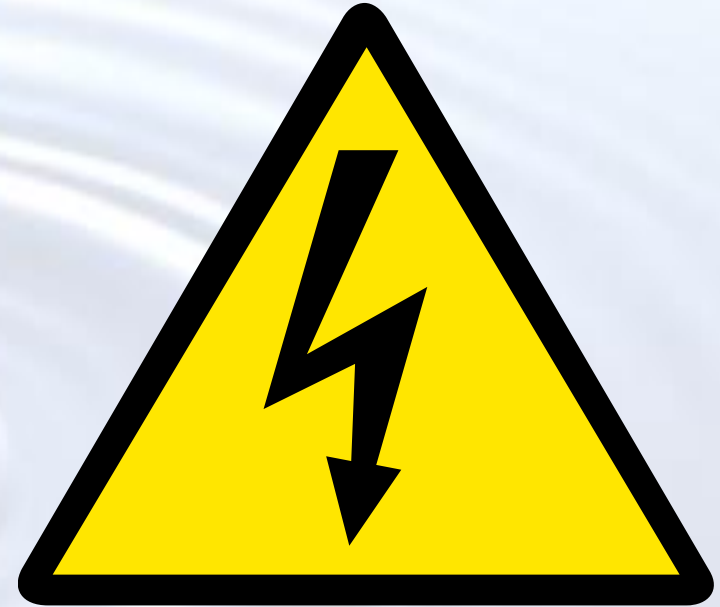


**BASIC ELECTRICAL
THEORY &
TROUBLESHOOTING**



**SAFETY IS THE
MOST IMPORTANT
THING.
ELECTRICITY CAN
KILL YOU!**

- VOLTAGE **ALWAYS**
FOLLOWS THE PATH OF
LEAST RESISTANCE
- IT TAKES **LESS THAN 1 AMP**
OF CURRENT TO STOP
YOUR HEART

**ALWAYS TURN OFF
POWER WHEN WORKING
INSIDE A CONTROL
PANEL, OR ON ANY
OTHER ELECTRICAL
DEVICE**

- **TURN OFF THE SERVICE BREAKER FEEDING THE CONTROL PANEL OR ELECTRICAL DEVICE, USUALLY LOCATED OUTSIDE OF THE CONTROL PANEL.**
- **TURNING OFF THE BREAKERS IN THE CONTROL PANEL ONLY KILLS POWER TO THE COMPONENTS DOWN STREAM OF THE BREAKER – THERE IS STILL POWER TO THE TOP OF THE BREAKERS AND ANYTHING BEFORE IT IN THE CIRCUIT.**

The background of the slide features a series of concentric, light blue ripples on a white surface, resembling water droplets. The ripples are centered and expand outwards, creating a sense of movement and focus.

**OKAY – LET’S GET
STARTED!!!**

WE CAN THINK OF ELECTRICITY IN TERMS OF WATER BEING PUMPED THROUGH A SERIES OF PIPES

- ❖ VOLTAGE IS THE PRESSURE BEING PRODUCED BY THE PUMP, THINK OF THIS AS H.P.
- ❖ CURRENT (AMPS) IS THE FLOW RATE, HOW FAST THE WATER FLOWS THROUGH THE PIPES. THINK OF THIS AS GAL/MIN
- ❖ OHMS IS THE RESISTANCE THAT ACTS ON THE WATER. THE MORE RESTRICTIONS THE HIGHER THE RESISTANCE.

COMMON ELECTRICAL TERMS

❖ VOLTAGE (VOLTS)

❖ CURRENT (AMPS)

❖ RESISTANCE (OHMS)

❖ POWER (WATTS)

DIGITAL VOLT METER – AN INSTALLERS/ELECTRICIAN’S BEST FRIEND!



The background of the slide features a series of concentric, light-colored ripples on a darker blue-grey surface, resembling water. The ripples are centered and expand outwards, creating a sense of depth and movement. The overall tone is calm and professional.

