

Pump Station Electrical Control Panel Training



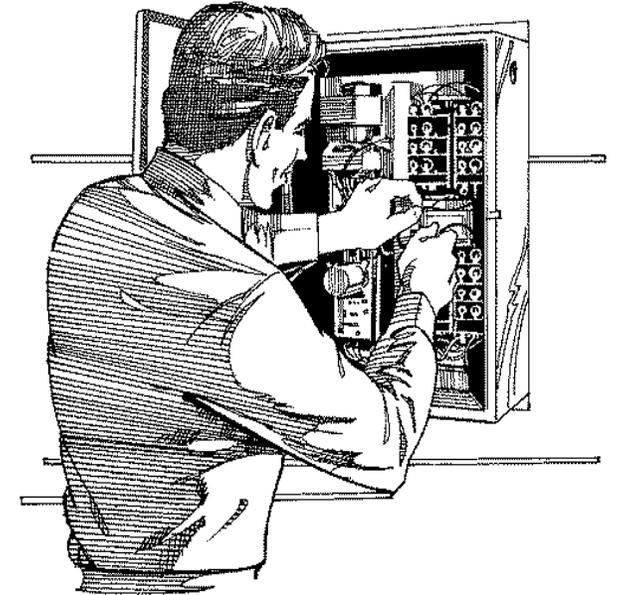
Course Objective

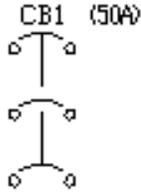
The objective of this class is to introduce class attendee's to the basic operation of electrical control panels and to provide a basic understanding of features and functions, which should aid in the operation, maintenance, and troubleshooting of typical wastewater pump control panels.



Training Agenda

- Identify electrical components in the control panel
- Identify electrical components on the schematics
- Explain the function of each component
- Discuss different types of level sensors
- Discuss basic control panel troubleshooting
- Draw a basic 230V, 3 Phase control panel schematic





Circuit Breakers

Molded Case - 3 Basic Types:

Thermal Magnetic

- Typically used as Main or Motor breakers

Magnetic Only (MCP - Motor Circuit Protector)

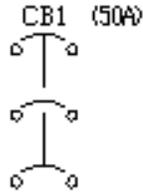
- Typically used as Motor Breaker Only

Molded Case Switches

- Used as Disconnect Device Only

- Circuit breakers are designed to protect electrical systems from damage caused by overloads, short circuits, and ground faults. A molded case circuit breaker is defined by the National Electrical Manufacturers Association (NEMA) as, "... a device assembled as an integral unit in supporting and enclosing housing of insulated material, designed to open and close a circuit by non-automatic means, and to open the circuit automatically on a predetermined over current, without injury to itself when properly applied within its rating."





F Frame



Q Frame

Circuit Breakers

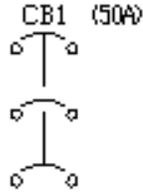
Thermal Magnetic

Characteristics: Most commonly used over current protection. Uses bimetal system to provide inverse time tripping for over current conditions and uses electromagnetic system to provide instantaneous tripping for short circuit conditions.

Sizing:

- For motors (UL) – 1.5 to 2.5 times actual amps
- For main (Typical) – Largest load X 1.5 plus all other loads
- For main (NEC) – 100% non-continuous load & 125% of Continuous load (80% of load when 3 hours or more)
- For main (UL) – 1.25 times actual amps



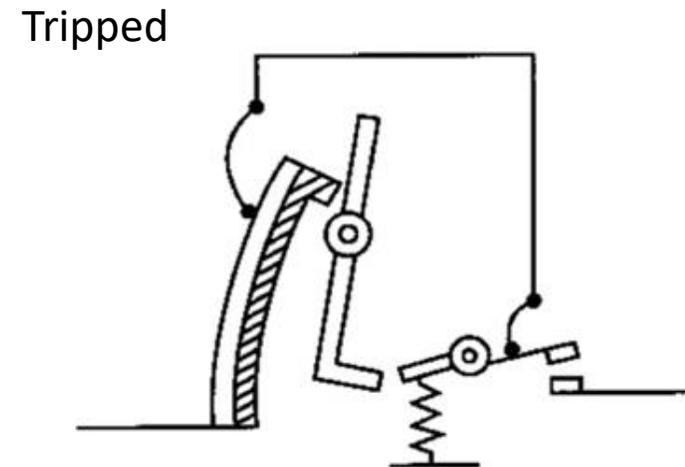
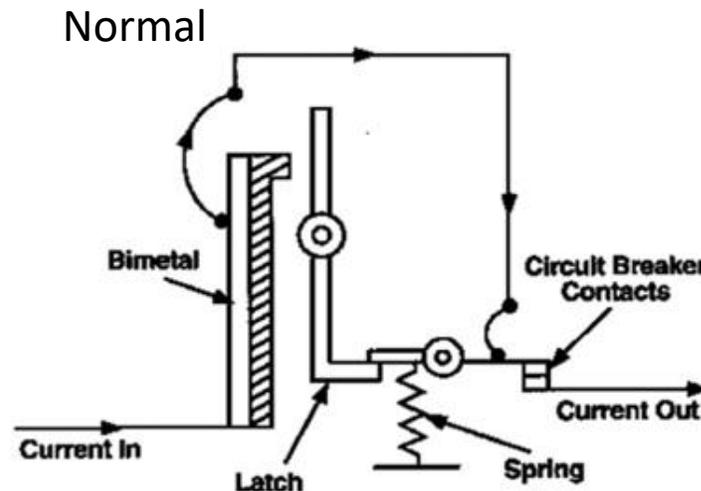


Circuit Breakers

Thermal Trip:

The bimetal thermal element is constructed from metals of dissimilar rates of expansion bonded together. The thermal portion responds to overloads by reacting to the heat generated both by the current flowing through the circuit breaker and by the heat contribution from the ambient conditions. The bending force of the bimetal causes the circuit breaker to trip. The deflection of the bimetal is predictable as a function of current and time.

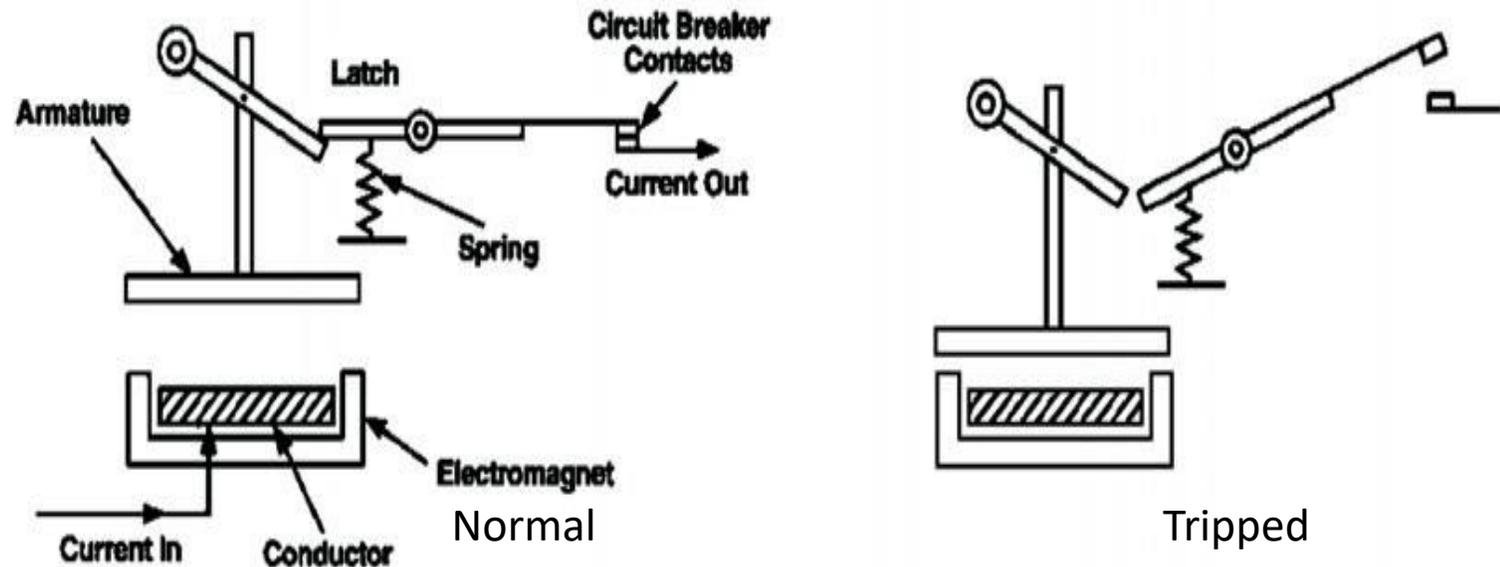
This is the inverse time tripping characteristics of the thermal element (i.e., the tripping time decreases as the magnitude of the current increases).



Circuit Breakers

Magnetic Trip:

- The magnetic (instantaneous) trip element uses an electromagnetic assembly, in series with the load current, to trip the circuit breaker instantaneously (with no intentional delay) at or above a predetermined current value. During a short circuit of significant magnitude, the high level current passing through the conductor rapidly increases the magnetic field of the electromagnet which attracts the armature.
- As the armature is drawn toward the electromagnet, it initiates an unlatching action and opens the circuit breaker contacts.



Circuit Breakers

- MCP (Motor Circuit Protector)

Characteristics: Designed as disconnect device for use in combination with motor starters. Provides adjustable Amps setting to open instantaneously at current values lightly above the motor starting inrush current. Does not use thermal detection elements (bimetals), therefore, they provide short circuit protection only. Also, they are not affected by ambient temperatures, which helps to eliminate nuisance tripping.

Sizing:

- For Motors – 1.25 times actual amps and 13 times actual amps for instantaneous trip range
- For Main – Do not use
(Not designed for multiple loads – one load only)



Circuit Breakers

- Molded Case Switches
- Characteristics: Molded case switches are intended for use as disconnect devices only. UL Standard 489 requires molded case switches to be protected by a thermal-magnetic circuit breaker (or fuse) of equivalent rating. They are similar in construction to thermal-magnetic circuit breakers, except that the thermal detection element is not present. These switches open instantaneously at a non-adjustable, factory preset, magnetic trip point calibrated to protect only the molded case construction.
- Sizing:
 - For device disconnect – 1.25 to 1.5 times actual amps
 - For main – Do not use
 - For motor – Do not use



Circuit Breakers & Motor Starter

- MSP (Manual Starter Protector)
- Characteristics: Include a manual disconnect, Class 10 ambient-compensated, bi-metallic thermal overload relay, and an instantaneous magnetic trip mechanism in one compact unit. Either starter can be used alone for local, manual control of a single motor or can be wired in front of a contactor to provide a complete, remotely operated motor control circuit.
- Sizing:
 - For Motors – Size by FLA
 - For Main – Do not use



Circuit Breakers

Breaker Problems

One of the biggest faults seen with breakers are not the breakers themselves, but rather the wiring at the terminals are loose and cause a heat problem. The heat problem causes a thermal trip, which then causes the reset mechanism to wear excessively over a period of normal use.

Circuit breaker terminals should be checked on a regular basis to help prevent over heating conditions. Check to see that screws on terminals are tight and make sure the screw is holding the bare wire in place and not holding the insulation of the wire in place.



Motor Contactors

Motor Contactor Ratings (Common to all types)

AC1 – Non-Inductive Loads (i.e. lights)

AC3 – Starting and stopping motors at a normal rate of speed.

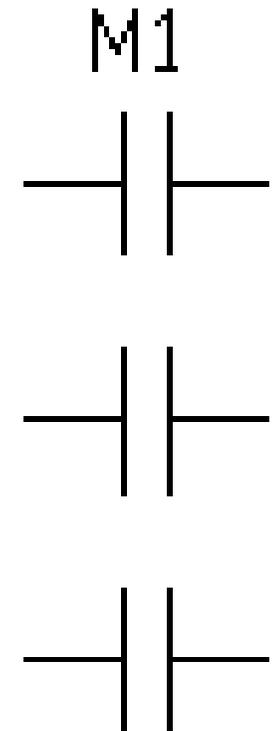
AC4 – Starting and stopping motors, jogging, power braking, or reversing motors at a normal rate of speed.

Contactors energize and de-energize motors. The AC rating corresponding to the Amps is listed on contactor label. The more usage, the more heat is generated. The more copper used in the contactors helps to dissipate the heat better and provide for longer life of the contacts.



