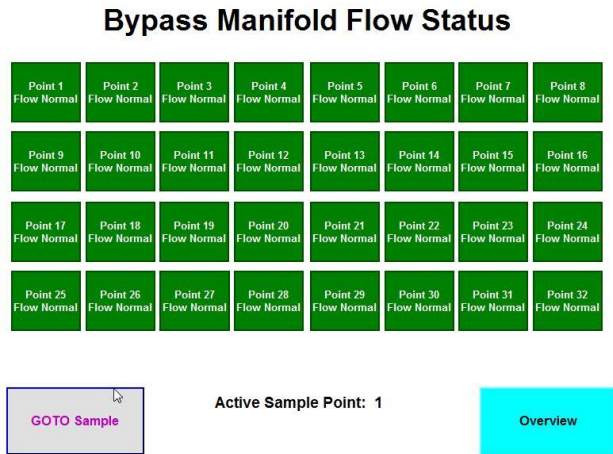


Figure 7: Sample Manifold Flow Status

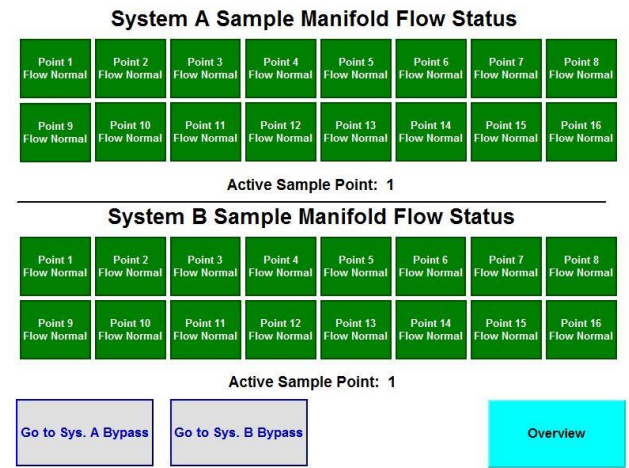


Figure 8: Sample Manifold Flow Status (Dual)

The Flow Status screen consists of the following:

"Sample Manifold Flow Status" - This is the screen title and it indicates which flow status is currently being displayed. The title may also appear as "Bypass Manifold Flow Status" and changes alternately with the "GOTO BYPASS" button described below..

"Point 1 Flow Normal" through "Point 32 Flow Normal" – During normal operation the array of 32 indicators are green and display “Point [XX] Flow Normal” for whichever manifold is selected. When flow failures exist the indicator(s) will turn red and display "Point [XX] Flow FAILURE" depending on which point and which manifold is in flow fail. [XX] will display which point number, 1-32 is normal or in failure.

*NOTE: Bypassing a point (eliminating a point from the sampling sequence) that has a sample or bypass flow loss indication, will lead to a situation where the trouble condition cannot be cleared. The MultiGard 5000 unit must access the line in question to determine that the fault condition has been corrected whereby the **CONDITION ACKNOWLEDGE** button may be used to return the unit to the normal operating state.*

"Flow Loss on Sample!" – This indicator will show when viewing the “Bypass Manifold Flow Status” screen and a flow failure has occurred in the sample manifold. When the screen is switched to view the “Sample Manifold Flow Status” screen, this indicator turns off.

"Flow Loss On Bypass!" - This indicator will show when viewing the “Sample Manifold Flow Status” screen and a flow failure has occurred in the bypass manifold. When the screen is switched to view the “Bypass Manifold Flow Status” screen, this indicator turns off.

"GOTO Bypass" - This is a push button that changes the screen from displaying sample status to bypass status. After being pushed the button now indicates "GOTO SAMPLE". Note that the screen

title alternates between “GOTO Bypass” and “GOTO Sample”, depending on screen being viewed.

"Overview" - This is an HMI navigation button which switches the screen back to the Overview.

“Active Sampling Point” – This indicator shows which point is currently being sampled by the system.

4.1.4 Auto Standardization

The auto standardization screen shows the operator all of the items of interest related to this function and allows the operator to manually trigger the procedure. This screen is only accessible if the Auto Standard feature is enabled. See section 4.2.11 for information on enabling and disabling the Auto Standard feature.

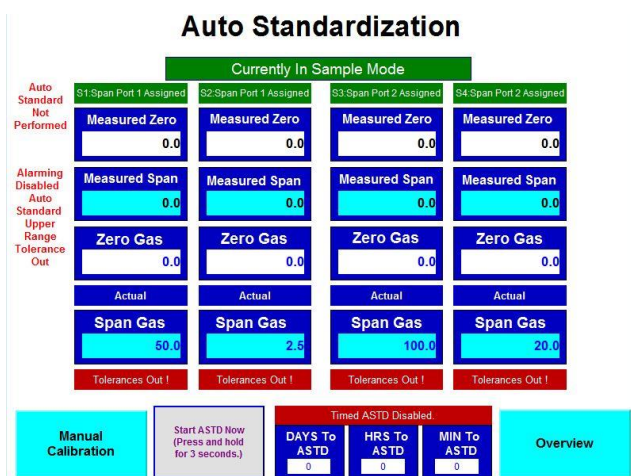


Figure 9: Auto Standardization (Single)

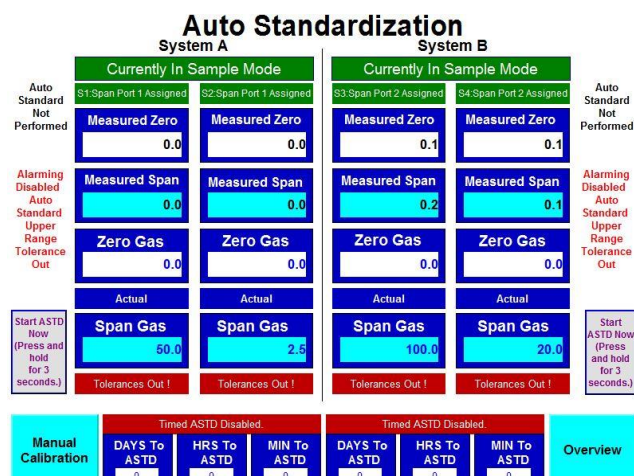


Figure 10: Auto Standardization (Dual)

The auto standardization screen consists of the following:

"Currently in Sample Mode" - This is a multistate indicator which shows the progress of the auto standardization procedure. It stays as shown until the procedure begins. The indicator steps through the following messages in this order: "Zero Gas Being Applied", "Span 1 Gas Being Applied", "Span 2 Gas Being Applied", "Purging With Gas Sample", and finally back to "Currently in Sample

Mode". Note that one of the span steps may be missing if the installed sensors do not require a second span gas supply.

Dual MultiGard 5000 Systems

The multistate indicator showing all the various stages of auto standardization exists for both System A and System B. All other items directly below these indicators apply to the specific System that is called out by the indicator. Remember that Sensors 1 and 2 are associated with System A and Sensors 3 & 4 are associated with System B.

Four columns consisting of "Disable/Span 1/Span 2" Indicator, "Measured Zero", "Measured Span", "Actual Zero Gas Value", Span Type Indicator, "Span Gas Value", and a Tolerance Indicator - These seven items are duplicated for each sensor and are defined as follows: The "S[1-4] Disabled" indicator will show for each sensor when auto standardization has not been MSA factory enabled. When auto standardization is enabled the indicator will show "S[1-4]:Span 1" or "S[1-4]:Span 2" depending on the span gas is required for each sensor. The "Measured Zero" is the real reading captured during the zero phase of auto standardization. The "Measure Span" is the real reading captured during the span phase of auto standardization. The Actual Zero Gas is the gas cylinder concentration and is displayed as a reference. The Span Type Indicator reads "Actual" or "Synthetic" depending on which type of span gas is being use. The Span Gas Value is the gas cylinder concentration and is displayed as a reference. When the "Measured Zero" and "Actual Zero Gas" values are equal and the "Measured Span" and "Span Gas" values are equal the sensor is in perfect alignment. The Span Gas value may be converted if a synthetic span gas is being used and was MSA factory configured. The tolerance indicator shows the combined status of any of the auto standardization tolerances and is either "Tolerances OK" or "Tolerances Out !".

When auto standardization tolerances are out, a manual calibration of the sensors is required to bring the sensors back into tolerance limits. See Section 3 for specific details.

"Manual Calibration" & Annunciator Bar - This is an HMI navigation button which switches to the Manual Calibration screen. The annunciator bar is normally an invisible indicator that will appear and flash when a gas cylinder flow failure(s) exist.

"Start ASTD Now" - This is a push button that will trigger the auto standardization procedure. The operator must ***press and hold the button 3 seconds*** for the auto standardization to start. Watch the multistate indicator at the top of the screen for when the procedure starts. This start requirement serves to prevent accidental false starts. Once started, the auto standardization procedure cannot be stopped.

"Timed ASTD Disabled" - This indicator shows that the Timed auto standardization feature has been disabled by the user or was left default. This indicator shows "Next Timed ASTD In:" when timed auto standardization is enabled.

"DAYS To ASTD" - The number of days until the next auto standardization is performed. This field is zero if the timed auto standardization is disabled.

"HRS To ASTD" - The number of hours until the next auto standardization is performed. This field is zero if the timed auto standardization is disabled.

"MIN To ASTD" - The number of minutes until the next auto standardization is performed. This field is zero if the timed auto standardization is disabled.

"Overview" - This is an HMI navigation button which switches the screen back to the Overview.

"Alarming Disabled, Auto Standardization Upper Range Out of Tolerance" – This indicator appears when an auto standardization upper limit has been exceeded. The operator must perform a manual calibration of the sensor to clear this condition.

"Auto Standardization Not Performed" – This indicator appears when an auto standardization has never been performed when auto standardization has been factory enabled. The values used in the correction of gas data are unknown and during this time uncorrected data is presented by the MultiGard 5000 unit.

4.1.5 Manual Calibration

The Manual Calibration screen is intended for use by the operator during sensor maintenance. It displays uncorrected sensor readings and gas cylinder flows. It also allows selection of calibration gases and entry into calibration mode for the purpose of manual sensor calibration. No Auto standardization occurs while on this screen.

NOTE: If auto standardization has been factory enabled, and after the manual calibration mode has been entered. Upon leaving the Manual Calibration screen a full auto standardization is triggered automatically.

NOTE: This screen may be viewed without the auto standardization being triggered upon leaving, as long as the manual calibration mode was never started. If the "GO TO MAN. CAL. MODE" button is pressed at any point, an auto standardization WILL be performed.

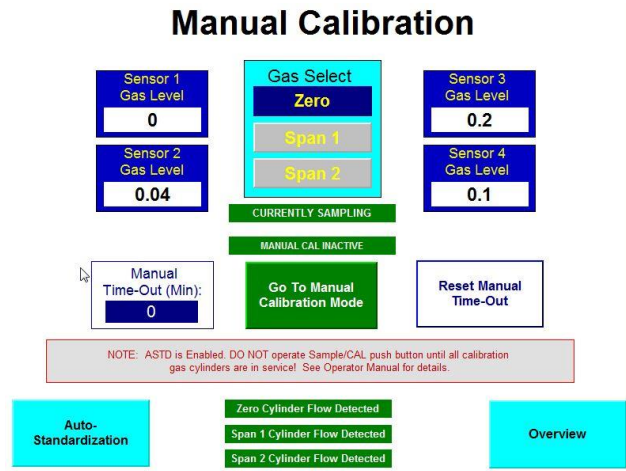


Figure 11: Manual Calibration

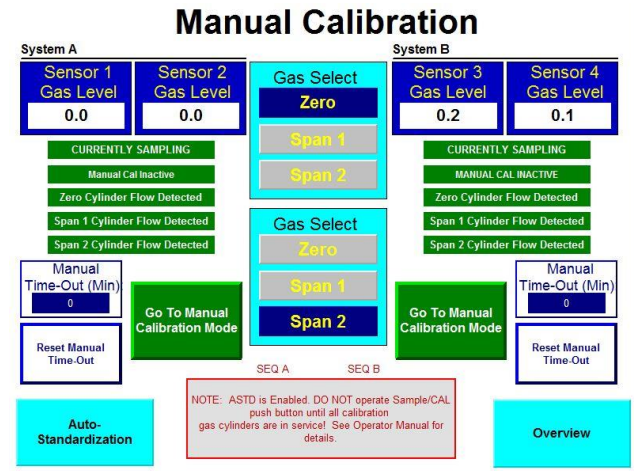


Figure 12: Manual Calibration (Dual)

The Manual Calibration screen consists of the following:

"Sensor 1 Gas Level" through "Sensor 4 Gas Level" - The four large gas level displays, show the real-time sensor gas readings **without any corrections**. These values are raw sensor readings that are continuously updated and will **NOT** match the sensor bar graphs when auto standardization is enabled. The sensor bar graphs show the corrected sensor readings. If auto standardization is not enabled, the gas level displays on the Manual Calibration screen **WILL** match the sensor bar graphs.

"Select Gas:" - This is a three position selector switch which allows the selection of Zero, Span 1, and Span 2 gases for application to the sensors. The selection may be done at any time and the actual application occurs only when the “GO TO MANUAL CALIBRATION MODE” button is pressed, starting the manual calibration mode.

"CURRENTLY SAMPLING" - This indicator advises the operator that he may enter the manual calibration mode. When auto standardization is in progress the indicator shows "ASTD IN PROGRESS" and the manual calibration is locked out until auto standardization is over.

“MANUAL CAL INACTIVE” – This normally green indicator alerts the operator as to what calibration mode the system is in. When a manual calibration is active, the indicator will turn yellow and display “MANUAL CAL ACTIVE”.

"Manual Time-out (MIN):" - This indicator shows the time that remains for manual calibration before the manual calibration time-out occurs. It is MSA factory set to 30 minutes and begins counting down when the manual calibration mode is entered. Upon time-out completion, a full Auto standardization will be executed on systems where auto standardization has been factory enabled. Once the auto standardization is complete, the system resumes gas sampling. On systems where auto standardization is not enabled, the unit resumes sampling.

"GO TO MANUAL CALIBRATION MODE" - This is the push button used to go to manual calibration. When pushed the system starts the manual calibration mode and the button indicates "RETURN TO SAMPLE MODE". Once done with manual calibration, pressing the “RETURN TO SAMPLE MODE” button will end the manual calibration mode. The same auto standardization rules apply as if the system were to time-out as discussed previously.

"Reset Manual Time-out" - This push button resets the time-out timer back to 30 minutes. It is intended for operator use when sensor maintenance is expected to take longer than 30 minutes.

NOTE: After the manual calibration mode is entered and 30 minutes has elapsed, the manual calibration mode ends and a full auto standardization is triggered automatically if factory enabled. If more than 30 minutes is needed to perform the sensor maintenance, press the "Reset Manual Time-Out" button to reset the 30 minute timer.

"Auto Standardization" - This is an HMI navigation button which changes the screen to auto standardization.

"Zero Cylinder Flow Detected" - This indicator shows that the gas cylinder flow was normal during the last calibration. It switches to "Zero Cylinder Flow Not Detected" when the gas cylinder is empty or any other zero gas flow failure condition exists.

"Span 1 Cylinder Flow Detected" - This indicator shows that the gas cylinder flow was normal during the last calibration. It switches to "Span 1 Cylinder Flow Not Detected" when the gas cylinder is empty or any other span 1 gas flow failure condition exists.

"Span 2 Cylinder Flow Detected" - This indicator shows that the gas cylinder flow was normal during the last calibration. It switches to "Span 2 Cylinder Flow Not Detected" when the gas cylinder is empty or any other span 2 gas flow failure condition exists.

"Overview" - This is an HMI navigation button which switches the screen back to the Overview screen.

4.1.6 Sequencer Control (And Point Bypass Status)

The Sequencer Control screen allows the operator to control the sequencer and to see the point bypass status currently in effect. This screen also allows the operator to get to the Actual Point Pattern screen.

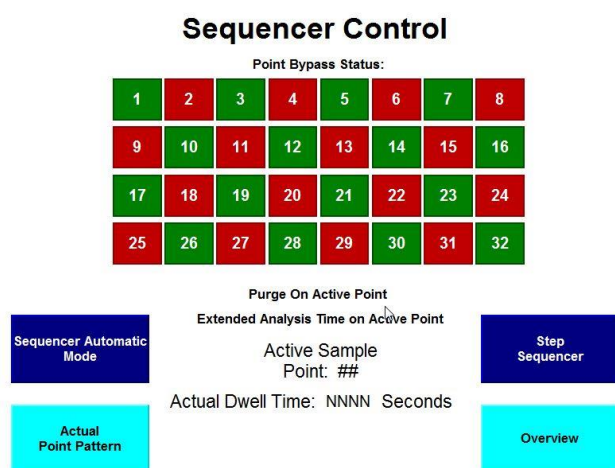


Figure 13: Sequencer Control

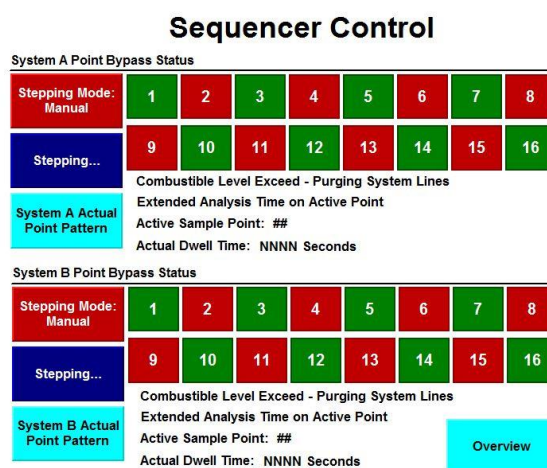


Figure 14: Sequencer Control (Dual)

"Point Bypass Status:" - This is an array of 32 [16] indicators which show the point bypass. Any point in green is not bypassed. Any point in red is bypassed and not sampling. Using this color code, the operator can quickly see which points, if any, are currently being bypassed. In the MultiGard 5000 24 [8] point system sample points 25-32 [9-16] are permanently bypassed.

"Combustible Level Exceeded – Purging System Lines" - This indicator only appears when the system determines that a purge is required on the indicated point. This feature is only applicable when the purge operation has been factory configured for MSA's catalytic combustible sensor. This indicator refers to the sample point number shown in the "Active Sample Point:" indicator. This indicator stays visible for the duration of the purge.

"Extended Analysis Time on Active Point" - This indicator only appears when any of the extended analysis triggers discussed in section 3.4, are active for any sensor on the current sample point. This indicator also refers to the sample point number shown in the "Active Sample Point:" indicator.

"Stepping Mode: Automatic" - This is a push button that switches the sequencer between automatic and manual modes. When button is pressed to enter manual mode, the button turns red and flashes "Stepping Mode: Manual" and a 15 minute time-out timer starts. At the end of the time-out timer, the system will automatically return to automatic mode.

"Active Sample Point:" - This indicator shows sample valve the sequencer is currently sampling. It is active in both automatic and manual modes.

"Step to Next Point" - This is a push button that steps the sequencer when in the manual mode. It is not operational in the automatic mode.

"Actual Dwell Time:" - This indicator shows the actual dwell time for the current point number. See Section 3.5 for a complete description of the dwell time calculation. This indicator shows the time in seconds.

"Actual Point Pattern" - This is an HMI navigation button which changes the screen to view the Actual Point Pattern currently being executed by the sequencer.

Dual MultiGard 5000 Systems

There are two Actual Point Pattern touch-buttons on the dual MultiGard 5000s; System A and System B.

"Overview" - This is an HMI navigation button which switches the screen back to the Overview.

4.1.7 Actual Point Pattern

The Actual Point Pattern screen shows the current pattern (or order) in which the physical sample valves are being opened by the sequencer. It is the combined result of the Point Order setup and Point Bypass setup screens described in sections 4.2.8 and 4.2.7, respectively. Any sequencer step(s) containing a point number zero in the Point Order setup screen is (are) eliminated in the Actual Point Pattern. In addition, any point(s) bypassed on the Point Bypass setup screen is (are) also eliminated in the Actual Point Pattern.

