



Packaged Water Systems  
***Level Control***

*Model LCS150e.1*

Single Tank System

Installation, Operation, and Parts



750-327  
08/2019

## **TO: Owners, Operators and/or Maintenance Personnel**

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood.

It is the responsibility of the owner to ensure that all personnel servicing, repairing, or operating the equipment have received proper safety training.

Cleaver-Brooks equipment is designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied as part of the unit were chosen because of their known ability to perform; however, proper operating techniques and maintenance procedures must be followed at all times.

Such "automatic" features as may be included in the design should not be understood as substituting for the normal responsibilities of the attendant. Such features merely free personnel from certain repetitive chores, allowing more time for the proper upkeep of equipment.

It is solely the operator's responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning and this manual is not intended to relieve the operating personnel of the responsibility for proper operation. On the other hand, a thorough understanding of this manual is required before attempting to operate, maintain, service, or repair this equipment.

It is not uncommon for operating controls to function normally for long periods without intervention - in such circumstances it should never be assumed that normal operation will continue indefinitely. A regular testing and maintenance schedule should be established and scrupulously followed.

The operation of this equipment must comply with all requirements or regulations of the insurance company and/or other authority having jurisdiction. In the event of any conflict or inconsistency between such requirements and the warnings or instructions contained herein, please contact Cleaver-Brooks before proceeding.



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## **CHAPTER 1 — GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION**

### **1.1-Introduction**

Congratulations and thank you for choosing the Cleaver-Brooks LCS150e.1 tank level control system. This system has been designed with the user in mind, and should provide many years of dependable, safe, and efficient operation. To ensure continued trouble-free operation, please be sure to follow all instructions in this manual regarding proper installation, set-up, operation, and maintenance.

### **1.2-How to Use this Instruction Manual**

This manual is arranged to provide a straight forward, step-by-step process from installation through operation and maintenance of your system.

Chapter 1 describes the system, components, and principles of operation, and explains how to identify what type of system and components you should have.

Chapter 2 details the installation procedures, including mounting, piping, wiring, and utility requirements, and the proper sequence to perform these procedures.

Chapter 3 explains how to setup the system and then place the system in operation.

Chapter 4 provides information on routine maintenance, troubleshooting, replacement parts, and warranty policy.

The appendix includes other pertinent information such as I/O addressing and information for remote data monitors.

### **1.3-System Description - General**

The C-B LCS150e.1 System is a PLC based control system intended to control level in a single tank using a 4-20 mA level signal and one or two 4-20 mA modulating water valves.

The LCS150e.1 uses a 3.5" 160x128 monochrome LCD touchscreen display.

The complete system comprises a level sensor, a control panel which houses the PLC, and modulating valves to control water flow into the tank.

The system provides visual indication of tank water level and feedwater valve position.

### **1.4-Principle of Operation**

The system monitors the water level in the tank and acts to maintain a desired level setpoint. When water level is low, the primary valve is modulated toward the open position. As water level returns to normal setpoint level, the valve is modulated toward the closed position. On systems equipped with two water valves, a secondary valve will also act to control water level to a setpoint. This valve acts as a backup to the primary valve. The setpoint of the secondary valve is typically set lower than that of the primary valve. There are five (5) level switch contacts available for either alarm or control use. For each relay contact, the switch point, differential for reset, and time delay can be user-programmed.

### **1.5-System Components**

#### **Level Sensor**

A level sensor is installed in the tank to provide a 4-20mA signal to the control system. A LWCO switch is also installed in the tank as a backup to the transmitter.

#### **PLC/HMI**

The system is controlled by an integrated HMI/-Programmable Logic Controller (PLC). Integrated I/O allows the PLC to interface with all the field equipment (valves, LWCO and level sensor). The PLC may

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communicate via Modbus RTU protocol to building management or SCADA systems provided by others.