Motor Contactors

- 3 Major Types:
 - NEMA (National Electrical Manufacturers Association)
 - IEC (International Electrotechnical Commission)
 - DP (Definite Purpose)



Motor Contactors

- NEMA (National Electrical Manufacturers Association)
- Characteristics: Makes and breaks motor load. Rated for 5 million electrical operations and 3 million mechanical operations. Has more copper to last longer and dissipate heat. Normally costs more than other ratings.
- Sizing: Size by horsepower and run amps.



**Type SC02
Size 1, 3-Pole Contactor**

Motor Contactors

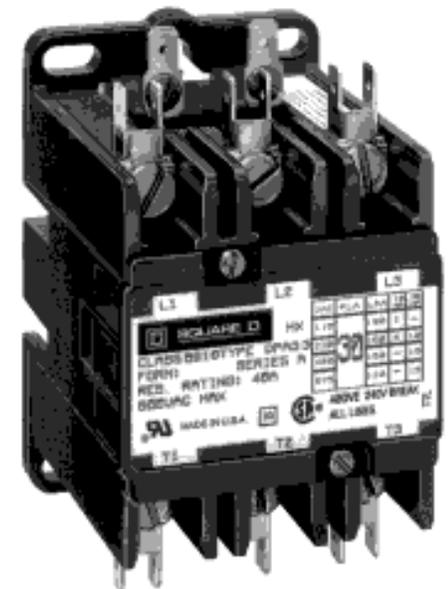
- IEC (International Electrotechnical Commission)
- Characteristics: Makes and breaks motor load. Rated for 3 million electrical operations and 1 million mechanical operations. Uses less copper than NEMA and would usually cost less.
- Sizing: Size by horsepower and run amps.



LC1D2510

Motor Contactors

- DP (Definite Purpose)
- Characteristics: Makes and breaks motor load. Rated for 1 million electrical operations and 500 thousand mechanical operations. Uses less copper than IEC and would usually cost less.
- Sizing: Size by horsepower and run amps.
- Example of Typical Duplex PS:
- (Pump start approximately every 30 min.)
- 48 Starts per day x 365 days = 17,520 per year. $1,000,000 / 17,520 = 57$ years.
- $500,000 / 17,520 = 28$ years.



Type DPA33V02
3-Pole

Motor Contactors

- Motor Contactor Problems
- Chattering of contactors may occur if moisture, metal shavings or other particles enter the contact area. Contamination normally occurs during the manufacturing process or installation of control panel when holes for power or other conduit connections are drilled. Contactors should be protected and checked after either process.
- Also, moisture normally forms during improper storage of the control panel prior to installation. Proper storage in a controlled environment, away from direct sunlight can help prevent corrosion build up. If corrosion occurs, replace contactor and never file contacts as a permanent solution.



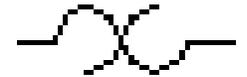
Motor Overload Relays

- Three Basic Types:

- Bimetal
- Solid State Ambient Compensated
- Electronic Solid State
- Size per FLA & Service Factor as Required (Per Square D)

A. All starter classes (except Class 8198 Medium Voltage Starters):

1. For 1.15 to 1.25 service factor motors use 100% of motor full load current for thermal unit selection.
2. For 1.0 service factor motors use 90% of motor full load current for thermal unit selection.



Motor Overload Relays

- Bimetal Overload
- Characteristics: Provides over current protection to the motor. Usually requires one element per phase. May cause nuisance tripping based on ambient temperature.
- Classes:
 - 10 – Trips at 6 X FLA for 10 seconds 20 – Trips at 6 X FLA for 20 seconds
- Sizing: Size using FLA & Service Factor as required



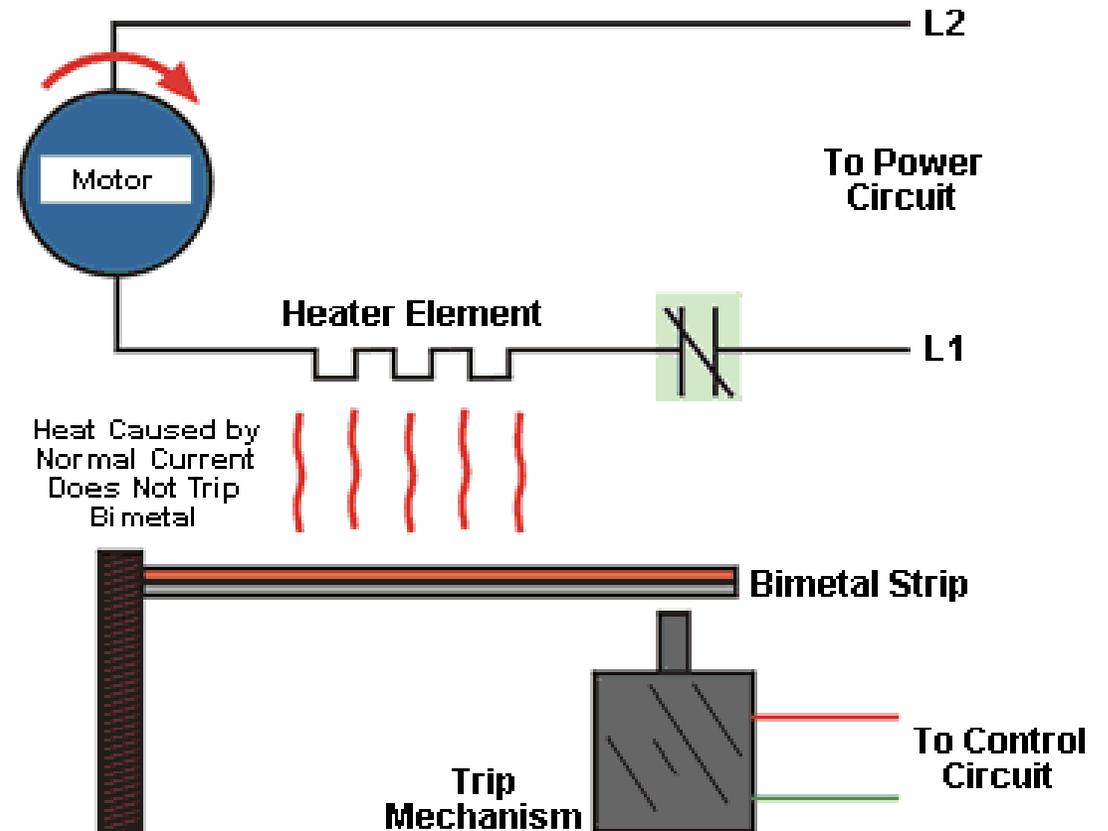
**Class 9065
Type SEO6B2
Three Pole Construction
Non-Compensated**

Motor Overload Relays

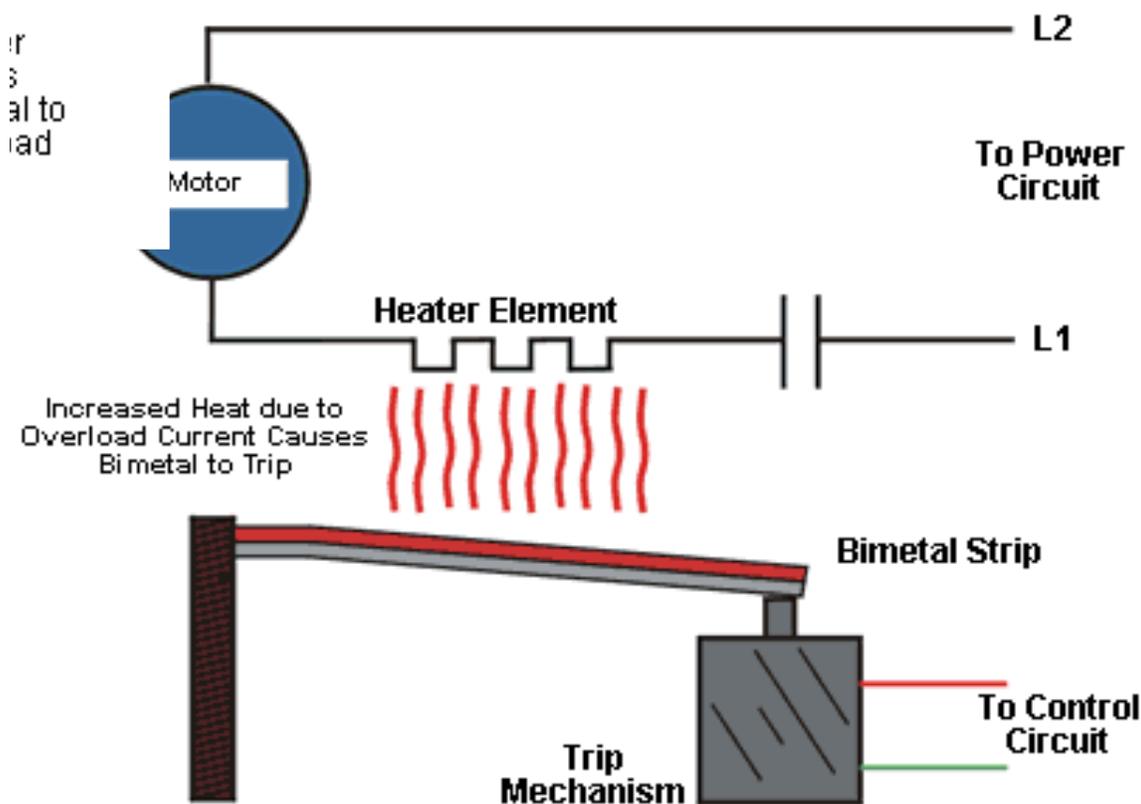
Bimetal Overloads

Overload protection may be accomplished using a bimetal overload. This consists of a small heater element, which is wired in series with the motor and a bimetal trip lever. The bimetal trip lever is made of two dissimilar metal strips. These metals have different thermal expansion characteristics, so the bimetal bends at a given rate when heated.

Under normal operating conditions, the bimetal will not bend enough to trip.

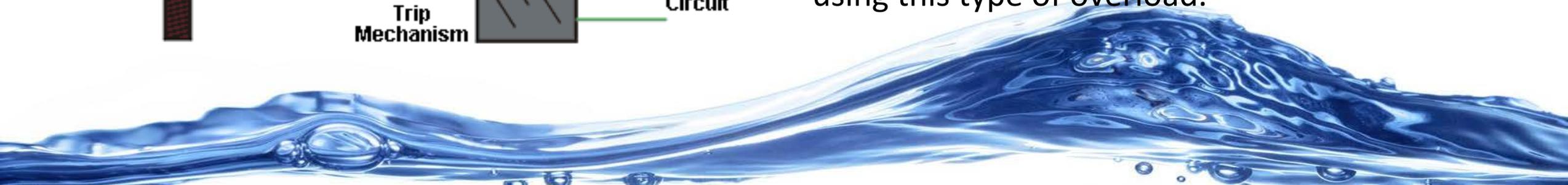


Motor Overload Relays



As the motor current rises, the heater element will increase its output. This increased heat will cause the bimetal to bend more than normal. In an overload condition, the heater will cause the bimetal strip to bend until the mechanism is tripped, stopping the motor.

Some bimetal type overloads will automatically reset when the bimetal strip has cooled and reshaped itself. This will restart the motor. If the overload condition still exists, the overload will trip again. This can cause cycling, which could damage the motor, so care should be exercised when using this type of overload.