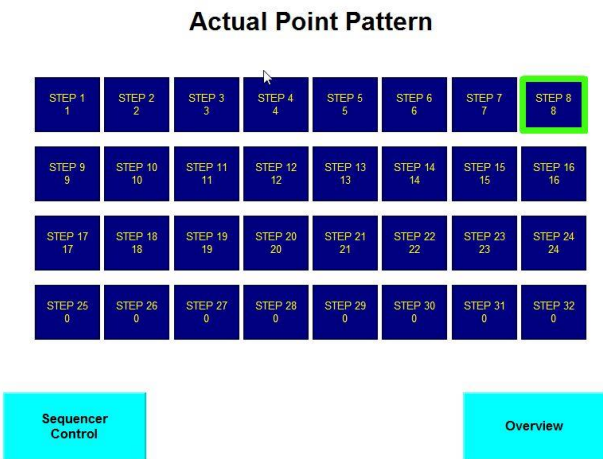


Figure 15: Actual Point Pattern

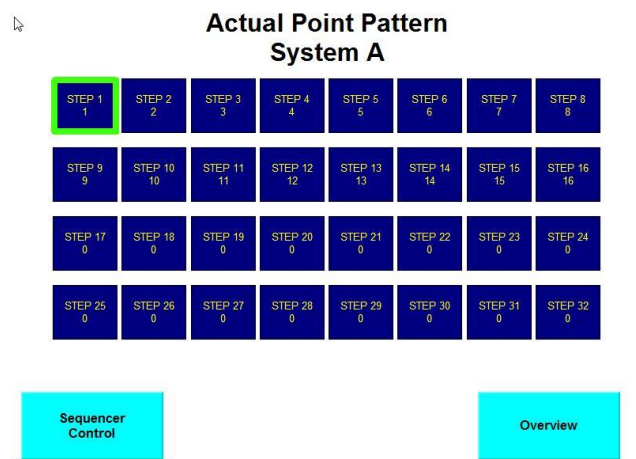


Figure 16: Actual Point Pattern (Dual – System A)

The Actual Point Pattern screen consists of the following:

"Step 1" through "Step 32" - An array of 32 indicators depicting each of the 32 steps in the sequencer. The number contained in each step indicator is the physical sampling valve number. The current sequencer step will be framed in green, and will cycle through all valid sequence steps.

"Sequencer Control" - This is an HMI navigation button which switches the screen back to the Sequencer Control screen.

"Overview" - This is an HMI navigation button which switches the screen back to the Overview.

Dual MultiGard 5000 Units

There are two Actual Point Pattern screens; System A and System B. Note that each sequencer has 32 steps.

4.1.8 About MultiGard 5000 Unit and Security Check

This screen contains information about MSA, the MultiGard 5000 System, and the customer order. It also serves as the security check point or gateway into the secured system setup section of the screen package (part 2).

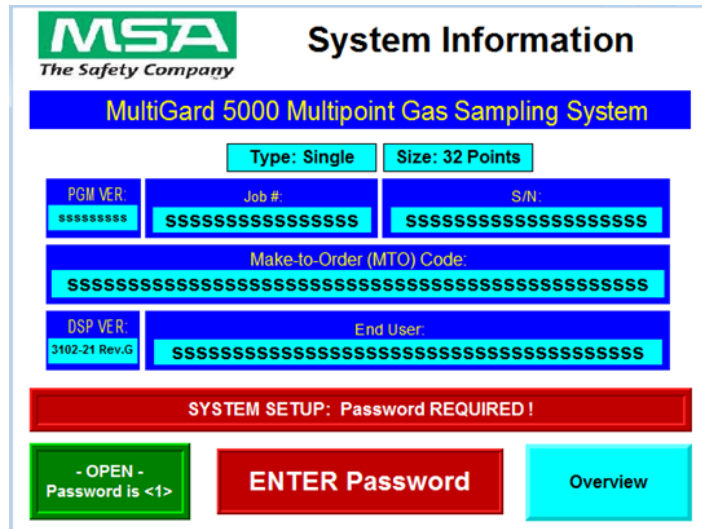


Figure 17: System Information

The About MultiGard 5000 and Security Check screen consists of the following:

"Type: Single" - This indicator shows whether the system is single or dual. When a dual system is configured the indicator reads "Type: Dual". The system type is a MSA factory parameter.

"Size: 16 Points" - This indicator shows whether the system is set up for 8 or 16 [24 or 32] points. When the 8 [24] point system is configured the indicator reads "Size: 8 [24] Points". The size is a MSA factory parameter.

"PGM VER:" - This indicator shows the current Compactlogix processor program version that is running this MultiGard 5000 unit.

"Job #" - This is the MSA internal job number for this customer order.

"S/N:" - This is the system serial number assigned by MSA.

"Make-to-Order (MTO) Code:" - This is the make-to-order code assigned by MSA. It describes the major configuration and options included in this MultiGard 5000 unit.

"DSP VER:" - This is the version of screen application that is running in this MultiGard 5000 unit.

"End User:" - This is the end user's name; the company who has this MultiGard 5000 system installed on site.

"SYSTEM SETUP: Password REQUIRED!:" - This indicator notifies the operator that a password is required to go into the system setup areas. If a failed attempt to enter a valid password has occurred the message changes to "SYSTEM SETUP: RE-ENTER Password!".

Once a valid password is entered the message reverts back to the original.

"SYSTEM SECURED" - This message indicates that a user entered password is in effect. This message switches to "-OPEN- Password is <1>" when unlocked. Informing the operator that the password is one (1) effectively unlocks the system. This is the factory default and also occurs anytime the user sets the password equal to "1". See Section 4.2.10 for details on changing the password.

"ENTER Password" - Touch on this flashing numerical entry element to enter the password. A valid password can be up to 7 digits in length. See Section 4.2.1 for a full explanation of the numerical entry element if necessary.

"Overview" - This is an HMI navigation button which switches the screen back to the Overview.

4.2 System Setup Screens - SECURE ACCESS

The second of two parts which make up the screen package is secure access. This part is intended to allow the responsible operator to make changes to the many user changeable parameters designed into the MultiGard 5000 unit.

Once the security check lets the operator into the secure access area a 15 minute time-out timer starts. Any screen change within the secure access area will reset the time-out timer. If no screen changes are made within the 15 minutes, the display returns to the overview screen.

NOTE: The security time-out will prevent the system from being accidentally left open for long time periods. The operator should intentionally leave the secure access area when finished.

The following figure, MultiGard 5000 Screen Hierarchy, Part 1 of 2, summarizes this portion of the package and can be used as a "road map" to system operation.

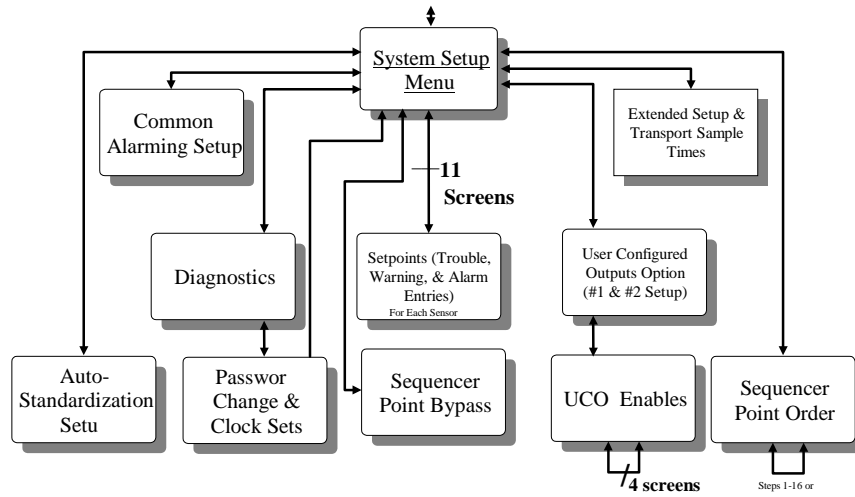


Figure 18: Screen Hierarchy (1 of 2)

Likewise, the following figure, Dual MultiGard 5000 Screen Hierarchy, Part 2 of 2, summarizes the Dual MultiGard 5000 units.

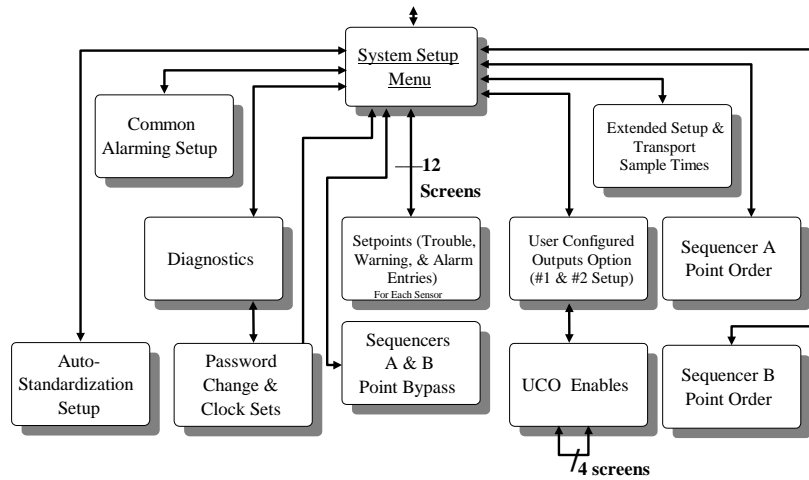


Figure 19: Screen Hierarchy (2 of 2)

4.2.1 Numerical Data Entry Screen

All Numerical Data Entry is accomplished by a keypad screen supplied by the touch screen manufacturer. When the screen is touched on top of a numerical entry element, the keypad will be displayed. The style is the same in all cases with specific details being different. The following example depicts a set point entry for sample point number one.

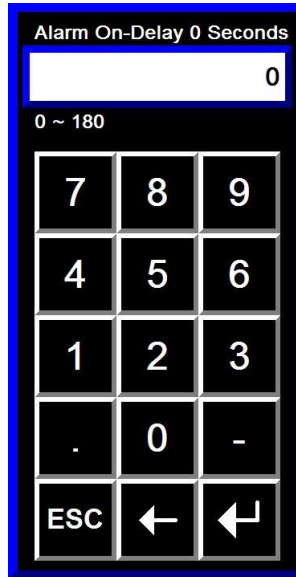


Figure 20: Numerical Entry Screen

The Numerical Entry Screen consists of the following:

"Point 1" - This is the legend text which is the same as that on the touch button that was pushed.

"Current Value:" field - This is the original or current value being used by the MultiGard 5000 unit at the time the numerical entry button was touched.

"Maximum >>>" and "Minimum >>>" - These limits provide a valid range for user entry through the keypad. If the data is out-of-range, no data will be sent to the COMPACTLOGIX when the "Enter" button is pressed and flashing warning messages, "Exceeded Maximum >>>" or "Exceeded Minimum >>>", along with 3 beeps will alert the user to the situation.

Numeric Keypad - Press the buttons to enter a number as desired. The entry is visible in the large field above the keypad. Pressing "Enter" sends the value to the COMPACTLOGIX controller. When finished with the entry press "Done" to go back to the original screen you were on. If "Enter" is not pressed after a numerical entry the previous value remains in effect within the COMPACTLOGIX.

4.2.2 System Setup Menu

The System Setup Menu screen is an array of HMI navigation push buttons which go to other screens and provide user entry of the many MultiGard 5000 unit parameters. System setup operations are

intended to center around this screen being inside the secure access area of the MultiGard 5000 System. It should not be necessary to go outside the secure access area until the operator is finished making setup changes.

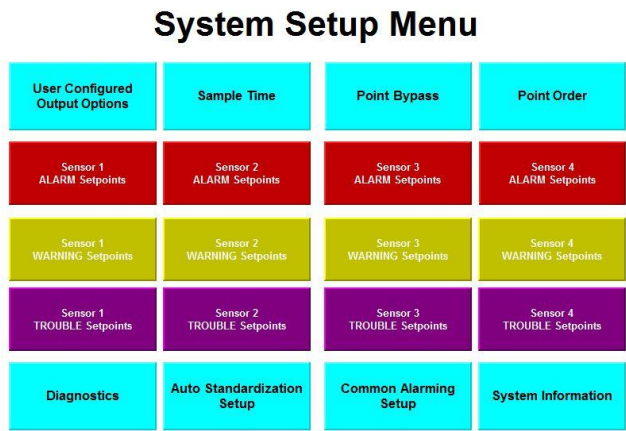


Figure 21: System Setup Menu

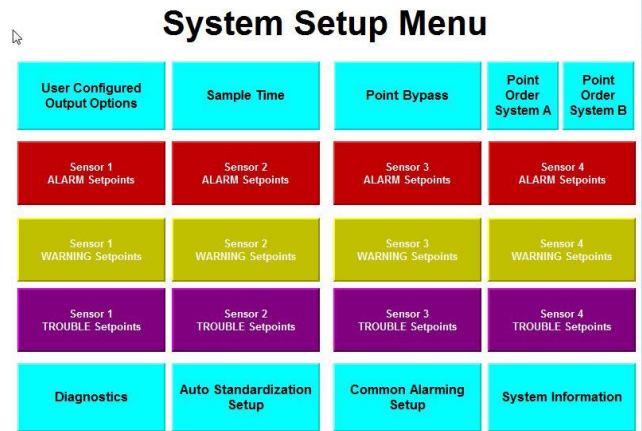


Figure 22: System Setup Menu (Dual)

The System Setup Menu consists of the following:

First row - These are four HMI navigation buttons which change the screen to the User Configured Output (UCO) Option, the Sample Time, the Point Bypass, and the Point Order screens, respectively. The Sample Time screen also handles the extended analysis related parameters.

Dual MultiGard 5000 Systems

The Point Order touch-button shown in the figure has been replaced with 2 touch-buttons; “Point Order System A” and “Point Order System B”.

Second through fourth row - These are an array of push buttons which changes the screen to enter Trouble, Warning, and Alarm Setpoints for each sensor.

Fifth row - These are five HMI navigation buttons which change the screen to the Diagnostics, Auto standardization Setup, Common Alarming and System Setup screens, respectively. The " System Information" button is the exit from this portion of the MultiGard 5000 unit. It goes back to the security check screen.

4.2.3 Set-points

The set-point screen is used to enter trouble, warning, and alarm set-points for each sensor per point. All 12 set-point screens take the same form except for the screen titles and the data within them. A typical set-point screen is shown below.

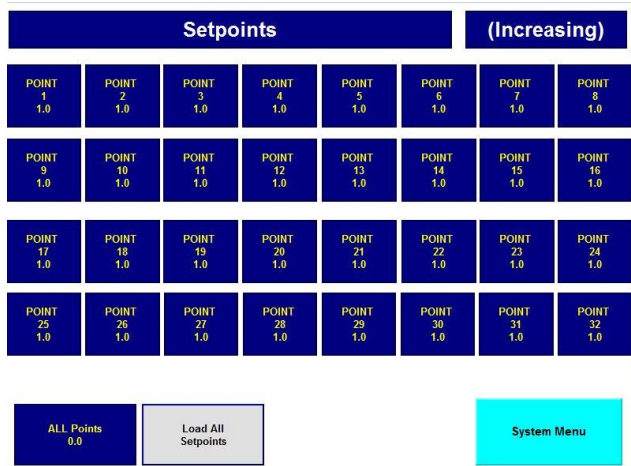


Figure 23: Sensor Set-Point

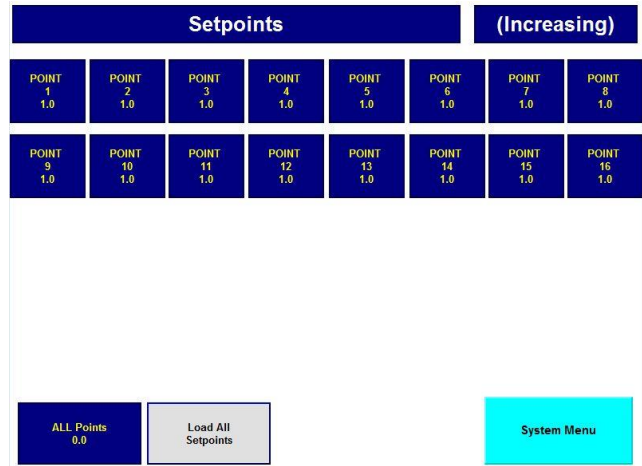


Figure 24: Sensor Set-Point (Dual)

"S1 ALARM Set points" - This is the screen title and is a multistage message indicator. This indicator has 12 messages corresponding to trouble, warning, and alarm for sensors 1-4. It states what set points are represented by the data on the screen. The screen title will also match the button legend that was pushed on the "System Setup Menu".

"(Increasing)" - This indicator shows whether the level detection for the set points are increasing or decreasing. The level detection direction can be either increasing or decreasing for warning and alarm and are MSA factory configured. Trouble is always decreasing.

"Point 1" through "Point 16" - An array of 16 [32] numerical entry elements representing one set point for each sampling point.

"Maximum 60% Full Scale per FMRC REGS" - This normally invisible message appears when necessary to advise the user that warning and alarm set points greater than 60% of full scale cannot be entered. This restriction makes the MultiGard 5000 System compliant with FMRC regulations and is factory enabled when any combustible sensor is attached to the MultiGard 5000 system.

"ALL Points" - A numerical entry element used as a common set point value which can be used to load all of the points shown on the screen.

"Load ALL Set points" - A push button which loads the value in "ALL Points" into "Point 1" through "Point 16 [32]"; thereby making them all the same. This is intended to be a short-cut procedure for set point entry if the desired values are defined per sensor instead of per point.

"System Menu" - An HMI navigation button which switches the screen back to the System Setup Menu.

4.2.4 User Configured Output (UCO) Option

The User Configured Output (“UCO”) Option screen is used for one or both of the options available in the MultiGard 5000 unit. A UCO option allows the user to custom configure outputs for special uses. The user has full control over what points logically combine to trigger an output and any of the special output features that are available. This screen specifically allows the operator to define all output related features of one or both of the options. See Chapter 7 for complete details on how to apply the UCO option(s). This screen also leads to the UCO Enable screen.

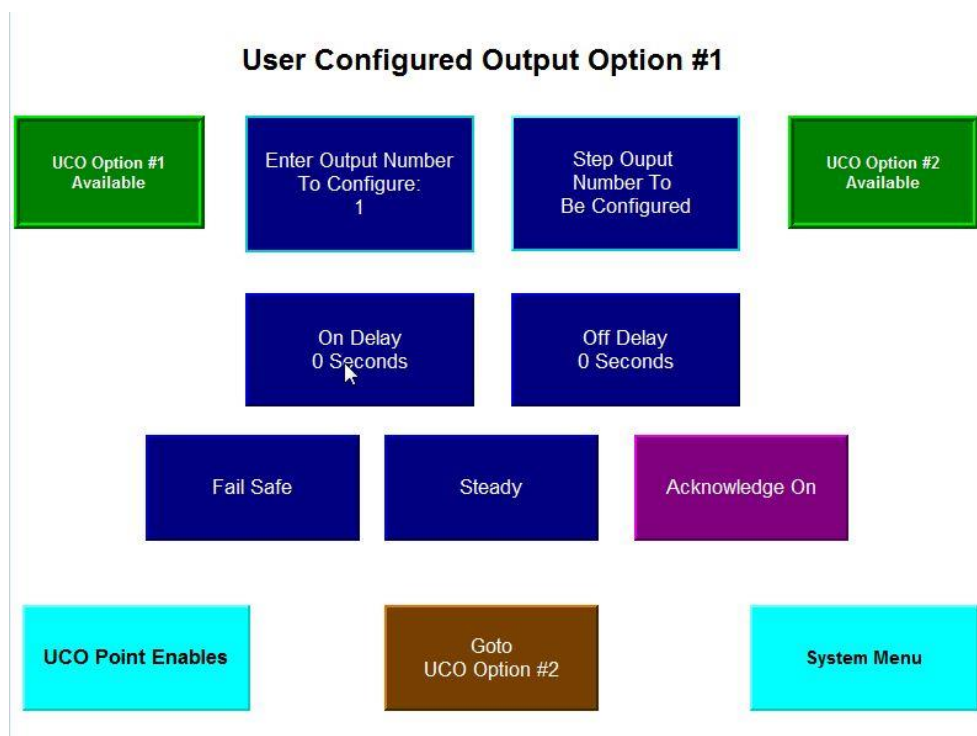


Figure 25: UCO Output

The UCO screen consists of the following:

"User Configured Output Option #1" - This is the screen title and also shows which option the other information is related to. When switched, the title can also read "User Configured Output Option #2".

"UCO#1 is Available" - This is an indicator that shows UCO option #1 has been MSA factory configured. If UCO option #1 was not configured the indicator will read "UCO#1 is NOT Available".

"Enter Output to Configure:" - This is a numerical entry element which allows the user to directly

enter an output number to configure. Once entered the other features on this screen now apply to this output number. For a small amount of configuration this selection method is most direct.

"Step Output # to Configure" - This is a push button which steps the output number from its current value up to 32 and back to 1 again in a loop. When a large amount of configuration is needed this button allows easy sequential stepping through all of the outputs.

"UCO#2 is NOT Available" - This is an indicator that shows UCO option #2 has not been MSA factory configured. If UCO option #2 was configured the indicator will read "UCO#2 is Available".

"On-Delay" - This numerical entry element represents an on-delay in the range 0-180 seconds for the specified output. By default no on-delay exists (0 seconds).

"Off-Delay" - This numerical entry element represents an off-delay in the range 0-180 seconds for the specified output. By default no off-delay exists (0 seconds). Ten seconds are shown above.

"Non-Fail-Safe" - This push button selects "Fail-Safe" (normally energized) or "Non-Fail-Safe" (normally de-energized) mode of operation for the specified output. By default Non-Fail-Safe operation is set.

"Steady" - This push button selects "Steady" or "Pulsed" operation of the selected output. By default steady operation is set. The pulsed output is 50% duty cycle (1 second on and 1 second off).