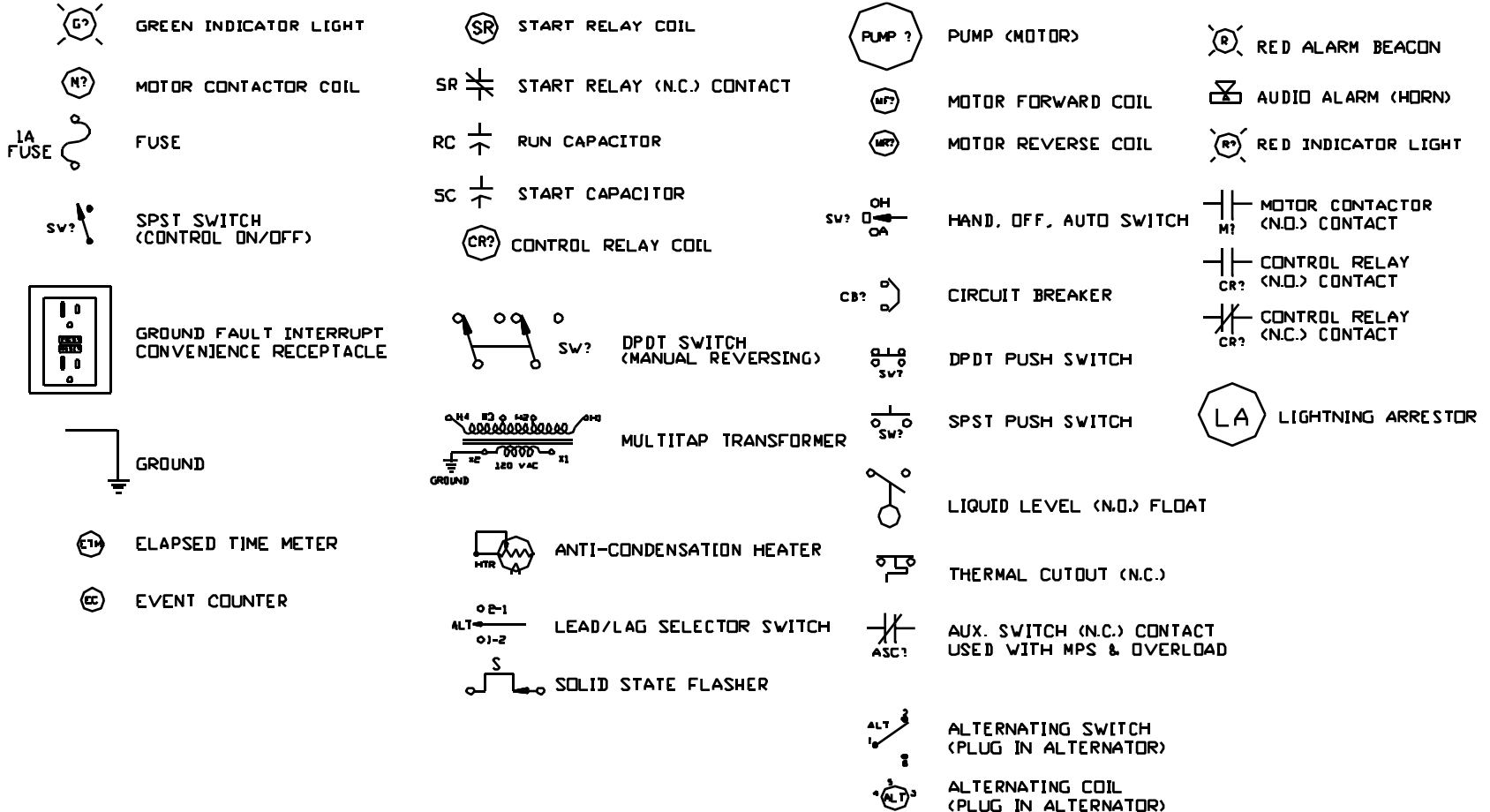
SCHEMATICS 101

IT'S NOT AS TOUGH AS YOU THINK

READING A SCHEMATIC

- READING A SCHEMATIC IS LIKE READING A ROAD MAP
- FIND YOUR STARTING POINT AND DESTINATION, THEN FOLLOW THE MAP.
- USE YOUR METER TO CHECK CIRCUITS ON THE WAY
- IT'S OKAY TO ASK FOR DIRECTIONS IF YOU GET LOST

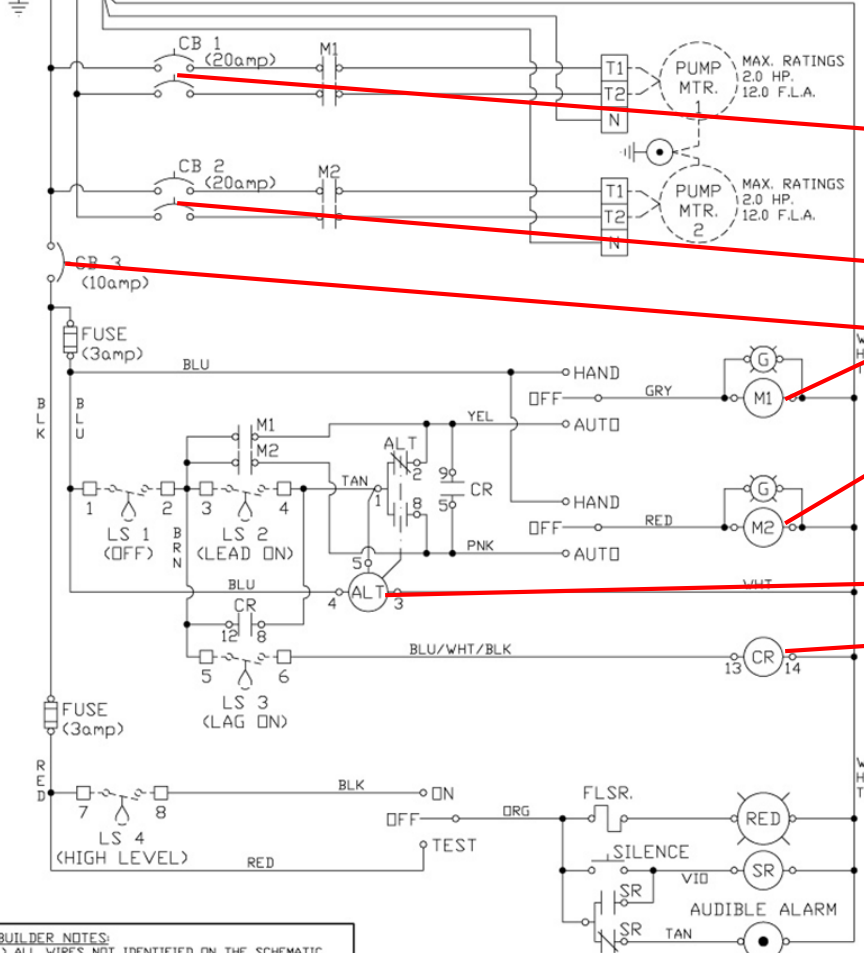
Schematic Symbols



? DENOTES THE NUMBER OF ITEM

230/115V-1Ø-60 Hertz-3 Wire Service

NOTE: OVERLOADS MUST BE IN PUMP MOTOR



BUILDER NOTES:

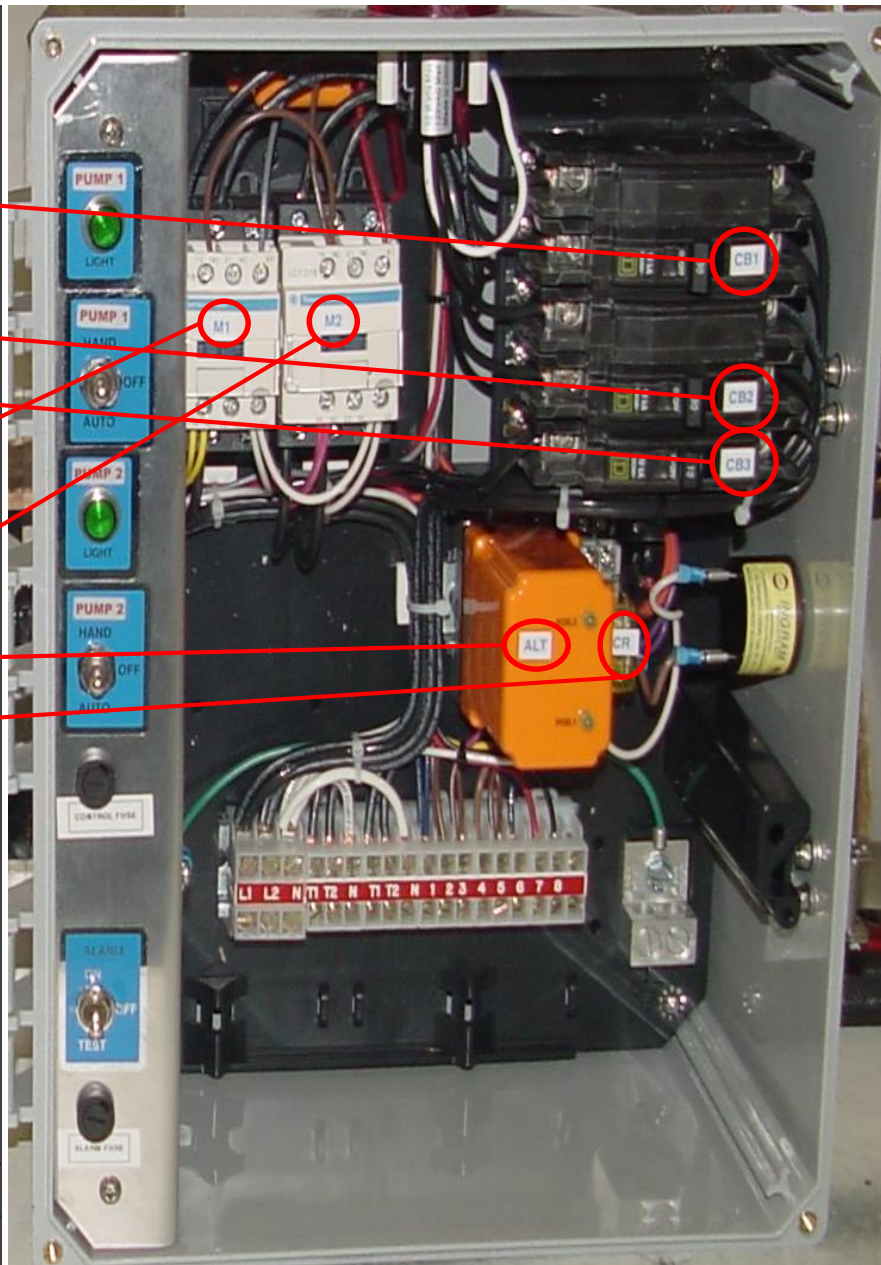
- 1) ALL WIRES NOT IDENTIFIED ON THE SCHEMATIC SHOULD BE BLACK, SIZED ACCORDING TO THE CIRCUIT. COLORED START COMPONENT WIRING SHOULD BE 14 AWG. ALL OTHER WIRES, UNLESS OTHERWISE SPECIFIED, ARE TO BE 22 AWG.

