

# WaterGard™ LLC water level control

INSTALLATION - OPERATION

10000022848 ISSUED 2/2024

READ AND UNDERSTAND THIS MANUAL PRIOR TO OPERATING OR SERVICING THIS PRODUCT.



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## contents

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### Note

***This manual contains vital information for the proper installation and operation of the WaterGard ready LLC controls. Carefully read the manual before installation or operation and follow all instructions. Save this manual for future reference.***

Description .....	4
Operation.....	6
Control Panel Internal Components .....	6
Electrode Probe Assembly .....	7
Water Makeup Function .....	7
HAND-OFF-AUTO Switch.....	7
WaterGard System.....	8
Single WaterGard Unit, Single LLC .....	9
Two to Four WaterGard Units, Single LLC .....	9
Five to Seven WaterGard Units, Single LLC.....	10
Single WaterGard Unit, Multiple LLCs.....	12
Two to Four WaterGard Units, Multiple LLCs .....	13
Multiple WaterGard Units, Multiple LLCs.....	13
Troubleshooting.....	15
Configuration Schematics .....	16

***The following defined terms are used throughout this manual to bring attention to the presence of hazards of various risk levels, or to important information concerning the life of the product.***

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### ⚠ Warning

***Indicates presence of a hazard which can cause severe personal injury, death or substantial property damage if ignored.***

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### ⚠ Caution

***Indicates presence of a hazard which will or can cause personal injury or property damage if ignored.***

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### Note

***Indicates special instructions on installation, operation or maintenance which are important but not related to personal injury hazards.***

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## introduction

These instructions are intended to assure that field connections are completed properly and the control system operates for the maximum time possible. Since product warranty may depend on your actions, please read these instructions thoroughly prior to operation. Additionally separate WaterGard and LLC user manuals are provided with additional detail for those specific products.

If you have questions about the operation and/or maintenance of this control system and you do not find the answers in this manual, please contact your Marley sales representative.

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### Warning

***Hazard of electrical shock or burn. Be sure to turn off power to the panel before servicing. If working on equipment out of site of panel disconnect, lockout using standard lockout procedure.***

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### Safety First

The Marley control system uses UL listed components installed in accordance with the NEC (National Electric Code). The location of the cooling tower and field installation of the control system can affect the safety of those responsible for installing, operating or maintaining the tower and controls. However, since SPX Cooling does not control the tower location, or field installation, we cannot be responsible for addressing safety issues that are affected by these items.

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### Warning

***The following safety issues should be addressed by those responsible for installation, maintenance or repair of the tower and controls:***

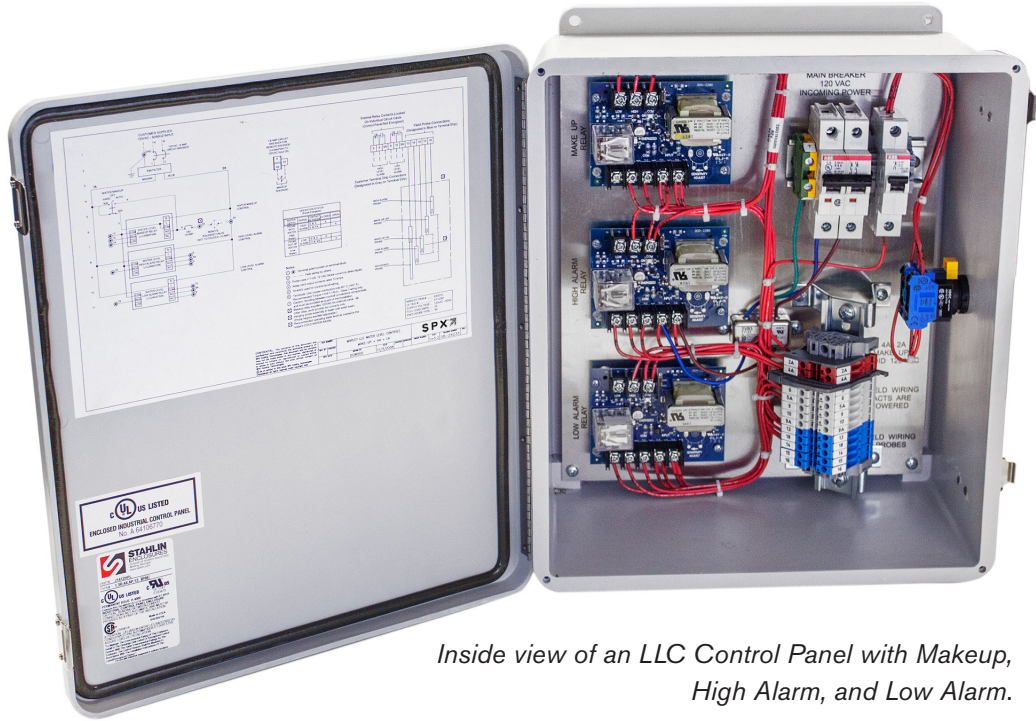
- Provide access to the control panel (including user supplied main disconnect/branch circuit protection.
- Ground all electrical control circuits to national and local electrical codes.
- Sizing and protection of branch circuits feeding the control panel to national and local electrical codes.
- Only qualified and trained technicians should install, maintain and service cooling tower electrical equipment.

These are only some of the safety issues that may arise in the design and installation process. SPX Cooling strongly recommends that you consult a safety engineer to be sure that all safety considerations have been addressed.

Other safety issues are addressed in literature supplied with your tower. You should closely review the literature prior to installing, maintaining or repairing your cooling tower.

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description



*Inside view of an LLC Control Panel with Makeup, High Alarm, and Low Alarm.*

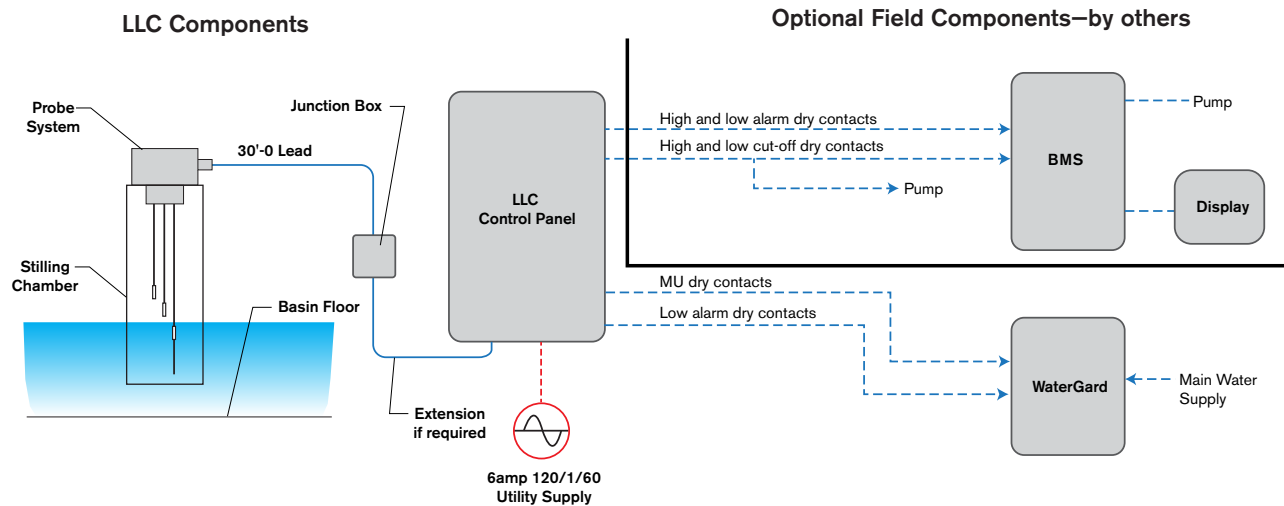
**Note: If the control panel is furnished with a water makeup selector switch, the switch will be located on the right-hand side of the enclosure.**