"Not ACK" - This push button selects either acknowledge on or off for the specified output.

"UCO ENAB" - This is an HMI navigation button that changes the screen to the UCO Enable screen which allows the selection of which points trigger the outputs.

"GOTO UCO Option #2" - This push button allows the operator to select which of the two UCO options is to be configured. It can also read "GOTO UCO Option #1". Note that the screen title changes in response to this switch and is always opposite.

"System Menu" - An HMI navigation button which switches the screen back to the System Setup Menu.

4.2.5 UCO Enables

The UCO Enables screen allows the user to select which points will cause each of the outputs to activate. For each output the user may choose any of the 16 [32] sample points associated with each of the 4 sensors; a large amount of flexibility. A logical OR relationship exists among the available sample point inputs. Enable push buttons close the link between the inputs and an output.

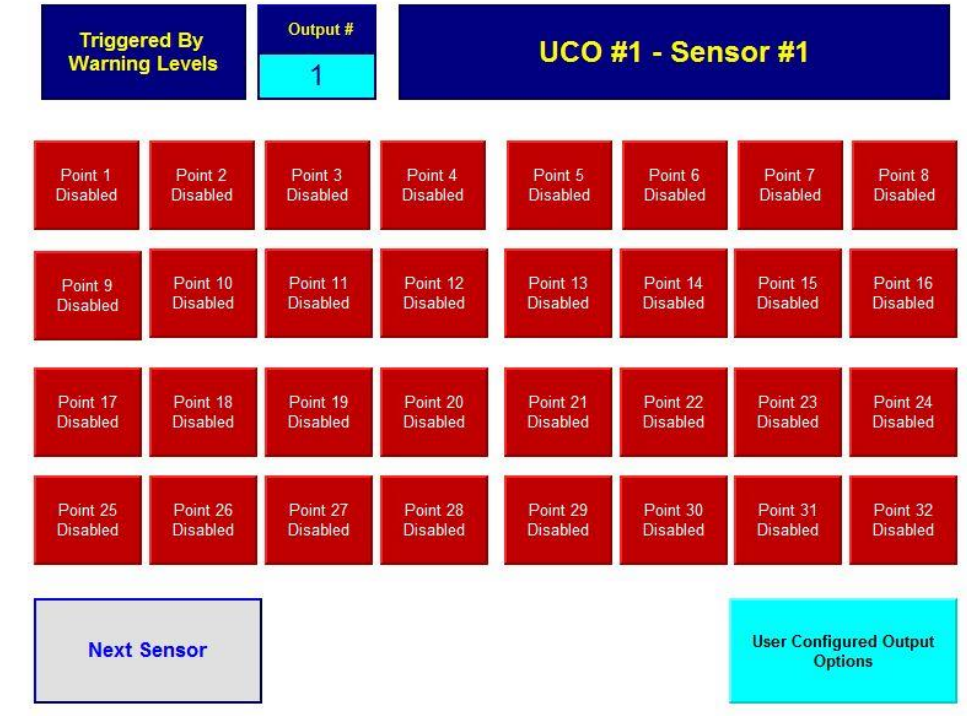


Figure 26: UCO Enable

The UCO Enables screen consists of the following:

"Triggered By Warning Levels" - This is an indicator which reminds the user what level triggers the selected output. It can also read "Triggered by Alarm Levels". Remember that outputs 1-8 and 17-24 are only triggered by warning levels and outputs 9-16 and 25-32 are only triggered by alarm levels.

"Output #1" - This indicator shows the currently selected output that is being configured.

"UCO#1 - Sensor #1" - This indicator shows which option is being configured and which sensor's points the push buttons represent. It has 9 states to show UCO#1 Sensors 1-4, UCO#2 Sensors 1-4, and "Nothing to Enable Both UCO's N/A (not available)".

"Point 1 Disabled" through "Point 16 Disabled" - This is an array of 16 [32] push buttons which enable the points to trigger a selected output. Once pushed the legends indicate that the points are enabled and will read "Point 1 ENABLED" through "Point 16 [32] ENABLED" appropriate to the users selection.

"Next Sensor" - This push button steps through sensors 1-4 in an endless loop. The indicator at the top right corner of the screen shows which sensor is selected.

"UCO Option" - This is an HMI navigation button which switches the screen back to the UCO Option screen.

4.2.6 Extended Setup and Sample Transport Times

The Extended Setup and Sample Transport Times screen allows the entry of analysis time (based on the slowest sensor), the amount of analysis time extension, and information which enables the extended analysis time logic. Sample Transport Times for each point are also entered on this screen. See Sections 3.3 and 3.4 for a complete description of these subjects.

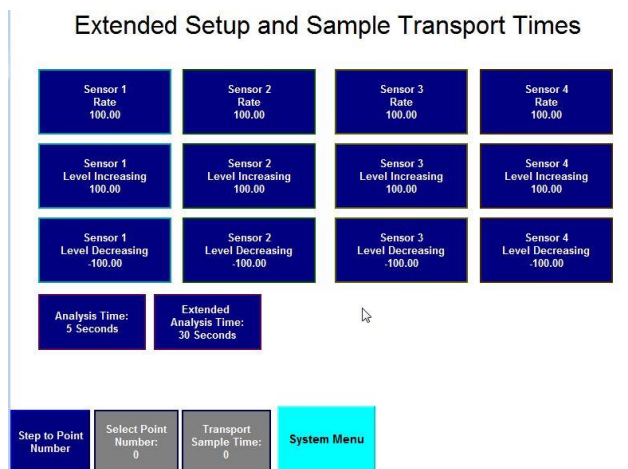


Figure 27: Extended Setup and Sample Transport Time

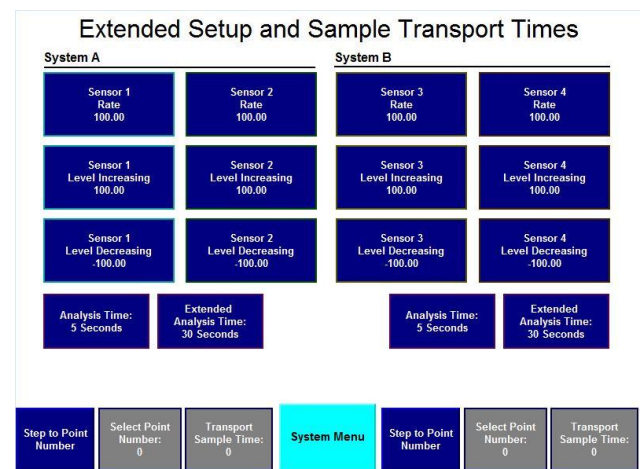


Figure 28: Extended Setup and Sample Transport Time (Dual)

The Extended Setup and Sample Transport Times screen consists of the following:

Four columns; Rate, Level Increasing, and Level Decreasing - These fields are numerical entry elements that allow entry of special set points used by the extended analysis time logic within the MultiGard 5000 unit. All set point values are in engineering units and are entered for rate, increasing, and decreasing for each of the 4 sensors. By default both the rate and increasing set points are set at full scale and the decreasing set point is set at negative full scale. This makes them ineffective or turned off. Enter reasonable values and they become active. This feature is useful if you want to continue monitoring a sample point for an amount of time in addition to the Analysis Time when a change in gas reading occurs that is outside the rate and level parameters.

"Analysis Time" - This numerical entry element is the analysis time and is defaulted to 90 seconds and has a valid entry range of 10-300 seconds. The slowest responding of the 4 sensors attached to the MultiGard 5000 system determines the appropriate value for this entry.

"Extended Analysis Time" - This numerical entry element is the extended time the user requires when any of the extended analysis time conditions (rate, increase, decrease) become true. By default it is set to zero seconds and has an entry range of 0-180 seconds.

"Step to Point #" - This push button sequentially steps through all point numbers for the purpose of viewing or entering the transport times per point.

"Select Point #:" - This numerical entry element allows direct entry of a point number for the purpose of viewing or entering a sample transport time.

"Transport SMPL Time:" - This numerical entry element is the sample transport time for the selected point. By default all transport times are zero and have an entry range of 0-300 seconds.

"System Menu" – An HMI navigation button which switches the screen back to the System Setup Menu.

4.2.7 Sequencer Point Bypass

The Point Bypass screen allows the user to stop the sampling of any of the available points in the MultiGard 5000 System. This is necessary when all available points are not being used or they are temporarily taken out of service.

*NOTE: Bypassing a point (eliminating a point from the sampling sequence) that has a sample or bypass flow loss indication, will lead to a situation where the trouble condition cannot be cleared. The MultiGard 5000 unit must access the line in question to determine that the fault condition has been corrected whereby the CONDITION ACKNOWLEDGE button may be used to return the unit to the normal operating state.*System

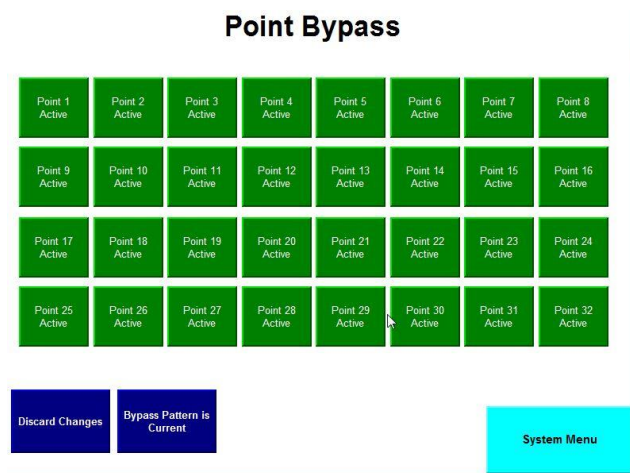


Figure 29: Point Bypass

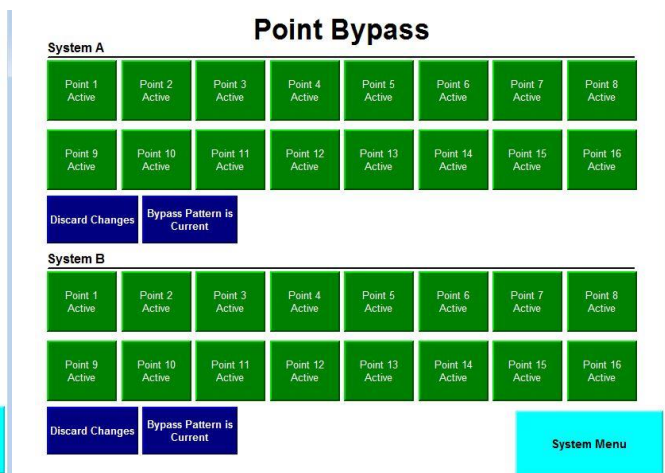


Figure 30: Point Bypass (Dual)

The Point Bypass screen consists of the following:

"Adjacent Steps Cannot Be Duplicates!" - This is a normally invisible indicator which warns of adjacent steps being the same. This condition can be generated by the use of the point bypass and point order features. This condition is possible when the user entered point order (see Section 4.2.8) sets up a situation where the same point is sampled more than once in a single sequencer loop. Bypassing the point(s) in between creates this invalid condition. When this indicator is visible no point bypass pattern updates are possible until the condition is corrected.

"Point 1 Active" through "Point 16 Active" - An array of 16 [32] push buttons that will bypass the indicated point. When pushed to bypass a point the button reads "Point 1 Bypassed";

"Discard Changes" - This push button clears all point bypass changes just made and restores everything to that currently running in the system. Note that this button operates as stated only before the "Apply Changes" (see below) push button is used.

"At Least 2 Points Must Be Active!" - This normally invisible indicator appears if less than two points are active. The system design requires that any 2 points must be active as a minimum.

"Bypass Pattern is Current" - This push button indicates whether the sequencer point bypass pattern is current or different than that running in the sequencer. When this button flashes "Apply Changes" the user should press it after all desired changes have been made. This restarts the sequencer with the new point bypass selections implemented.

"System Menu" – An HMI navigation button which switches the screen back to the System Setup Menu.

4.2.8 Sequencer Point Order

All MultiGard 5000 sequencers contains 32 steps which always runs truly sequential; step 1 through step 32, back to step 1, etc. This is true regardless of how many physical sample points MultiGard 5000 unit is configured to have. When the physical sample point count is less than 32 it is possible to sample a specific point more than once per sequencer loop. User defined point order is accomplished by use of the Point Order screen and allows the flexibility to accommodate a variety of sampling schemes.



Figure 31: Sequencer Point Order Screen-Shot



Figure 32: Sequencer Point Order (Dual – System B)

The Point Order screen consists of the following:

"Adjacent Steps Cannot Be Duplicates!" - This is a normally invisible indicator which warns of adjacent points being the same. This condition can be generated directly by entering the same point number into two adjacent steps; which is not allowed. This condition is also possible indirectly when the point order sets up a situation where the same point is sampled more than once in a single sequencer loop. Bypassing the point(s) in between creates this invalid condition. When this indicator is visible no point order pattern updates are possible until the condition is corrected.

"At Least 2 Points Must Be Active!" - This normally invisible indicator appears if less than two points are active. The system design requires that any 2 points must be active as a minimum.

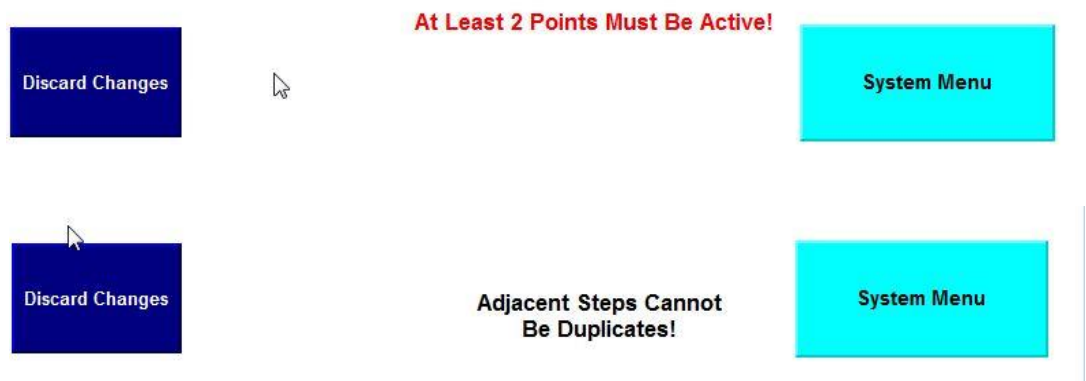


Figure 33: Sequencer Point Order Duplicate Adjacent Steps and At Least 2 Message

"Discard Changes" - This push button clears all point order changes just made and restores everything to that currently running in the sequencer. Note that this button operates as stated only before the update push button is used.

"Point Order is Current " - This push button indicates whether the sequencer point order pattern is current or different than that running in the sequencer. When this button flashes "Apply Changes?"

the user should press it after all desired changes have been made. This restarts the sequencer with the new point order selections implemented.

"System Menu" - An HMI navigation button which switches the screen back to the System Setup Menu.

The Point Order screen on MultiGard 5000 24, 32, Dual 8 and Dual 16 Systems are identical. The only exception is the entries that are considered to be valid are limited by the size of the system. For example, "32" would not be a valid entry on an 8, 16 or 24 point system.

Dual MultiGard 5000 Systems

The previous paragraph applies to the dual MultiGard 5000 Systems. There are two Point Order screens; System A and System B. Note that each system in the dual MultiGard 5000 systems can have 32 steps.

4.2.9 Diagnostics

The Diagnostic screen provides a variety of test features for use by the operator. Most significant are the common alarming relay tests, the UCO tests, and the simultaneous leak test of both sample and bypass manifolds.



Test buttons described in this section activate the output circuits wired to the MultiGard 5000 System. Be sure the consequences associated with randomly activating the outputs are properly considered before any action is taken; otherwise a hazardous condition may result.

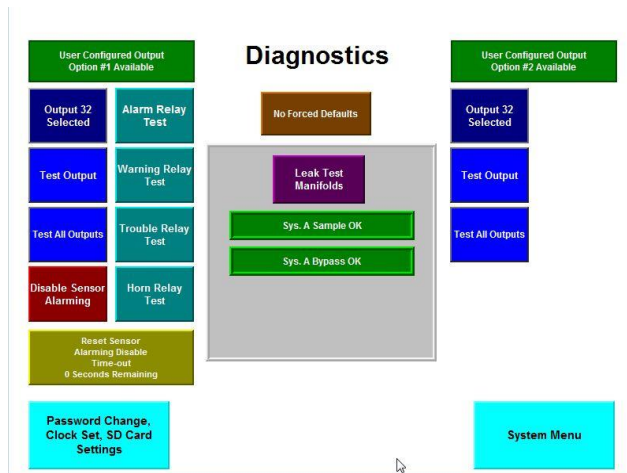


Figure 34: System Diagnostics

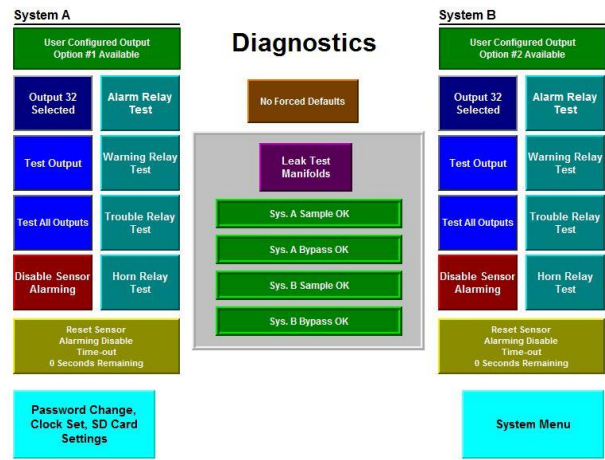


Figure 35: System Diagnostics (Dual)

The Diagnostics screen consists of the following:

First and Fourth columns; "UCO#1 N/A" through "Test All Outputs" - The first column handles the UCO#1 option and the fourth column handles the UCO#2 option. Both sets of controls operate identically. The indicators "UCO#1 N/A" and "UCO#2 N/A" indicate that the UCO options are not available. When they are available the indicators read "UCO#1" and "UCO#2".

The "Selected Output:" indicators show what output is selected for test. The "Select Output" push button sequentially steps through all of the 32 outputs. The "Test Output" push button will activate the selected output for as long as the operator holds the button. The "Test All Outputs" push button will trigger a sequential test of all 32 outputs. Each one will be activated for one half second.

Second Column; "Alarm Relay Test" through "Horn Relay Test" - The array of 4 push buttons allow the operator to test all of the common alarming relay outputs separately. The outputs are activated for as long as the button is pushed.

"No Forced Defaults" - When the push button indicator is visible as shown system operation is normal. When the Compactlogix processor loads the factory default program from the SD card, this push button indicator appears flashing as "-DEFAULTS- Reset Flag". When this happens, any user entered parameters are lost and the MSA factory defaults are loaded. See section 4.2.10 for instructions on how to restore saved user settings from the SD card. The processor restoring from factory defaults is classified as a trouble condition and the source of the processor action must be determined. The only normal cause for this is battery failure followed by power being turned off long enough for internal capacitors to discharge. This event should be rare assuming the MultiGard 5000 system is powered up most of the time while in service. This condition flag can be reset by pressing this button.

WARNING

If “-DEFAULTS- Reset Flag” indicator flashes, all user entered parameters are lost and the MSA factory defaults are restored. Immediate action is required! The cause of this condition must be determined and corrected. This condition requires the operator to manually re-enter all user configured parameters to restore MultiGard 5000 unit to its most recent desired operation. If no action is taken the MultiGard 5000 unit will remain in default operation with only common alarming as defined in Section 1. This results in operation identical to the initial delivery of MultiGard 5000 unit.

"Reset Sensor Alarming Disable Time-Out" - This push button resets the sensor alarming disable time-out timer if it is necessary to extend the function. The time remaining until alarming is restored is shown on this button.

"Disable Sensor Alarming" - This push button disables all sensor alarming by operator control and is intended for service purposes. A time-out timer will automatically enable alarms after 30 minutes for safety reasons. Note that the operator should immediately enable the alarming when the reason to disable it is no longer valid.

"Password Change, Clock Set, SD Card, Settings" - This is an HMI navigation button which switches the screen to the Password Change and Clock Sets screen.

Center indicators and "Leak Test Manifolds" - The push button in the center triggers the simultaneous leak test of both the sample and bypass manifolds. The legend and indicators on either side of the button shows the results of the test. As shown the sample manifold "Sys. A Sample OK" and the bypass manifold "Sys. A Bypass OK". These indicators show "Leaks Detected" when leaks are found.

"System Menu" - An HMI navigation button which switches the screen back to the System Setup Menu.

4.2.10 Password Change, Clock Set, and SD Card Setup

The Password Change, Clock Set and SD Card Setup screen allows the operator to change the MultiGard 5000 System password and set the clock in the touchscreen display. This screen is also used to read and write user settings to and from the PLC's SD card.