**Level Control Valve**

Water is added to the tank through a modulating valve controlling water flow. The valve is modulated by the PLC with a 4-20 mA control signal. An optional secondary valve can be used as a backup to the primary valve. When using a two valve system, the primary valve would typically control water from a surge tank or condensate return line, and the secondary valve would typically control water from a fresh water source.

## **CHAPTER 2 — INSTALLATION**

### **2.1-System Requirements**

#### **Electrical**

120 VAC, 60 Hz, or 110 VAC 50 Hz 10 Amp  
3-wire grounded system.

#### **Environmental**

Temperature:  
Control Panel 32-122 °F

### **2.2-Determining Locations**

The interconnecting signal cables between the LCS panel and field devices should be located as far as possible from high voltage wiring and large electrical equipment. Devices such as the pump motor can introduce voltage spikes which could upset the operation of the PLC. The signal cables should be run at right angles to any power wiring and must not be routed with any boiler wiring.

The Control Panel may be mounted on a pedestal, a wall, or a convenient post. It should be located away from large or high voltage equipment such as power distribution panels, motors, ignition transformers, etc. If pedestal mounted, the base must be securely anchored.

### **2.3-Wiring**

The control panel requires 120 VAC, 10 Amp. All wiring must conform to the National Electrical Code (NEC), and all applicable local codes.



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## CHAPTER 3 — SYSTEM OVERVIEW

### 3.1-PLC Overview

The system monitors the water level in the tank and acts to maintain a desired level setpoint. When water level is low, the primary valve is modulated toward the open position. As water level returns to normal setpoint level, the valve is modulated toward the closed position. On systems equipped with two water valves, a secondary valve will also act to control water level to a setpoint. This valve acts as a backup to the primary valve. The setpoint of the secondary valve is set lower than that of the primary valve.

The PLC has five (5) available 'soft switches' - programmable level positions that when reached will trip a relay. Each soft switch is available for either alarm or control use, with programmable switch point, differential for reset, and time delay.

### 3.2-Data Logging

The PLC can log data to an optional Micro SD memory card. When Data Logging is enabled, data for the water level level setpoint, actual water level, valve position, and I/O status are written to a .CSV file on the memory card. A new data log file is created every hour with a time and date coded file name: MMDDHH.CSV. Data logging can be enabled/disabled and the logging interval set via push button at the HMI. The used capacity of the memory card is also displayed at the HMI.

*To install a Micro SD card:* Align its 8-pin gold edge connector down, facing the front of the HMI. Carefully push it all the way into the memory slot. Ensure that it clicks into place.

*To remove the Micro SD card:* Disable data logging before removing. Push down on the top of the card gently to release the spring. The card will pop up for removal.

### 3.3-Remote Monitoring

The PLC provides data via Modbus RTU serial protocol. See APPENDIX C for address information and communications parameters

### 3.4-HMI Screens

The HMI displays all the information related to the LCS150e.1 system. There are several screens that are used to view and/or change the system parameters.

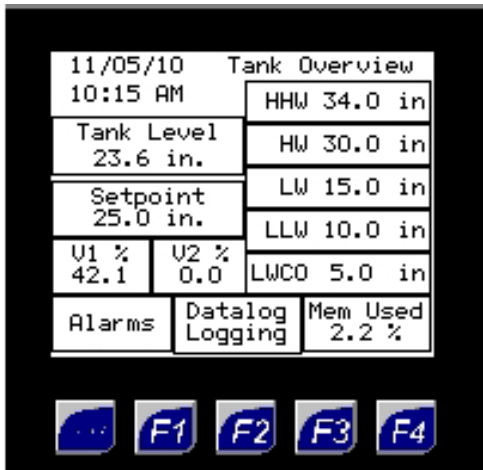
### Main Menu Screen

This screen is the primary navigation screen to gain access to all the other screens.