**HAND** Position: Solenoid will energize. **OFF** Position: Solenoid is de-energized

**AUTO**: Solenoid will operate depending on water level in relation to water level probe height.

# description

## SYSTEM DIAGRAM



The Liquid Level Control systems are used to accomplish five different functions:

- Water Makeup
- Low Water Alarm
- Low Water Cutoff
- High Water Alarm
- High Water Cutoff

The most common application of a water level control system is water makeup. The system regulates the amount of water in the tower basin and keeps it within normal operating levels. This makeup system is used to control a remotely installed water solenoid valve. When the water level drops below a prescribed, preset level, the solenoid valve is energized by the control system to fill the basin to its proper level.

High and low water alarms can be utilized to give warnings associated with abnormal operating water levels. To provide indication of these types of alerts, the control system provides dry contacts to interface with various digital control systems or can be connected to user supplied alarm indicators to signal when corrective action is required.

Low-water cutoffs are commonly used to protect pumps from operating without sufficient water. When used in unattended operating environments, the low-water cutoff is configured to shut the pump off, thus preventing costly repairs. Dry contacts can be wired directly in series with pilot duty controls or to digital control systems to initiate the shutdown of protected equipment during low-water situations.

The Marley LLC water level system is integrated with the Marley WaterGard inlet filtration system to maintain healthy cooling tower water conditions by removing dissolved solids in the make-up water.

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# installation

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## Operation

The LLC (liquid level controller) water level control system consists of special purpose liquid sensing relays on one or more individual circuit cards connected to a probe assembly located in the cold-water basin. Each circuit card contains one relay and external signaling is provided by each of these special purpose cards. The individual relay provides a Form C normally open and normally closed dry contact. The circuit card activates the relay using through-the-water continuity by way of the sensor probes located in the cold-water basin of the cooling tower.

Utilizing water's ability to conduct electricity, a circuit path can be established between one probe tip and the other. Current conducts through the water across probes of dissimilar length. One common or reference probe is present in all systems and is shared by all functions of the system. This probe can be identified by its length. It is the longest probe in the system and extends the deepest into the basin. The current path is routed between all other probe tips and this one common. When the water level reaches the shorter probe, the circuit is completed and the relay responds, opening or closing relay contacts corresponding to a fixed level. For low-level control, the ground reference probe and a slightly shorter probe provide the circuit. When the water level drops below this tip, the continuity between this probe and the reference probe is interrupted and the relay contacts transfer. The distance from the tip of the low probe to the floor of the basin determines the minimum water level that is allowed before an alarm is produced or pump operation is interrupted.

WaterGard ready LLC systems have terminal connections to communicate the makeup and low-level alarm status. The three card version of the LLC control panel has Makeup, High level alarm and Low level alarm status signals connected to the basin probes. When adjusting water event levels on LLC systems, hanging probes are manually adjusted up or down within the metal stilling chamber.

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## Control Panel Internal Components

WaterGard ready LLC control panels are built to UL and cUL standards and are designed to provide the numerous configurations needed for cooling tower applications. All panels include a main circuit breaker to protect the entire panel. When the system includes a water makeup circuit an additional circuit breaker is provided along with a HAND-OFF-AUTO to control the mode of operation. The additional circuit breaker provides an exclusive control circuit for a 120VAC water solenoid valve. High and low circuit relay cards and the

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## installation

appropriate terminal connections comprise the rest of the components necessary for the specific configuration. The raised terminal strip provides easy access to make the connections of the water probe assembly.

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### **Stainless Steel Electrode Probe Assembly**

The electrode probe tips are stainless steel suspended from a noncorrosive PVC enclosure box with 30 feet of wire for each probe. A galvanized or stainless steel stilling chamber is installed around the probes to calm the water for accurate readings.

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### **Water Makeup Function**

The LLC is designed with a dedicated circuit breaker for direct connection to a 110-120VAC makeup water solenoid valve. This added feature allows installation without having to provide an additional power circuit to energize the solenoid. The makeup solenoid wiring should be connected to terminals 2A and 4A as represented on the control's specific wiring diagram.

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### **Purpose and Function of the HAND-OFF-AUTO Switch**

Located on the right side of the control's enclosure is a HAND-OFF-AUTO switch. This switch is used primarily at cooling tower startup and in maintenance procedures where the tower basin is empty or has been drained. When the tower's basin needs to be manually filled, the switch is placed in the HAND position. This selection bypasses the probe assembly's feedback and directly energizes the solenoid valve connected to the water supply. Once the cooling tower basin is filled, the switch is placed in the AUTO position to allow the adjusted probe assembly to monitor and sustain the proper operating level. Placing the switch in the OFF position completely interrupts any monitoring or fill action normally provided by the LLC control panel. Normal tower operation depends upon the HAND-OFF-AUTO switch being positioned in the AUTO mode.



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# installation

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## **WaterGard System**

WaterGard is a membrane-based dissolved-solids rejection unit. The systems are built on factory assembled skids that consist of a controller, pump, sediment filter, membrane filters and an optional granular activated carbon (GAC) fluidized bed for pre-treatment.

WaterGard units require two signals from the LLC system:

- Demand for makeup water
- Status indicator of Low-Level alarm.

Status signals are provided on LLC control panel at clearly marked terminal blocks allowing for easy connection in the field. When the LLC generates a water makeup signal, the WaterGard system opens the water supply solenoid and activates an internal pump to filter makeup water for the cooling tower. If the LLC activate a low-level alarm, the WaterGard will activate a second solenoid that bypasses the filters for faster water makeup capability to maintain proper water collection basin depth for the cooling tower to run effectively.

WaterGard ready LLC systems are available in two arrangements. The three card version allows for makeup and low-level alarm. The five card version provides signals for high cut off, high alarm, makeup, low alarm, and low cut off. Follow the drawing found inside the LLC panel enclosure door for connection of the hanging probes to the LLC control panel.