NOTES:

1. MAIN POWER DISCONNECT IS TO BE PROVIDED BY INSTALLER
2. REPLACE CONTROL FUSE WITH 250V, 3A MAX Fuse. LITTELFUSE P/N 021802-5HP OR EQUIVALENT.
3. TORQUE LARGE FIELD WIRING TERMINALS TO 35 In. Lbs. TORQUE SMALL FIELD WIRING TERMINALS TO 12 In. Lbs. FIELD WIRING MUST BE 60°C COPPER WIRE MINIMUM.
4. LEVEL SWITCHES MUST BE RATED A MINIMUM OF 2 AMPS @ 120 VOLTS.
5. OVERLOAD DEVICE MUST BE IN PUMP MOTOR.
6. ----- = ITEMS NOT SUPPLIED IN CONTROL PANEL.
7. CAUTION: NONMETALLIC ENCLOSURE DOES NOT PROVIDE GROUNDING BETWEEN CONDUIT CONNECTIONS. USE GROUNDING BUSHINGS AND JUMPER WIRES.

REV. 4/1/11 - CHANGED CR CONTACT PIN 8 WIRING.
REV. 1/29/08 - STANDARDIZED WIRE COLORS

DRWN.	FUSION		220 Ohio Street
DWF	by CSI Controls		Ashland, Ohio
DATE	SCALE	DRWG. NO.	(419)281-5767
6/21/07	NONE	A-FD230CB	



TROUBLESHOOTING 101

**EVEN EASIER THAN READING A
SCHEMATIC**

Troubleshooting Basics

A pumping station has 4 basic elements:

1. Electrical Service

- must match motor rated voltage
- measure with meters

2. Control panel

Control circuit

- check for voltage at terminals
- check for blown fuses
- run pumps manually with HOA switch
- simulate float sequence