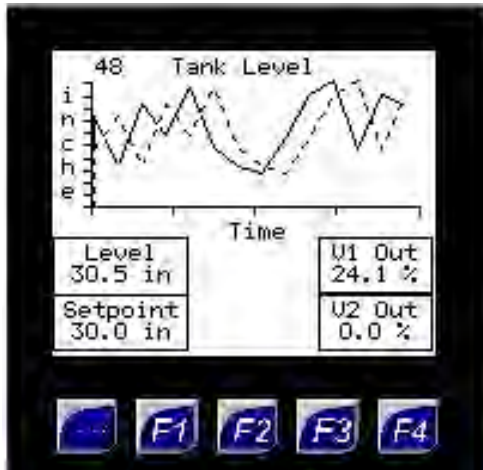
### Overview Screen

This screen displays all the pertinent data for the tank. The valve positions and level are displayed. Tank level setpoint and level switch setpoints and status are also displayed.



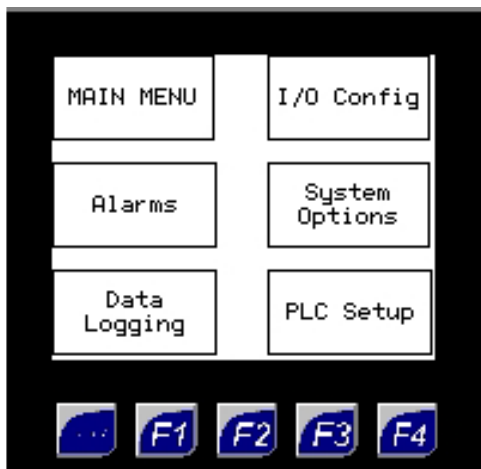
### Overview Trend Screen

This screen displays the tank level information in a trend format. The valve positions and level are also displayed in numerical format.



### System Setup Menu Screen

This screen allows the operator to access the I/O Configuration screens, System Options, PLC Setup, Data Logging and the Alarm screen. This screen is password protected.



### Analog Input Scaling Screen

This screen allows the operator to adjust the raw input and scaled values for each analog input point. Normal signal values are 4mA and 20 mA. The scaled values should correspond to the engineering unit range of the level transmitter that is wired to the analog input.



### Analog Output Scaling Screen

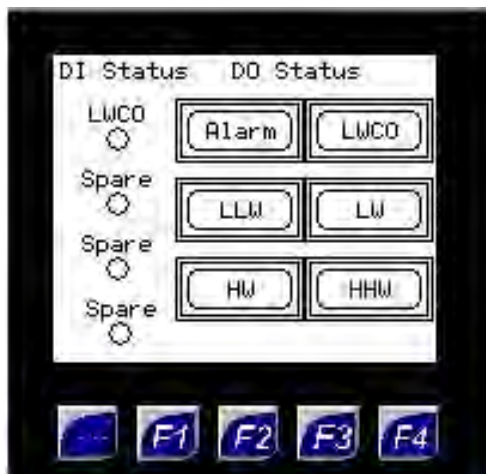
The screen allows the operator to adjust the scaled and actual values for each analog output point. **Note: When this screen is displayed, the normal control values for the analog points are overridden by the values displayed on this screen. Analog output adjustments should not be done while the system is in operation.** Normal raw values are 0-100% open valve position. The scaled values should correspond to the 4-20 mA signal controlling the valve.



## Digital I/O Screen

The screen allows the operator to view the status for each digital input point. When an input signal is on, the corresponding indicator for that point is highlighted. When the input signal is off, the indicator is clear. The operator can also view the current status of the output points. The operator is able to 'force' each output to an on state by pressing the button corresponding to the digital output point.