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# installation

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## Configuration 1—Single LLC - Single WaterGard Unit

**Principle of operation:** When a LLC controller is connected to a single WaterGard unit, water makeup is controlled by the WaterGard control systems. Two sets of dry contacts are present in each LLC panel, one for connection to makeup command in the WaterGard, a second for WaterGard bypass if a low alarm in the LLC is activated. When a single cooling tower connected to a single WaterGard unit system there is no need for a solenoid valve in the water piping between the LLC and the WaterGard therefore terminal connection points for makeup solenoid in the LLC do not need to be connected.

**Wiring and plumbing connections:** Refer to **Table 1** and the schematic in this manual for Configuration 1.

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**Table 1**

LLC Terminal	WaterGard Terminal
Double end arrow indicates the connection between the two terminal blocks	
E81-1 ←	→ E81
E82-2 ←	→ E82
E11-1 ←	→ E11
E52-1 ←	→ E52

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**Note**

***The solenoid terminals in LLC panel will not be connected. Water basin supply pipe is directly connected to the WaterGard outlet.***

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## Configuration 2A—Single LLC - Two to Four WaterGard Units

**Principle of operation:** When a single LLC controller is connected to a multiple (four or less) WaterGard units, water makeup is provided by all WaterGard units at the same time. Up to four sets of dry contacts are present in each LLC panel. One of these single sets from the LLC panel will connect with the corresponding points in one of the WaterGard units. This technique will allow for up to four sets of contacts for makeup and four sets for low level alarm. In this arrangement terminal point connections for makeup solenoid in the LLC will not be utilized.

**Wiring and plumbing connections:** Refer to **Table 2** and the schematic in this manual for Configuration 2A.



# installation

LLC Terminal	WaterGard 1 Terminal	WaterGard 2 Terminal	WaterGard 3 Terminal	WaterGard 4 Terminal
Double end arrow indicates the connection between the two terminal blocks				
E81-1	←→ E81			
E82-1	←→ E82			
E11-1	←→ E11			
E52-1	←→ E52			
E81-2	←→	→ E81		
E82-2	←→	→ E82		
E11-2	←→	→ E11		
E52-2	←→	→ E52		
E81-3	←→		→ E81	
E82-3	←→		→ E82	
E11-3	←→		→ E11	
E52-3	←→		→ E52	
E81-4	←→			→ E81
E82-4	←→			→ E82
E11-4	←→			→ E11
E52-4	←→			→ E52

**Table 2**

This connection pattern can be duplicated for up to four WaterGard units. Water basin supply is directly connected to WaterGard outlet.

## Configuration 2B—Single LLC - Five to Seven WaterGard Units

**Principle of operation:** When a single LLC controller is connected to a multiple (more than four) WaterGard units, water makeup is provided by all WaterGard units at the same time. Five sets of dry contacts are present in each LLC panel along with an available expansion relay box powered from the primary LLC controller to support an additional four WaterGard units. If more than five WaterGard systems are necessary, one additional external relay box can be included to add additional relays in groups of four relays. Consult your Marley sales representative if a system requires more than 13 WaterGard units to be powered from a single LLC controller.

**Wiring and plumbing connections:** Refer to **Table 3** and the schematic in this manual for Configuration 2B.

Water basin supply is directly connected to WaterGard outlet.

# installation

LLC Terminal	WaterGard 1 Terminal	WaterGard 2 Terminal	WaterGard 3 Terminal	WaterGard 4 Terminal	WaterGard 5 Terminal	External Relay Box	WaterGard 6 Terminal	WaterGard 7 Terminal	
Double end arrow indicates the connection between the two terminal blocks									
E81-1	←→	E81							
E82-1	←→	E82							
E11-1	←→	E11							
E52-1	←→	E52							
E81-2	←	→	E81						
E82-2	←	→	E82						
E11-2	←	→	E11						
E52-2	←	→	E52						
E81-3	←		→	E81					
E82-3	←		→	E82					
E11-3	←		→	E11					
E52-3	←		→	E52					
E81-4	←			→	E81				
E82-4	←			→	E82				
E11-4	←			→	E11				
E52-4	←			→	E52				
E81-5	←				→	E81			
E82-5	←				→	E82			
E11-5	←				→	E11			
E52-5	←				→	E52			
LA COIL	←					→	LA COIL		
2A	←					→	2A		
MU COIL	←					→	MU COIL		
2A	←					→	2A		
						E81-X1	←→	E81	
						E82-X1	←→	E82	
						E11-X1	←→	E11	
						E52-X1	←→	E52	
						E81-X2	←	→	E81
						E82-X2	←	→	E82
						E11-X2	←	→	E11
						E52-X2	←	→	E52
LA COIL (low alarm status) - 2A (low alarm status)   MU COIL (makeup status) - 2A (makeup status)									

**Table 3**

# installation

## Configuration 3—Single WaterGard Unit - Multiple LLCs

**Principle of operation:** When multiple cooling towers each having an individual LLC connected to a single WaterGard system, the individual cooling tower’s local water makeup solenoid will be used to allow makeup water into the cooling tower water collection basin from the WaterGard unit at each individual cooling tower. Makeup statuses are connected in parallel allowing each LLC to send individual signals. The Low Alarm status is connected in series to require the WaterGard unit to bypass the WaterGard system when required. Both connections will route through the closest LLC system to the WaterGard unit. If connecting more than three LLC systems please consult your Marley sales representative.

**Wiring and plumbing connections:** Refer to **Table 4** and the schematic in this manual for Configuration 3.

LLC 1 Terminal	LLC 2 Terminal	LLC 3 Terminal	WaterGard Terminal
Double end arrow indicates the connection between the two terminal blocks			
E81-1	← → E81-1		
E82-1	← → E82-1		
	E81-1	← → E81-1	
	E82-1	← → E82-1	
		E81-1	← → E81
		E82-1	← → E82
E11-1	← →		E11
E52-1	← → E11-1		
	E52-1	← → E11-1	
		E52-1	← → E52

**Table 4**

# installation

## Configuration 4A—Multiple LLCs - Two to Four WaterGard Units

Table 5 shows three LLCs and four WaterGard units. This scheme can be repeated for up to five WaterGard units in the system.

**Wiring and plumbing connections:** Refer to **Table 5** and the schematic in this manual for Configuration 4A.

LLC 1 Terminal	LLC 2 Terminal	LLC 3 Terminal	WaterGard 1 Terminal	WaterGard 2 Terminal	WaterGard 3 Terminal	WaterGard 4 Terminal
Arrows indicate the connection between the two terminal blocks						
E81-1 ←	→ E81-1 ←	→ E81-1 ←	→ E81			
E82-1 ←	→ E82-1 ←	→ E82-1 ←	→ E82			
E11-1 ←			→ E11			
E52-1 ←	→ E11-1					
	E52-1	E11-1 ←	→ E52			
E81-2 ←	→ E81-2 ←	→ E81-2 ←	→ E81			
E82-2 ←	→ E82-2 ←	→ E82-2 ←	→ E82			
E11-2 ←			→ E11			
E52-2 ←	→ E11-2					
	E52-2 ←	→ E11-2 ←	→ E52			
E81-3 ←	→ E81-3 ←	→ E81-3 ←			→ E81	
E82-3 ←	→ E82-3 ←	→ E82-3 ←			→ E82	
E11-3 ←					→ E11	
E52-3	E11-3					
	E52-3 ←	→ E11-3 ←			→ E52	
E81-4 ←	→ E81-4 ←	→ E81-4 ←				→ E81
E82-4 ←	→ E82-4 ←	→ E82-4 ←				→ E82
E11-4 ←						→ E11
E52-4 ←	→ E11-4					
	E52-4 ←	→ E11-4 ←				→ E52

**Table 5**

## Configuration 4B—Multiple LLCs - Multiple WaterGard Units

Table 6 shows three LLCs and nine WaterGard units.