Motor Overload Relays

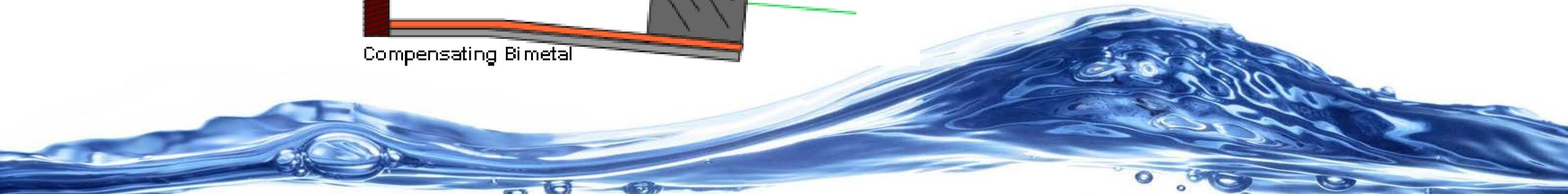
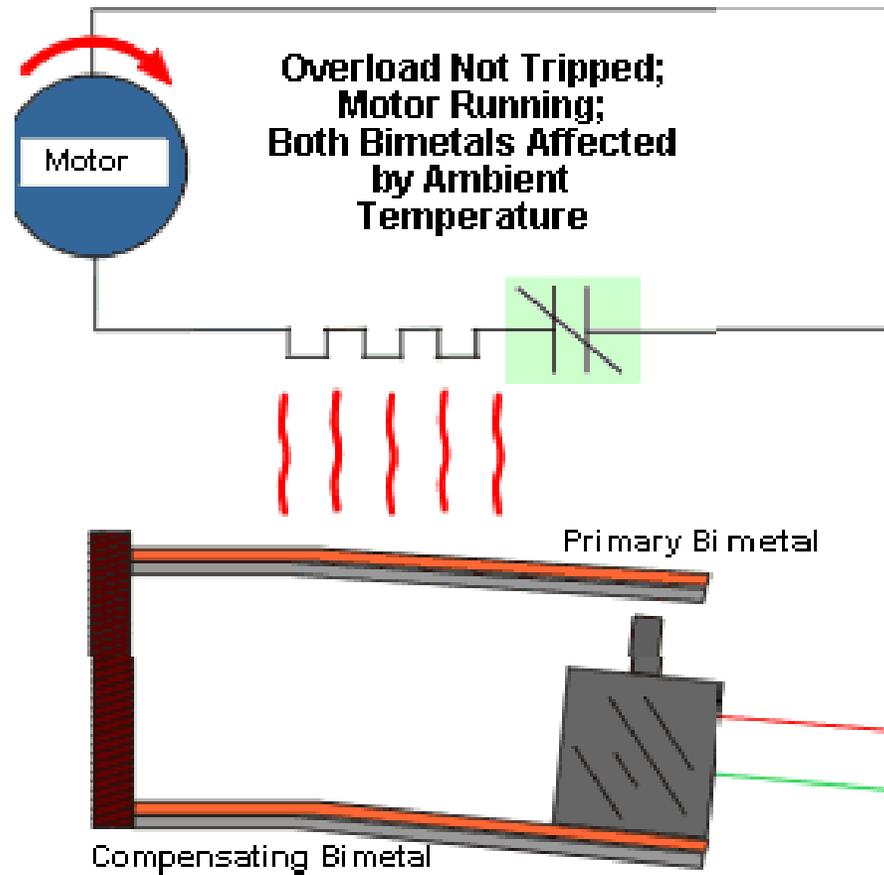
- Solid State Ambient Compensated
- Characteristics: Provides over current protection to the motor. Usually requires one block per motor.
- temperature to eliminate nuisance tripping.

Classes:

- 10 – Trips at 6 X FLA for 10 seconds 20 – Trips at 6 X FLA for 20 seconds
- Sizing: Size using FLA & Service Factor as required

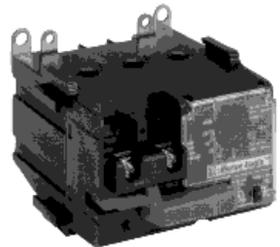


Motor Overload Relays



Motor Overload Relays

- Electronic Solid State
- Characteristics: Provides over current protection to the motor. Usually requires one block per motor with adjustable setting for amps. Utilizes CT (Current
- protection (Usually the highest cost option) Classes:
 - 10 – Trips at 6 X FLA for 10 seconds
 - 20 – Trips at 6 X FLA for 20 seconds
- Sizing: Size using FLA & Service Factor as required



MOTOR LOGIC



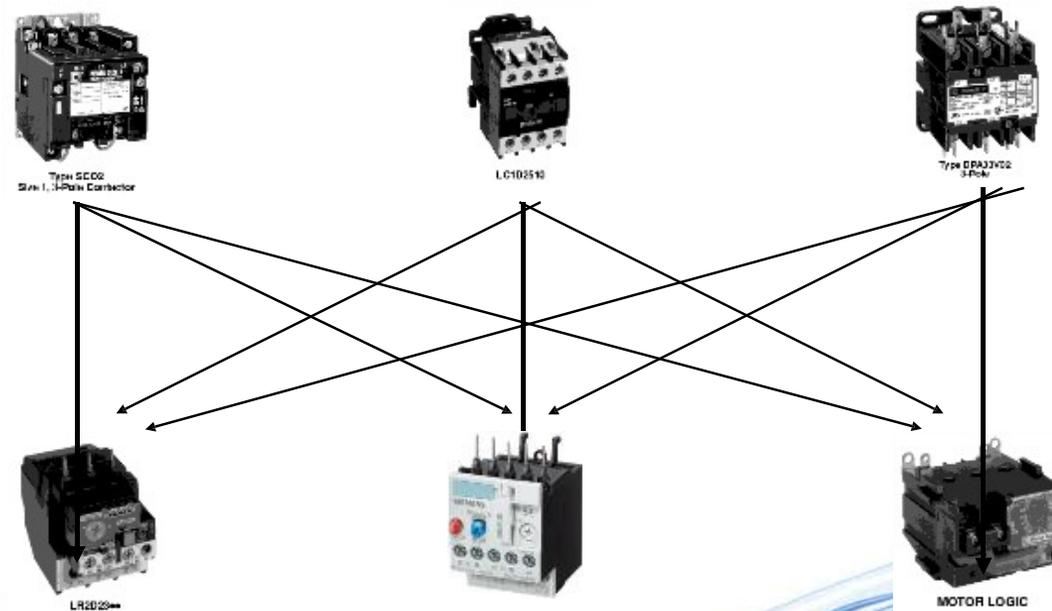
Motor Overload Relays

- Overload Relay Trip Examples:
- An example for class 10 is as follows: A motor with FLA of 5 amps ($5 \text{ amps} \times 6 = 30 \text{ amps}$) drawing 30 amps for 10 seconds causes a trip.
- The class 20 for the same FLA of 5 amps ($5 \text{ amps} \times 6 = 30 \text{ amps}$) drawing 30 amps for 20 seconds causes a trip.
- A squirrel cage motor usually draws 6-10 times the amp rating at start up and a submersible pump usually draws 12 - 15 times the amp rating at start up.



Motor Starters

- Motor Starter Combinations
- The combination of any contactor and any overload relay is generally known as a motor starter.



Motor Starters

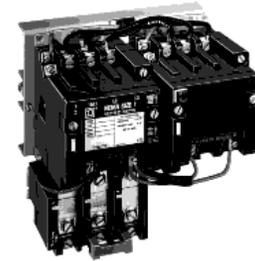
- Full Voltage Non-Reversing (FVNR)
 - Add contactor to overload relay (Motor Starter).
 - Also generally known as Across-the-Line (ACL) starting



Type SC03
Size 1, 3-Pole Starter

Motor Starters

- Full Voltage Reversing (FVR)
- Add one contactor to a full voltage non-reversing motor starter
- One contactor for forward operation and one contactor for reversing the motor.



NEMA Sizes 00, 0, 1
Reversing Starter



Motor Starters

- Two Speed
 - Add contactor to overload relay for each speed.
 - Sizing: Typically one motor starter for Full Load Amps (Full Speed) and one for half of the Full Load amps (Slow Speed), and must be mechanically interlocked.



Motor Starters

- Reduced Voltage – Solid State Soft Start

- Similar to VFD w/o Adjustable Speed function. Controls Voltage based on time not Hertz Ratio to reduce inrush current and reduce water hammer.
- Typically offers soft starting and deceleration functions, machine and motor protection functions such as ground fault, over temp, current imbalance, phase loss, and phase rotation protection, and functions for communicating with control systems.
- Typically provides for By-Pass contactor function to reduce heat during normal operation and emergency By-Pass for across the line starting.
- Reduce pump operating costs by reducing mechanical stress and improving machine availability. Reduce stress placed on electrical distribution system by reducing line current peaks and voltage drops during motor starts.
- Size using FLA and HP.
- Soft Starts are normally required by Power Utilities for pumps larger than 25 HP. May require ventilation or A/C system for cooling.



Motor Starters

- Variable Frequency Drives (VFD)

- Controls the motor utilizing a constant “Volts to Hertz” ratio. Must vary the frequency and voltage to the motor. Converts AC to DC to simulate AC to the motor. Used to maintain flow, level, or pressure to provide a smoother operation in application process. Also reduces inrush current & helps to conserve energy.
- Typically offers soft starting and deceleration functions, machine and motor protection functions such as ground fault, over temp, current imbalance, phase loss, and phase rotation protection, and functions for communicating with control systems.
- Typically requires separate By-Pass contactors for emergency across the line starting.
- Reduce pump operating costs by reducing mechanical stress and improving machine availability. Reduce the stress placed on the electrical distribution system by reducing line current peaks and voltage drops during motor starts.
- Size using FLA and HP. Requires “Inverter Duty Motors” & review of power lead lengths between the motor & drive. 50’ or more may need filter. Typically requires ventilation or A/C system for cooling.





Motor Starters

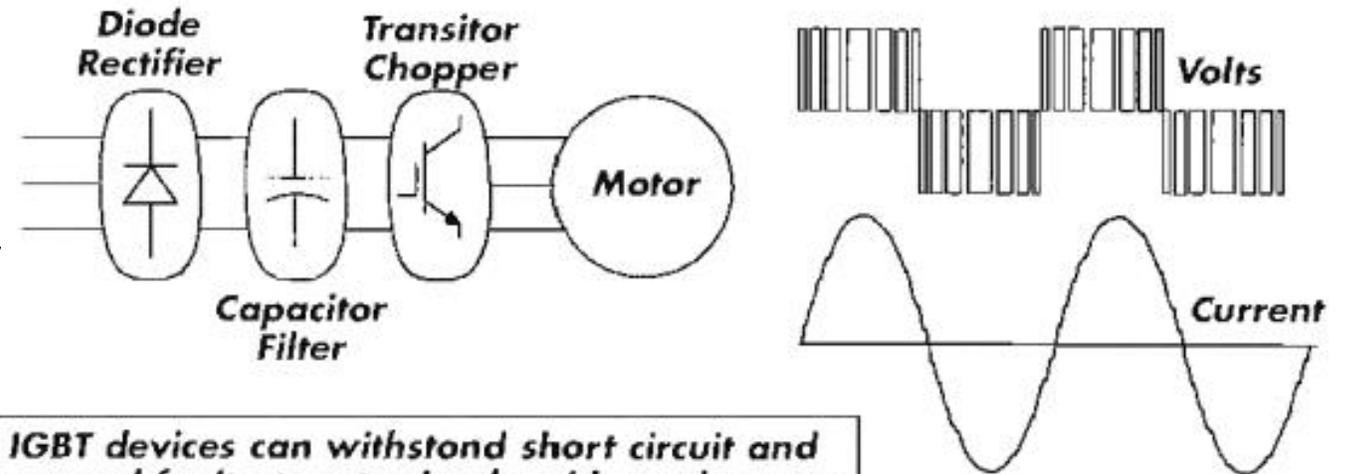
- Variable Frequency Drives (VFD) – 1 to 3 Phase Conversion
 - Can be used to convert single phase power to three phase power to eliminate single phase pumps and start kits.
 - 3 Phase motors typically cost less than 1 phase
 - 3 Phase motors are typically more efficient than 1 phase
 - 3 Phase motors develop more torque during startup
 - 3 Phase motors typically require less maintenance
 - 3 Phase motors typically have a longer life span
 - VFD needs to be de-rated to handle extra load
 - Some brands use chart for selection process
 - General multiplier (FLA of Motor x 1.73 = VFD Amp Rating Required)



Motor Starters

- Variable Frequency Drives (VFD) – How it works

- Takes in AC power and converts to DC using a rectifier.
- A filter (usually a bank of capacitors) smooths the DC.
- The DC is then chopped into the motor leads to simulate AC.

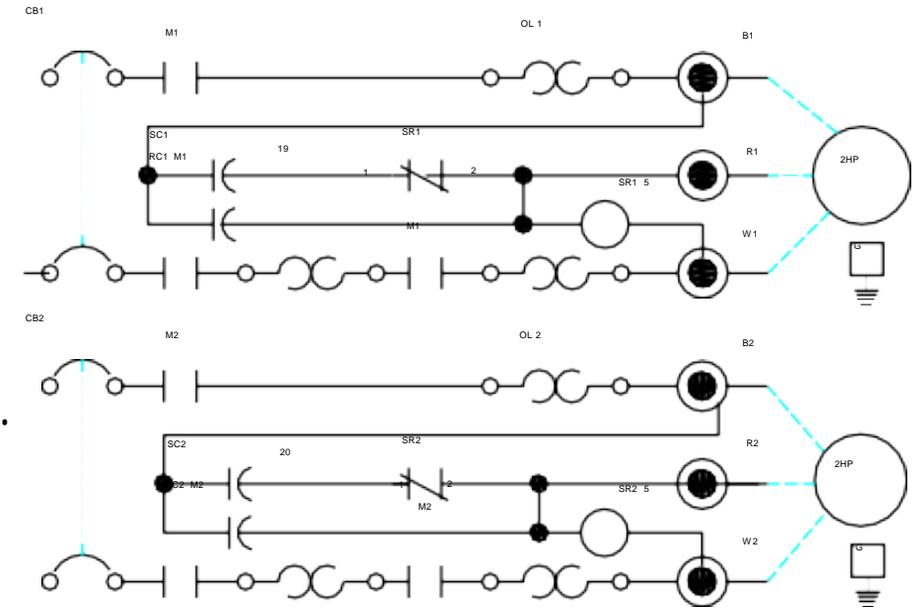


IGBT devices can withstand short circuit and ground fault at motor leads with no damage when designed with proper protection.