**Note: When this screen is displayed, the normal control values for the digital output points may be overridden by operator input. Changes should not be made while the system is in operation**



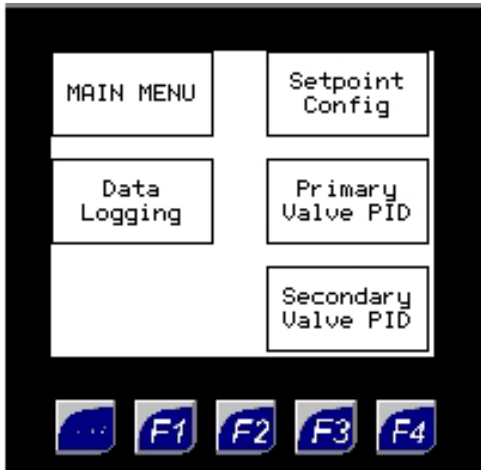
## System Options Screen

This screen is used to set the site-specific configuration of the system. The secondary valve can be enabled or disabled. If the secondary valve is enabled, the operator can choose to have the setpoint for the valve be either independent or calculated by an offset from the primary valve level setpoint. The operator can also configure the Modbus data communications and clear the Alarm history.



## Setpoint and Tuning Menu

This screen allows access to the setpoint entry and PID tuning screens. The screen is password protected.



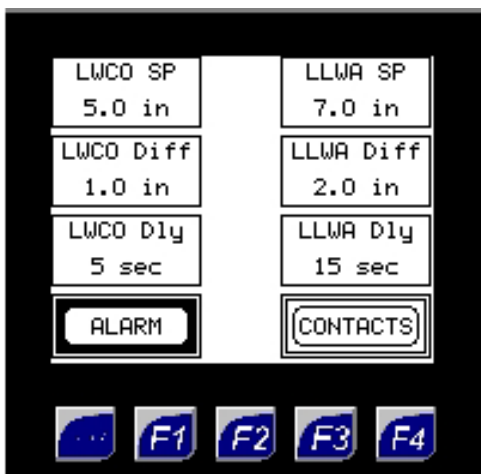
## Setpoint Entry Screens

The screen allows the operator to adjust the current level setpoint for each soft switch.

The operator can also set the differential for each switch. This value is the number of inches above (for low level switches) or below (for high level switches) setpoint that the water level must reach to reset the switch.

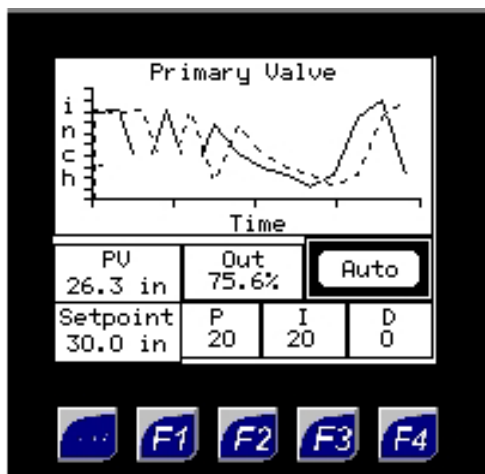
The operator can also set a time delay to avoid triggering nuisance alarms on a momentary excursion past the level setpoint.

Each level switch can be designated as 'alarm' or 'contact'. Switches defined as 'alarm' require operator acknowledgement before being reset to the normal state. Switches defined as 'contacts' will reset automatically based on water level. The F4 key is used to display the next set of level switch setpoints.



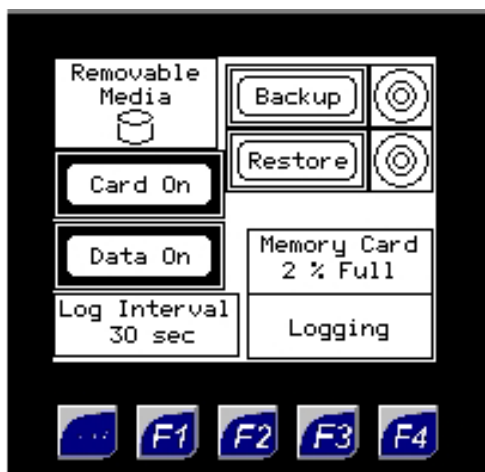
## PID Tuning Screen

This screen displays the PID control loop parameters for the feedwater valve. The operator can manually control the valve from this screen, as well as set the PID parameters and level control setpoint. On systems using two valves, each would be controlled by an independent PID loop.