**Wiring and plumbing connections:** Refer to **Table 6** and the schematic in this manual for Configuration 4B.



LLC 1 Terminal	LLC 2 Terminal	LLC 3 Terminal	WG 1 Terminal	WG 2 Terminal	WG 3 Terminal	WG 4 Terminal	WG 5 Terminal	Relay Box 1	Relay Box 1	Relay Box 1	WG 6 Terminal	WG 7 Terminal
Double end arrow indicates the connection between the two terminal blocks												
LA COIL								LA COIL				
2A								2A				
CU COIL								CU COIL				
2A								2A				
	LA COIL							LA COIL				
	2A							2A				
	CU COIL							CU COIL				
	2A							2A				
		LA COIL								LA COIL		
		2A								2A		
		CU COIL								CU COIL		
		2A								2A		
E81-1	E81-1	E81-1	E81									
E82-1	E82-1	E82-1	E82									
E11-1			E11									
E52-1	E11-1											
	E52-1	E11-1										
		E52-1	E52									
E81-2	E81-2	E81-2	E81									
E82-2	E82-2	E82-2	E82									
E11-2			E11									
E52-2	E11-2											
	E52-2	E11-2										
		E52-2	E52									
E81-3	E81-3	E81-3	E81									
E82-3	E82-3	E82-3	E82									
E11-3			E11									
E52-3	E11-3											
	E52-3	E11-3										
		E52-3	E52									
E81-4	E81-4	E81-4	E81									
E82-4	E82-4	E82-4	E82									
E11-4			E11									
E52-4	E11-4											
	E52-4	E11-4										
		E52-4	E52									
E81-5	E81-5	E81-5	E81									
E82-5	E82-5	E82-5	E82									
E11-5			E11									
E52-5	E11-5											
	E52-5	E11-5										
		E52-5	E52									
								E81-X1	E81-X1			
								E82-X2	E82-X2			
								E81-X1	E81-X1			
								E82-X2	E82-X2			
								E81-X1	E81-X1	E81		
								E82-X2	E82-X2	E82		
								E11-X1		E11		
								E52-X1	E11-X1			
								E52-X1	E11-X1			
								E52-X1	E52-X1	E52		
								E81-X1	E81-X1			
								E82-X1	E82-X1			
								E81-X1	E81-X1	E81		
								E82-X1	E82-X1	E82		
								E11-X1		E11		
								E52-X1	E11-X1			
								E52-X1	E11-X1			
								E52-X1		E52		

**Table 6**

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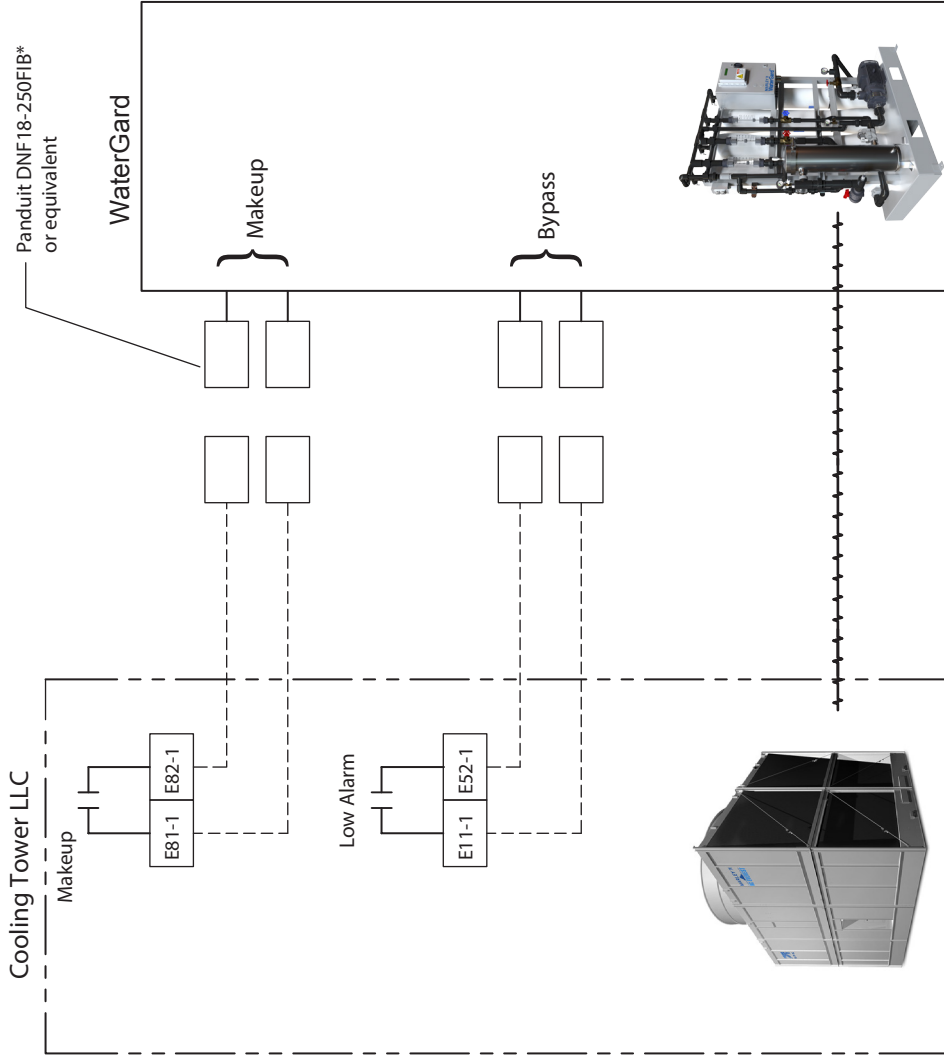
## troubleshooting

LLC control panels are tested before shipment to guarantee smooth installation and operation. Any potential issues outside of the control panel should be investigated prior to troubleshooting the control panel. Typically most issues are found in field wiring connections in the control panel. When troubleshooting the LLC controls, please verify the following:

- Both circuit breakers in the panel must be energized with the switches in the UP position (ON).
- Check water makeup selector switch position to verify proper position.
- Confirm the two sensor wires are installed correctly and properly connected at terminal points in the control panel. To properly verify the terminal connection, be sure the terminal connections does not land on the insulation of the sensor wire. Strip back just enough wire insulation so you can see some copper wire exposed assuring a metal-to-metal connection. Additionally, once the terminal connection is tightened on a wire, conduct a pull-test on the wire.
- The sensor wire is a shielded four conductor cable. The red and black wires connect to terminal points +24 and 13. Do not to cut back the shield wire. The shield wire connects to ground to eliminate potential noise for the sensor reading. Improper grounding of the shield wire may result in improper LLC operation. Always refer to the as-built wiring diagram on the inside control panel door for current connection points. Tape back the white and green wires that are not used.
- Check that the extension wires are numbered correctly and connections secure.
- If there are issues with sensor readings, moving any external power wiring so that it does not run parallel with the sensor wiring will help to reduce noise. Follow best-practice wiring for power and instrumentation wiring.
- Rotate the HAND-OFF-AUTO switch to the HAND position. The solenoid should energize allowing makeup water to flow directly to the cooling tower. The single-pole circuit breaker should be in the UP or ON position to energize the makeup solenoid.

**Configuration 1** — Single Cooling Tower LLC — Single WaterGard Unit

Makeup and Low Alarm signal wires from dry contacts connected to a dedicated single WaterGard. Only two pairs of wire (four wires in total) connect to the dedicated single WaterGard. On a single LLC and single WaterGard configuration the makeup solenoid is internal to the WaterGard unit.



- Legend**
- Customer wired connection
  - OEM wired connection
  - Piping

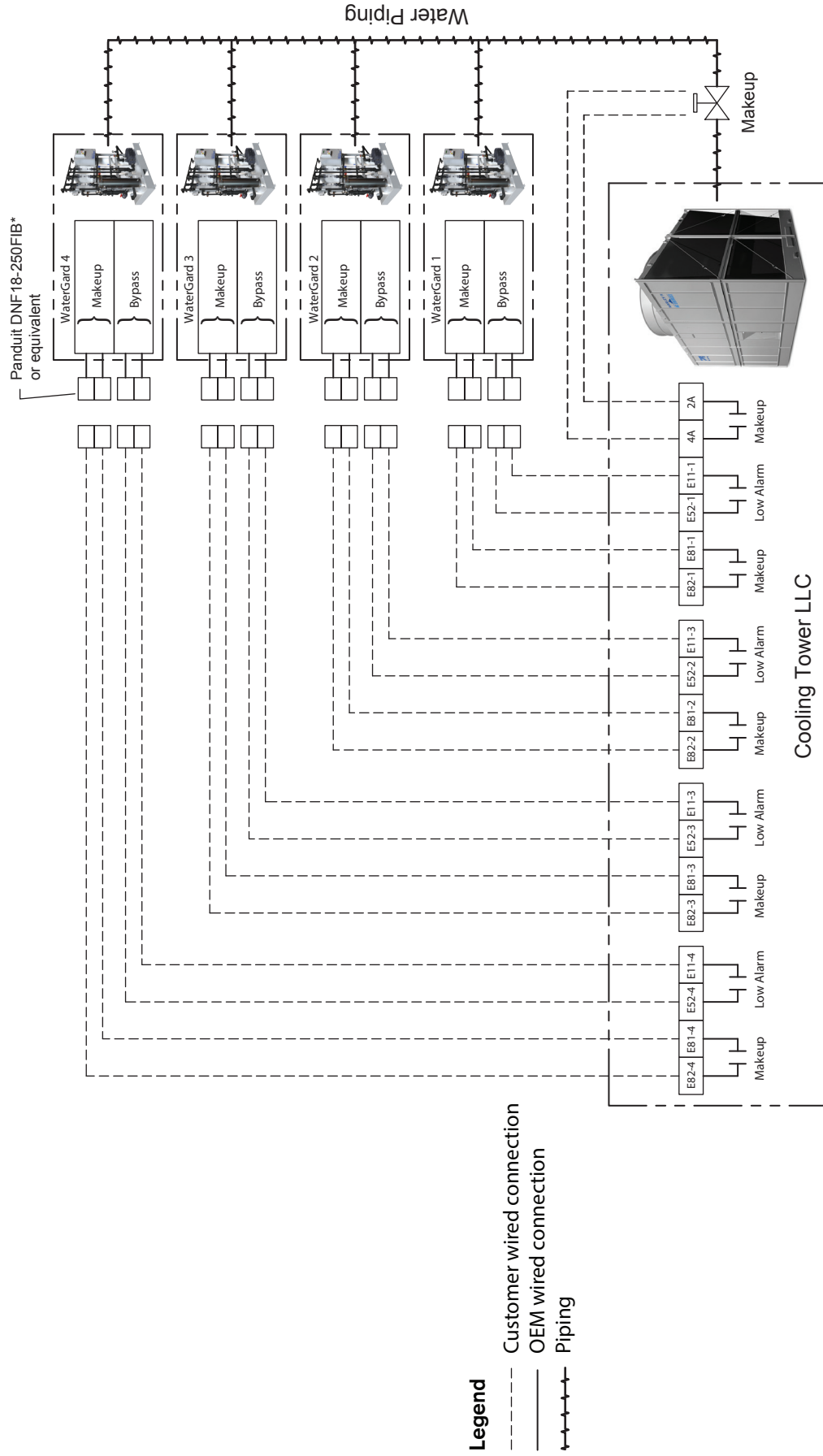
**Note**

- 1 Makeup and Low Alarm relays are shown in a de-energized state. Makeup NO contact will close when makeup water is being requested. Low Alarm NO contact will close when water level is below the Low Alarm water level.



**Configuration 2A** – Single Cooling Tower LLC – Two to Four WaterGard units

Makeup an Low Alarm signal wires from dry contacts connected directly to each LLC.  
 Only two pairs of wire (four wires in total) connect to the each WaterGard unit.  
 The basin water makeup solenoid on each LLC must be connected as illustrated for proper operation.