Single Phase Starting

- Single Phase Start Kit
- Starts and runs the motor utilizing capacitors. A run capacitor is typically used to increase efficiency in the motor. A start capacitor is typically used to create a phase shift, increasing torque upon start-up. A start relay is used to drop out the start capacitor based on a set voltage.
- The motor manufacturer determines the value of the capacitors based on the resistance of the windings.
 - Note - If a motor does not reach the voltage as set by the potential relay, the start capacitor will typically overheat and fail.
 - Typical Ohm Readings Unconnected as follows: Run to Common - Low Ohms
 - Start to Common - Med Ohms
 - Run to Start - High & Equals other 2 combined Typical High Reading 6 to 8 Ohms
 - High Ohms typically means short to ground

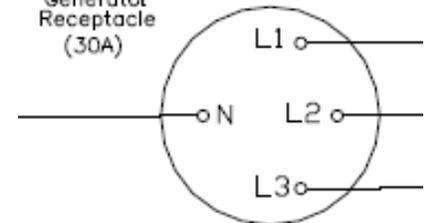


Generator Receptacles

- Generator Receptacles
- Used to provide power from a generator when AC power has failed or is not available
- Typically 30, 60, 100, 200, or 400 Amp models are available. Size per total amps needed
- Must take into consideration the number of pumps to be available to run on generator
- Normal and reverse service plugs available
- Angle Kits, Spring Cap, & Screw Caps optional



Generator Receptacle (30A)



Relays

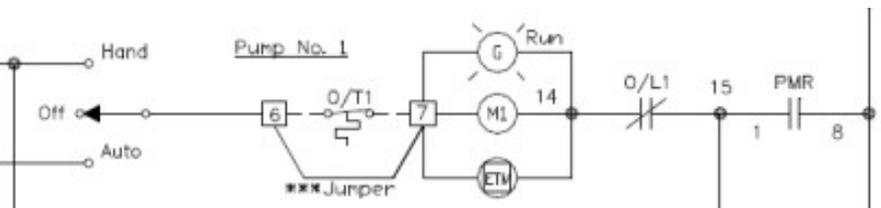
• Phase Monitor Relay

- Monitors the voltage and de-energizes (Drop out) upon phase loss, under voltage (10%), and phase reversal. Forgiving and non-forgiving models available. Forgiving is preferred to reduce nuisance tripping.
- Some models may offer phase unbalance monitoring, adjustable restart and fault delay, manual or automatic reset, and auto ranging voltage scaling
- Plug-in (A), Surface Mounted (E), and epoxy encapsulated (N) styles are typically available
- Select as required by the voltage supplied.



Style "A"

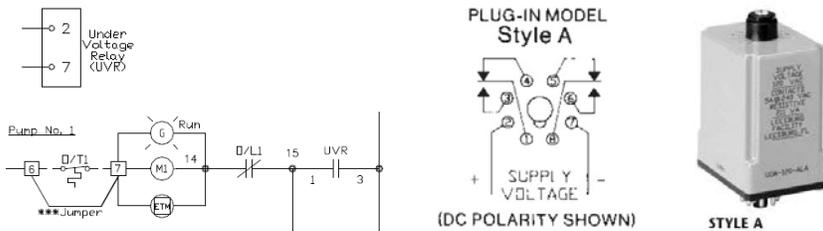
Style "A"



Style "N"



Style "E"

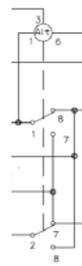
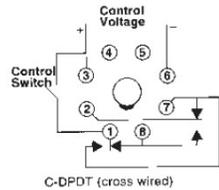


Relays

- Under Voltage Relay

- With operating voltage applied above the preset PICK-UP voltage, the internal relay will energize. When the voltage falls below the preset DROPOUT voltage for a period longer than the release delay, the output relay will de-energize. When line conditions return above the preset PICK-UP voltage, the unit automatically resets and the internal relay energizes. The HYSTERESIS in each unit provides a differential between the PICK-UP and DROP-OUT trip points
- Select as required by the voltage supplied.





Relays

- Alternating Relay

- Alternating relays are used to alternate 2 pump motors. When the coil is energized the first time, one contact closes and will open when the coil is de-energized. When the coil is energized again, the other contact will close and will open when the coil is de-energized. The contacts from these alternators are to be used in the control circuit of the starters that are controlling pump motors.

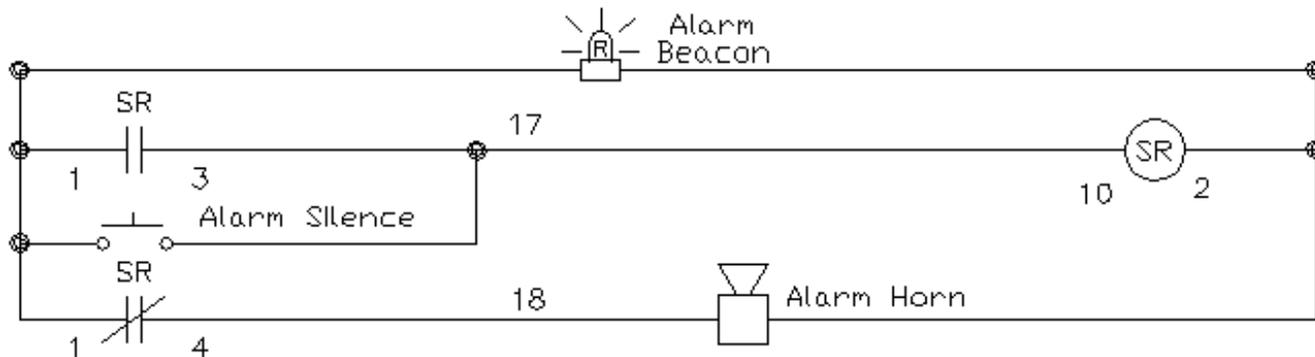
- As required by the voltage supplied.



Relays

- Ice Cube Control Relays

- An electrically controlled mechanical device that opens and closes electrical contacts when a voltage (or current) is applied to a coil. A relay provides isolation of control signals from switched signals.
- As required by the voltage supplied.



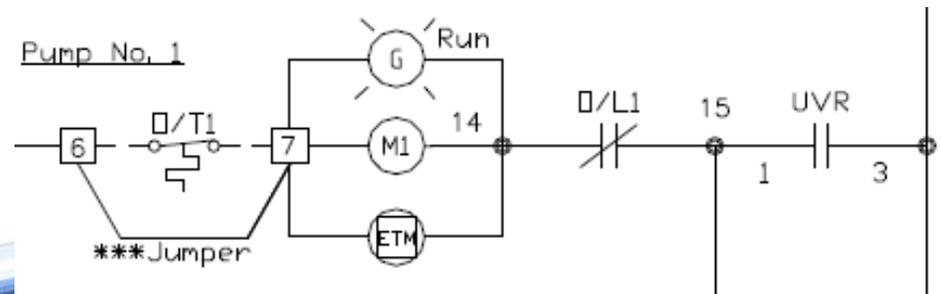
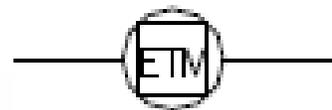


Timers

- Timer Functions
 - On Delay – Begins timing once energized, changes contact position at the end of the timing sequence. Used to delay start of second pump.
 - Off Delay – Begins timing once de-energized, changes contact position immediately and returns to normal at the end of timing sequence. Can be used to keep a pump running at the end of a cycle.
 - Repeat Cycle – Two settings for time, one for on time and one for off time. Begins timing once energized, changes contact position and the end of timing for on and off time.
 - 24 Hour - Multiple settings that allow you to choose blocks of time to call on a device such as a mixer in a wet well.

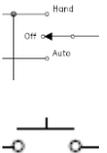
ETM's

- Elapsed Time Meters
- Used to record pump run times for maintenance and trouble shooting.
- Typically available in A/C and DC voltages such as 10-28VDC, 24VAC, 120VAC, & 230VAC
- Available in several different shapes like round square, and rectangular.
- Typically flush mounted in panel dead front.
- Typically non-resettable.



Switches & Push Buttons

- Switches & Push Buttons
 - HOA switches used to turn pumps on manually, off, or to put in automatic control mode.
 - Typically available in toggle, 16mm, 22mm, & 30mm styles.
 - Push Buttons typically used for alarm horn silencing, test functions, or emergency notification.
 - Typically flush mounted in panel dead front or enclosure side.



16 mm XB6
(p. 19-4)



22 mm XB4
(p. 19-15)



30 mm Type K
(p. 19-55)



30 mm Type SK
(p. 19-68)

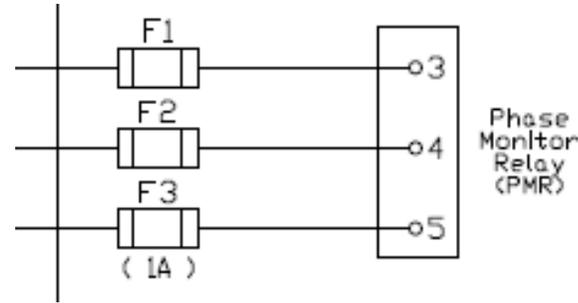


Alarm Beacons, Horns & Bells

• Alarm Beacons, Horns & Bells

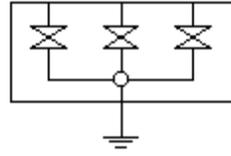
- Alarm Beacons, Horns, and Bells are typically used for High & Low Water Level Alarms
- Beacons typically available in steady, flashing, strobe, or rotating type models. Incandescent & LED bulb models.
- Beacons typically available in 12VDC, 24VDC, & 120VAC with 12 volt being the typical choice for battery back alarm systems
- Horns, Bells, and Buzzers typically available in flush and surface mounting styles and 12VDC, 24VDC, & 120VAC models





Fuses

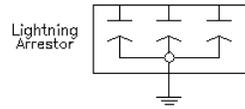
- Time Delay Fuses
 - Fuses are used to protect a device from over voltage or over current.
 - Typically used to protect Phase Monitor Relays.
 - Required to protect the primary and secondary sides of control transformers.
 - NOTE: When testing fuses always remove the fuse and read it with an ohmmeter.



Surge Protection

- Surge Capacitors
- Monitors the voltage and absorbs any surges from the power source. Must be installed on the load side of the main breaker. Utilizes capacitors and will require replacement upon a strong surge. (Will cause problems with test equipment for Power Company if connected to the line side of the main breaker)
- As required by the voltage supplied.





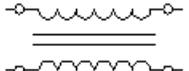
Surge Protection

- Lightning Arrestors
 - Monitors the voltage and absorbs any surges from the power source. May be installed on the line side of the main breaker. Utilizes Metal Oxide Varistors (MOV's) and will require replacement upon a strong surge. (Normally does not cause problems with test equipment for Power Company)
 - As required by the voltage supplied.



Control Transformers

- Open Style Control Transformer
 - Must be supplied when the power supply does not provide a neutral (Equipment Ground) or when the power supply is 460 volt.
 - As required by the voltage supplied.


CPT2: 100 VA
120/24 Volt



Control Transformers

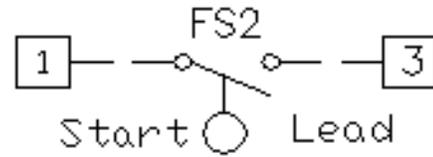
- External Industrial Control Transformer
 - Must be supplied when the power supply does not provide a neutral (Equipment Ground) or when the power supply is 460 volt. Used when larger VA is required and internal mounting is prohibited.
 - As required by the voltage supplied.