## Data Logging Screen

This screen is for controlling the removable media (Micro SD card). The operator can enable or disable data logging and the memory card. The data logging needs to be disabled before removing the memory card. The data logging time interval can be adjusted on this screen as well. The time range is from 1 second to 3600 seconds (once per hour). The data logging status and disk usage are displayed. The operator can also backup and restore the PLC data registers.



### Password Entry Screen

This screen is for entering passwords to access secured screens.



### Alarm Summary and History Screens

The Alarm Summary screen displays the current alarms for the system. Each alarm is time stamped. The operator may also acknowledge alarms at this screen. The F4 button is used to access the Alarm History screen. This screen displays a historical record of all alarms and the time they were acknowledged.





### 3.5-Control Panel

**HMI Display** – The PLC has a built-in screen display. It shows all the information pertaining to the LCS system and is the means for operator interface to the PLC. All operating parameters are entered and/or adjusted via this interface.

**Power Supplies** – The 24 VDC power supply mounted on the back panel provides power to the PLC/HMI.

**Relays** – The relays provide dry contacts for use by the customer.

**Circuit Breaker/Fuse Blocks** – These provide protection from electrical shorts caused by improper wiring or damaged electrical equipment.

**Transformer** – This device is used on installations that require 24 VAC power to operate the valves. The transformer steps down the 120 VAC power to 24 VAC for use by the valve actuator.

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## CHAPTER 4 — PLACING SYSTEM INTO OPERATION

It is suggested the following sequence be used when the LCS150e.1 is started for the first time.

If, at any time, the expected result is not obtained, see the troubleshooting chapter.

Before applying power to the unit inspect all wiring.

### 4.1-Supplying Power to the System

Check that the supplied voltage is 120 VAC (+/- 10%). Turn on the main power breaker. Turn on the main power switch. The PLC will power up and the HMI will display the Main Menu screen.

### 4.2-System Setup and Configuration

The system needs to be configured to reflect the various options that have been selected for the installation.

#### A. Set System Options

1. Go to the Setup Screen Menu at the HMI by pressing the "Setup" button.
2. At the setup menu, press the "System Setup" button.
3. After entering the correct password, select "System Options"
4. If a secondary valve is used, enable it by pressing the 'Enable/Disable' button.
5. If a secondary valve is used, choose the type of setpoint it will use—'Independent' or 'Offset'. The 'Independent' selection will use a level setpoint that is independent of the primary valve level setpoint. The 'Offset' selection will calculate the secondary level control setpoint by subtracting an offset from the primary level control setpoint.
6. If Modbus data monitoring is desired, turn the Modbus port on by pressing the button. The Modbus address has a default value of 1. A different value may be entered at this screen.
7. Press 'F1' to return to the System Setup menu.

#### B. I/O Configuration/verification

1. Select "I/O Config" from the System Setup menu.
2. At the I/O Config menu, select the "Analog In Config" button.
3. Enter the appropriate parameters for the level transmitter. Typically the 'Raw' signal values will be 4 and 20 mA. The Scale values should correspond to the range of the transmitter in inches of water. The actual values for the input signal and the scaled signal are displayed.
4. Press 'F1' to return to the I/O Config menu.
5. Select the 'Analog Out Config' button.
6. The Scale Min and Max values should correspond to 0-100% open valve position. The 'Out Min' and 'Out Max' values correspond to the 4-20 mA modulation signal to the valve. Enter 0 for the 'Force Value' and verify that the valve travels to the 0% open position. Repeat with 50% and 100% open positions.
7. Press the 'F4' button to access the configuration screen for the second analog output. This output controls the secondary valve (if used) or a retransmission of the tank level signal.
8. Repeat step 6 to configure the second analog output.
9. Press 'F1' to return to the I/O Config menu.
10. Select the 'Digital I/O' button.