Pump circuit

- check voltage
- tripped circuit breakers
- check contactor or overload unit

3. Floats

- disconnect at least one lead and check with ohmmeter

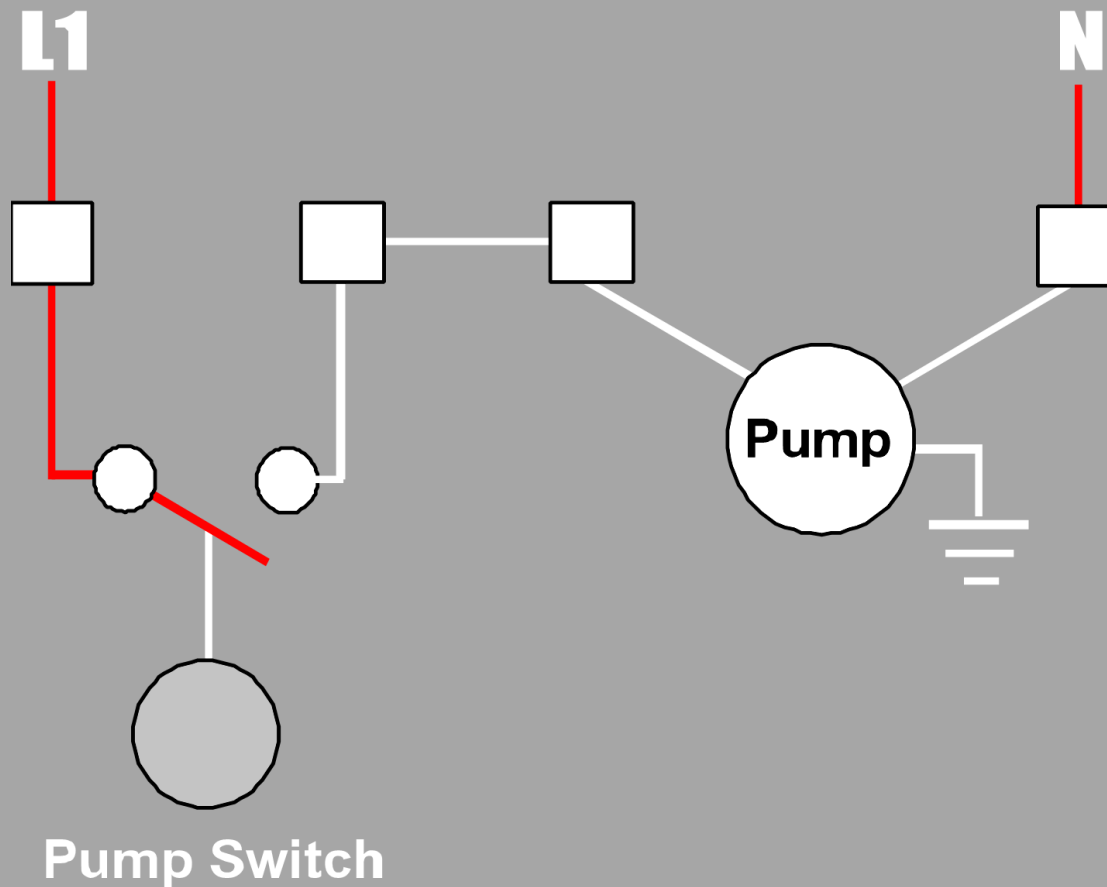
4. Motor

- disconnect leads and check with ohmmeter

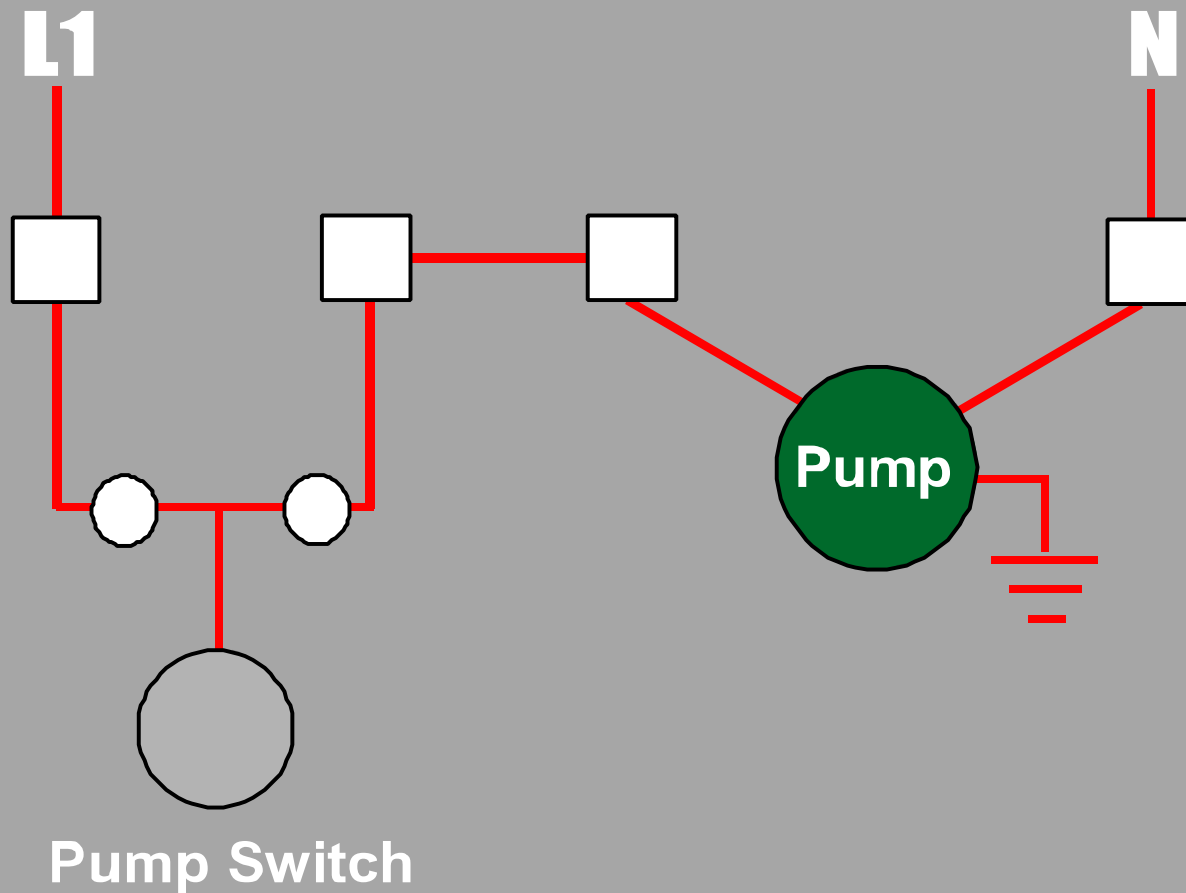
TROUBLESHOOTING A FLOAT

- **CHECKING RESISTANCE (OHMS) DOESN'T ALWAYS TELL THE TALE.**
- **TO GET THE WHOLE STORY YOU MUST CHECK VOLTAGE ACROSS THE FLOAT, THIS IS ESPECIALLY TRUE WHEN IT COMES TO MECHANICAL FLOATS.**
- **IN A CONTROL PANEL THE PUMP ON/OFF FLOATS ARE POWERED BY THE CONTROL CIRCUIT.**
- **WHEN CHECKING VOLTAGE YOU MUST BE SURE OF WHAT YOUR CONTROL VOLTAGE SHOULD BE, I.E. 12VDC, 24VDC, 120VAC (THIS CAN BE FOUND ON THE CONTROL PANEL RATINGS LABEL).**

Pump Switches



Pump Switches



The background of the image consists of concentric, light blue ripples on a white surface, resembling water droplets. The ripples are centered and spread outwards, creating a sense of depth and movement. The word "QUESTIONS?" is superimposed in the center of these ripples.

QUESTIONS?

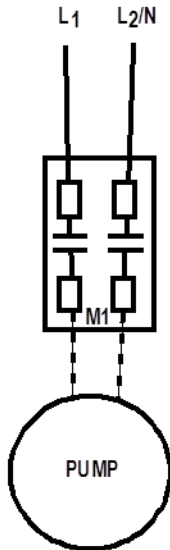
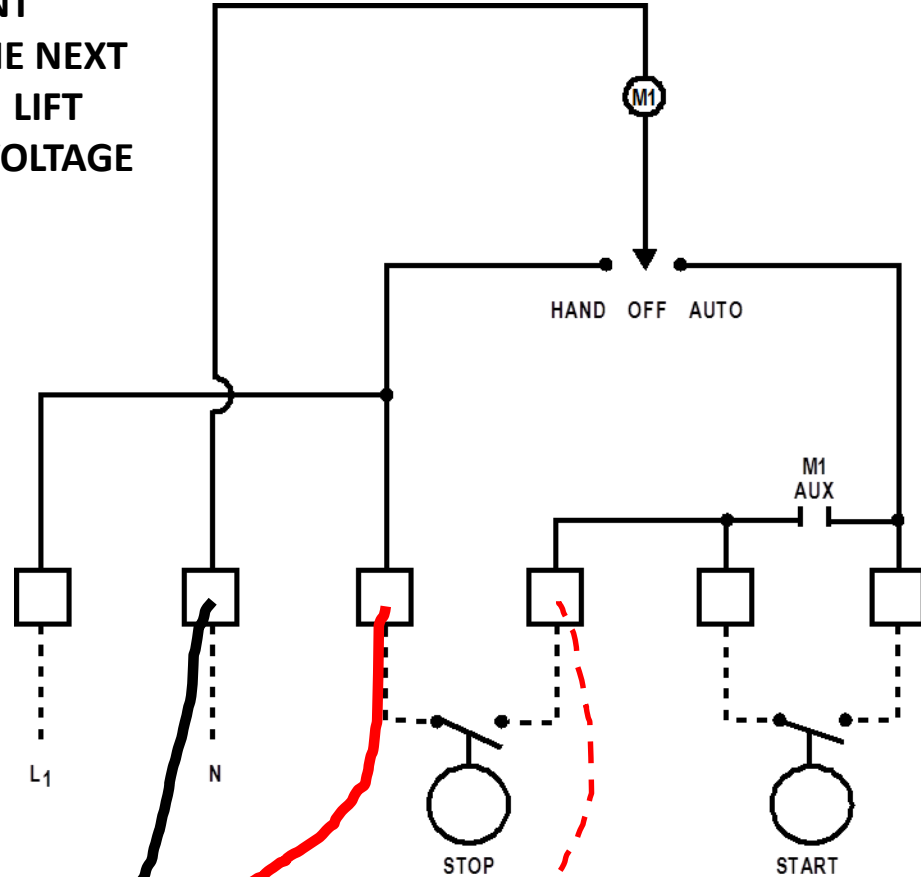
The background of the slide features a series of concentric, light-colored circles that resemble ripples on water, centered around the text. The circles are evenly spaced and create a subtle, circular pattern across the entire page.