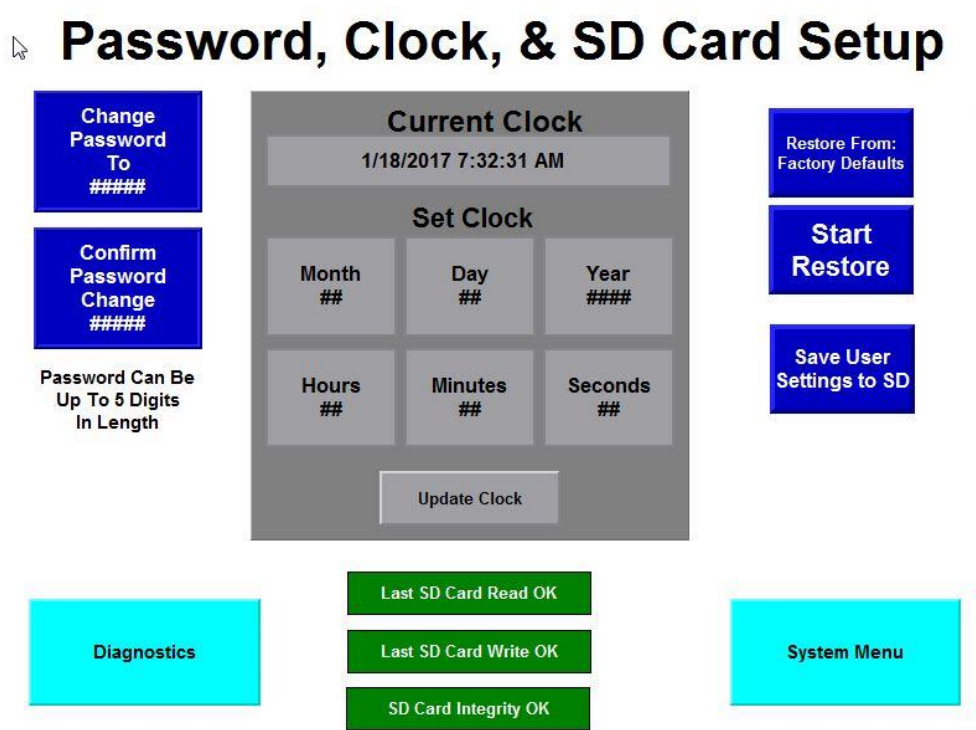


Figure 36: Password, Clock and SD Card Setup Screen-Shot

The Password Change, Clock Set and SD Card Setup screen consists of the following:

"Month" through "Seconds" - An array of 6 numerical entry elements which allows the display date and time to be set.

"Change Password To" and "Confirm Password Change" - The two numerical entry elements allow entry of a custom user password to be installed into the MultiGard 5000 System. The password can be up to 5 digits long. Enter the same number into both entries. If the entries are different both numbers will be visible and the old password is still in effect. Once the same numbers are entered in both entries the new password becomes effective and zeros are displayed in these entries.

NOTE: The user must record the current password in a safe, secured location. If forgotten there is no way to view it!

"Restore From: Factory Defaults" - This button toggles the profile from which the user wants to restore. There are two options. The default setting is to restore from Factory Defaults which returns the entire Multigard System program to the state as it was supplied from the factory. This means all user stored data including but not limited to alarm levels, sequence patterns, calibration data, timers, user configured output settings and passwords will be lost. Pressing this button once will toggle the restore location to "User Settings". Before a user can restore from the User Settings profile, a saved User Settings profile needs to be created. See "Save User Settings to SD" below for instructions on creating a User Settings Profile. The Factory Defaults Profile is created at the factory and cannot be altered by the user. In the event of a memory fault, the Multigard is configured to automatically restore from the Factory Defaults Profile. If this occurs, indication will be given to the user as described in Section 4.1.1 under "User Settings Stored"

"Start Restore" - This button initiates the restore process once the desired restore profile has been selected as described above. When pressed, the button will display "Restoring" for the duration of the process. It will return to its original state when the process has stopped. Check the SD status indicators at the bottom center of the screen to determine the result of the restore.

"Save User Settings to SD" - This button initiates the saving of user entered parameters to the SD card. When pressed, the button will display "Saving" for the duration of the process. It will return to its original state when the process has stopped. Check the SD status indicators at the bottom center of the screen to determine the result of the restore. If a user wishes to restore the Multigard 5000 to its complete user configured state after a memory fault has occurred, it is critical that the user settings be saved via this button after the Multigard 5000 has been setup to the user's needs. Failure to save user entered parameters after setup will only allow for the system to be restored to factory defaults. A "User Settings" profile must be saved using the above described method before a user can restore from this profile. Attempting to restore from "User Settings" without first creating a "User Settings" profile will result in an unsuccessful load and SD card errors being displayed at the bottom center of the screen.

"Last SD Card Read OK" - This indicator displays the status of the last attempted SD card read as initiated by the "Restore From: Factory Defaults/User Settings" button. If an unsuccessful attempt results, the indicator will display "SD Card Read Fault". Typical causes for this are either that the SD card is missing for the Compactlogix slot, the SD Card is corrupt, or the User Settings Profile has not been created on the SD card yet. Attempting to create a User Settings Profile via the "Save User Settings to SD" and restoring from that profile may clear the "SD Card Read Fault".

"Last SD Card Write OK" - This indicator displays the status of the last attempted SD card write as initiated by the "Save User Settings to SD" button. If an unsuccessful attempt results, the indicator will display "SD Card Write Fault". Typical causes for this are either that the SD card is missing for the Compactlogix slot, the SD Card is corrupt.

"SD Card Integrity OK" - This indicator displays the status of the data integrity on the SD Card. After each save to the SD card, the processor checks the characteristics of the written data to ensure proper formatting. In the event corrupt data the indicator will display "SD Card Integrity Error". Typical causes for this are either that the SD card is missing for the Compactlogix slot or the SD Card is corrupt.

"Diagnostics" - This is an HMI navigation button which switches the screen back to Diagnostics.

"System Menu" - A an HMI navigation button which switches the screen back to the System Setup Menu.

4.2.11 Auto Standardization Setup

The auto standardization Setup screen provides for enabling the timed feature, entry of the number of days, and 3 specific times for timed auto standardization. The zero gas concentrations and span gas concentrations for each sensor are also entered here.

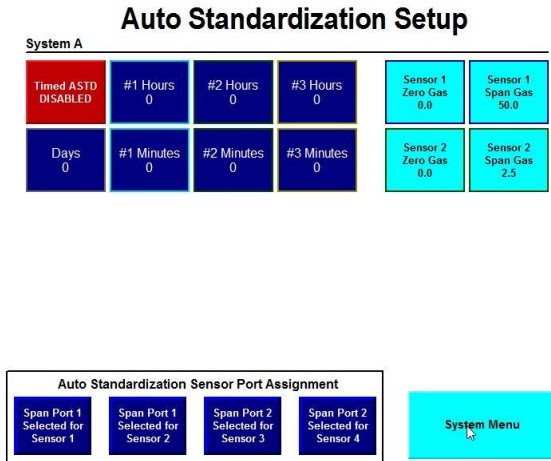


Figure 37: Auto Standardization Setup

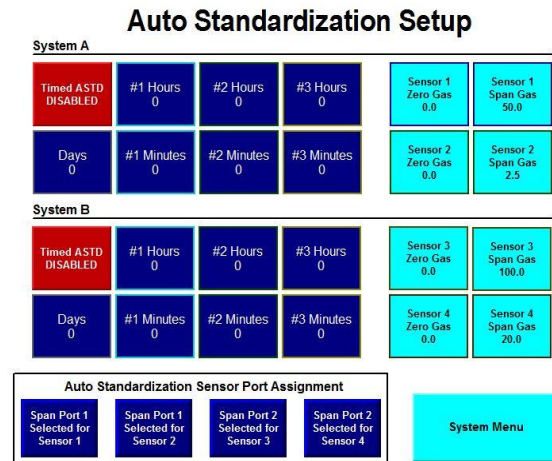


Figure 38: Auto Standardization Setup (Dual)

The auto standardization Setup screen consists of the following:

"Days" - A numerical entry element that allows entry of the number of days between auto standardization. It defaults to 30 days and has a valid entry range of 0-180 days.

"#1 Hours" and "#1 Minutes" - Two numerical entry elements that allows a specific time to be entered for auto standardization. This is the first of three time entries.

"#2 Hours" and "#2 Minutes" - Two numerical entry elements that allows a specific time to be entered for auto standardization. This is the second of three time entries.

"#3 Hours" and "#3 Minutes" - Two numerical entry elements that allows a specific time to be entered for auto standardization. This is the third of three time entries.

One, two, or three auto standardization per day are possible by adjusting the time entries as follows: When all three times are equal there is one auto standardization per day. When two of the three times are equal there are two auto standardizations per day. When none of the three times are equal there are three auto standardizations per day.

"Timed ASTD DISABLED" - This is a push button that enables timed auto standardization. By default it is disabled. It reads "Timed ASTD ENABLED" when pressed.

"Sensor 1 Zero Gas" through "Sensor 4 Zero Gas" - These four numerical entry elements allow the zero gas concentrations for each sensor to be entered. These values come directly from the gas

cylinder labels and are entered in engineering units. They default to zero and will most likely always be zero unless a special application is implemented.

NOTE: Every time the gas cylinders are replaced the new values must be entered to maintain auto standardization accuracy if the new cylinders are of a different concentration value.

"Sensor 1 Span Gas" through "Sensor 4 Span Gas" - These four numerical entry elements allow the span gas concentrations for each sensor to be entered. These values come directly from the gas cylinder labels and are entered in engineering units.

"Sensor 1 A.S. Disabled" – This button toggles between the selectable options for which Span Port to use during an auto standardization for Sensor 1. When in the “Disabled” selection, an auto standardization will not occur on Sensor 1. “Span Port 1 Selected for Sensor 1 will turn on auto standardization for Sensor 1 and assign physical Span Port 1 on the side of the enclosure for the introduction of span gas during auto standardization. “Span Port 2 Selected for Sensor 1 will turn on auto standardization for Sensor 1 and assign physical Span Port 2 on the side of the enclosure for the introduction of span gas during auto standardization.

"Sensor 2 A.S. Disabled" – This button toggles between the selectable options for which Span Port to use during an auto standardization for Sensor 2. When in the “Disabled” selection, an auto standardization will not occur on Sensor 2. “Span Port 1 Selected for Sensor 2 will turn on auto standardization for Sensor 2 and assign physical Span Port 1 on the side of the enclosure for the introduction of span gas during auto standardization. “Span Port 2 Selected for Sensor 2 will turn on auto standardization for Sensor 2 and assign physical Span Port 2 on the side of the enclosure for the introduction of span gas during auto standardization.

"Sensor 3 A.S. Disabled" – This button toggles between the selectable options for which Span Port to use during an auto standardization for Sensor 3. When in the “Disabled” selection, an auto standardization will not occur on Sensor 3. “Span Port 1 Selected for Sensor 3 will turn on auto standardization for Sensor 3 and assign physical Span Port 1 on the side of the enclosure for the introduction of span gas during auto standardization. “Span Port 2 Selected for Sensor 3 will turn on auto standardization for Sensor 3 and assign physical Span Port 2 on the side of the enclosure for the introduction of span gas during auto standardization.

"Sensor 4 A.S. Disabled" – This button toggles between the selectable options for which Span Port to use during an auto standardization for Sensor 4. When in the “Disabled” selection, an auto standardization will not occur on Sensor 4. “Span Port 1 Selected for Sensor 4 will turn on auto standardization for Sensor 4 and assign physical Span Port 1 on the side of the enclosure for the introduction of span gas during auto standardization. “Span Port 2 Selected for Sensor 4 will turn on auto standardization for Sensor 4 and assign physical Span Port 2 on the side of the enclosure for the introduction of span gas during auto standardization.

NOTE: If all active sensors are set to “Disabled”, the auto standardization feature will be turned off on the Multigard 5000 system. All correction factors will not be applied. This is helpful in a case where gases used in the auto standardization process have run out and an auto standardization

could not be performed successfully. Any screens that are associated with the auto standardization feature (Except the Auto Standardization Setup Screen) will not be accessible or visible until auto standardization turned back on by assigning at least one span port to a sensor in the auto standardizations Screen.

"System Menu" - An HMI navigation button which switches the screen back to the System Setup Menu.

4.2.12 Common Alarming Setup

The Common Alarming Setup screen provides user access to parameters related to the Common Alarm, Warning, and Trouble relays. It also allows entry of an alarming hysteresis value per sensor. See Chapter 5 for additional information on common alarming.

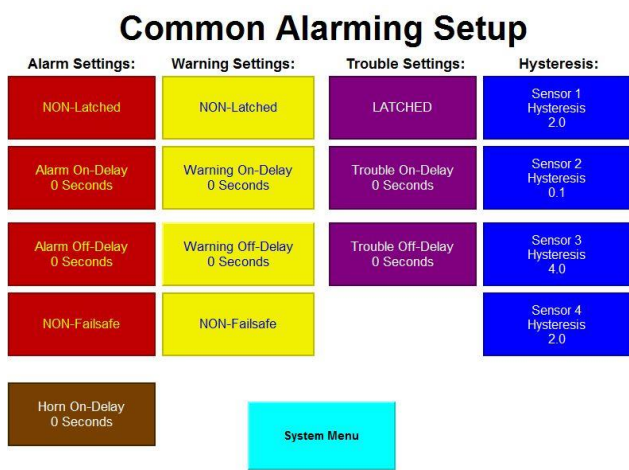


Figure 39: Common Alarming

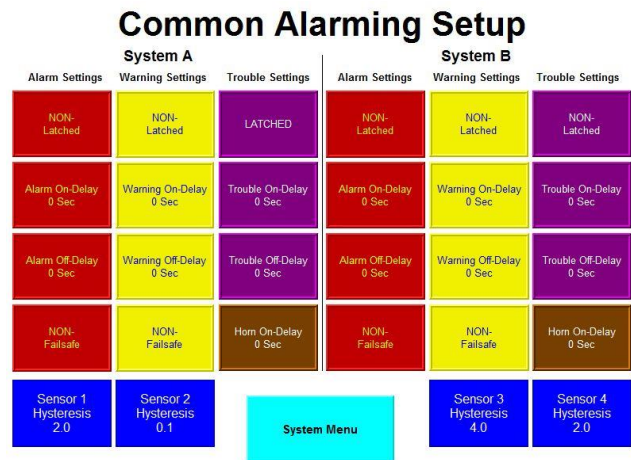


Figure 40: Common Alarming (Dual)

The Common Alarming Setup screen consists of the following:

First two columns; "NON-Latched" through "NON-Failsafe" -The first column refers to the common alarm relay and the second column refers to the common warning relay. By default they are both "NON-Latched" and these push buttons will change operation to "Latched". The "Alarm On Delay" and "Warning On Delay" are on-delay numerical entry elements. They default to zero seconds and have a valid entry range of 0-180 seconds. The "Alarm Off Delay" and "Warning On Delay" are off-delay numerical entry elements. They default to zero seconds and have a valid entry range of 0-180 seconds. Relay operation is "NON-Failsafe" (normally de-energized) by default and these push buttons will change operation to "Failsafe" (normally energized).

Third column; "Latched" through "Trouble Off Delay" - This column refers to the common trouble relay parameters. By default trouble operates "Latched" and the push button will switch it to "NON-Latched" operation. The "Trouble On Delay" is an on-delay numerical entry element that defaults to zero seconds and has a valid entry range of 0-180 seconds. The "Trouble Off Delay" is an off-delay numerical entry element that defaults to zero seconds and has a valid entry range of 0-180 seconds. The trouble relay is always Failsafe (normally energized) and cannot be changed.

"Horn On Delay" - This horn on-delay numerical entry element defaults to zero seconds and has a valid entry range of 0-180 seconds.

"Sensor 1 Hysteresis" through "Sensor 4 Hysteresis" - These four numerical entry elements allow entry of a hysteresis value in engineering units for each sensor. These values apply to trouble, warning and alarm level detection across all points associated with each sensor.

"System Menu" - An HMI navigation button which switches the screen to the System Setup Menu.

5. Common Alarming

Four outputs (alarm, warning, trouble and horn) are provided for common alarming. The function of these relays is to indicate the Alarm Status of the MultiGard 5000 System. The alarm status of each line per sensor is indicated in the Status column of each of the Gas Levels and Alarming Status display screens (see section 4.1.2).

Dual MultiGard 5000 Systems

On the dual MultiGard 5000 Systems there are two sets of four outputs; one set for System A and the other set for System B. Functionality is identical except as noted later in this section.

5.1 Alarm

The alarm set point per sensor per point can be entered in the Set Points display screen (see section 4.2.3). The alarm relay may be configured as fail-safe (normally energized) or non-fail safe (normally de-energized) in the Common Alarming Set-up display screen (see section 4.2.12).

Exceeding an alarm level will cause the MultiGard 5000 unit to indicate an alarm level, alter the state of the alarm relay and energize the horn relay. The Acknowledge Horn button on the overview screen will promptly de-energize the horn relay. Once a latched alarm has cleared, the Condition Acknowledge button can be used to return the unit to the normal operating state.

5.2 Warning

The warning set point per sensor per point can be entered in the Set Points display screen (see section 4.2.3). The warning relay may be configured as fail-safe (normally energized) or non-fail safe (normally de-energized) in the Common Alarming Set-up display screen (see section 4.2.12).

Exceeding a warning level will cause the MultiGard 5000 System to indicate a warning level, alter the state of the warning relay and pulse the horn relay at a 50% duty cycle (2 sec. energized, 2 sec. de-energized). The Acknowledge Horn button on the overview screen will promptly de-energize the horn relay and inhibit the pulsing action. Once a latched warning has cleared, the Condition Acknowledge button can be used to return the unit to the normal operating state.

5.3 Trouble

The trouble set point is used to detect below scale sensor drift and its value can be entered per sensor per point in the Set Points display screen (see section 4.2.3). The Trouble relay is always configured to be fail-safe (normally energized) and may not be changed. Exceeding a trouble level will cause the MultiGard 5000 System to indicate a trouble, de-energize the trouble relay and pulse the horn relay at a 20% duty cycle (1 sec. energized, 4 sec. de-energized). The Acknowledge Horn button on the overview screen will promptly de-energize the horn relay and inhibit the pulsing action.

The Condition Acknowledge button can be used to return the unit to the normal operating state once

the trouble condition has been cleared. The horn will resume pulsing immediately if another trouble condition occurs or, in 30 minutes if the trouble condition is not cleared. The only exception is a trouble condition indicating an auto standardization low level tolerance has been exceeded. Once acknowledged, the horn relay will not re-activate unless triggered by some other condition.

Other trouble conditions as shown in Table 5.3 will also result in a trouble indication similar to the above.

<u>Table 5.3: MultiGard 5000 Trouble Conditions</u>	
Sensor drift below scale	PIR not ready
Flow fail, sample manifold	Auto-standardize low tolerance exceeded
Flow fail, bypass manifold	Auto-standardize high tolerance exceeded
Sample manifold failed diagnostic leak test	No calibration/purge gas
Bypass manifold failed diagnostic leak test	
Loss of memory, default parameters forced	

Dual MultiGard 5000 Systems

On the dual MultiGard 5000 systems, the “Loss of memory, default parameters forced” trouble conditions are common to the entire assembly and are indicated on System A. They are **not** duplicated on System B

 WARNING

Wire Trouble Relay to operate an externally powered device (horn, beacon, computer, PLC, etc.) using the common and normally closed contacts for fail-safe operation on loss of power. The Trouble Relay is an important safety device and failure to wire as specified may result in no indication should gas detection system malfunction and/or become disabled.

5.4 Horn / Local Buzzer

The operation of the horn relay has been covered to a large extent in the Alarm, Warning and Trouble sections of this manual. Table 5.2 is a summary of horn relay/local buzzer function. The horn relay is always configured to be non-fail safe (normally de-energized) and may not be changed. The local audible buzzer mounted on the front of the unit duplicates the function of the horn relay.

<u>Table 5.4: Horn Relay / Local Audible Buzzer Functions</u>		
Condition	Horn Relay Function	Buzzer Function
Alarm	Energize horn relay	Continuous tone
Warning	Pulsing, Energize horn relay, 2 sec. De-energize horn relay, 2 sec.	Pulsing tone, 2 sec. ON, 2 sec. OFF (50% Duty)
Trouble	Pulsing, Energize horn relay, 1 sec. De-energize horn relay, 4 sec.	Pulsing tone, 1 sec. ON, 4 sec. OFF (20% Duty)

6. Maintenance

6.1 General Maintenance

A regular schedule of maintenance will help ensure continued operation of the MultiGard 5000 Gas Sampling System. Calibration of sensor(s)/analyzer(s) should occur promptly after the indication of a “sensor out of tolerance” event and otherwise periodically to ensure proper operation.

WARNING

The only absolute method to ensure proper operation of a sensor/analyzer is to check it with a known concentration of gas for which it has been calibrated. Consequently, calibration checks must be included as part of the routine inspection of the system.