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11. Verify that the LWCO input is highlighted when the LWCO switch is made.
  12. Verify that the LWCO input is not highlighted when the LWCO switch is open.
  13. Press each of the DO buttons and verify that the correct relay changes state while the button is pressed. Relays that are off will turn on and relays that are on will turn off.
  14. Press 'F1' until the Main Menu is displayed.

#### C. Setpoint Entry

1. Select the 'SP & Tuning' button.
2. After entering the correct password, select the 'Setpoint Config' button.
3. Enter the water level setpoint for the LWCO soft switch.
4. Enter the level differential that the system will use to reset the switch state.
5. Enter the desired time delay before the system sets the switch when the water level passes setpoint.
6. Select 'Alarm' or 'Contact' for the level switch. Switches defined as alarms will remain set until the condition clears and the operator acknowledges the alarm. Switches defined as contacts will clear automatically when the water level passes the setpoint differential point.
7. Repeat for each level switch. Press the 'F4' button to access the next set of level switches.
8. After all level switch setpoints have been set, press the 'F1' button to return to the Setpoint and Tuning menu screen.

#### D. PID Loop Setup

1. Select the 'Primary Valve PID' button.
2. A trend of water level and setpoint is displayed. The PID loop is toggled between 'Manual' and 'Auto' modes by pressing the 'Auto/Manual' button. When in manual mode, the valve may be forced to a specified position. The position is entered by touching the 'Out' value and entering the desired valve position with the numeric keypad. Verify that the valve responds to the manual commands.
3. Enter the setpoint to be maintained by the PID control loop.
4. Place the system in Auto mode for normal operation.
5. Enter values for the P and I parameters. In general, larger values cause the loop to respond faster to water level deviations from setpoint, and smaller values will cause the loop to respond more slowly.
6. Adjust P and I parameters for proper valve operation and control of level.
7. Press the 'F1' button to return to the Main menu.

On systems equipped with two water valves, a secondary valve will also act to control water level to a setpoint. This valve acts as a backup to the primary valve. The setpoint of the secondary valve is typically set lower than that of the primary valve.

#### E. Acknowledge alarms

1. From the Main Menu screen, select "Alarm".
2. If any alarms are indicated on the Alarm Summary screen, they may be acknowledged by touching the alarm summary and pressing the 'Ack' or 'Ack All' button.
3. Press the 'F1' button to return to the Main menu.

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## CHAPTER 5 — MAINTENANCE AND TROUBLESHOOTING

Under normal operating circumstances the LCS150e.1 requires little maintenance. See table below for basic troubleshooting.

### Basic Troubleshooting

Problem	Possible Cause	Action
No display at HMI	Power Failure	Check supply voltage to the panel is 120 VAC +/- 10% Check supply voltage to the HMI is 24 VDC
	Tripped circuit breaker or blown fuse	Check circuit breaker and fuses inside the control panel. 24 VDC power supply should have a green LED to indicate power
I/O Failure Alarms	Blown Fuse/Power Failure	Check that the 24 VDC power supply is on. A green LED should be lit to indicate power. Replace fuse or power supply if necessary.
	Signal Polarity Reversed	Check signal from the transmitter. Verify that the transmitter is wired correctly. Reverse the signal wires if necessary.
	Transmitter Problem	Check signal from the transmitter. Verify that the signal corresponds to the water level in the tank. Ensure float is installed in correct orientation. Ensure transmitter sensor is 180 degrees opposite the indicator flag assembly. Replace transmitter if necessary.
Valve not controlling level	Valve not moving	Check that 24 VAC power is at the valve. Verify that the correct control signal is at the valve. Correct wiring problems or replace transformer if necessary.
	PID signal to valve not changing	Verify that the PID loop is in Auto mode. Verify that values are entered for the PID parameters.

