CONTROL/ALARM CIRCUITS 101

- **THE CONTROL/ALARM CIRCUIT SENDS POWER TO THE FLOATS.**
- **THE CONTROL/ALARM CIRCUIT POWERS THE MOTOR CONTACTOR COIL, ALL THE LIGHTS, AND THE BEACON & HORN.**
- **THE CONTROL/ALARM CIRCUIT IS SEPARATE ELECTRICALLY FROM THE PUMP CIRCUIT.**

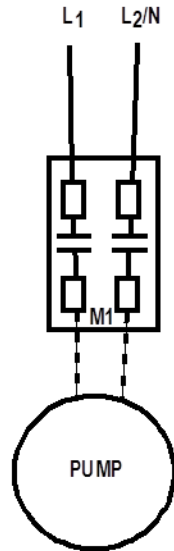
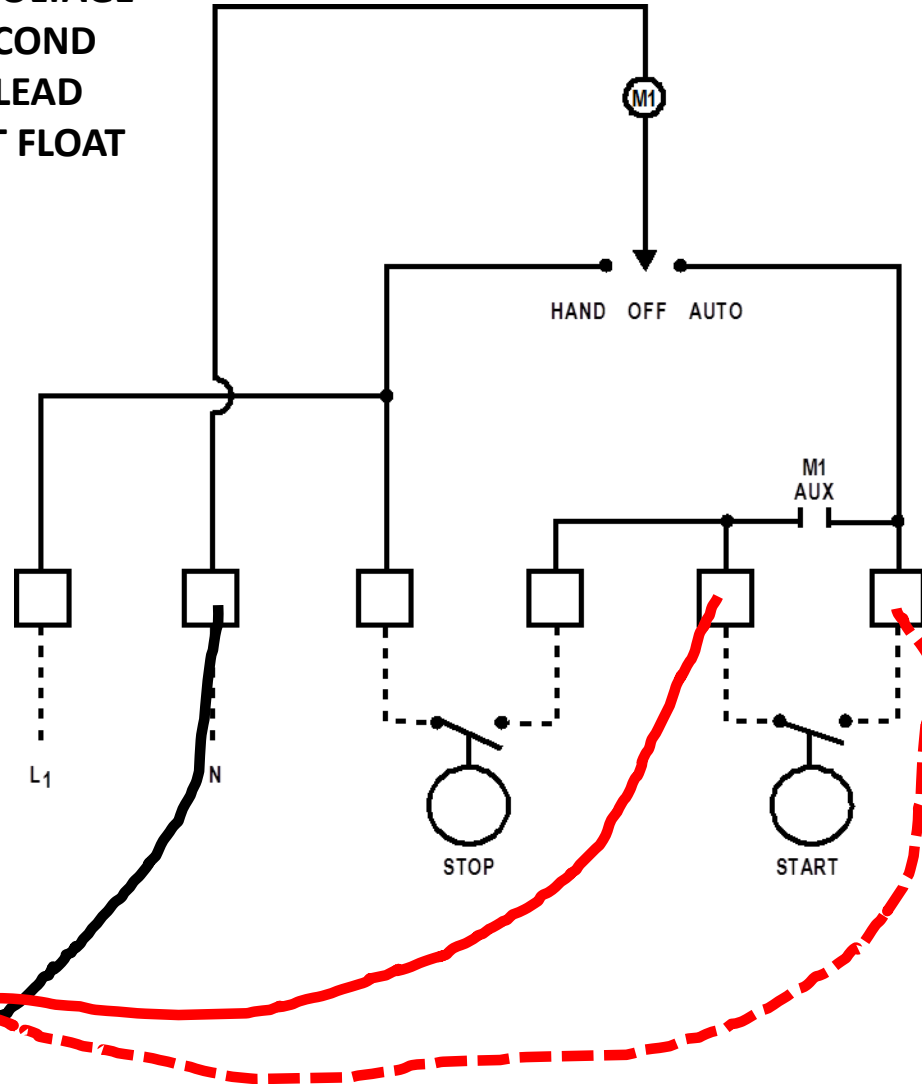
CHECKING FLOATS

- RED LEAD GOES TO FIRST FLOAT CONNECTION (NON-SWITCHED SIDE)
- BLACK LEAD GOES TO NEUTRAL AND STAYS THERE
- MEASURE VOLTAGE, IF IT IS PRESENT MOVE THE RED LEAD DOWN TO THE NEXT TERMINAL FOR THAT SAME FLOAT. LIFT THE FLOAT AND SEE IF THE SAME VOLTAGE IS PRESENT.