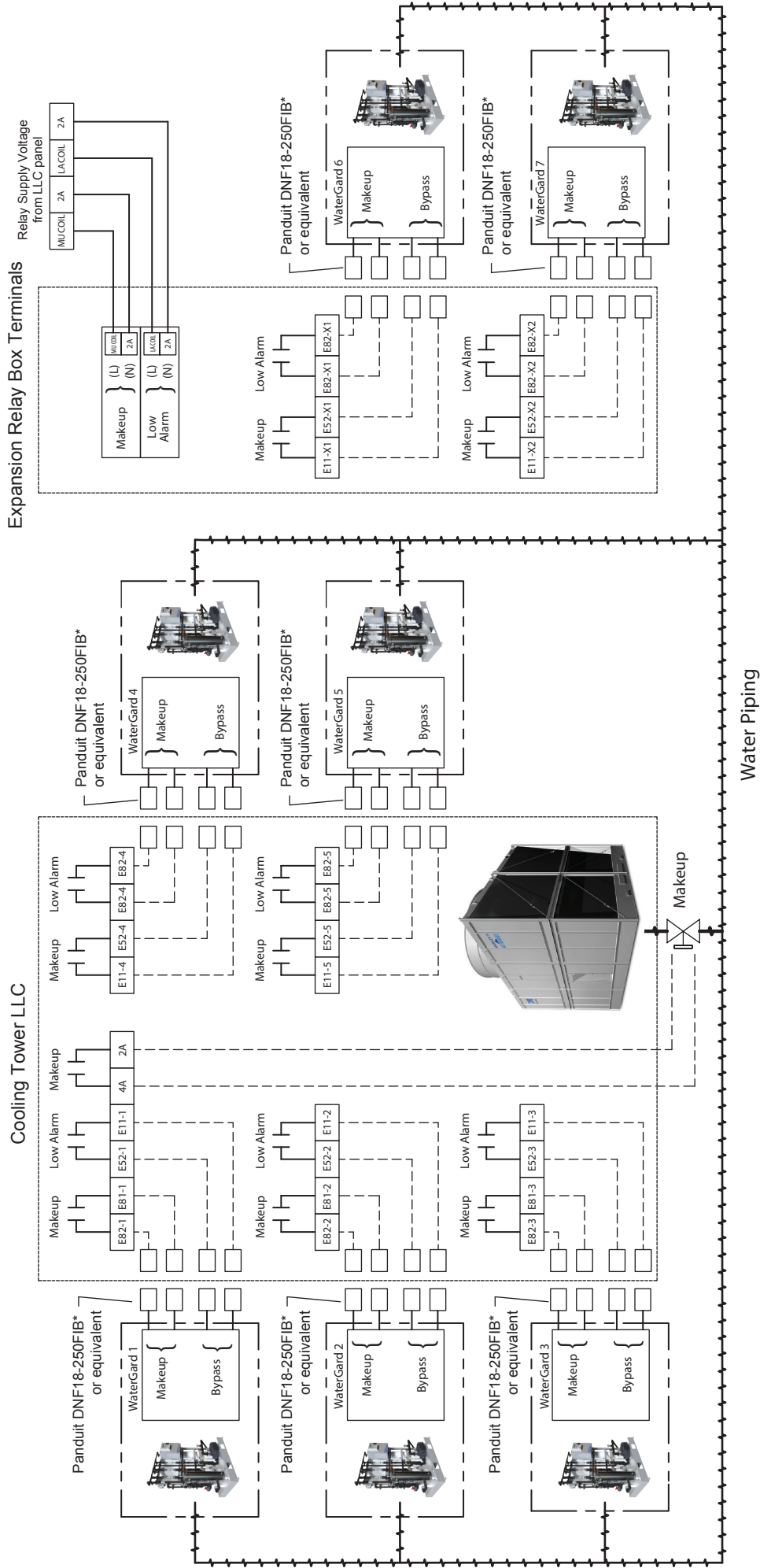


**Note**

- 1 A water makeup valve is optional at the water makeup connection to the cooling tower in this arrangement.
- 2 Makeup and Low Alarm relays are shown in a de-energized state. Makeup NO contact will close when makeup water is being requested. Low Alarm NO contact will close when water level is below the Low Alarm water level.

**Configuration 2B** — Single Cooling Tower LLC — Five to Seven WaterGard units with Expansion Relay

Makeup and Low Alarm signal wires from dry contacts in one LLC unit to dry contacts in the next. Only two pairs of wire (four wires in total) connect to the WaterGard unit. The basin makeup solenoid on a single LLC must be connected as illustrated for proper operation.



**Legend**

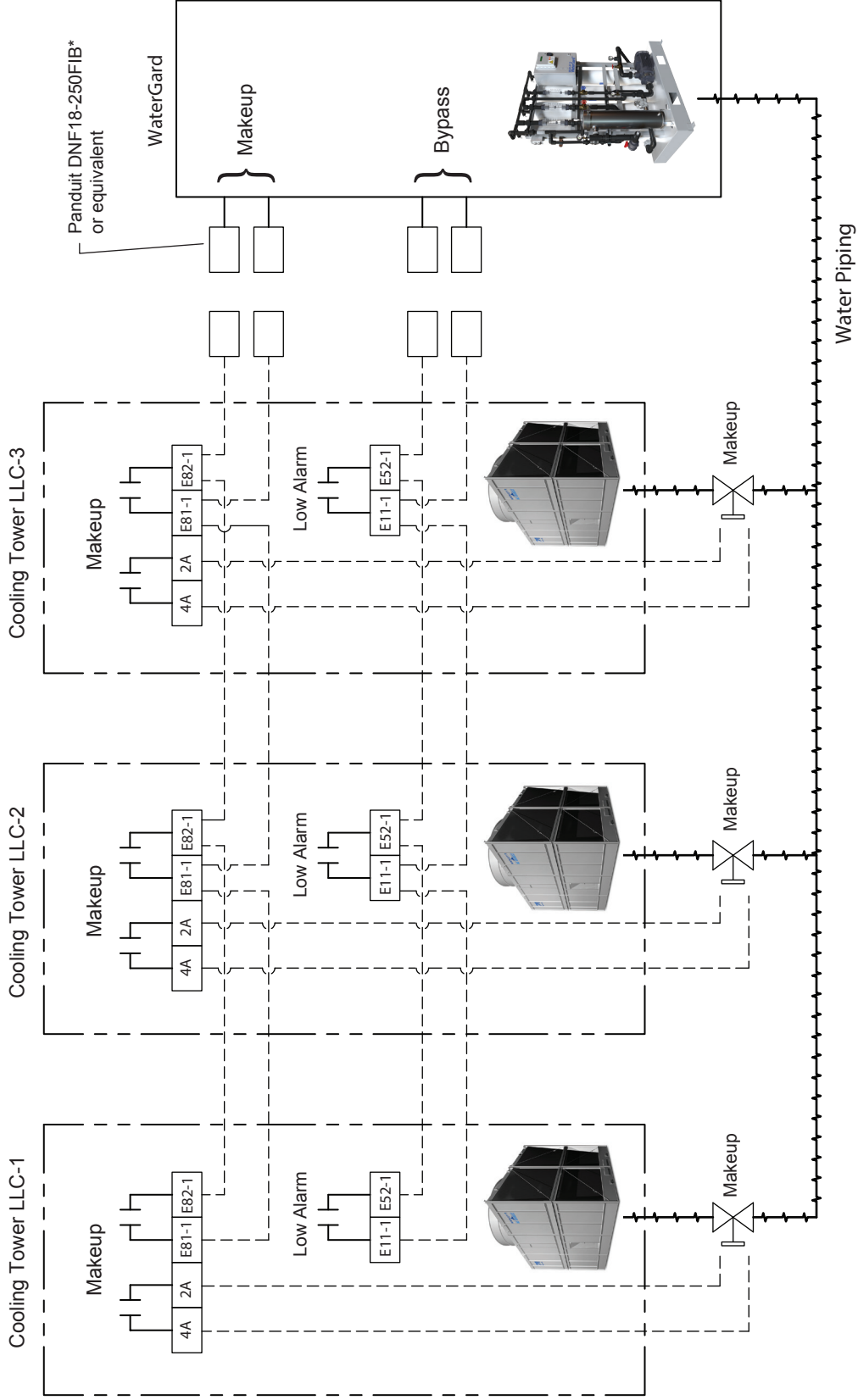
- Customer wired connection
- OEM wired connection
- Piping

**Note**

- 1 A water makeup valve is optional at the water makeup connection to the cooling tower in this arrangement.
- 2 Makeup and Low Alarm relays are shown in a de-energized state. Makeup NO contact will close when makeup water is being requested. Low Alarm NO contact will close when water level is below the Low Alarm water level.