At regular intervals, depending on cleanliness of the area being monitored, all particulate filters should be checked and changed if necessary. All sample lines should be checked for leaks to avoid sample dilution and lower than actual erroneous readings. Exhaust lines should be checked for obstruction.

Upon indication of any trouble by the MultiGard 5000 Gas Sampling System, the cause should be determined and corrected promptly. The trouble shooting section may help in determining possible causes of the trouble indication.

6.2 Trouble Shooting Guide

Table 6.2 is provided as a general guide for first level trouble shooting. Conditions not correctable by this guide should be referred to MSA.

Table 6.2 Trouble Shooting Guide		
Indication	Possible Cause	Corrective Action
No power to view screen	Power not connected to unit	Wire in accordance with field wiring diagram
	System circuit breaker in off position	Place system circuit breaker into the On position
	System DC power supply faulted	Check DC power supply and replaced if necessary
No power to Compactlogix	Power not connected to unit	Wire in accordance with field wiring diagram
	System circuit breaker in off position	Place system circuit breaker into the On position
	System DC power supply faulted	Check DC power supply and replaced if necessary
Pump not operational	Power not connected to unit	Wire in accordance with field wiring diagram
	Pump circuit breaker in off position	Place pump circuit breaker into the On position
	Pump faulted	Replace pump
Flow Status Bar Flashing	Sample line blocked or kinked	Remove obstruction from line
	Saturated end of line filter	Replace end of line filter
	Pump not operational	Replace pump
	Faulted sample/bypass solenoid valve	Replace defective valve
Flow Status and Calibration bars flashing	Calibration gas cylinder empty	Replace gas cylinder
	Gas flow set incorrectly	Adjust flow per section 3.2
	Faulted solenoid on calibration manifold	Replace calibration manifold
Calibration bars flashing	Sensor drifted out of tolerance	Calibrate sensor
	Incorrect calibration gas value entered in Auto Standard Setup Screen	Check and enter correct span gas value
"PIR Faulted or Warming Up" indicator flashing	PIR in trouble	Correct PIR trouble
	PIR in start up sequence	Allow PIR to warm up and switch to ready mode (About 60 sec from applying power)
Sensor trouble	Sensor out of tolerance	Calibrate sensor
	PIR in start up sequence	Allow PIR to warm up and switch to ready mode (About 60 sec from applying power)
"Auto Standard Not Performed" indicator flashing	An auto standardization has not been successfully performed on the system	Manually start auto standardization
"Alarming Disabled Auto Standard Upper Range Out of Tolerance" indicator flashing	Sensor drifted out of tolerance	Calibrate sensor and manually run auto standardization
"Defaults Forced" indicator flashing	Processor has booted from the SD Card due to memory corruption	Contact MSA for diagnosis or attempt to load User Settings Profile
"Leaks Detected" indicator flashing	Pump diaphragm has ruptured	Replace pump
	Sample manifold valve or plumbing contains leaks	Replace leaking component
	Bypass manifold valve or plumbing	Replace leaking component
	Flow switch malfunctioning	Clean or replace flow switch

6.3 Replacement Parts

WARNING

Use only genuine MSA replacement parts when performing any maintenance procedures provided in this manual. Failure to do so may seriously impair the MultiGard 5000 System performance. Repair or alteration of the MultiGard 5000 System, beyond the scope of these maintenance instructions or by anyone other than an authorized MSA service person, could cause the product to fail to perform as designed and persons who rely on this product for their safety could sustain personal injury or death.

Refer to the MultiGard 5000 System drawings for replacement parts. Each system is delivered with a unique set of drawings per order.

The MultiGard 5000 System Instruction, Section 4 (Manufacturers Data Sheets), includes complete vendor instructions and parts breakout drawings for the pump(s) used in this MultiGard 5000 system. Other items appropriate to a specific order may also be included in this section.

Address any parts inquiries to:

Mine Safety Appliances Company
1000 Cranberry Woods Drive
Cranberry Township, PA 16066

Or call toll free, **1-800-MSA-INST**

7. User Configured Outputs Option

Two options of User Configured Outputs are offered with the MultiGard 5000 System. Each option is 32 outputs for a maximum of 64 User Configured Outputs. These outputs may either take the form of solid state outputs or form C relay contacts. Refer to the specifications section of this manual for technical data on the User Configured Outputs. User Configured Outputs are a factory installed option as both hardware and software modifications are required.

7.1 Planning Matrix

Prior to configuring the outputs, it is recommended that the User Configured Outputs Planning Matrix (form BSK 3103-24) be completed for each option. This process will clarify functionality; simplify the data entry process and aid in trouble shooting logic errors. This form should be filled without regard to the MultiGard 5000 System. Only facility functions should be considered while completing this form. The planning matrix should indicate if it applies to option #1 or #2, solid state outputs or form C contacts by marking the appropriate check box.

7.1.1 Output Trigger

For each of the two user configured options, outputs 1 to 8 and outputs 17 to 24, are triggered by warning levels. Outputs 9 to 16 and outputs 25 to 32, are triggered by alarm levels. For each output, indicate the sensor(s) and line(s) that will trigger that output by marking the corresponding box with an X. For an 8 [24] point sequencer, lines 9 to 16 [25 to 32] are not applicable.

Dual MultiGard 5000 Systems

Sensors 1 and 2 are on System A, sensors 3 and 4 are on System B. A User Configured Output may be triggered from any combination of the 4 sensors or lines available.

7.1.2 Output Characteristics

Each output may further be defined to have an On delay or an Off delay (in seconds). Each output may be configured as fail safe (normally energized), or non-fail safe (normally de-energized) to activate on loss of power. Each output may be further defined to activate in the steady mode or pulse 1 sec. ON, 1 sec. OFF.

Each User Configured Output may be configured so that it can be acknowledged. This feature allows for the silencing of audible devices wired to these outputs.

Once an operator has acknowledged an output, it will only reactivate under one of the following conditions:

1. A warning or alarm condition occurs after all conditions that are associated with that User Configured Output have returned to normal. On outputs that are triggered by multiple points/sensors,

once acknowledged, another condition will not reactivate the output.

2. Thirty minutes has elapsed since the User Configured Output was acknowledged by the operator and the conditions that caused that event are still present.

This operation is in contrast to the Common Alarms, where each new condition causes a reactivation of the warning or alarm.

WARNING

A Warning or Alarm indication by the MultiGard 5000 Gas Sampling System requires immediate action by the operator. Failure to do so may lead to serious injury or death. Once an operator has acknowledge a User Configured Output, It is imperative that immediate action be taken to determine the source of this condition, take remedial action and continue to monitor the Gas Level Screens until all levels return to normal.

NOTE: Unless specifically requested otherwise, the MultiGard 5000 unit is shipped without defining the functions of the User Configured Outputs. Under those conditions, none of the outputs will activate until they are configured in the field.

7.2 Data Entry

Upon completion of the Planning Matrix, the data can be entered into the MultiGard 5000 System using the User Configured Outputs data screen (see section 4.2.4). Two flags are used to indicate if option #1 and/or option #2 have been installed and are available for use. The header will indicate the option number being programmed.

For each option, the UCO's are numbered 1 to 32. The "ENTER OUTPUT TO CONFIGURE" button may be used to select the desired output. At this time, the data entered in the Planning Matrix for On delay and Off delay may be entered if it is required to be other than the default value of 0 seconds. The Fail-Safe / Non Fail Safe and Steady / Pulse buttons may be toggled to the required state. Then the "UCO Point Enables" button may be used to move to the UCO Point Enables display screen (see section 4.2.5). Flags are used to indicate if the output is triggered by a warning or an alarm level, the UCO number, the UCO option number, and the sensor number. Enable each point/line number to match the entries on the Planning Matrix. Use the "Next Sensor" button to scroll to the next page and enter the configurations for sensors #2, 3 and 4 if applicable. Use the "UCO Option" button to return to the UCO display screen.

Repeat the procedure for all other UCO outputs indicated on the Planning Matrix.

7.3 Functionality Testing

WARNING

User Configured Outputs must be tested to verify that actual functionality is identical to intended functionality as indicated in the UCO Planning Matrix. Failure to verify setup may result in system performance other than expected.

CAUTION

Do not connect any system controlled process shut down circuits until the system has been function checked, calibrated and is ready for normal operation. False alarms may occur if this connection is done before full system startup is completed

To test the functionality of the User Configured Outputs, the conditions that trigger these outputs must be simulated. Place the unit in manual mode and step to line/point #1. Use the sensor zero adjustment (see sensor manual) to artificially create an upscale reading in excess of the preset warning level for sensor #1. Verify that the conditions triggered by a warning on line/point #1 for sensor #1 as indicated in the Planning Matrix do actually occur. Repeat this procedure for all other line/point numbers. Use the sensor zero adjustment (see sensor manual) to artificially create an upscale reading in excess of the preset alarm level for sensor #1. Verify that the conditions triggered by an alarm on line/point #1 for sensor #1 as indicated in the Planning Matrix do actually occur. Repeat this procedure for all other line/point numbers. Reset the sensor output to zero. Verify that the conditions triggered by either an alarm or a warning for line/point #1 for sensor #1 are no longer indicated. Repeat this procedure for all other line/point numbers.

Repeat above procedure for sensors #2, 3 and 4 if applicable.

Follow with a calibration of all sensors.

8. MultiGard 5000 System Configuration

The MultiGard 5000 Gas Sampling Systems are configured both by the MSA factory and by the user to obtain desired results. Factory parameters cannot under any circumstances be changed by the user. All **user** parameters may be changed at any time and are secured by a password.

WARNING

Entering valid System Parameters is critical to proper system operation. Incorrect entries may lead to a hazardous situation. Contact MSA if you have any questions related to the MultiGard 5000 Gas Sampling System User Configured Parameters.

A summary of MultiGard 5000 System default parameters is provided upon shipment from MSA. These documents describe the system delivered and are located in Section 1.

8.1 MultiGard 5000 System Factory Configured Parameters

The factory parameters are derived from order entry information, the sensor complement in use, and the results of applications engineering. This ensures proper system operation and integrity upon delivery. All factory configured parameters are summarized below:

- Mode of Operation (8, 16, & Dual 8 Point or 24, 32, & Dual 16 Point)
- Analyzer(s) Ready Enable
- Sensor Low Engineering Units (per input)
- Sensor High Engineering Units (per input)
- Sensor Scaling for Voltage (V) or Current (I) (per input)
- Sensor Input Minimum V or I (per input)
- Sensor Input Maximum V or I (per input)
- Sensor Alarming Direction - Warning (per input)
- Sensor Alarming Direction - Alarm (per input)
- Sensor Type (per input)
- Sensor Engineering Units (per input)
- Auto Standardization (ASTD) Enable & Span Valve Selection (per input)
- Low ASTD Tolerances (per input)
- High ASTD Tolerances (per input)
- ASTD Duration: Zero, Span1, Span2, & Purge
- Enable Synthetic Span Gas Usage (per input)
- Synthetic Span Gas Conversion Parameters (per input): slope (m) and intercept (b)
- User Configured Output (UCO) Option #1 Enable
- UCO Option #2 Enable
- Version # for Logix Program
- S/N, B-Job #, MTO Code, & End User's Name
- Purge Operation? (per sensor)
- Purge Valve Selection
- Purge Set point (per sensor)
- Purge Duration
- Attached device combustible? (per sensor)
- Combustible W&A Set point Limit (per sensor) per FMRC Regulations

8.2 MultiGard 5000 System Secured User Configured Parameters

All user parameters are defaulted by MSA that produce a basic implementation of MultiGard 5000 System. Selected user configured parameters are preset by MSA appropriate to the customer order (underlined below) to ensure a safe system immediately upon delivery. As the customer's application requirements change, all of these parameters can be altered without MSA's involvement. This list also represents the parameters that are saved to the SD card when a "User Settings" profile is created. All user changeable parameters are summarized below:

- Change Password
- Trouble (T), Warning (W), & Alarm (A) Set points (per point per sensor)
- Sequencer Point Order
- Sequencer Point Bypass
- Transport Sample Time (per point)
- Analysis Time (based on slowest sensor response)
- Extended Analysis Time (EAT)
- EAT Trigger - Rate (Engineering Units/Second) (per sensor)
- EAT Trigger - Level Increasing (per sensor)
- EAT Trigger - Level Decreasing (per sensor)
- For Common Alarming:
 - Latched/Non-Latched - Trouble, Warning, & Alarm Relays
 - Fail-Safe/Non-Fail-Safe - Warning & Alarm Relays
 - On-Delays - Trouble, Warning, Alarm, & Horn Relays
 - Off-Delays - Trouble, Warning, & Alarm Relays
- Alarming Hysteresis (per sensor)
- Zero Gas in Use (common to all sensors)
- Span Gases in Use (per sensor)
- Timed ASTD Enable
- Days Interval; Timed ASTD
- Hours & Minutes for each of 3 ASTD's/Day
- For Both UCO Options; Each consisting of 32 Outputs (16 Warning Triggered & 16 Alarm Triggered):
 - On-delay
 - Off-delay
 - Fail-Safe/Non-Fail-Safe
 - Steady/Pulsed
 - Enables (Points 1-16 Available from Each Sensor)
- Set Clocks: Compactlogix for ASTD & Display

9. MultiGard 5000 System Remote Data Display (RDD) Option

9.1 Introduction

The MultiGard 5000 Remote Data Display (RDD) Option is a touch-screen that allows the viewing of selected information contained in the MultiGard 5000 unit. The RDD communicates with the MultiGard 5000 System via serial or over Ethernet.

A 10.4" color touch-screen version is standard for all MultiGard systems.

Throughout this chapter the RDD screens for MultiGard 5000 8/16 unit are shown in the figures. Users of the MultiGard 5000 24/32 unit should note the following rules on using the same operator manual:

- The location of any item is in the same relative position across all screen sizes.
- The same information content is provided on each screen across all screen sizes.
- Wherever 16 points of information are shown in the figures, 32 points of information will actually be seen on the screens in a similar format.
- The phrases underlined and in quotes which lead to a description of an item still refer to the figures. Any changes will be noted in the description (see next bullet).
- In the item descriptions point ranges or references to system size may be specified which match the figure. Substitute the numbers in brackets ([]) in place of those in the sentence.
- Any exceptions to these rules will be discussed in the appropriate section.

Users of MultiGard 5000 Dual 8 and MultiGard 5000 Dual 16 Systems should note the following rules on using the same operator manual:

- The same information content is provided on each screen across all screen sizes and across all models. The location of some items may be different between the single and dual models.
- Wherever dual MultiGard 5000 data is presented based on the number of sample points the quantity will vary between 8 or 16 and be presented in a similar manner.
- The phrases underlined and in quotes which lead to a description of an item still refer to the original figures. In addition these items in the dual MultiGard 5000 Systems are specifically labeled System A (SYS A) and System B (SYS B) to distinguish between the two systems. Items common to the overall assembly do not use this designation.

- When explicit labeling is not used the header text System A: _____ and System B: _____ are used. Everything directly under these headers then applies to the system as labeled.
- The relative position of System A grouped data is on the left. The relative position of System B grouped data is on the right. Data common the overall assembly is located in the center or where space permits.
- Any special notes and exceptions to these rules will be discussed in the appropriate section and will be visually distinguished by the text box style as shown below.

Dual MultiGard 5000 Systems

Sample text related to the dual MultiGard Systems.

This information can be ignored by users of single MultiGard Systems.

The graphical style used in the RDD is identical to the MultiGard 5000 touchscreen shown in Chapter 4 of this manual.

All MultiGard 5000 RDD touch-screen displays have a screen saver feature enabled. The screen will turn off after 30 minutes of touch inactivity. After it turns off, the first touch will restore the screen to normal operation.

9.2 Installation

Refer to the RDD installation drawing provided for the installation and wiring of your remote data display. The drawing provides information on cut out size required for panel mounting the RDD, power requirements of the RDD and the type and correct wiring of the communication cable.

9.3 Operation

The RDD is intended to provide an operator with information about the gases being monitored and the basic operation of the MultiGard 5000 System. *It is a view only device and does not allow changing any of the user changeable parameters.*

The following figure, MultiGard 5000 Remote Data Display (RDD) Screen Hierarchy, summarizes this package and can be used as a "road map" to RDD operation.

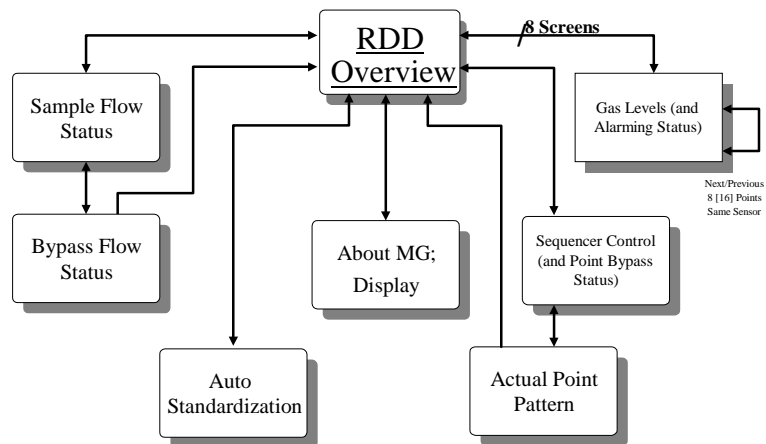


Figure 41: RDD Screen Hierarchy

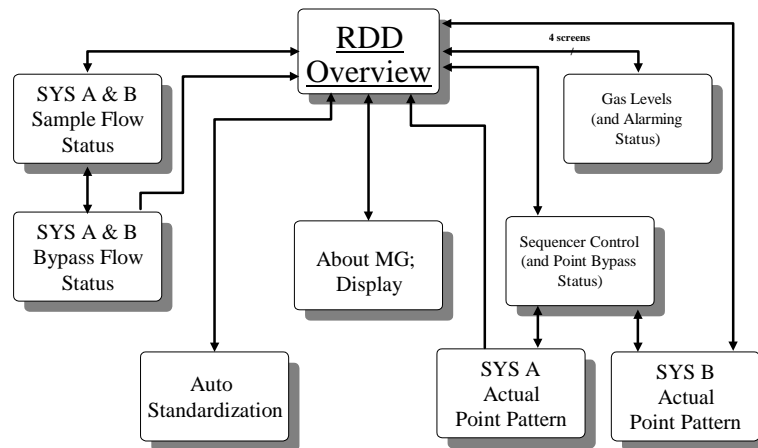


Figure 42: RDD Screen Hierarchy – Dual Systems

9.3.1 Overview

The RDD Overview screen, shown below, provides a single place to see what is happening within the MultiGard 5000 System. In a summary format, gas alarming and internal system conditions are depicted. Visual attributes will indicate the subject area where a condition exists and act as "off-page" indicators to lead the operator to other screens for the details.

NOTE: It is intended that this screen be visible most of the time during normal system operation. Any time the local horn sounds, the operator should return to observe the Overview screen to determine what occurred. The operator should then proceed to gather details by selecting other appropriate screens as flagged on the Overview screen.

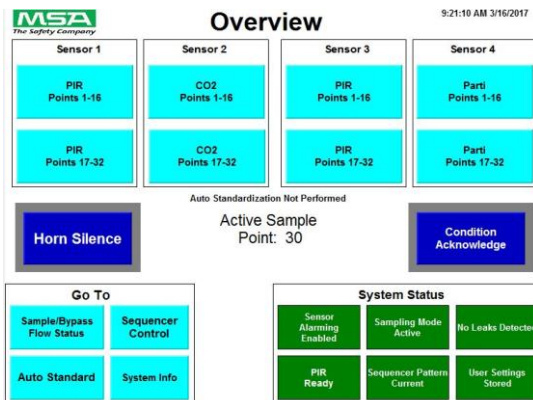


Figure 43: Overview Screen (Single 32 Point)

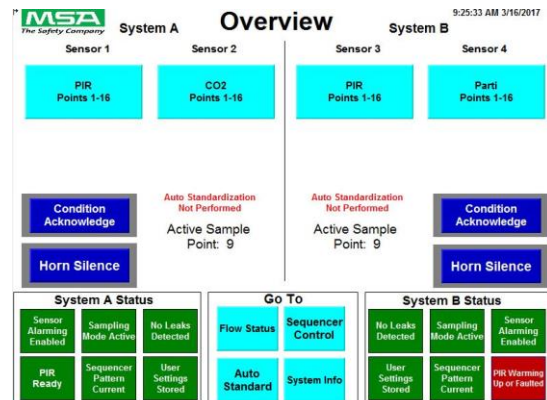


Figure 44: Overview Screen (Dual 16 Point)

The RDD Overview screen consists of the following:

Due to a close similarity to the MultiGard 5000 Overview screen refer to Section 4.1.1 for a description of any items not listed in this section.

"Sensor 1 P1-8" through "Sensor 4 P9-16" - A group of 8 HMI navigation buttons which change the screen to view sensor data and alarming status. The bar overlaying the appropriate button(s) will flash as an "off-page" indication whenever a condition exists that requires operator attention.