Control Transformers

- Note: When specifying a GFI Outlet, be sure to properly size the control transformer to meet the needs of the planned use of the outlet. When requested, a panel manufacturer will typically supply a 15 amp duplex outlet because it is normally the smallest size available. However, the control transformer supplied may not be large enough to carry the full 15 amp load.
- A normal control load would be approximately 2 amps and a trouble light might draw about 1 amp. If you want to run a 3/8 inch drill from this outlet, you will need approximately 7.5 amps for the drill plus the 2 amp control load. This means you will need a 1.5 KVA (12.5 amps) control transformer to handle the anticipated load. Please refer to the Control Transformer Chart in the back of the training manual for additional information.

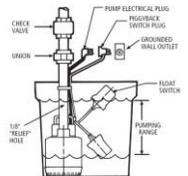




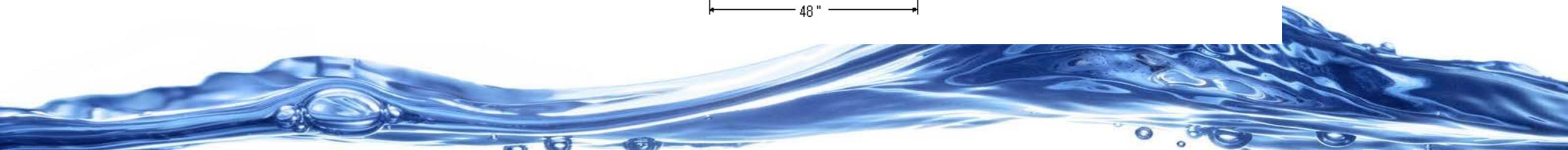
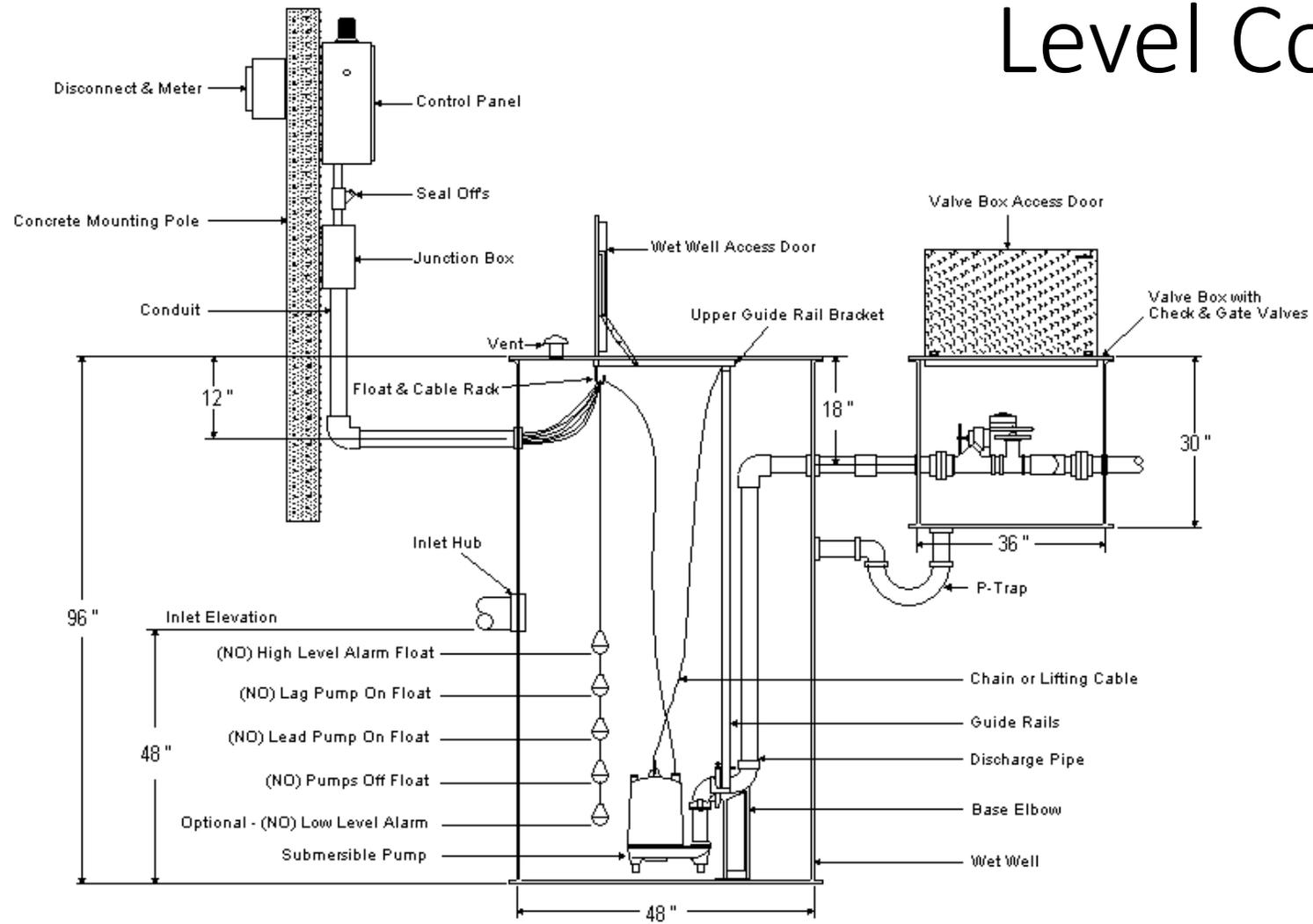
Level Controls

- Float Switches

- Float switches rising and falling determine level of the tank. Voltage is sent to the control panel circuitry from the float once the float has tilted, closing a switch. These contacts can be used to start and stop pumps and signal an alarm. Both a single pole mercury switch & a non-mercury switch are available with NO or NC contacts. Typically made of polypropylene, but available in Stainless Steel as well.
- 120 Volt – The control circuit sends the signal through the float utilizing 120 VAC
- 24 Volt – The control circuit sends the signal through the float utilizing 24 VAC
- Intrinsically Safe – The control circuit sends the signal through the float utilizing 24VDC at less than 30 mA, never causing a spark with two simultaneous shorts.



Level Controls



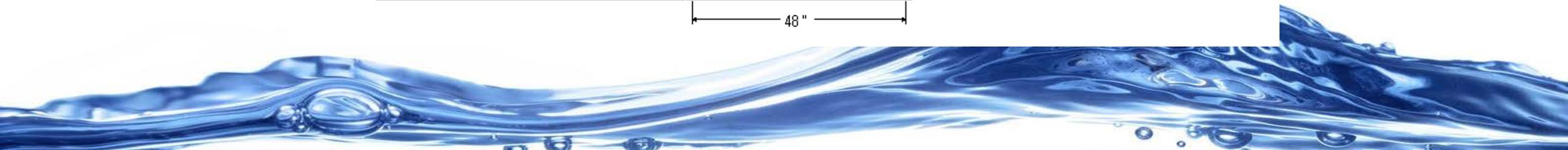
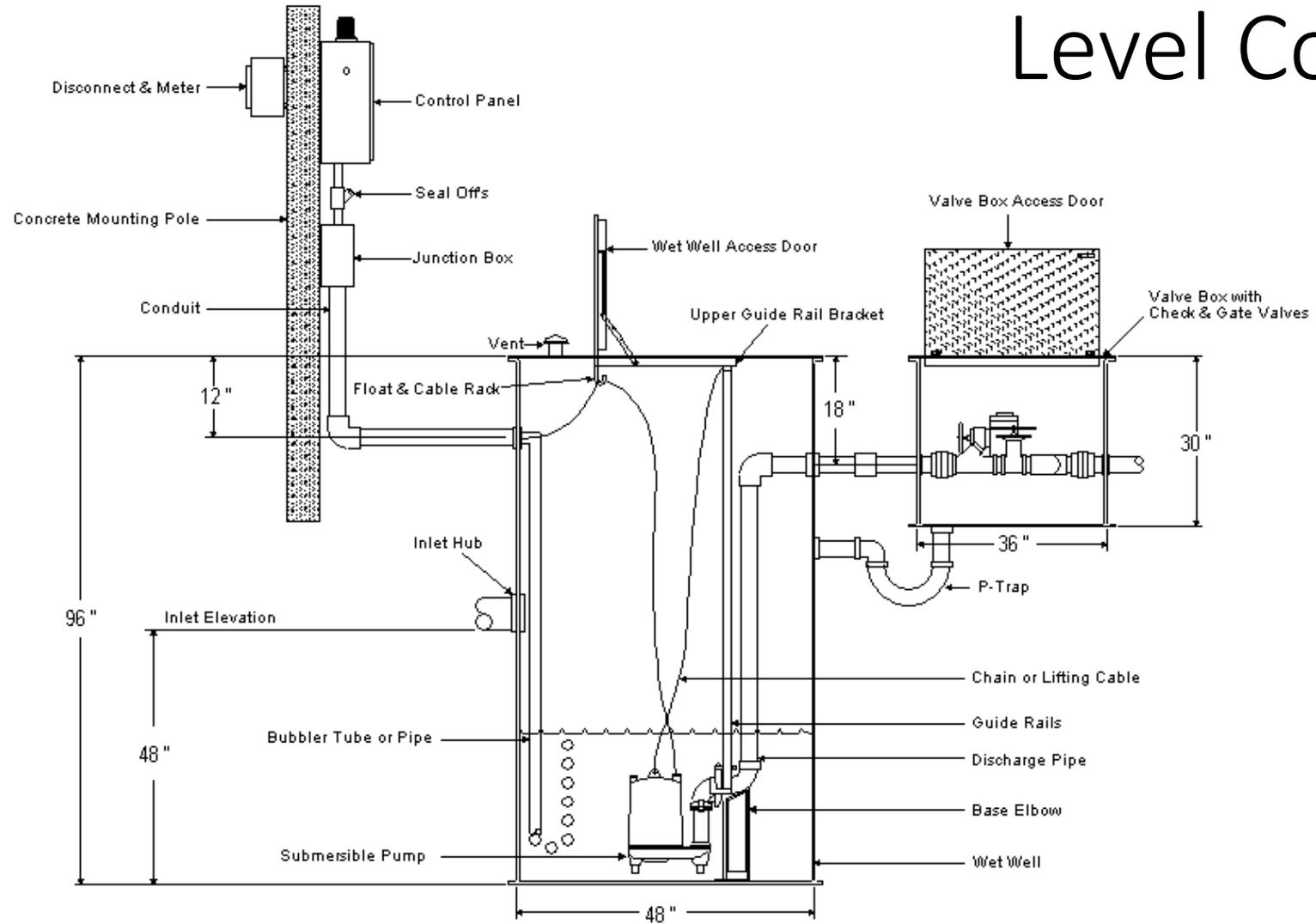
Level Controls

- Bubbler

- Utilizes back pressure in a pipe to determine level of the tank. Generally an air compressor supplies air to a tube in a wet well. A sensor measures the backpressure inside the tube and converts that pressure to a level
- Pressure switches – May be used to measure the back pressure supplying on and off settings
- Pressure Transducer – May be used to measure the back pressure supplying infinite settings