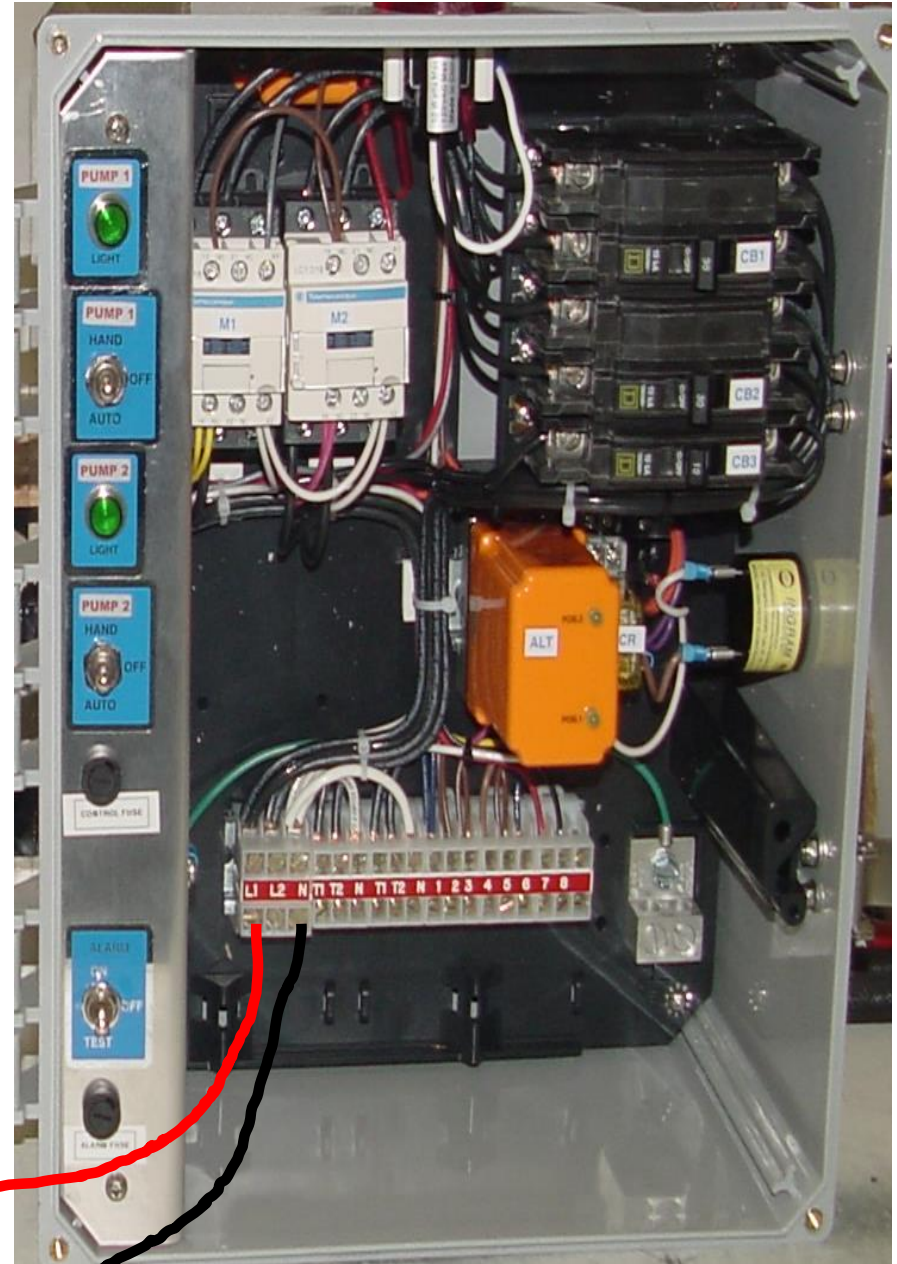
- SECURE BOTTOM FLOAT IN THE UP (CLOSED POSITION)
- LEAVE THE BLACK LEAD ON NEUTRAL
- RED LEAD GOES TO NON-SWITCHED SIDE OF SECOND FLOAT, CHECK VOLTAGE
- IF VOLTAGE IS PRESENT RAISE SECOND FLOAT AND HOLD IT, MOVE RED LEAD TO THE NEXT TERMINAL OF THAT FLOAT (SWITCHED SIDE)

CHECKING FLOATS (CONT.)



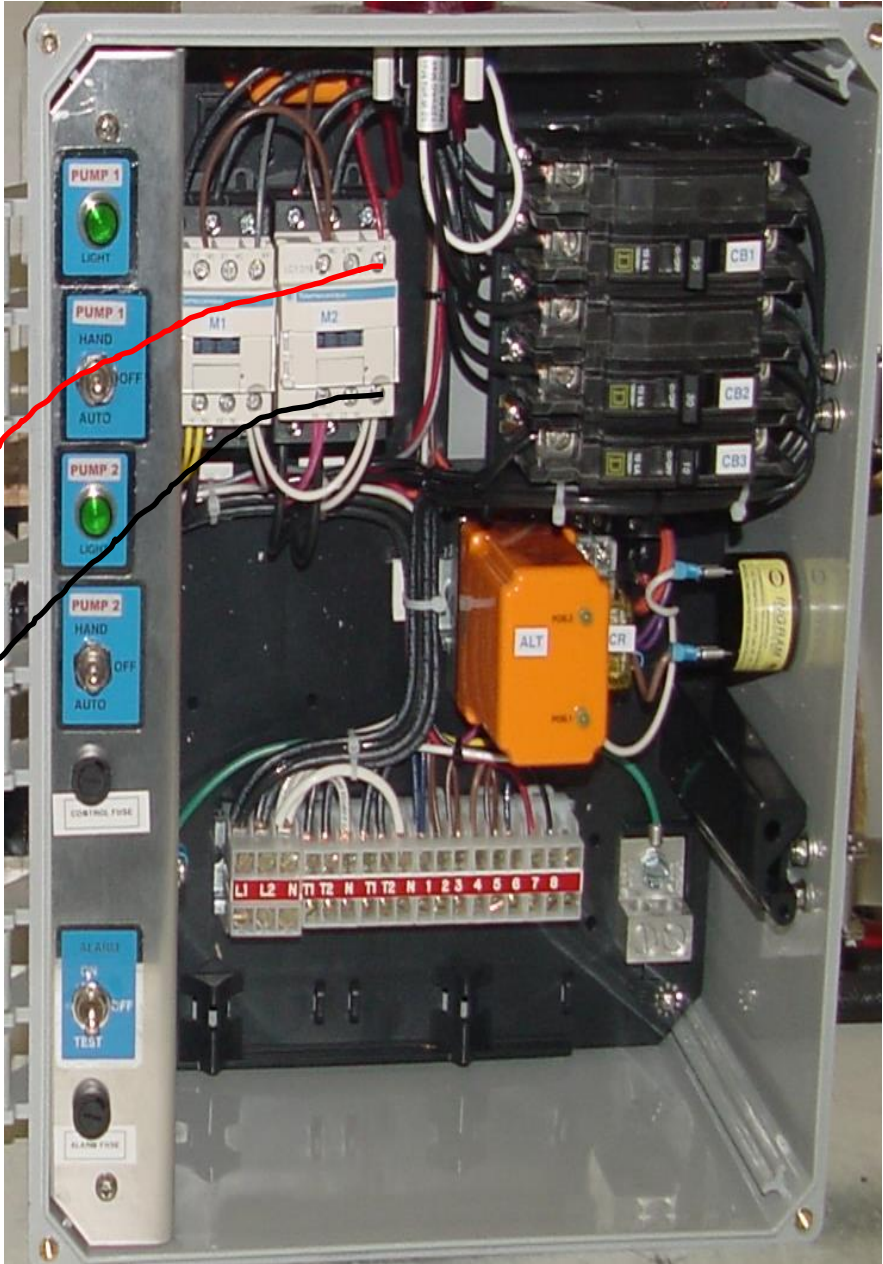
CHECKING CONTROL/ALARM VOLTAGE IN A CONTROL PANEL

- PUT METER TO VOLTS A/C
- CONNECT BLACK LEAD TO “COM” TERMINAL & RED LEAD TO “V” TERMINAL
- PUT RED LEAD TO INCOMING POWER TERMINAL (L1)
- PUT BLACK LEAD TO NEUTRAL TERMINAL (N). SHOULD BE 120VAC



TROUBLESHOOTING A MOTOR CONTACTOR COIL

- LOCATE THE MOTOR CONTACTOR AND IDENTIFY THE COIL CONNECTIONS (USUALLY LABELED A1 AND A2). SET METER TO VOLTS A/C
- RED LEAD GOES TO ONE COIL CONNECTION.
- BLACK LEAD GOES TO THE OTHER COIL CONNECTION
- PUT HOA SWITCH TO HAND AND WATCH TO SEE IF YOU HAVE VOLTAGE. IF YOU DO BUT THE CONTACTOR DOES NOT PULL IN THE CONTACTOR IS BAD, IF YOU DON'T HAVE VOLTAGE CHECK CONNECTIONS AND FUSES.