"Horn Silence" - When this RDD indicator appears the horn may be silenced by the operator by pressing the Horn Silence button on the MultiGard 5000 System Overview display screen or by use of an optional remote horn acknowledge switch wired in accordance with the Field Wiring Diagram. See Chapter 5, Common Alarming for more details.

"Condition Acknowledge" - When this RDD indicator appears, any condition (trouble, warning, or alarm) has occurred and may be acknowledged by the operator only at the MultiGard 5000 touchscreen. See Alarming, Chapter 5 for more details.

9.3.2 Gas Levels (and Alarming Status)

The Gas Levels and Alarming Status screen is identical to that described in Section 4.1.2.

9.3.3 Flow Status (Sample and Bypass)

The Flow Status screen is identical to that described in Section 4.1.3.

9.3.4 Auto Standardization

The Auto Standardization screen is identical to that described in Section 4.1.4 with one exception. The ASTD trigger push buttons have been eliminated. These functions are only available at the MultiGard 5000 touch-screen.

9.3.5 Sequencer Control (and Point Bypass Status)

The Sequencer Control and Point Bypass Status screen is identical to that described in Section 4.1.6 with two exceptions. The mode pushbutton has been replaced by a mode status indicator and the step push button has been eliminated. The status indicator will show "Stepping Mode: Automatic" or "Stepping Mode: Manual". Actual control of the sequencer is only available at the MultiGard 5000 touch-screen.

9.3.6 Actual Point Pattern

The Actual Point Pattern screen is identical to that described in Section 4.1.7.

9.3.7 About MultiGard 5000 System

The About MultiGard 5000 System screen is identical to that described in Section 4.1.8 except for three areas. The "DSP VER:" has been changed to "RDD VER:". All three elements associated with password security have been eliminated.

10. Gas Concentration and Alarm Log

10.1 Introduction

The MultiGard 5000's touchscreen interface continuously generates an electronic log of system events that are retrievable by the user as needed. This log is stored internally to the touchscreen interface and can be written to an SD card for viewing, printing and saving on a computer. An SD card with a specific batch file is provided with each Multigard 5000 and should be kept in a safe place for periodic retrieval and backup of the system event and data logs.

The events that are stored upon an occurrence basis are as follows;

- Trouble conditions for any active sensor along any active sampling point on System A or B
- Gas level warnings for any active sensor along any active sampling point on System A or B
- Gas level alarms for any active sensor along any active sampling point on System A or B
- Flow failure for any active sampling points on System A or B
- Flow failure for any bypass flow points on System A or B
- Horn and condition acknowledgements
- Leak conditions
- Alarming Enabled Status
- PIR Status
- Sequencer Pattern Changes
- Bad Password Attempt
- UCO Activity
- Relay Testing Activity
- Sequencer Stepping Mode Activity
- Auto Standardization Activity
- Calibration Gas Activity

The SD card provided with the Multigard 5000 has a 2GB capacity and so is capable of storing a large number of event logs. The more frequently events occur in the system, the quicker the SD capacity will be used up and old events will become unavailable. It is important to retrieve event logs regularly and save them to a secure and backed up location.

10.2 Retrieving Event Log

To Retrieve the event log from the Mutligard 5000, the SD card with the batch file needs to be inserted into the SD slot on the back side of the touchscreen interface. With the door of the Multigard open and looking at the back of the touchscreen interface, the SD slot is located to the left side on the back of the interface. The SD card needs to be inserted for a moment until the LCD screen of the interface briefly displays a white screen with a small amount of text. Once the LCD screen returns to the Multigard 5000 program, the retrieval of the event log is complete and the SD card can be removed from the slot.

10.3 Viewing Alarms

All necessary programs are present on the SD card to view, print and export the event log. To begin viewing the log, insert the SD card into a Windows 7 or newer based PC. Navigate to the SD card as shown in Figure 45.

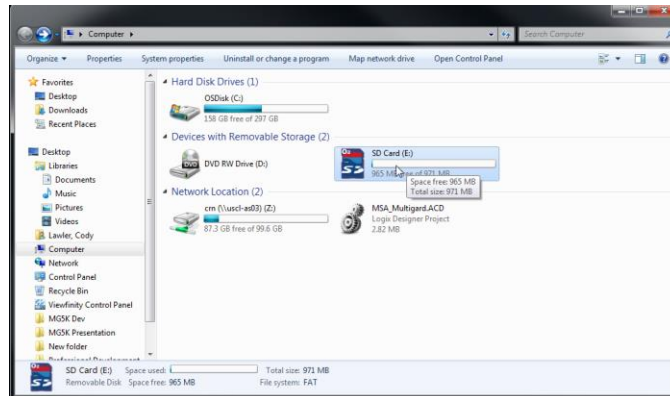


Figure 45: SD Card Location

In the root file of the SD card, there is an executable program named FTViewFileViewer.exe. Double click this executable file. There will be other files present in the Root. Do not modify, move or delete these files.

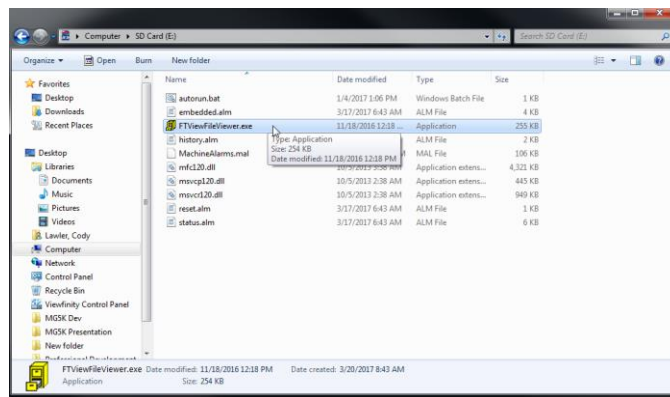


Figure 46: SD Card Location

The program will launch as shown in Figure 47.



Figure 47: FactoryTalk View File Viewer

In the menu, click on “File” and select “Open”. In the bottom right corner of the “Open” screen, select “ME Alarm Log File (*.ALM)” as shown in Figure 48. Then double click on “history.alm” from the available files.

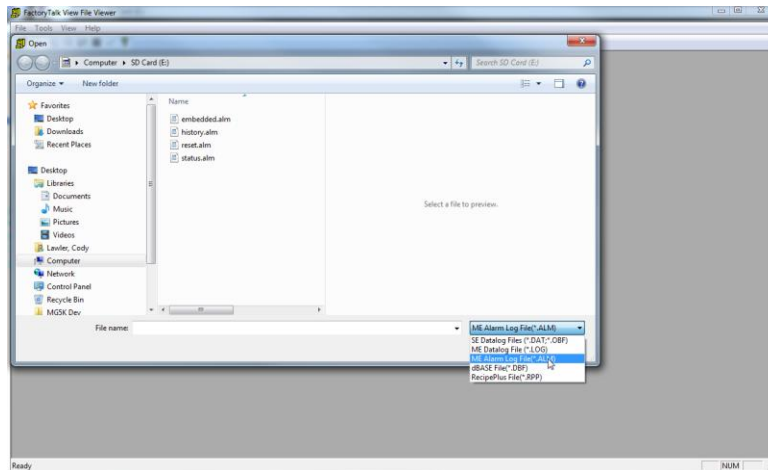


Figure 48: Select “history.alm” from the file options

You will then be asked to specify “FactoryTalk View ME Alarm Setup File” as shown in Figure 49. If not selected already, ensure that the “Win32/CE (9.0 or later)” radio button is selected. Click on the ellipses (...) under “FactoryTalk View ME alarm setup file”. Select “MachineAlarms.mal” from the root folder of the SD card.

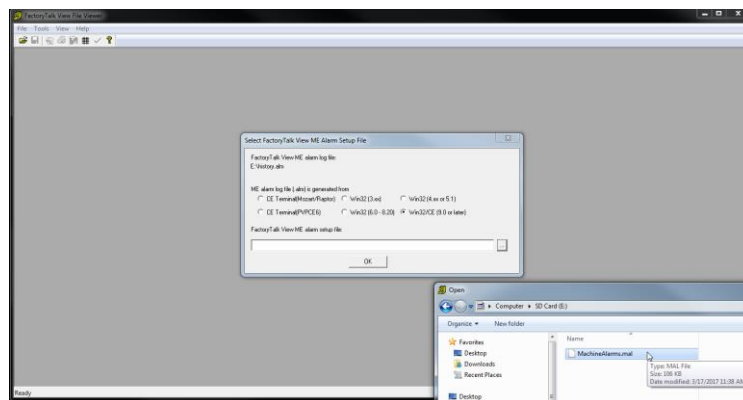


Figure 49: Select Alarm Setup File “MachineAlarms.mal”

The event log will then load as shown in Figure 50 displaying all associated events with the Multigard 5000. The columns of interest to a user are “Message” and “TimeOn”. These two columns indicate the event and the time it occurred.

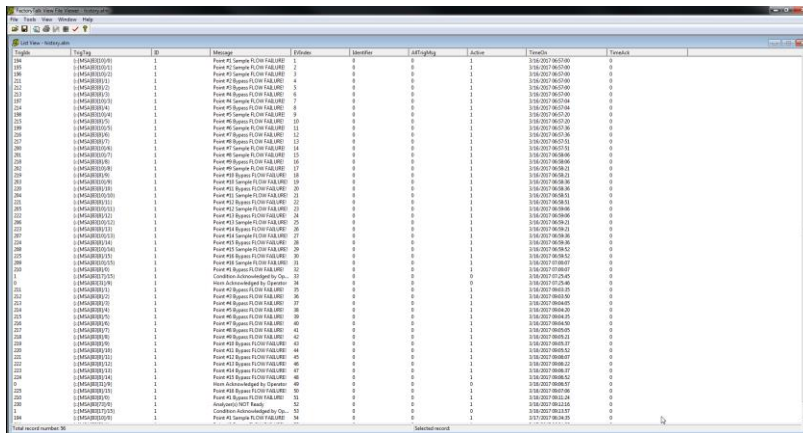


Figure 50: Event Log

To save the event log as a .CSV file, click on “File” in the menu and then click on “Save As”. Give the file a name and specify the location to save. Once in this format, the file can be saved and printed as needed.

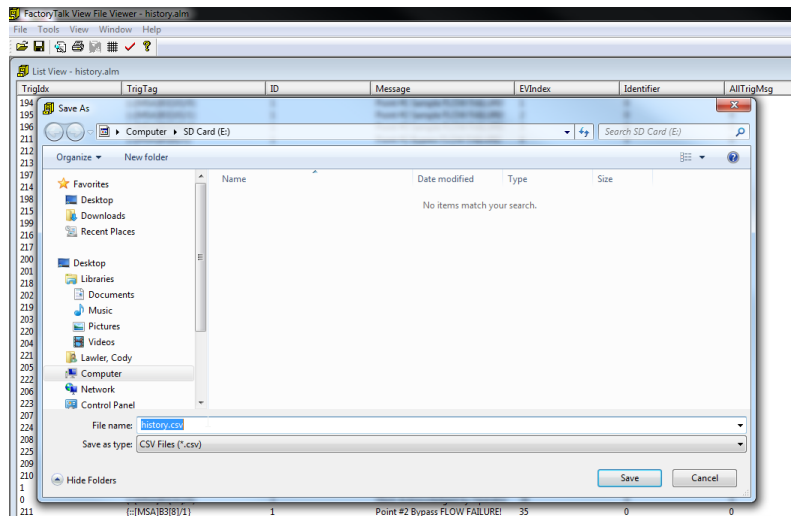


Figure 51: Save as CSV

11. Modbus TCP/BACNet IP Configuration

11.1 Introduction

The MultiGard 5000 can be equipped with an optional Ethernet gateway that allows users to access system information and diagnostics over a Modbus TCP or BACNet IP network. The gateway is configured with a default profile and will need to be setup specifically to a user’s network before system and diagnostic data will become available. For a complete list of system data that is available, refer to MSA document 3103-1047 and 3103-1048.

11.2 PC Configuration

The Modbus/BACNet gateway has a factory default IP address of 192.168.1.110 on the WAN side connection of the router. Physically connect to the IP Router's WAN port using a CAT5 or better pass through cable. In order to access the gateway, a user must have IP configuration privileges on their computer. Set the computer's network adapter to the 192.168.1.XXX scheme with the last octet to something other than 110. The subnet mask should be set to 255.255.255.0 and the default gateway can be left blank.

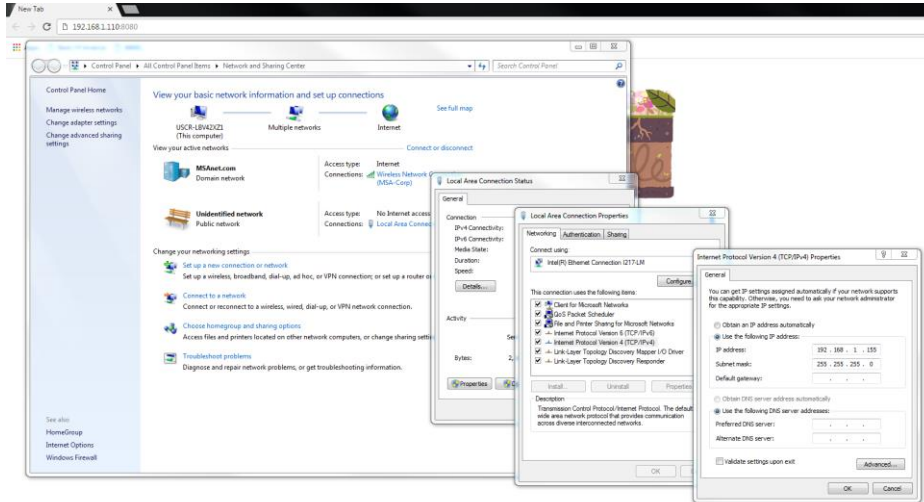


Figure 52: Configure computer network adapter

After the computer's network adapter has been properly configured, connect a pass through Ethernet cable from the computer's RJ45 network jack to the WAN side RJ45 jack on the Multigard's internal network router.

11.2 Router Configuration

Once the computer's network adapter has been configured and the computer is physically connected to the Multigard router, open an Internet Explorer or Google Chrome browser. Type in 192.168.1.110:8080 into the address bar and hit enter.

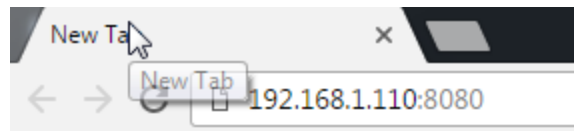


Figure 53: Router WAN URL

You will immediately be prompted for a user name and password. The login credentials are as follows;

User Name: admin
Password : admin

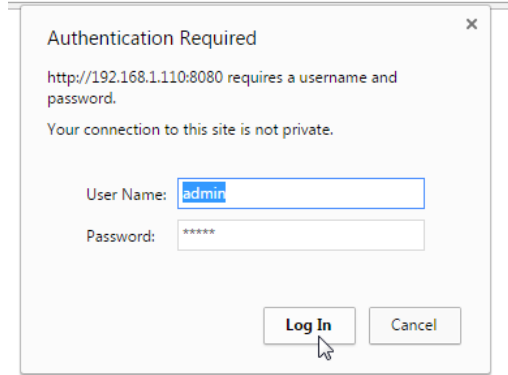


Figure 54: Login Prompt

Once verified, the configuration utility for the router will appear as in Figure 55.

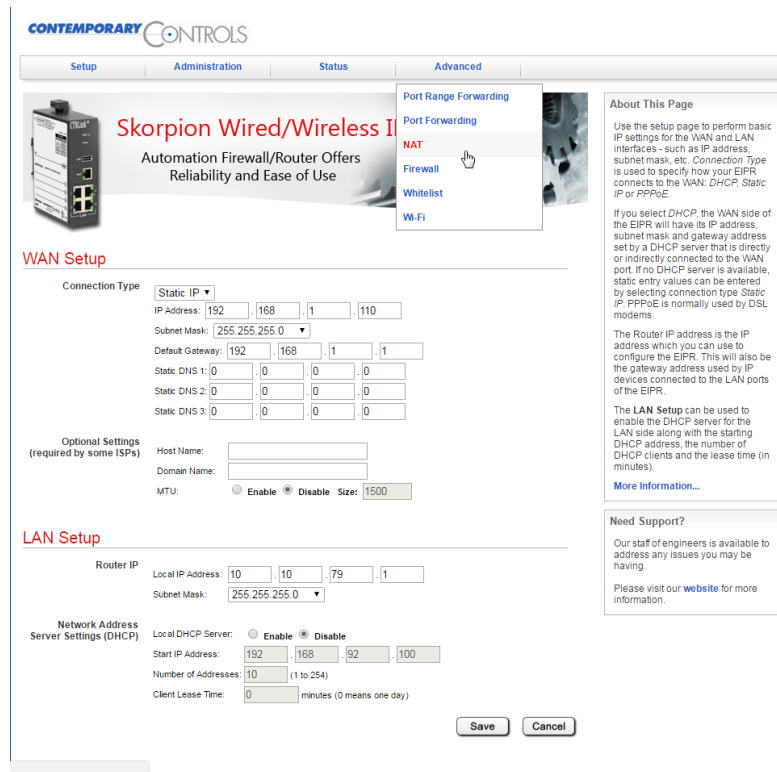


Figure 55: Main Screen

To set the IP address of the Modbus/BACNet gateway as it will appear on the user's network you must enter the NAT settings of the router. From the main screen, hover over "Advanced" in the title menu and click on "NAT". The screen will appear as in Figure 43 except "10.10.79.103" will not appear in the "LAN IP Address" column on the right and the "Enabled" checkbox will not be checked. The user will to enter the LAN side IP address of "10.10.79.103" and check the "Enabled" box. The user will then need to define the WAN side IP address where they would like the BACNet IP or Modbus TCP data to be accessed once connected to their network. This address entry is marked with a red arrow in Figure 56. Click "Save" when complete and the router will reboot after 30 seconds. Follow instructions from section 11.2 above to regain access to the router main configuration screen once the reboot has completed.

CONTEMPORARY CONTROLS

Setup Administration Status **Advanced**

Skorpion Wired/Wireless IP Router
Automation Firewall/Router Offers Reliability and Ease of Use

NAT

WAN IP Address	LAN IP Address	Enabled
<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> TO <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	10 10 79 103	<input checked="" type="checkbox"/>
<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> TO <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="checkbox"/>
<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> TO <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="checkbox"/>
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<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> TO <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="checkbox"/>
<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> TO <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="checkbox"/>
<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> TO <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="checkbox"/>

Save Cancel

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About This Page
NAT (Network Address Translation) is used to pass data from one IP address in one network to another IP address on a another network. Thus, the EIPR translates a WAN-side IP address to a specific LAN-side IP address. The firewall within the EIPR will block all communications originated on the WAN side - unless you specify exceptions. Enter the LAN device address in the NAT LAN IP Address boxes. In the WAN IP Address boxes, enter the address you want it to "appear as" on the WAN side. For example, if you want LAN device 192.168.1.2 to appear on the WAN network as 1.2.3.4 then put 192.168.1.2 in the LAN IP Address boxes and 1.2.3.4 in the WAN IP Address boxes - then enable this entry.

Need Support?
Our staff of engineers is available to address any issues you may be having. Please visit our [website](#) for more information.

Figure 56: NAT Screen

Upon returning to the main utility screen, the WAN side IP address of the router must also be defined by the user and follow the same scheme as the WAN side address entered in the NAT table in the previous step. The location for the WAN side IP address is shown in Figure 57 marked with a red arrow. The Subnet Mask and Default Gateway should be changed as needed. Once this address has been entered, saved and router rebooted, the user will then input this address into the Internet browser to access the router from the WAN side port. Click “Save” when complete and the router will reboot after 30 seconds. Follow instructions from section 11.2 above to regain access to the router main configuration screen once the reboot has completed. Use the new IP address entered in this step as opposed to 192.168.1.110 used previously.

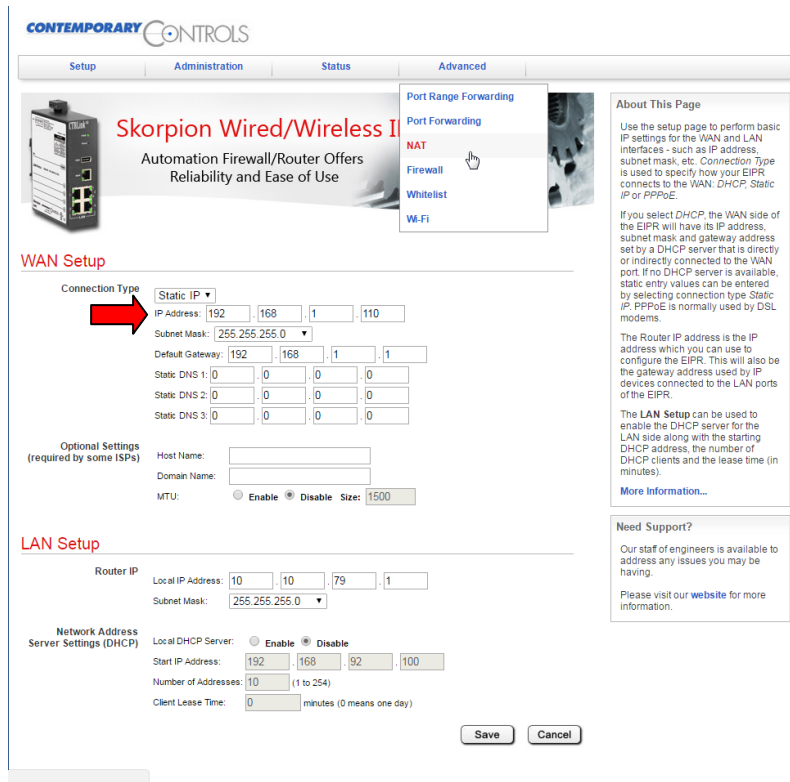


Figure 57: Setting WAN IP

Upon returning to the main utility screen, the user has the option to change the login credentials if desired under the “Administration” tab. The user name, password and administration port fields are marked with a red arrow in Figure 58. Click “Save” when complete and the router will reboot after 30 seconds. The router has now been properly configured and the WAN side port can be connected to the user’s network for use.