Level Controls

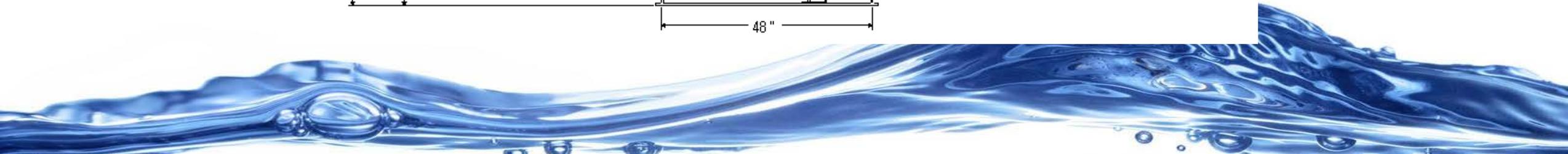
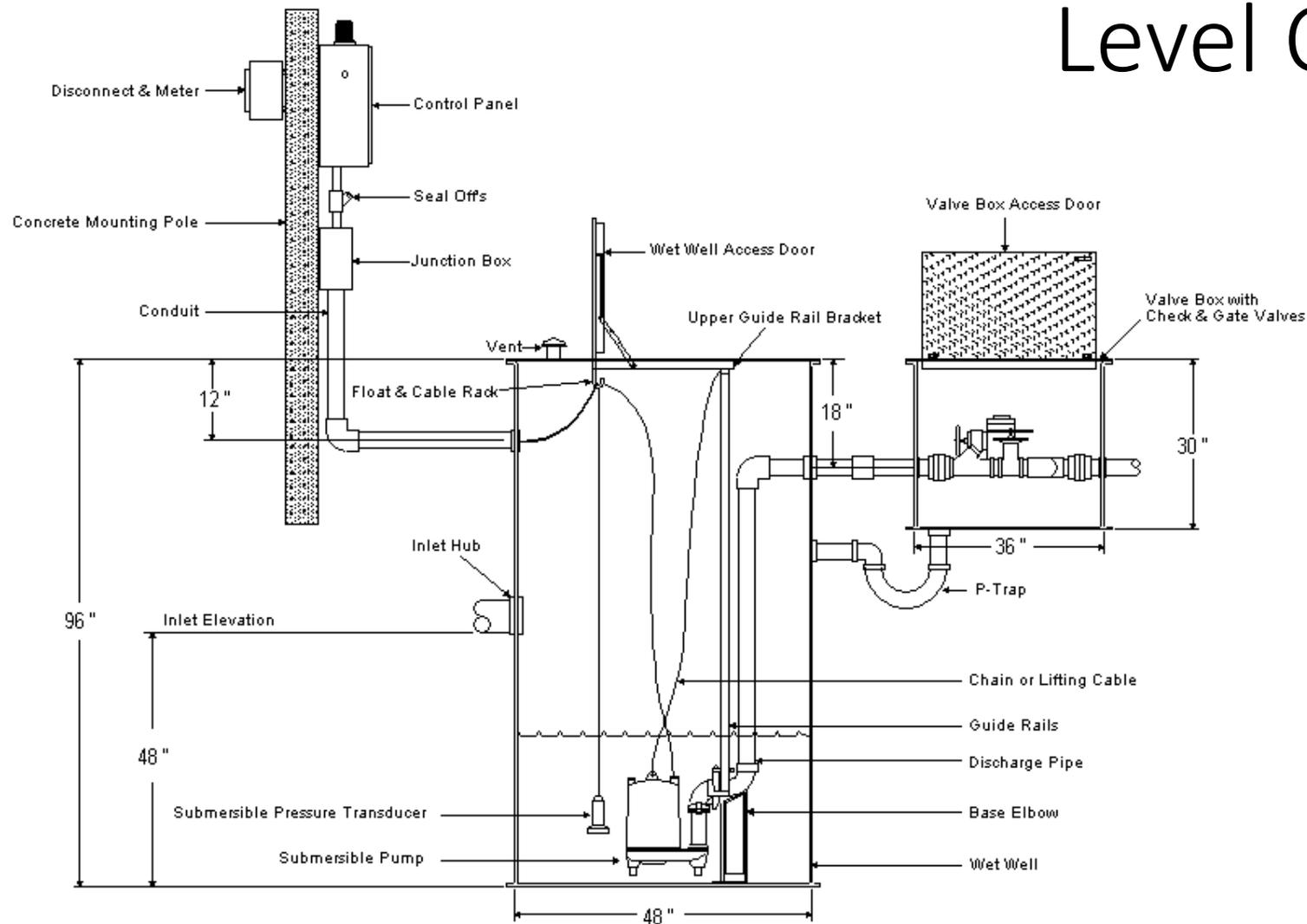


Level Controls

- Submersible Transducer
 - Utilizes water pressure to determine level of the tank. Generally a transducer is lowered into the tank. The transducer senses the water pressure against its diaphragm and converts that pressure to a level.
 - Most devices output a 0-5 volt or 4-20 ma level signal.
 - Some devices provide level signals only and others provide built-in control functions with relay outputs for control and alarm functions.



Level Controls



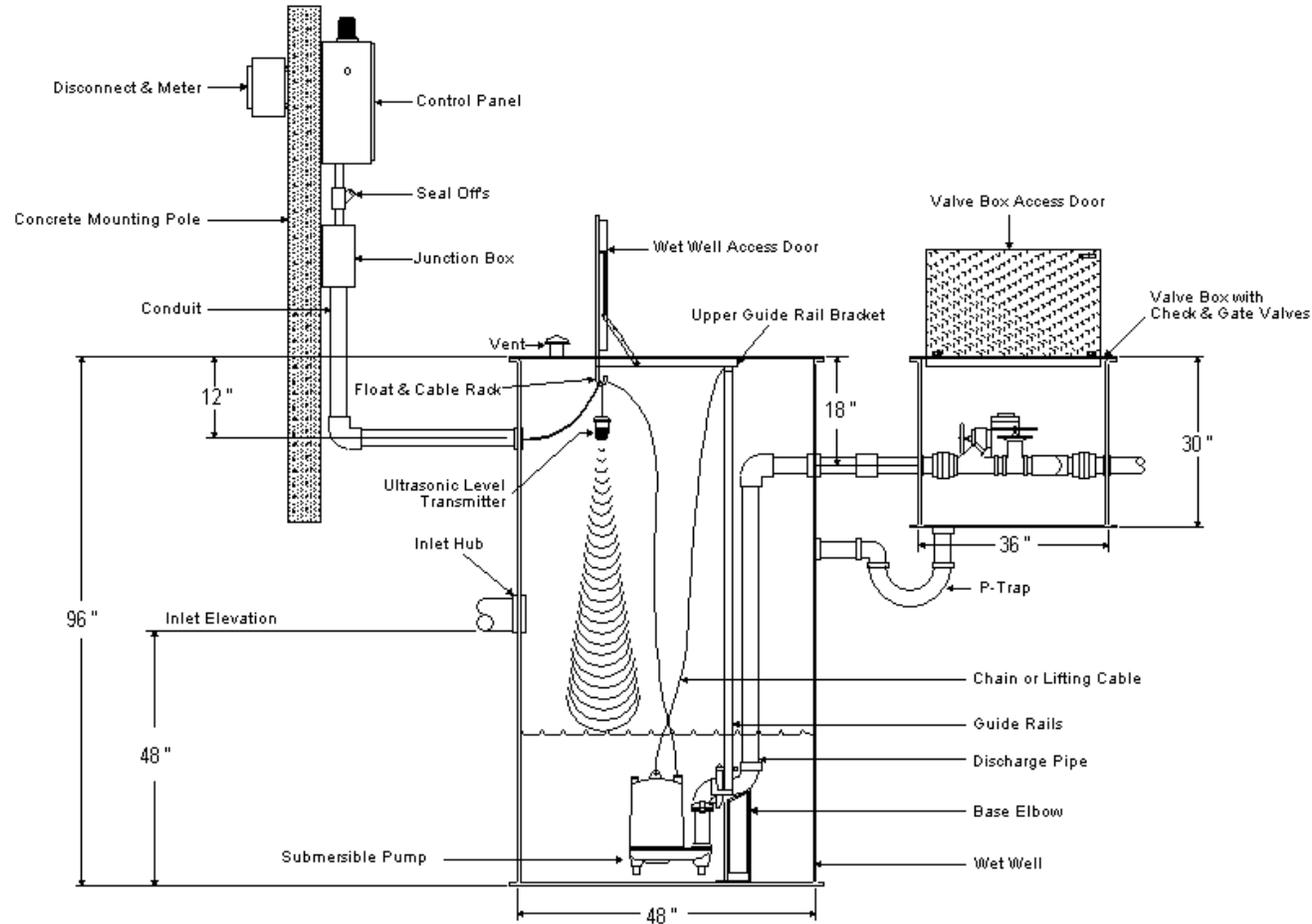
Level Controls

- Ultrasonic Transducer

- Utilizes a sonic pulse to determine level of the tank. Generally a transducer is placed on top of the tank. The transducer sends sonic pulses to the top of the water being measured and times the pulses return. The time is then converted to a level.
- Most devices output a 0-5 volt or 4-20 ma level signal.
- Some devices provide level signals only and others provide built-in control functions with relay outputs for control and alarm functions.



Level Controls



Enclosures

- Nema 1 (IP10)
- Indoor use to provide a degree of protection against falling dirt. (Metal, spot welded box with open gaps and no gasket)
- Nema 3R (IP14)
- Indoor or outdoor use to provide a degree of protection against falling dirt, rain, sleet, and snow; and will be undamaged by the external formation of ice on the enclosure. (Metal, spot-welded box with wrapper, bottom, & cap. Helps prevent rainfall from entering and has gaps in bottom for draining. No gasket. Several latches and handles available depending on manufacturer)
- Nema 4 (IP66)
- Indoor or outdoor use to provide a degree of protection against falling dirt, rain, sleet, and snow, wind blown dust, splashing water and hosed directed water; and will be undamaged by the external formation of ice on the enclosure. (Metal, seam-welded box with no gaps and gasket. Several latches and handles available depending on manufacturer)



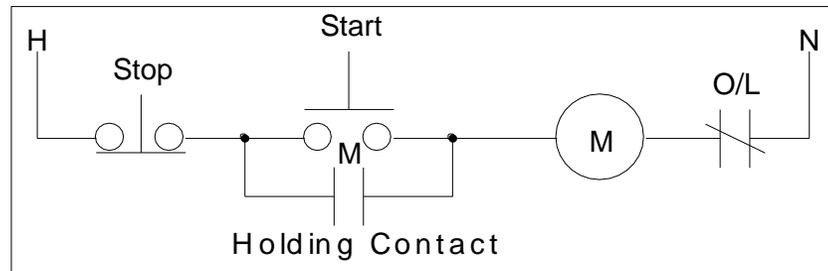
Enclosures

- Nema 4X (IP66)
- Indoor or outdoor use to provide a degree of protection against falling dirt, rain, sleet, and snow, wind blown dust, splashing water and hosed directed water and corrosion; and will be undamaged by the external formation of ice on the enclosure. (Stainless Steel seam-welded, fiberglass, or aluminum box with gasket. Typically comes with clamps on top, bottom, and sides. Quick release latches available as option. Some manufacturers now offering optional handles.)
- Nema 12 (IP52)
- Indoor use to provide a degree of protection against falling dirt, circulating dust, lint, fibers and light splashing of water. (Typically painted steel, seam-welded box with gasket. Several latches and handles available depending on manufacturer)



Basic Control Circuits

- Start and Stop Control Circuit
- Generally using a momentary start push button and momentary stop push button requires a holding circuit.



Control Panel Storage

- Proper Control Panel Storage
- The proper place to store a control panel until installation would be inside a building, preferably in a cool and dry area that is out of direct sunlight to help prevent condensation build up.
- If left outside or at the job site in direct sunlight, condensation will start to form as the panel heats up and cools down during the day, causing condensation damage.
- Control panels contain many electrical devices that require proper storage to prevent corrosion damage until put into normal every day use. Once a control panel is put into normal every day use, the heat generated by its components help prevent moisture buildup and condensation damage.