**Configuration 3** — Multiple Cooling Tower LLC units — Single WaterGuard unit

Makeup and Low Alarm signal wires are daisy chained in parallel from dry contacts in one LLC to dry contacts in the next. Only two pairs of wire (four wires in total) connect to the WaterGuard unit. The basin makeup solenoid on each LLC must be connected as illustrated for proper operation.



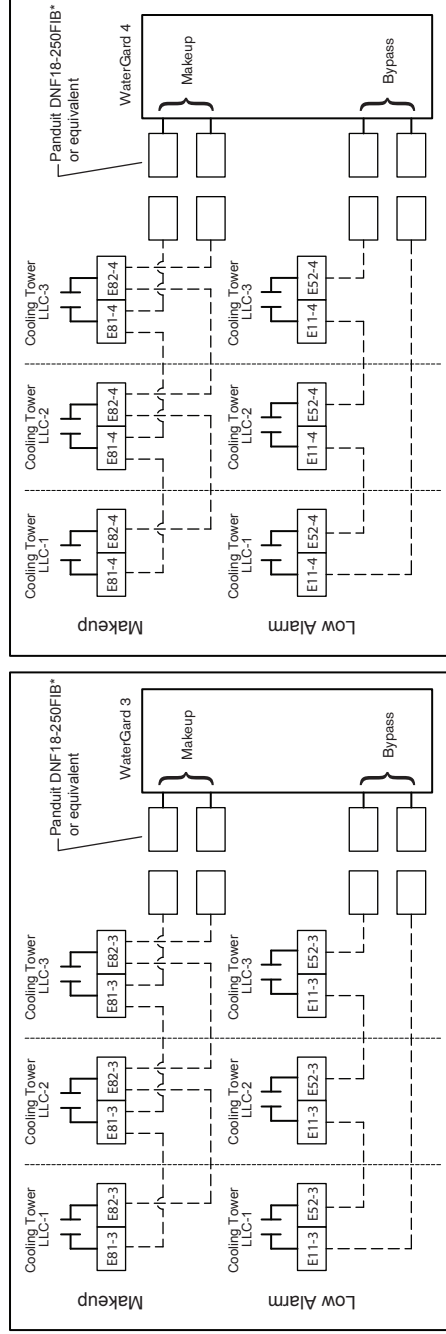
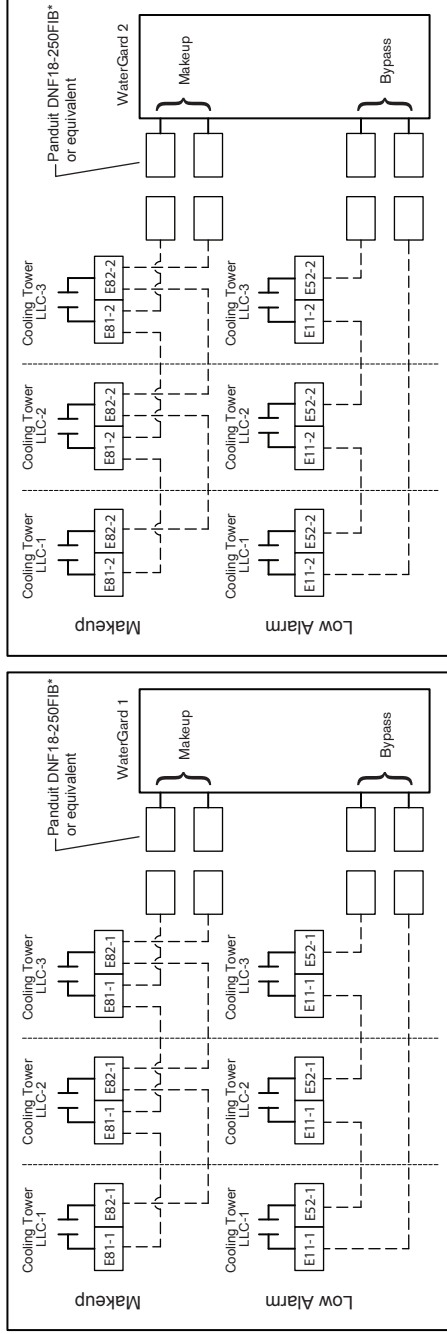
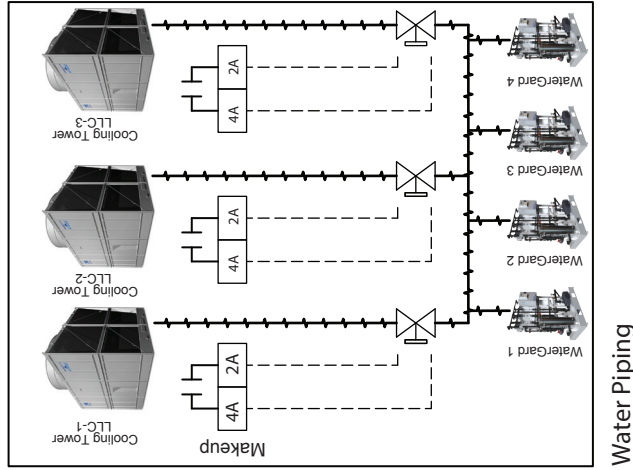
**Legend**

- Customer wired connection
- OEM wired connection
- +—— Piping

**Note**

- 1 A water makeup valve is optional at the water makeup connection to the cooling tower in this arrangement.
- 2 Makeup and Low Alarm relays are shown in a de-energized state. Makeup NO contact will close when makeup water is being requested. Low Alarm NO contact will close when water level is below the Low Alarm water level.

**Configuration 4A** – Multiple Cooling Tower LLC units - Two to Four WaterGard units  
 Makeup and Low Alarm signal wires are daisy chained in parallel from dry contacts in one LLC to dry contacts in the next. Only two pairs of wire (four wires in total), connect to the WaterGard. The basin makeup solenoid on each LLC must be connected as illustrated for proper operation.