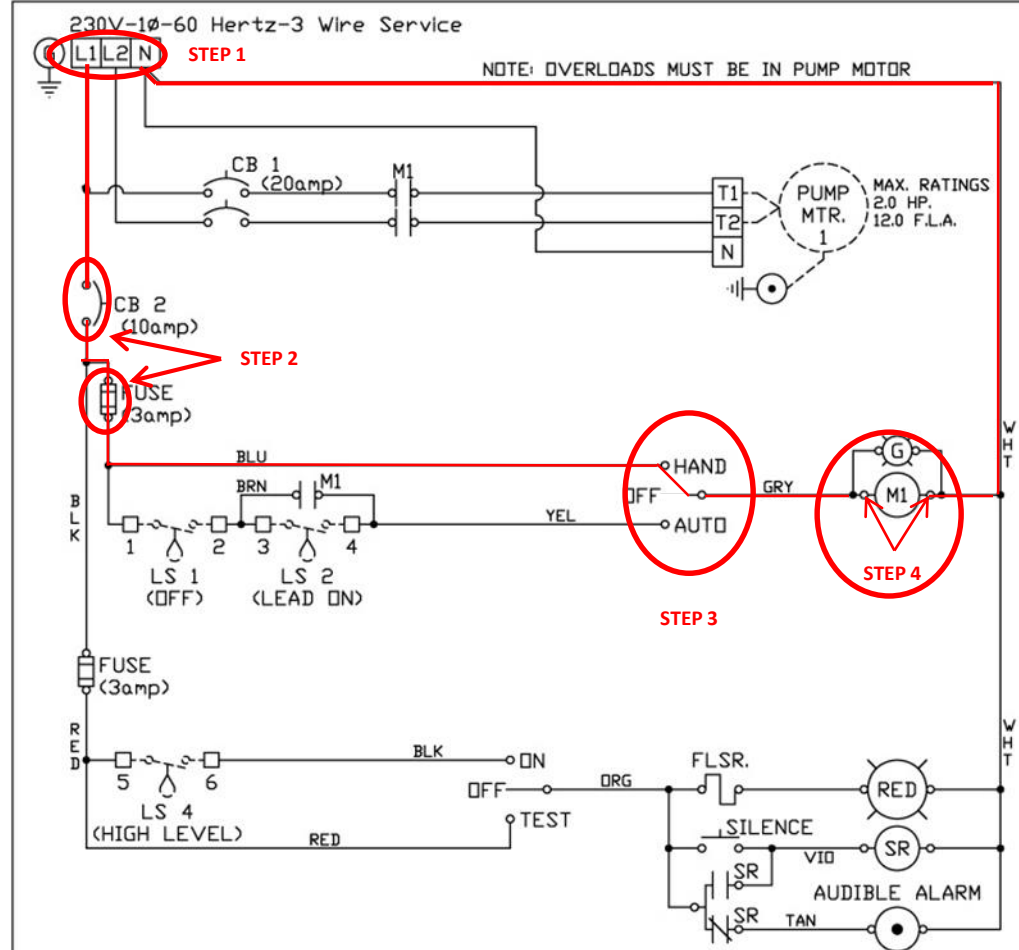
IN THIS EXAMPLE THE PUMP WILL NOT RUN IN HAND OR AUTO, CONTACTOR DOES NOT PULL IN. PUMP DOES RUN WHEN CONTACTOR IS PUSHED IN MANUALLY.

STEP 1: PLACE HOA SWITCH TO "OFF", CHECK INCOMING VOLTAGE FOR CONTROL ALARM CIRCUIT

STEP 2: CHECK FUSES AND CIRCUIT BREAKERS

STEP 3: PLACE HOA SWITCH TO "HAND"

STEP 4: CHECK VOLTAGE AT MOTOR CONTACTOR COIL



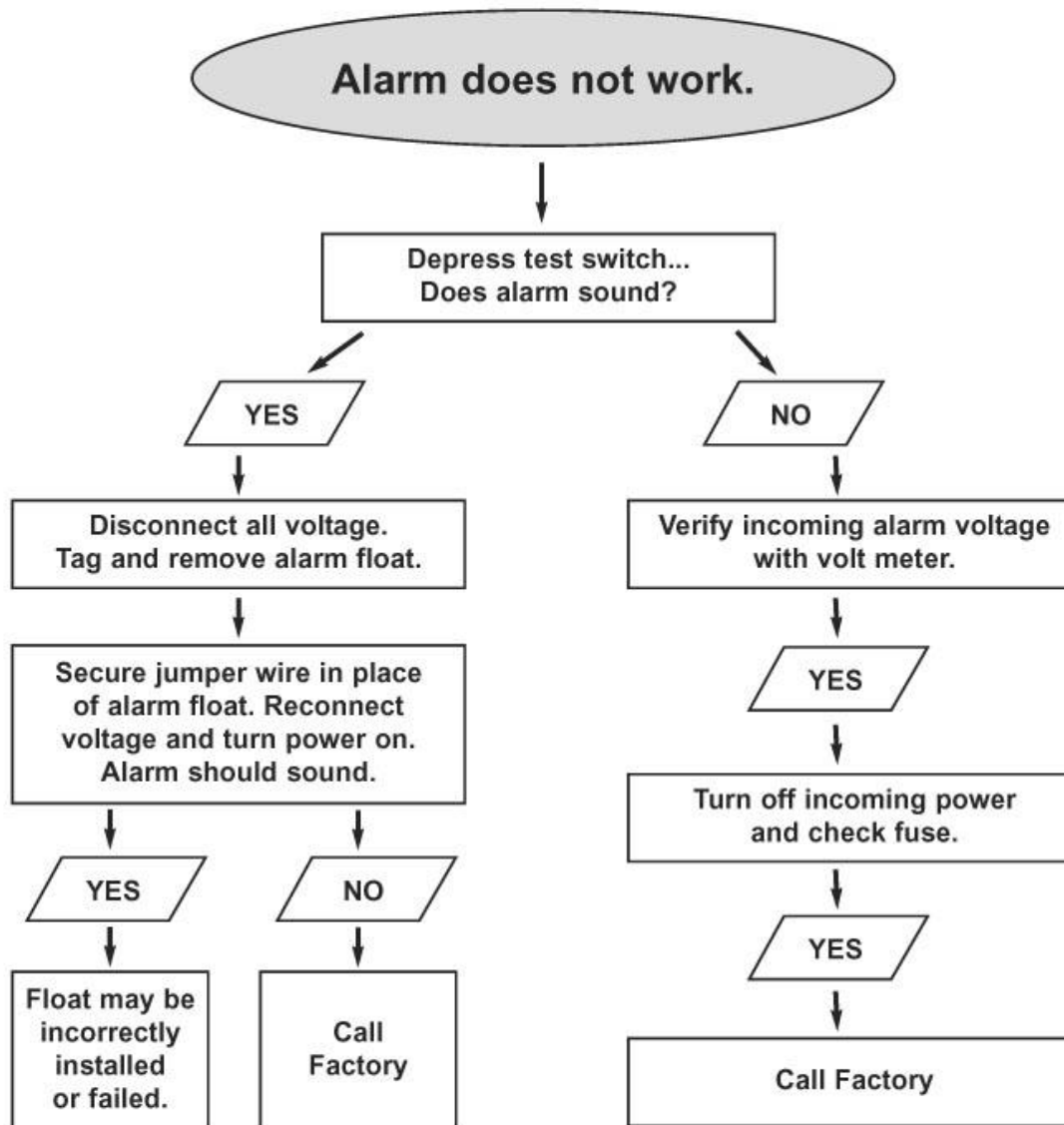
BUILDER NOTES:
 1) ALL WIRES NOT IDENTIFIED ON THE SCHEMATIC SHOULD BE BLACK, SIZED ACCORDING TO THE CIRCUIT. COLORED START COMPONENT WIRING SHOULD BE 14 AWG. ALL OTHER WIRES, UNLESS OTHERWISE SPECIFIED, ARE TO BE 22 AWG.