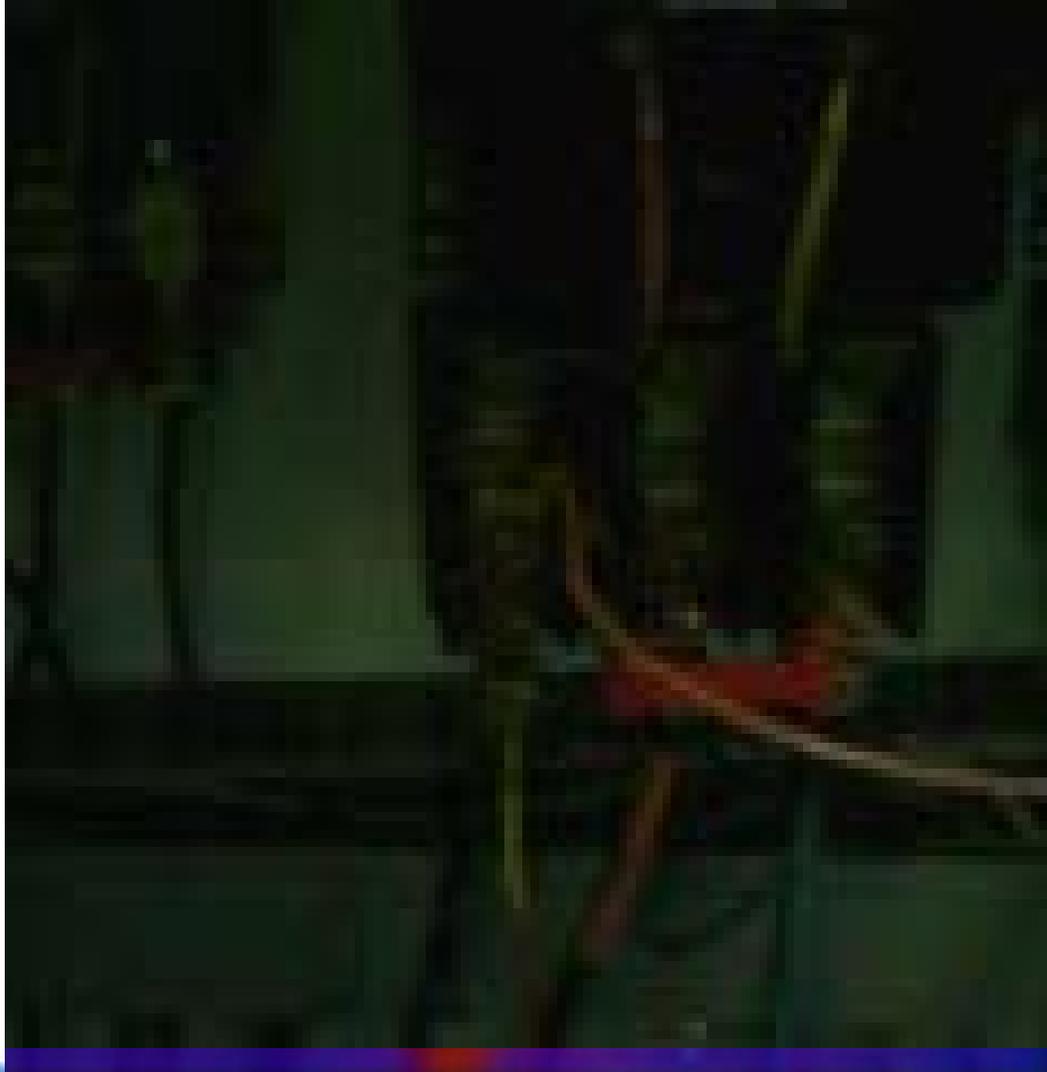


Control Panel Maintenance

- Proper Control Panel Maintenance
 - After the installation of a new control panel, all component screws, terminal screws, and bolts should be tightened.
 - During normal use with the heating and cooling of the panel, expansion and contraction will occur, causing screws to loosen over time.
 - A loose wire can cause extra heat to be generated, which can lead to premature failure of components.
 - Make it a practice to have someone check breakers, starters, and terminals on a regular basis to help ensure longer life of your control panel and its components.



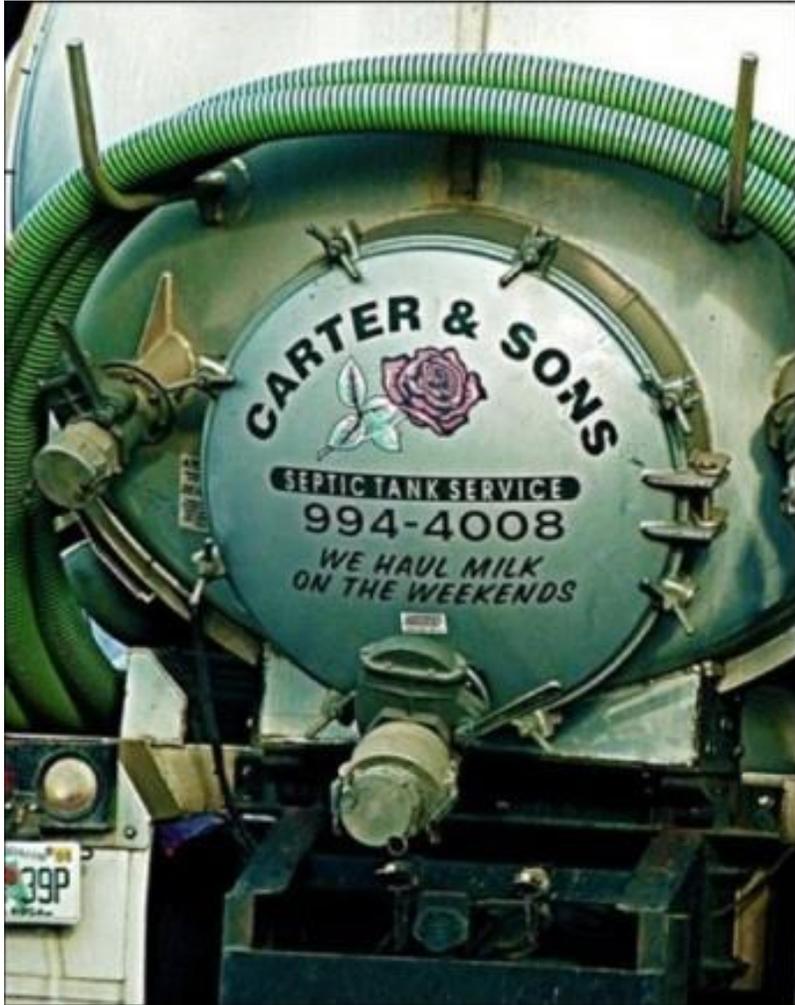
Control Panel Maintenance



Conclusion of Part 1

- Conclusion of Multimedia Presentation
- This concludes part one, the multimedia portion of the control panel training class. Additional information is located in the back of your training manual, which includes samples of a single and three phase control panel schematic, several useful reference charts, and a list of word definitions.
- Part two of this class will include drawing a standard 230V, 3 Phase control panel schematic from scratch and some basic troubleshooting, which will begin after the lunch break.