**Electrical Wiring**

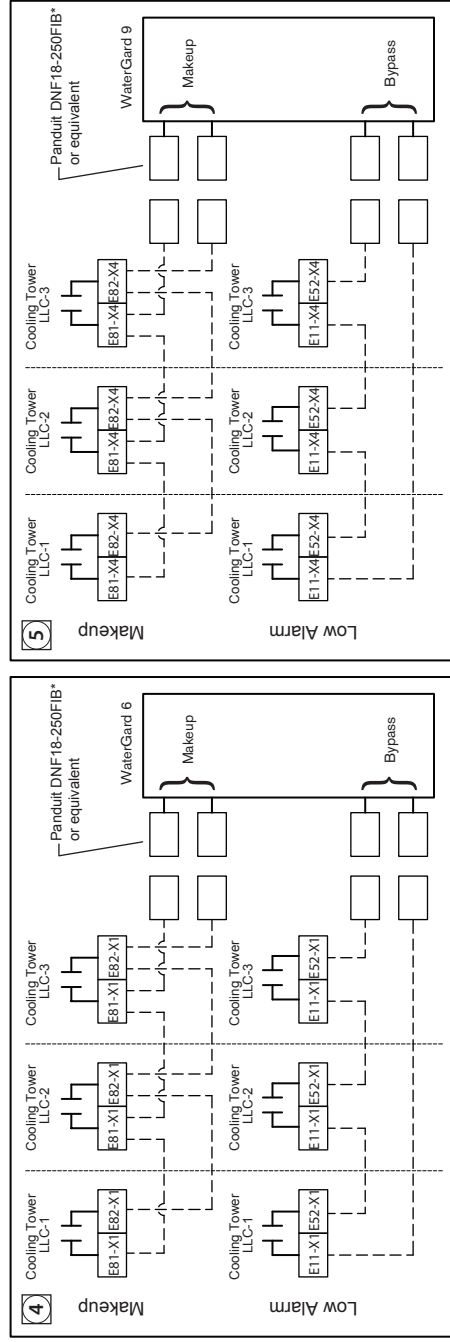
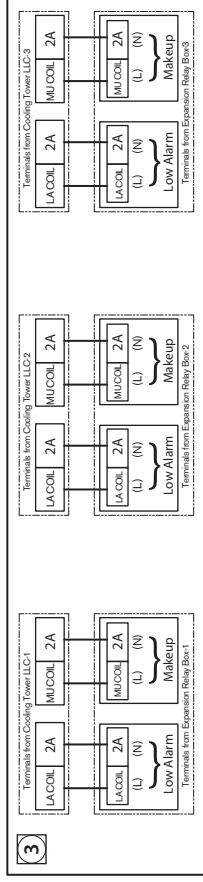
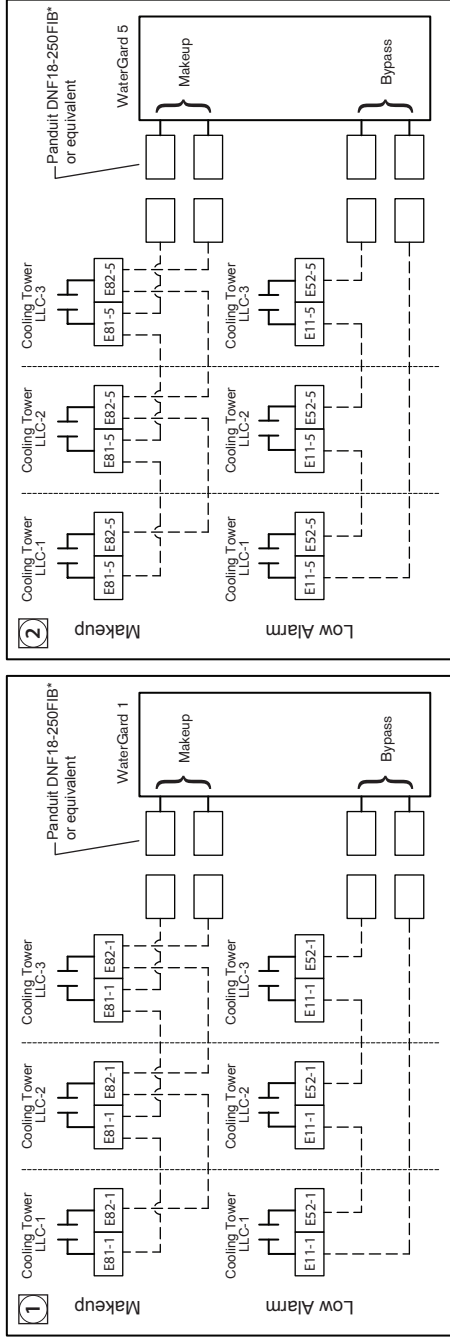
**Legend**

- Customer wired connection
- OEM wired connection
- +++++ Piping

**Note**

- 1 A water makeup valve is optional at the water makeup connection to the cooling tower in this arrangement.
- 2 Makeup and Low Alarm relays are shown in a de-energized state. Makeup NO contact will close when makeup water is being requested. Low Alarm NO contact will close when water level is below the Low Alarm water level.

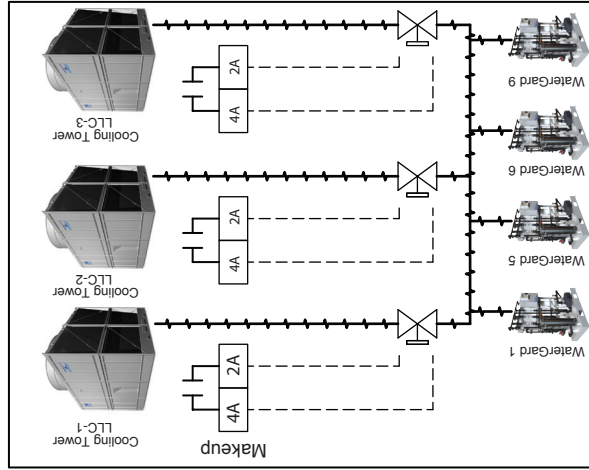
**Configuration 4B** — Multiple Cooling Tower LLC units - Multiple WaterGard units  
 Makeup and Low Alarm signal wires are daisy chained in parallel from dry contacts in one LLC to dry contacts in the next. Only two pairs of wire (four wires in total) connect to the WaterGard. The basin makeup solenoid on each LLC must be connected as illustrated for proper operation.



**Electrical Wiring**

**Note**

- 1 A water makeup valve is optional at the water makeup connection to the cooling tower in this arrangement.
- 2 Makeup and Low Alarm relays are shown in a de-energized state. Makeup NO contact will close when makeup water is being requested. Low Alarm NO contact will close when water level is below the Low Alarm water level.



**Water Piping**

**Note**

- 1 These sections represent connections from WaterGard 1 and 5, the same connections follow for WaterGard 2, 3 and 4.
- 2 This section represents the relay coil connections from Cooling Tower LLC to expansion relay box.
- 3 These sections represent connections from WaterGard 6 and 9, the same connections follow for WaterGard 7 and 8.





# WaterGard LLC water level control

USER MANUAL

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**SPX COOLING TECH, LLC**

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