Figure 58: Login Credentials



Section 3

**MULTIGARD® 5000 SYSTEM
CUSTOM FUNCTIONS AND FEATURES**

**Instrument Division 1-800-MSA-INST or FAX (724) 776-8783
MSA International (412) 967-3354 or FAX (412) 967-3451
In Canada 1-800-267-0672 or FAX (416) 663-5908**

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**Manufactured by
MINE SAFETY APPLIANCES COMPANY
PITTSBURGH, PENNSYLVANIA 15230**

MSA

Permanent Instrument Warranty

1. Warranty – Seller warrants that this product will be free from mechanical defect or faulty workmanship for a period of eighteen (18) months from date of shipment or one (1) year from installation, whichever occurs first, provided it is maintained and used in accordance with Seller's instructions and / or recommendations. This warranty does not apply to expendable or consumable parts whose normal life expectancy is less than one (1) year such as, but not limited to, non-rechargeable batteries, filament units, filter, lamps, fuses etc. There is no warranty on end-user added programming or related modifications. The Seller shall be released from all obligations under this warranty in the event repairs or modifications are made by persons other than its own or authorized service personnel or if the warranty claim results from physical abuse or misuse of the product. No agent, employee or representative of the Seller has any authority to bind the Seller to any affirmation, representation or warranty concerning the product. Seller makes no warranty concerning components or accessories not manufactured by the Seller, but will pass on to the Purchaser all warranties of manufacturers of such components. **THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, AND IS STRICTLY LIMITED TO THE TERMS HEREOF. SELLER SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.**

2. Exclusive Remedy – It is expressly agreed that Purchaser's sole and exclusive remedy for breach of the above warranty, for any tortious conduct of Seller, or for any other cause of action, shall be the repair and / or replacement at Seller's option, of any equipment or parts thereof, which after examination by Seller is proven to be defective. Replacement equipment and /or parts will be provided at no cost to Purchaser, F.O.B. Seller's Plant. Failure of Seller to successfully repair any nonconforming product shall not cause the remedy established hereby to fail of its essential purpose.

3. Exclusion of Consequential Damage – Purchaser specifically understands and agrees that under no circumstances will Seller be liable to Purchaser for economic, special, incidental or consequential damages or losses of any kind whatsoever, including but not limited to, loss of anticipated profits and any other loss caused by reason of nonoperation of the goods. This exclusion is applicable to claims for breach of warranty, tortious conduct or any other cause of action against seller.

CUSTOM FUNCTIONS AND FEATURES

Each MultiGard 5000 System is Made-To-Order (MTO) to meet a specific application requirement. A MultiGard 5000 System consists of the enclosure, selected configuration options, and associated sensors/analyzers. Sensor/Analyzers can be installed internally or externally to the MultiGard enclosure.

A MultiGard 5000 System enclosure contains several sub-systems. These sub-systems include:

- Operator Interface (Display and Touch Screen Controls)
- PLC processor and associated modules
- User Electrical Interface:
 - Power Distribution and Terminal Strips
 - Common Alarm Relay Contacts with associated Local Alarm Buzzer (Optional) Discrete, Programmable Alarm Relay Contacts
- Sample gas flow system.
- Sensor/Analyzers (Internal and/or External)

Also available for use with a MultiGard 5000 System is an optional Remote Data Display (RDD).

A MultiGard 5000 System is configured at the factory. Refer to the System Configuration Data Sheets in this section of the operator's instruction manual for the factory parameters, available operator selections, and factory imposed default values. The MultiGard 5000 System Configuration Data Sheets are described in the Instruction Manual Section 9 in Section 2.

The MultiGard 5000 System Configuration Data Sheets include two forms of system configuration data: Factory Configured Parameters and Default User Parameters. A system that leaves the factory has entries placed in both sets of parameters, which makes the system functional.

- Factory configured parameters are not available to the MultiGard 5000 System operator for data entry. Therefore, these data fields cannot be changed on-site.
- User configured parameters are available to the operator and can be changed on-site. Default entries are made at the factory and this represents the operation of the MultiGard 5000 System upon delivery.

The MultiGard 5000 System processor retains all of the above parameters. In the event of a processor memory fault, all factory entered default values are restored.

SAFETY CONSIDERATIONS

Cautions and warnings presented in the Sensor/Analyzer and the MultiGard 5000 System sections of this instruction manual require special attention by the system operator. *All cautions and warnings must be read and understood before the MultiGard 5000 System is operated and placed into service.*

MULTIGARD 5000 FLOW SYSTEM OPERATION

In all cases, the MultiGard 5000 flow system provides sample gas or calibration gas to the Sensor/Analyzers for analysis or calibration, respectively. Sample or calibration gas flow must be established to the Sensor/Analyzer for normal operation.

WARNING

Do not operate the system without ensuring proper flow on all of the sample points. Flow failures will prevent the proper analysis of gas samples and a trouble indication will occur. Failure to restore the sample point flow immediately may result in a hazardous condition.

All MultiGard 5000 Systems require sample line filtration for each of the sample points.

NOTICE

Do not operate the system without providing adequate sample line filtration for all sample lines. Flow system damage will occur if dirt, water, or other foreign matter enters the flow system.

Refer to the flow diagram for the MultiGard 5000 System or to the parts list in the MultiGard System operator's manual for sample line filter part numbers and descriptions.

A manual calibration of all Sensor/Analyzers is required before the MultiGard 5000 System is placed into service. A MultiGard 5000 Manual Calibration screen is provided to aid with manual calibration. Read the Sensor/Analyzer instruction manual in Section 3 before placing the MultiGard system in operation.

Manual Calibration functions are described in the MultiGard 5000 Instruction Manual Section 4.1.5, Section 2. Sensor/Analyzer instructions appear in Section 3.



Section 4

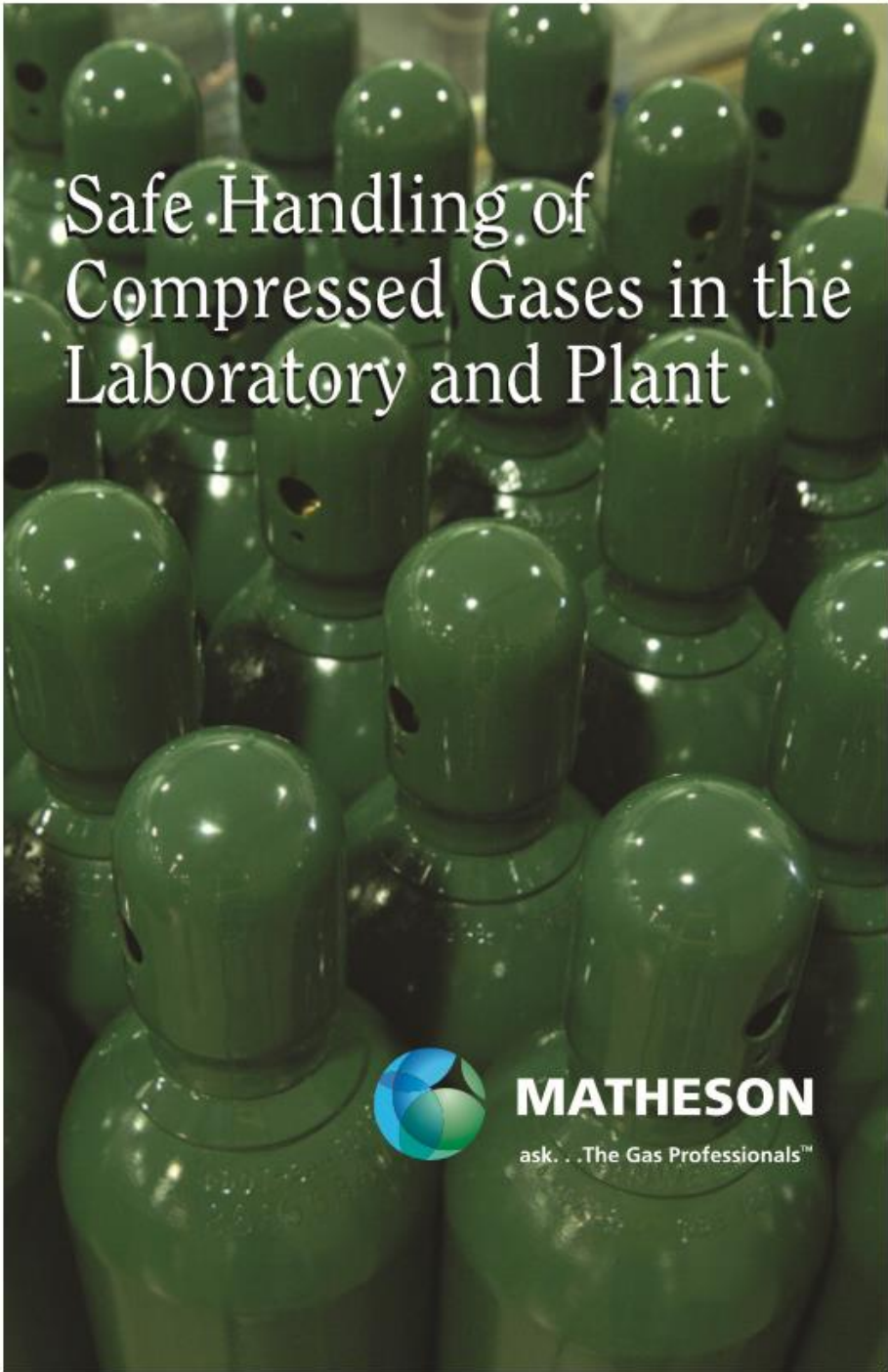
SENSOR/ANALYZER MANUALS

Supplied on SD Card



Section 5

**MULTIGARD 5000[®] SYSTEM
SUPPORT DOCUMENTS**

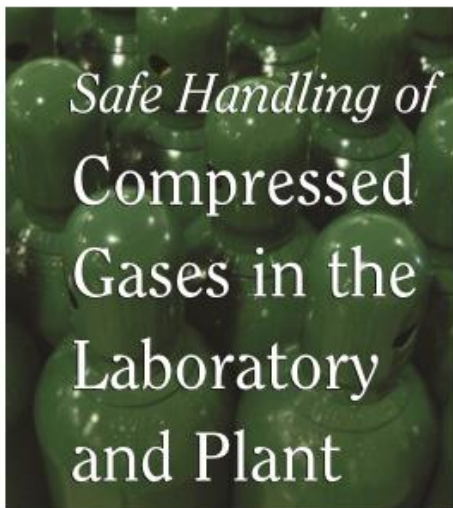


Safe Handling of Compressed Gases in the Laboratory and Plant



MATHESON

ask...The Gas Professionals™



Safe Handling of Compressed Gases in the Laboratory and Plant

Before we are allowed to drive a car, most states require proof of our ability to drive. To become a proficient and safe driver, one must have skill, judgment, and driver education. We do not always consider that we are performing a hazardous operation by driving a car; yet the fact remains that many people are killed or hurt every day as a result of carelessness in handling this machine. Although the safety record of the compressed gas industry is excellent, the questions raised by the users of gas products, and the accidents involving these same users, show that many of them have neither learned nor applied the safety measures that would earn them their "license" for handling compressed gas. When handled by personnel who are properly trained and aware of the potential hazards, compressed gases are as safe to work with as most of the ordinary chemical liquids and solids normally handled on a routine basis in any laboratory or plant.

A compressed gas is defined by the Department of Transportation (DOT) as "any material or mixture which exerts in the packaging an absolute pressure of 280 kPa (40.6 psia) or greater at 20°C (68°F)."

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Hazards

The handling of compressed gases must be considered more hazardous than the handling of liquid and solid materials because of the following properties unique to compressed gases: pressure, low flash points for flammable gases, low boiling points, and no visual and/or odor detection of many hazardous gases. Hazards may arise as a result of equipment failure and leakage from systems that are not pressure-tight. Also, improper pressure control may cause unsafe reaction rates due to poor flow control. Diffusion of leaking gases may cause rapid contamination of the atmosphere, giving rise to toxicity, anesthetic effects, asphyxiation, and rapid formation of explosive concentrations of flammable gases. The flash point of a flammable gas under pressure is always lower than ambient or room temperature. Leaking gas can therefore rapidly form an explosive mixture with air.

Low-boiling-point materials can cause frostbite on contact with living tissue. This is common among the cryogenic liquids such as nitrogen and oxygen, but it also can result from contact of the liquid phase of liquefied gases such as carbon dioxide, fluorocarbons, and propylene. Some compressed gases are similar to other chemicals in that they are corrosive, irritating, and highly reactive.

The procedures adopted for the safe handling of compressed gases are mainly centered on containment of the material, to prevent its escape to the atmosphere, and proper control of pressure and flow. All rules and regulations are directed toward these ends. Emergency procedures are usually only necessary because a basic rule of handling has been broken. It is far better to observe the rules and avoid the need for emergency measures. A listing of some common violations of basic rules for handling compressed gases is given in Table 1.

Table 1

Common OSHA Violations Involving Compressed Gas

1. Unsecured cylinders
2. Cylinders stored without protective caps
3. Noncompatible gases (such as hydrogen and oxygen) stored together
4. Cylinder valves open when cylinder is not in use (an attached regulator with a closed discharge valve is not sufficient)
5. Fire extinguishers not present during welding, burning, or brazing operations
6. No safety showers and eyewash fountains where corrosive gases are used
7. No gas masks and/or self-contained breathing apparatus conveniently located near areas where toxic gases are used or stored

General Precautions

Some general precautions for handling, storing, and using compressed gases follow.^{1,3,4}

1. Never drop cylinders or permit them to strike each other violently.
2. Cylinders may be stored in the open, but should be protected from the ground beneath to prevent rusting. Cylinders may be stored in the sun, except in localities where extreme temperatures prevail; in the case of certain gases, the supplier's recommendation for shading should be observed. If ice or snow accumulates on a cylinder, thaw at room temperature.
3. The valve-protection cap should be left on each cylinder until it has been secured against a wall or bench, or placed in a cylinder stand, and is ready to be used.
4. Avoid dragging, rolling, or sliding cylinders, even for a short distance. They should be moved by using a suitable hand truck.
5. Never tamper with pressure relief devices in valves or cylinders.
6. Do not store full and empty cylinders together.
7. Do not have full and empty cylinders connected to the same manifold. Reverse flow can occur when an empty cylinder is attached to a pressurized system.
8. No part of a cylinder should be subjected to a temperature higher than 125°F. A flame should never be permitted to come in contact with any part of a compressed gas cylinder.
9. Cylinders should not be subjected to artificially created low temperatures (-40°F or lower), since many types of steel will lose their ductility and impact strength at low temperatures. Special stainless steel cylinders are available for low temperature use.
10. Do not place cylinders where they may become part of an electric circuit. When electric arc-welding, precautions must be taken to prevent striking an arc against a cylinder.
11. Bond and ground all cylinders, lines, and equipment used with flammable compressed gases.
12. Use compressed gases only in a well-ventilated area. Toxic, flammable, and corrosive gases should be carefully handled in a hood. Proper containment systems should be used and minimum quantities of these products should be kept on-site.
13. Cylinders should be used in rotation as received from the supplier. Storage areas should be set up to permit proper inventory rotation.

14. When discharging gas into a liquid, a trap or suitable check valve should be used to prevent liquid from getting back into the cylinder or regulator.
15. When using compressed gases, wear appropriate protective equipment, such as safety goggles or face shield, rubber gloves, and safety shoes. Well-ventilated barricades should be used in extremely hazardous operations, such as in the handling of fluorine. Gas masks should be kept available for immediate use when working with toxic gases. These masks should be placed in convenient locations in areas not likely to become contaminated, and should be approved by the U.S. Bureau of Mines for the service intended. Those involved in the handling of compressed gases should become familiar with the proper application and limitations of the various types of masks and respiration aids available.
16. When returning empty cylinders, close the valve before shipment, leaving some positive pressure in the cylinder. Replace any valve outlet and protective caps originally shipped with the cylinder. Mark or label the cylinder "empty" (or utilize standard DOT "empty" labels) and store in a designated area for return to the supplier.
17. Before using cylinders, read all label information and Material Safety Data Sheets (MSDS) associated with the gas being used. Observe all applicable safety practices.
18. Eye baths, safety showers, gas masks, respirators, and/or resuscitators should be located nearby but out of the immediate area that is likely to become contaminated in the event of a large release of gas.
19. Fire extinguishers, preferably of the dry chemical type, should be kept close

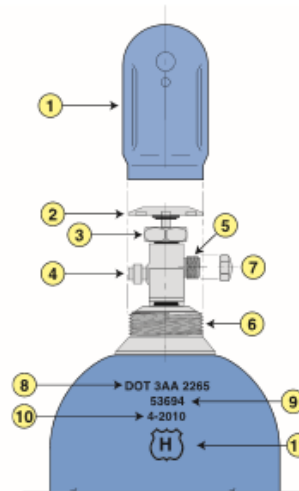
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at hand and should be checked periodically to ensure their proper operation.

The user of compressed gases should become familiar with the first-aid methods to be employed in cases of overexposure or burns caused by a gas. A plant doctor should be familiar with whatever further treatments may be necessary. Unnecessary delay in the treatment of a patient overcome by a toxic gas or burned by a corrosive gas could cause the patient permanent damage, and might even result in death. Authorized personnel should administer first aid; however, they should not take it upon themselves to administer medical treatments. A physician should be contacted immediately.

Cylinders

Figure 1 Cylinder parts and markings.



The supplier seeks to assure the safety of cylinders through adherence to regulations set forth by the Department of Transportation, and by supplying cylinders with specific valves, labels, and/or markings in accordance with recognized standards.

It is mandatory for the supplier to ship cylinders manufactured in conformance with DOT regulations and to follow DOT regulations in the testing and inspection of cylinders, the proper filling of these cylinders, and the use of pressure relief devices that are approved by the DOT.

Figure 1 shows cylinder parts and important cylinder markings. The cylinder cap (1) protects the cylinder valve. The valve handwheel (2) is used to open and close the cylinder valve. Valves are occasionally not equipped with handwheels, and require special wrenches to effect operation. The valve packing nut (3) contains a packing gland and packing around the stem. It should not be tampered with when used in conjunction with diaphragm-type valves. A pressure relief device (4) permits gas to escape if increased unsafe pressures are attained. The valve outlet connection (5) connects to pressure and/or flow-regulating equipment. Various types of connections are provided to prevent interchange of equipment for incompatible gases, usually identified by CGA (Compressed Gas Association) number; for example, CGA No. 350 is used for hydrogen service. A cylinder collar (6) holds the cylinder cap at all times, except when regulating equipment is attached to the cylinder valve. The valve outlet cap (7) protects valve threads from damage and keeps the outlet clean; it is not used universally.

Specification number (8) signifies that the cylinder conforms to the Department of Transportation specification DOT-3AA, governing materials of construction, capacities, and test procedures, and that the service pressure for which the cylinder is designed is 2265 psig at 70°F.

The cylinder serial number is indicated by (9), and (10) indicates the date (month and year: in this case, October 2010) of initial hydrostatic testing. Thereafter, hydrostatic pressure tests are performed on cylinders, for most gases, every 5 years to determine

their fitness for further use. At this time new test dates are stamped into the shoulder of the cylinder. Present regulations permit visual test in lieu of hydrostatic tests for low-pressure cylinders in certain gases free of corrosive agents; regulations also allow for hydrostatic pressure tests at 10-year intervals for cylinders in high-pressure service for certain gases. The original inspector's insignia for conducting hydrostatic and other required tests to approve the cylinder under DOT specifications is shown by (11).

Filling

Nonliquefied gases may be filled to the service pressure marked on a cylinder. These markings will appear on the shoulder of the cylinder, i.e., DOT3AA-2265, indicating that the cylinder has been manufactured in accordance with DOT specifications 3AA, and the cylinder filling pressure is 2265 psi at 70°F. At present, DOT regulations permit a 110% filling for certain non-liquefied, non-flammable gases. Liquefied gases, on the other hand, must be filled to a filling density. This filling density represents the maximum weight of the material permitted in the cylinder, as a percentage of the water capacity of the cylinder.