Sewer Truck Humor



Sewer Truck Humor



Sewer Truck Humor

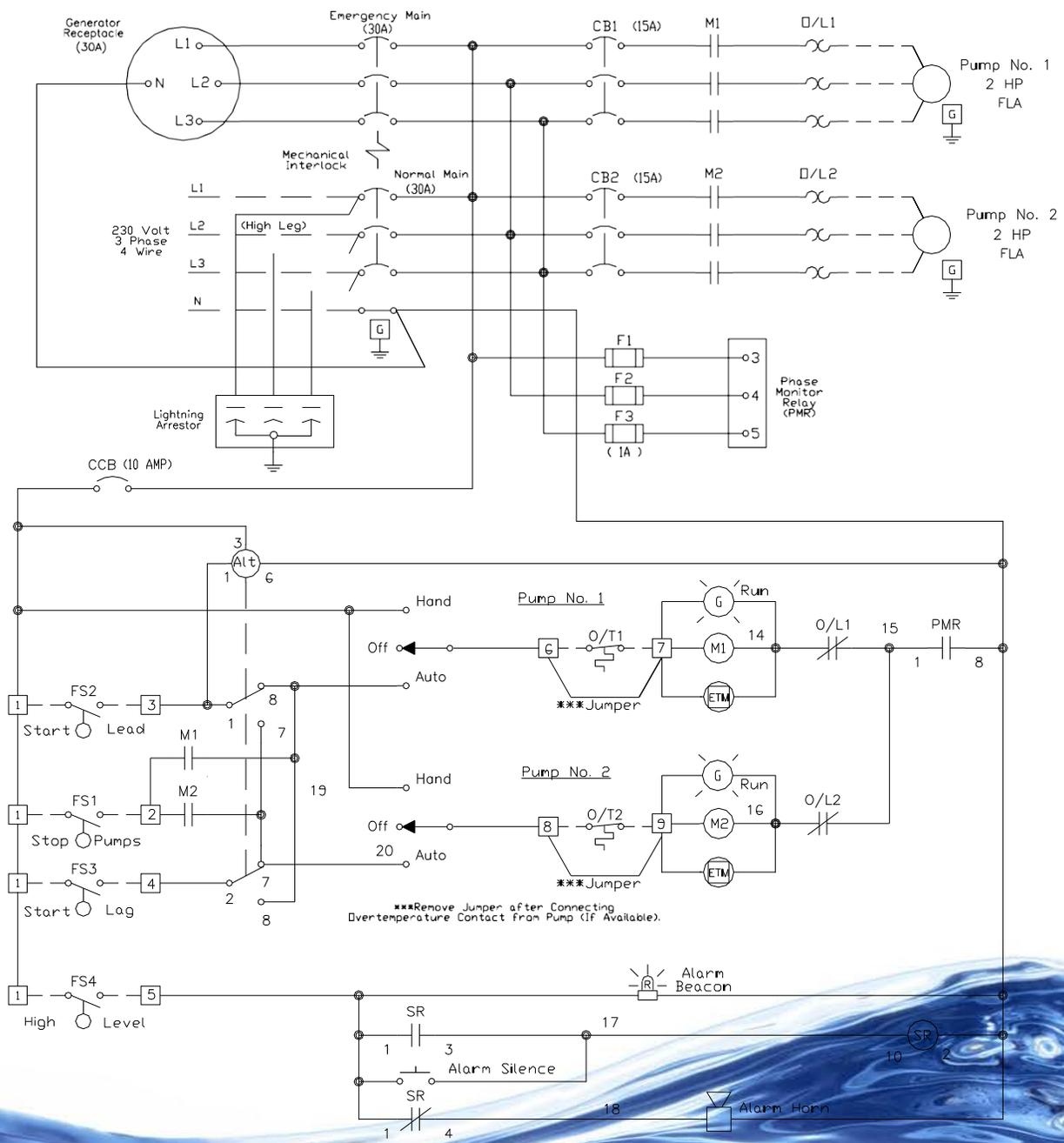


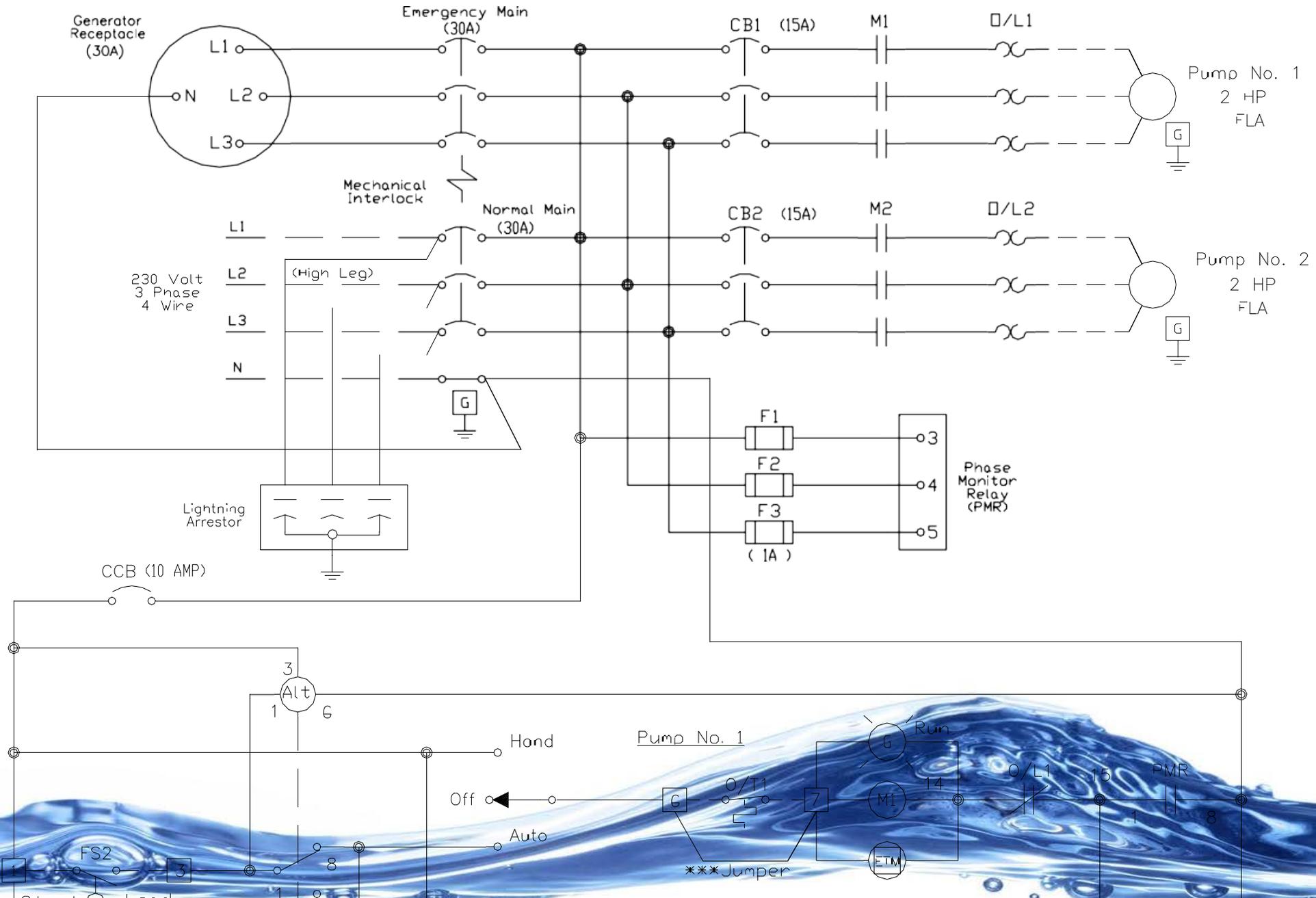
Sewer Truck Humor

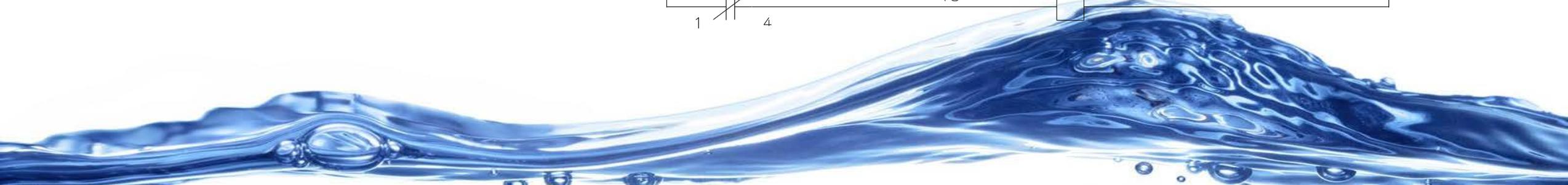
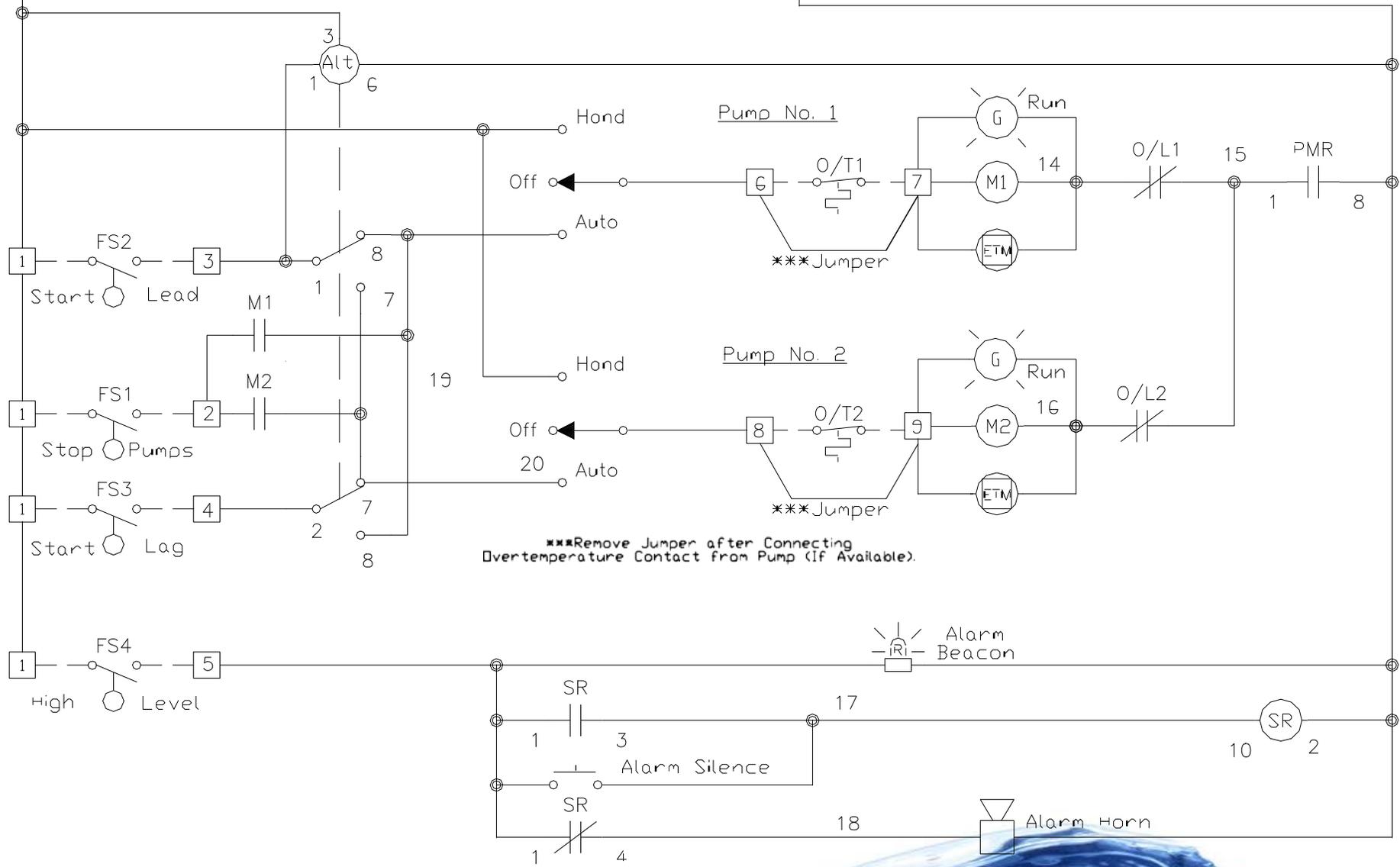


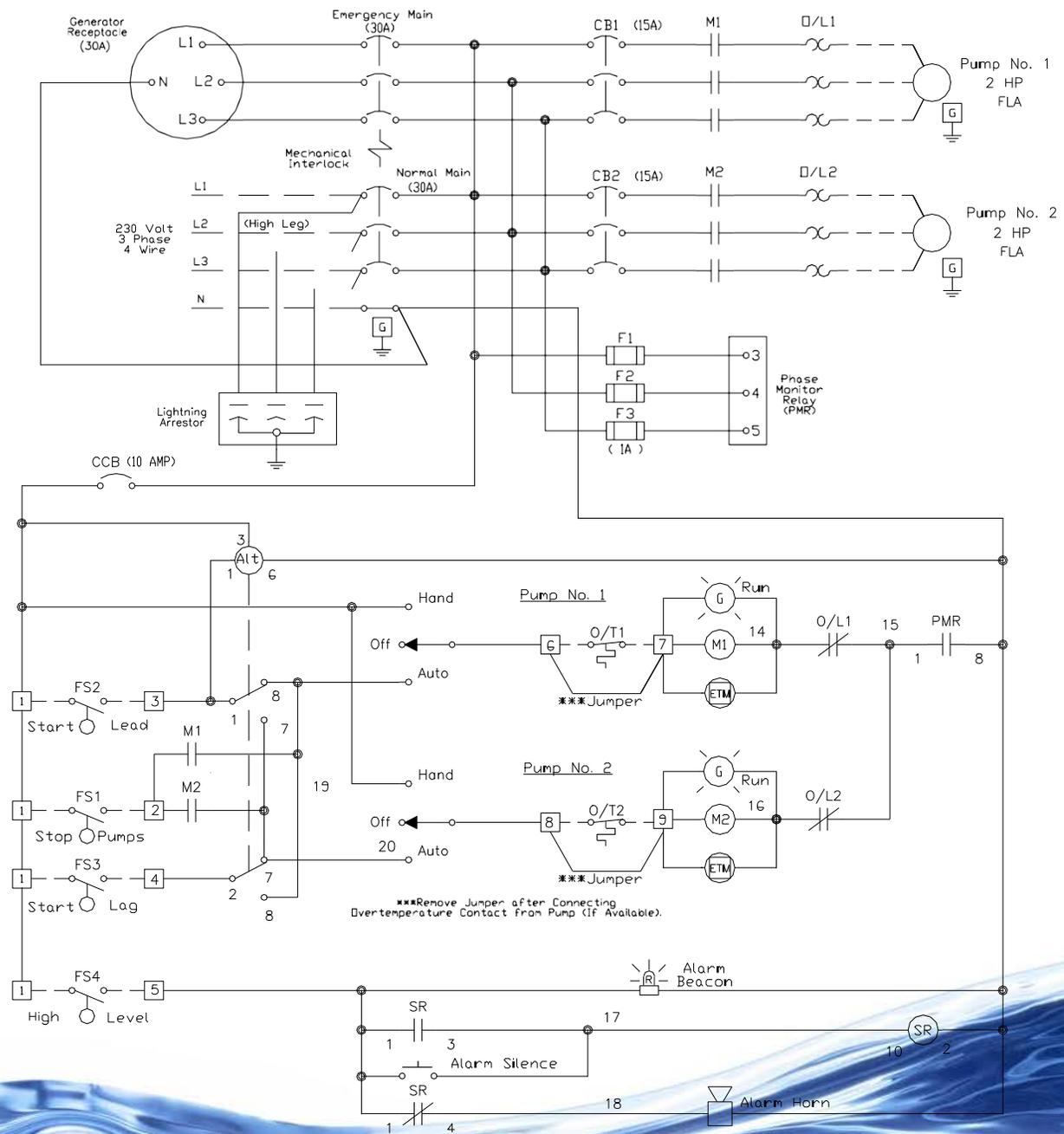
Sewer Truck Humor

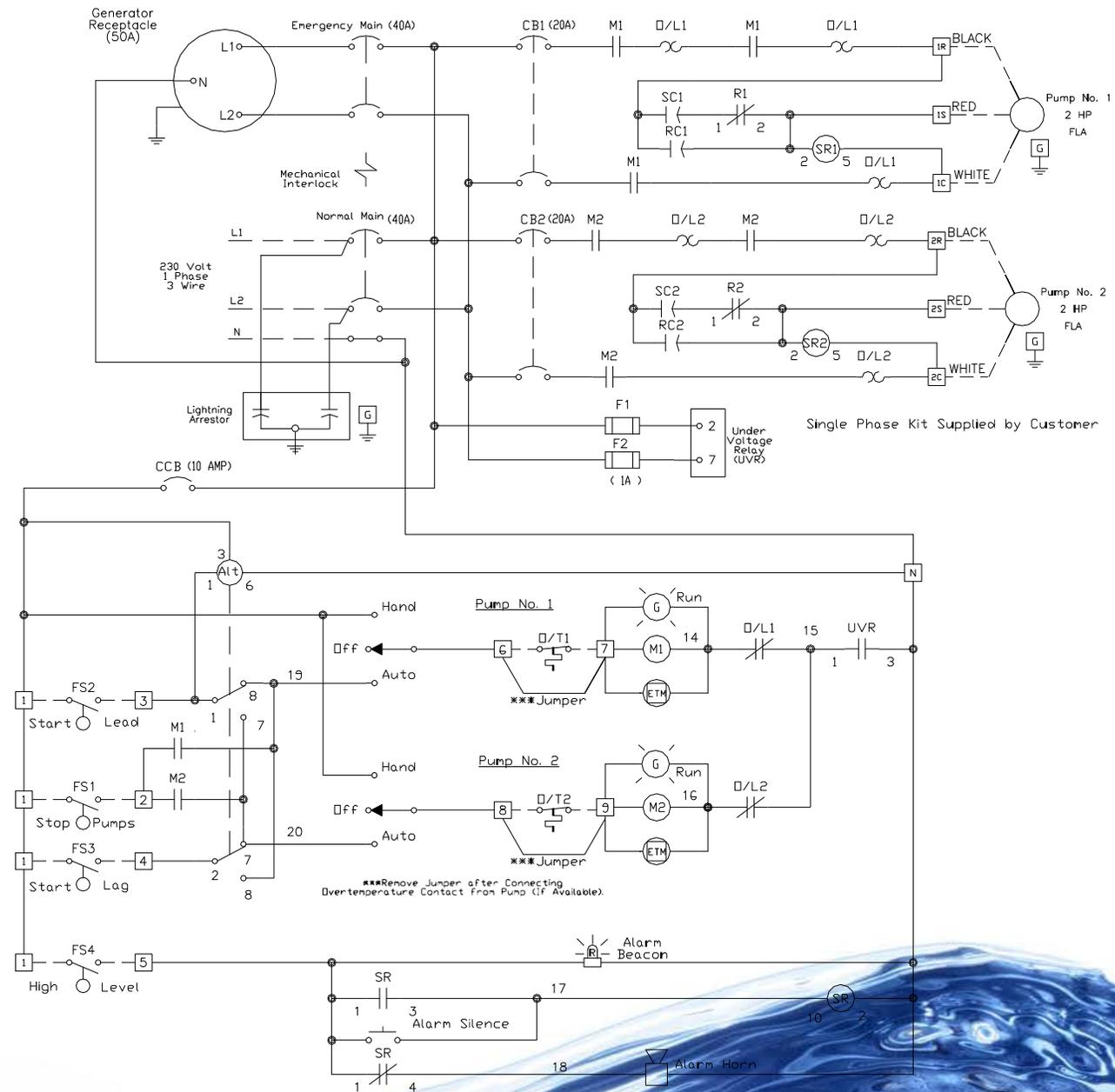












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