Since compressed gas cylinders are handled by a number of different types of plant personnel, consider the precautions to be taken in handling from the time it is delivered until the time it is emptied and ready for return.

Receipt and Content Identification

When a cylinder is delivered to the receiving department, it should have 1) content identification by stenciling or labels, 2) a DOT label, and 3) a valve-protection cap. Under no circumstances should the means of identification be removed from the cylinder. The valve-protection cap (Figure 1) should also remain in place until the user has secured

the cylinder and is ready to withdraw the contents. DOT labels are required for cylinders in interstate transportation. Some states require these labels for intrastate shipments also. These labels have a minimum of precautionary handling information and will classify the cylinder contents as flammable, nonflammable, poison, or corrosive.

Proper identification of cylinder content can be made by checking the cylinder shoulder label. Stenciling and/or cylinder color should never be used for positive identification. If any doubt exists as to cylinder content, contact your supplier before using the cylinder.

Proper Storage

After cylinders are received, they should be stored in a detached and well-ventilated or open-sided building. Storage buildings or areas should be fire resistant, well ventilated, located away from sources of ignition or excessive heat, and dry. Such areas should be prominently posted with the names of the gases being stored. Indoor storage areas should not be located near boilers, steam or hot water pipes, or any sources of ignition. Outdoor storage areas should have the proper drainage and should be protected from the direct rays of the sun in localities where high temperatures prevail. Subsurface storage areas should be avoided. Cylinders should be protected against tampering by unauthorized personnel.

Cylinders should be stored in accordance with CGA Pamphlet P-1. Where gases of different types are stored at the same location, cylinders should be grouped by types of gas, the groups arranged to take into account the gases contained -- for example, flammable gases should not be stored near oxidizing gases. Storage in a laboratory should be confined to only those cylinders in use. In all cases, storage areas should comply with federal, state, and local

requirements as well as with the standards of the Compressed Gas Association and the National Fire Protection Association.^{2,4}

Transportation

When cylinders are being moved from a storage area into the laboratory or plant, the valve-protection cap should be left in place. The cylinder should then be transported by means of a suitable hand truck (Figure 2). Such a hand truck should be provided with a chain or belt for securing the cylinder on the truck. If a large number of cylinders must be moved from one area to another, a power device, such as a fork truck equipped with a special container and provided with some means of securing the cylinder, can be used. Do not lift cylinders by the cap. Avoid dragging or sliding cylinders. Use hand trucks even for short distances.



*Figure 2 – Models 6114A and 6214A
Cylinder Hand Trucks*

Securing Cylinder Prior to Use

When the cylinder has reached its destination in the laboratory or plant, it should be secured to a wall, a bench, or some other firm support, or placed in a cylinder stand, rack or cabinet (Figures 3-9). An ordinary chain or belt of the type commonly available from your gas supplier can be used. Once the cylinder has been secured, the cap may be removed, exposing the valve. The number of cylinders in a laboratory should be limited to minimize the fire and toxicity hazards.



Figure 3 – Model 708 Bench Type Cylinder Holder



Figure 4 – Model 710 Wall Mounted Cylinder Holder



Figure 5 – Model 700 and 701 Small Cylinder Stands



Figure 6 – Model 704-B Lecture Bottle Holder for Bench Use



Figure 7 – Model 704-W Lecture Bottle Holder for Wall Mounting



Figure 8 – Model 1191 Lecture Bottle Storage Cabinet



Figure 9 – Model 6530 Series Cylinder Storage Racks

Pressure Relief Devices

Pressure relief devices are incorporated in most DOT compressed gas cylinders, except those containing poison or toxic gas, where the risk of exposure to fumes is considered more hazardous than that of a potential cylinder failure. Pressure relief devices are incorporated in the cylinder valve, in plugs in the cylinder itself, or both. In certain types of gas service, and in many cylinders over a particular length (usually 65"), two pressure relief devices may be required, one at each end of the cylinder.

Pressure relief devices are required to meet DOT regulations.⁵ These pressure relief devices are of four basic types:

1. Spring-loaded pressure relief valve, used mostly for low-pressure, liquefied, flammable gases.
2. Frangible disc, used mostly for high-pressure cylinders.
3. Frangible disc backed up by a fusible metal for non-liquefied, flammable gases and some liquefied gases such as hydrogen, carbon monoxide, and hydrogen chloride.
4. Fusible metal for certain toxic, corrosive gases such as chlorine and sulfur dioxide.

The spring-loaded pressure relief valve consists of a spring-loaded seat that opens to relieve excessively high pressures and then closes when the pressure returns to a safe value.

The frangible disc will burst at a pressure that is above the service pressure of the cylinder, but usually not higher than the test pressure for that cylinder.

The frangible disc backed up by a fusible metal will function only if there is the presence of excess pressure which causes the disc to burst, and high temperature which causes the fusible metal to melt. The release of the cylinder contents is dependent upon both pressure and temperature.

The fusible metal devices melt at excessive temperatures (either 165°F or 212°F), allowing the entire contents of the cylinder to escape.

Pressure relief devices will prevent a charged cylinder from bursting due to excessively high temperatures or pressures. However, devices 3 and 4 will not prevent a charged cylinder from bursting solely, as a result of over pressurization. A temperature in excess of the melting point of the fusible metal is required for release of the product. Since the proper functioning of cylinder pressure relief devices depends to a large extent on the proper filling of a cylinder, such filling should never be attempted by the user. Pressure relief devices may also fail to function properly if an intense flame impinging on the side wall of a cylinder weakens the metal to the point of failure before heat or pressure can cause the pressure relief device to function properly.

Finally, it must be emphasized that tampering with cylinder pressure relief devices is extremely hazardous.

Knowing the Gas to be Handled

It is of the utmost importance that the user be well aware of those properties of a compressed gas that represent hazards (such as flammability, toxicity, chemical activity, and corrosive effects). Every attempt should be made to learn these various properties before the gas is put to use. It is sometimes difficult to determine the major hazard of any one gas, since this factor is influenced a great deal by how the gas is used. In a laboratory hood in the presence of an open flame, the flammability of carbon monoxide might well be the major hazard, whereas in a pilot-plant run using carbon monoxide as a reactant, leakage, and therefore toxicity, may represent the major hazard.

Figure 10 shows the flammability ranges of various gases.⁶ Although the flammability

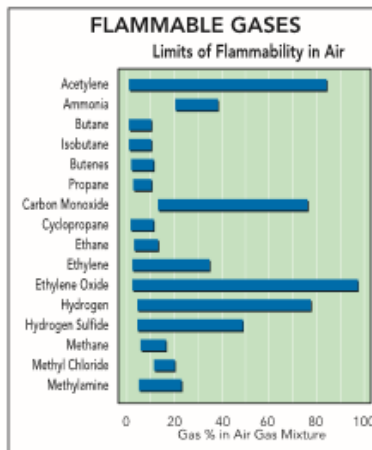


Figure 10 – Flammability Range of Gases

ranges of liquefied petroleum gases such as butane and propane are relatively short, only very small concentrations are necessary to create flammable mixtures. The flammability ranges of acetylene, carbon monoxide, ethylene oxide, hydrogen sulfide, and hydrogen are extremely long, indicating that they can form explosive mixtures with air under a wide variety of conditions.

It is important to know what materials of construction must be used with a gas to prevent failure of equipment due to corrosion, or to avoid possible formation of hazardous compounds (such as acetylides formed by the reaction of copper with acetylene or gases containing acetylene as an impurity) or the possible formation of fulminates when mercury is used in the presence of ammonia.

The hazards of toxic, flammable, and corrosive gases can be minimized by working in well-ventilated areas. Where possible, work should be done in a hood, employing cylinder sizes that will assure use of all the gas within a reasonable amount of time. Leaks should not be allowed to go unchecked. Advise the

supplier immediately of cylinder leaks that cannot be stopped by simple adjustment, such as tightening a packing nut.

Proper Discharge of Cylinder Contents



Figure 11 – Model 4351 Manual Control Valve

For controlled removal of the liquid phase of a liquefied gas, a manual control is used (Figure 11). Special liquid flow regulators are also available. It must be remembered that withdrawal of liquid must necessarily be carried out at the vapor pressure of the material. Any attempt to reduce the pressure will result in flashing of all or part of the liquid to the gas phase.

Rapid removal of the gas phase from a liquefied gas may cause the liquid to cool too rapidly, causing the pressure and flow to drop below the required level. In such cases, cylinders may be heated in a water bath with temperature controlled to no higher than 125°F. Rapid gas removal can also be effected by transferring the liquid to a heat-exchanger, where the liquid is vaporized to a gas. This method imposes no temperature limitations on the material; however, care should be taken to prevent blockage of the gas line downstream of the heat-exchanger, as this may cause excessive pressure to build up in both the heat-exchanger and the cylinder. Safety relief devices should be installed in all liquid-transfer lines to relieve sudden, dangerous hydrostatic or vapor-pressure buildups.



Figure 12 – Model 3120 Dual Stage High Purity Brass Regulator

For nonliquefied gases, the most common device used to reduce pressure to a safe value for gas removal is a pressure regulator. This device is shown in Figure 12. It consists of a spring - (or gas-) loaded diaphragm that controls the throttling of an orifice. Delivery pressure will exactly balance the delivery pressure spring to give a relatively constant delivery pressure.

Pressure Regulator Handling and Use

A regulator should be attached to a cylinder without forcing the threads. If the inlet of a regulator does not fit the cylinder outlet, no effort should be made to try to force the fitting. A poor fit may indicate that the regulator is not intended for use on the gas chosen.

The following procedure should be used to obtain the required delivery pressure:

1. After the regulator has been attached to the cylinder valve outlet, turn the delivery pressure-adjusting screw counterclockwise until it turns freely.
2. Open the cylinder valve slowly until the tank gauge on the regulator registers the cylinder pressure. At this point, the cylinder pressure should be checked to see if it is at the expected value. Contact your gas supplier if pressure is less than expected. (Note: Low cylinder pressure may indicate a leaking valve which can be a serious safety issue.)

3. With the flow-control valve at the regulator outlet closed, turn the delivery pressure-adjusting screw clockwise until the required delivery pressure is reached. Control of flow can be regulated by means of the valve supplied in the regulator outlet or by a supplementary valve put in a pipeline downstream from the regulator. The regulator itself should not be used as a flow control by adjusting the pressure to obtain different flow rates. This defeats the purpose of the pressure regulator, and in some cases where higher flows are obtained in this manner, the pressure setting may be in excess of the design pressure of the system.
4. After flow is established, the set delivery pressure may decrease slightly. Check to see that the delivery pressure is as desired and make any necessary adjustments.

Types of Pressure Regulators

The proper choice of a regulator depends on the delivery-pressure range required, the degree of accuracy of delivery pressure to be maintained, and the flow rate required. There are two basic types of pressure regulators, single-stage and double, or two-stage. The single-stage type will show a slight variation in delivery pressure as the cylinder pressure drops. It will also show a greater drop in delivery pressure than a two-stage regulator as the flow rate is increased. In addition, it will show a higher "lock up" pressure (pressure increase above the delivery set-point necessary to stop flow) than the two-stage regulator. In general, the two-stage regulator will deliver a more nearly constant pressure under more stringent operating conditions than will the single-stage regulator.

Gas purity will also need to be considered when selecting the correct regulator.

Regulator design and materials of construction could adversely affect the purity of the gas being used. Choose a High Purity Regulator for applications where purity of gas is critical. For more details and information on high purity designs, reference your MATHESON Catalog or contact your specialty gas representative.

Manual Flow Controls

Where intermittent flow control is needed and an operator will be present at all times, a manual type of flow control may be used. This type of control (illustrated in Figure 11) is simply a valve that is operated manually to deliver the proper amount of gas. Fine flow control can be obtained, but it must be remembered that dangerous pressures can build up in a closed system or in one that becomes plugged, since no means are provided for automatic prevention of excessive pressures.

Determining the Amount of Gas in a Cylinder

As the content of a cylinder of nonliquefied gas is discharged, the cylinder pressure decreases by an amount proportional to the amount withdrawn. The cylinder should be considered empty while positive pressure (25 psig or greater) still remains, in order to prevent reverse flow and contamination. Failure to close the valve on an empty cylinder will allow air and moisture to be drawn into the cylinder as it "breathes" during temperature changes; an explosive mixture may build up if the gas is flammable; and an extremely corrosive condition will be created in cylinders that contain chlorine, hydrogen chloride, or other acid-forming or corrosive gases.

As the vapor phase of a liquefied gas is withdrawn from a cylinder, the cylinder pressure or vapor pressure will remain constant as long as any liquid is present.

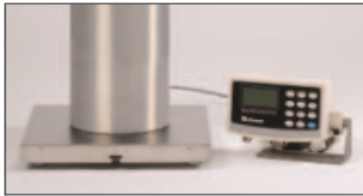


Figure 13 – Model DS-R Electronic Cylinder Scales

This condition holds true if the temperature does not vary. If, however, the material is withdrawn from the cylinder at a rapid rate, the material itself will supply the heat for vaporization, and upon subsequent cooling, the vapor pressure will be lowered. It is, therefore, impossible to determine the content of a cylinder containing a liquefied gas, except by weighing. A scale such as the one shown in Figure 13 makes this convenient. Cylinders containing liquefied gases are stamped or tagged with the tare weight in order to allow the content to be determined.

An indication of cylinder-content depletion for some high pressure liquefied gases such as carbon dioxide, ethane, and nitrous oxide can be obtained by noting the cylinder pressure. After depletion of the liquid phase, the cylinder pressure will decrease below the normal vapor pressure, as long as the contents have not been withdrawn rapidly before the cylinder pressure is noted. A cylinder containing carbon dioxide will have approximately 20% of its original content remaining after depletion of the liquid phase. As with cylinders of nonliquefied gases, cylinders containing liquefied gases should never be completely emptied, in order to prevent reverse flow and contamination of the cylinder.

Handling Empty Cylinders

Where cylinders are considered empty, the valves should be closed. Valve-protection caps, outlet dust caps, and other

accessories shipped with the cylinder should be attached to the cylinder as received. The cylinder should be marked or labeled "empty." Cylinders should then be placed in a proper storage area, segregated from full cylinders, to await pickup for return to the supplier.

Carelessness in the handling of an empty cylinder could result in its being mistaken for a full cylinder. Connecting an empty cylinder to a high-pressure system could cause foreign materials to back up into the cylinder, resulting in all the attendant hazards of reverse flow, and possible violent reaction within the cylinder.

Leak Detection

Check cylinders and all connections under pressure for leaks prior to using the contents.

When using toxic gases, it is advisable that some device be used to warn of the presence of toxic concentrations.



Figure 14 - Model 8066 LeakHunter Plus

There are numerous monitoring devices available for detection of dangerous concentrations of gases in the atmosphere (Figure 14). There are also appropriate chemical procedures for detecting leaks in lines and equipment and for determining dangerous concentrations of gases in the atmosphere. The user of gases should become familiar with suitable control procedures for the determination of such dangerous concentrations. Instructions are usually supplied in the Materials Safety Data Sheets (MSDS) associated with the particular gas being used. MSDS sheets can be found at www.mathesongas.com/MSDS

An emergency plan can function efficiently only if a trained safety crew is educated in the proper handling of gas cylinders, with training in the procedures to be followed in cases of emergency with all the gases handled by the facility. Equipment such as self-contained gas masks must be available for handling toxic gases or for handling asphyxiating gases in close confines. Emergencies involving flammable gases must be managed with the utmost care in order to prevent ignition. The aftermath of gross leakage is extremely important. All areas must be adequately vented before the restoration of power in cases of flammable-gas leakage. Areas contaminated by corrosive gases must be adequately vented and completely washed down to prevent subsequent degradation of delicate instruments, electrical contacts, etc.

On rare occasions, emergency action may be necessary in order to move a leaking cylinder to a location where it can vent safely, or it may have to be removed from a building and brought outdoors. In such instances, an emergency plan should be put into effect:

1. Properly warn all personnel required to evacuate a building or section of a building.
2. Shut off electrical power to prevent ignition of a leaking flammable gas.
3. Determine the shortest route to the point of gas disposal.
4. Obtain satisfactory conveyance, such as a hand truck, to move the cylinder swiftly.
5. Post the area where the cylinder is venting to prevent tampering by unauthorized personnel.

Handling of Corrosive Gases

Corrosive gases should be stored for the shortest possible periods before use, preferably less than three months. Storage areas should be as dry as possible. A good supply of water should be available to handle emergency leaks. Most corrosive gases can be absorbed in water.

Corrosive gases should not be stored in areas containing instruments or other devices sensitive to corrosion. These gases should be segregated as to type, and rotated so that the oldest stock is used first. Toxic, flammable and corrosive gases should be handled carefully. Proper containment systems should be used and minimum quantities of these products should be kept on-site. Cylinders used and then put back in storage should have all appurtenances (regulators, control valves, etc.) removed from the valve outlet and should preferably be flushed with dry nitrogen or air to keep them in good working order.

When corrosive gases are being used, the cylinder valve stem should be periodically opened and closed to prevent "freezing." The valve should be closed when the cylinder is not in use. Regulators and valves should be closed when the cylinder is not in use and flushed with dry air or nitrogen after use. Such control devices should not be left on a cylinder, except when it is in frequent use. When corrosive gases are to be discharged into a liquid, a trap, check valve, or vacuum break device should always be employed to prevent dangerous reverse flow.

Other Safety Ideas from MATHESON



Model 6104A Series Flash Arrester

The Use of Flash Arrestors

Whenever a flammable gas is to be used it is recommended that a simple flash arrester be installed in the line. Flashback is the reversing of the flame such that it travels through the line back into the pressure regulator or cylinder. Most welders incorporate flash arrestors in their system.

Laboratories, however, often use gases like acetylene, one of the most hazardous, for atomic absorption instruments...and do not incorporate a flash arrester. The same is true for other instrumentation such as flame ionization detector GC and flame photometers. Flash arrestors are easy to install in existing systems. They are available in either brass or stainless steel.

Heavy Duty Hand Trucks

When transporting cylinders, one or two, we recommend the use of heavy duty hand trucks. The hand trucks that we propose are specifically designed to handle compressed gas cylinders and transport them safely over all types of surfaces, even gravel beds.



Model 6211A Two Cylinder Hand Truck

The wheels are designated "hi-load capacity" and there is a rigid rear carriage support which supports the weight of the cylinders to balance the truck and cylinder, so you can concentrate on steering.



Model 6114A Single Cylinder Hand Truck

A less specific truck may not encompass such features and will lack the necessary stability for cylinder transport.

Gas Detection

Where toxic gases are in constant or intermittent use, it is recommended that some sort of toxic gas detector system is used. A continuous monitoring system based on a GC principle is frequently ideal for a plant which uses benzene or vinyl chloride all the time. If the use of toxic gas is intermittent, we recommend the MATHESON-Kitagawa Toxic Gas Detector System.

This system consists of a small, calibrated, 100cc hand pump. A tube for a specific vapor is inserted and



Kitagawa Toxic Gas Detector Tubes



Model 8014KA Toxic Gas Detector Tube System

a sample of the atmosphere is drawn through the tube by the pump. In most cases, a constant color stain is produced which varies in length according to the concentration of the vapor being measured. The system measures over 100 different materials such as ammonia, benzene, chlorine, ethylene oxide, hydrogen sulfide, etc. It is designed for operation by nontechnical personnel.

MATHESON Gas Cabinets

Many industries have recognized gas cylinder cabinets as a cost effective way of protecting life and property from toxic, flammable and corrosive gases. Gas cabinets can also help the user comply with building and fire codes specified by federal, state and local agencies.



Model 1170 Series Gas Cylinder Cabinet

MATHESON's line of gas cabinets offers many advantages to users:

- Compliance with Article 80 of the Uniform Fire Code, OSHA and NFPA standards.
- Separate access panel and wire-reinforced safety glass viewing window provide added protection for employees working with hazardous gases in the cabinet.
- Innovative design provides continuous flow of air through the cabinet without channeling or dead spots.
- Fire control sprinkler head for extra fire protection.
- Low-profile cylinder deck makes cylinder installation and removal safe and easy.
- Constructed of rugged 11-gauge cold rolled steel for maximum durability.

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- Cabinets are fitted with unistrut supports for easy installation and adjustment of many types of gas handling systems.

Excess Flow Valves

The excess flow valve is designed to shut down gas supply systems in the event of abnormal flow conditions caused by rupture, fire, open free flowing valves, etc. The valve will automatically detect excess flow when the event occurs and will shut down the supply flow immediately so that the remaining content of the cylinder(s) does not empty into the work or storage area. This is critical with toxic, poisonous or flammable gases but can also be important when dealing with inert gases in small, poorly ventilated areas where asphyxiation can be a potential hazard. Excess flow valves are highly effective and important safety equipment -- MATHESON recommends these devices wherever hazardous gases are being used.



Model 6290 Series Excess Flow Valve

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