NOTES:
 1. MAIN POWER DISCONNECT IS TO BE PROVIDED BY INSTALLER
 2. REPLACE CONTROL FUSE WITH 250V, 3A MAX Fuse. LITTELFUSE P/N 021802SHXP OR EQUIVALENT.
 3. TORQUE LARGE FIELD WIRING TERMINALS TO 35 In. Lbs. TORQUE SMALL FIELD WIRING TERMINALS TO 12 In. Lbs.
 4. LEVEL SWITCHES MUST BE RATED A MINIMUM OF 2 AMPS @ 120 VOLTS.
 5. OVERLOAD DEVICE MUST BE IN PUMP MOTOR.
 6. ----- = ITEMS NOT SUPPLIED IN CONTROL PANEL.
 7. CAUTION: NONMETALLIC ENCLOSURE DOES NOT PROVIDE GROUNDING BETWEEN CONDUIT CONNECTIONS. USE GROUNDING BUSHINGS AND JUMPER WIRES.

REV. 1/29/08 - STANDARDIZED WIRE COLORS

DRWN.	FUSION <i>by CSI Controls</i>	220 Ohio Street Ashland, Ohio (419)281-5767
DWF		
DATE	SCALE	DRWG. NO.
6/21/07	NONE	A-FS230CB

Alarm Circuit Troubleshooting



The background of the slide features a series of concentric, light blue ripples on a white surface, resembling water droplets. The ripples are centered and spread outwards, creating a sense of depth and movement. The word "QUESTIONS?" is superimposed in the center of these ripples.

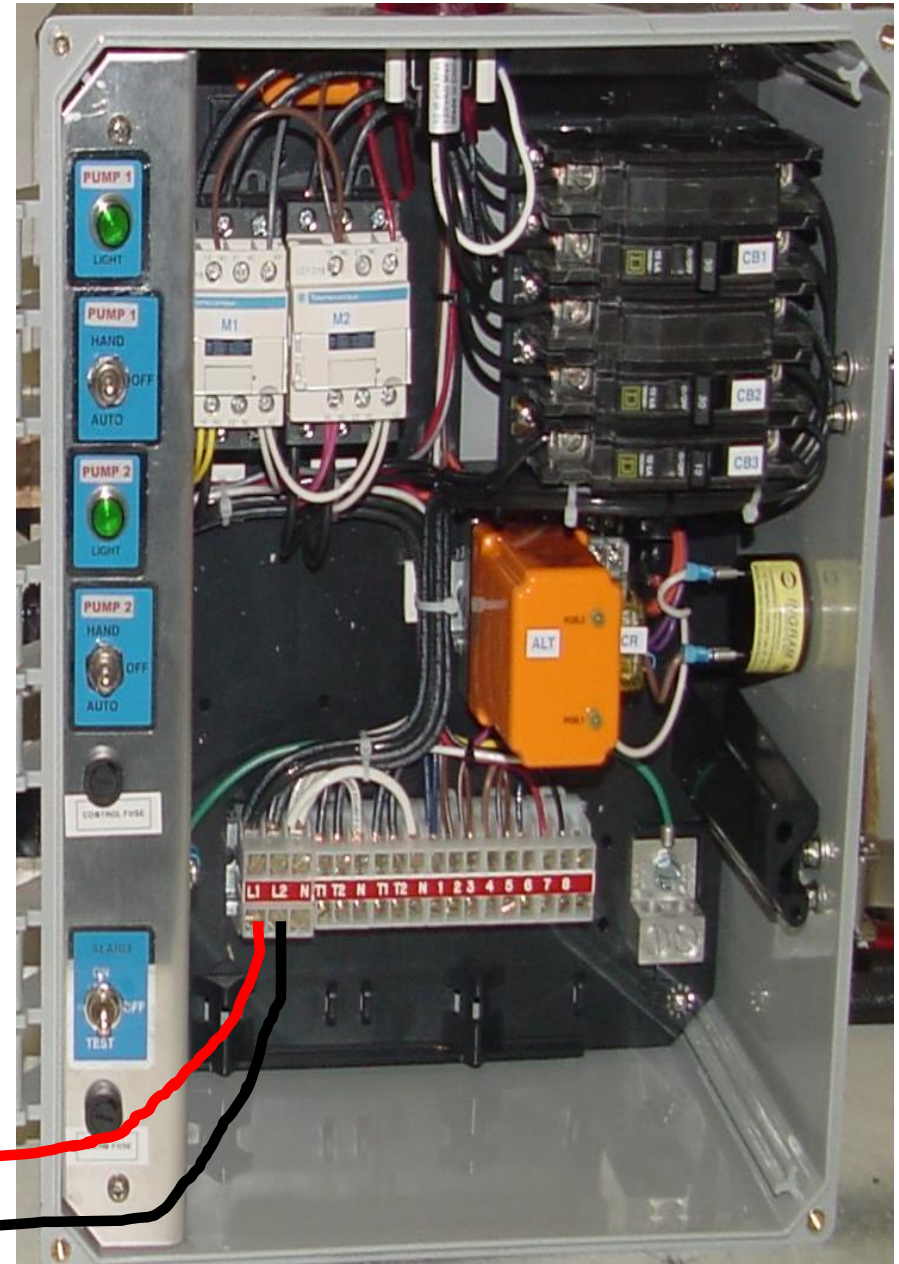
QUESTIONS?

PUMP CIRCUITS

101

CHECKING INCOMING PUMP VOLTAGE

- PUT METER TO VOLTS A/C
- CONNECT BLACK LEAD TO “COM” AND RED LEAD TO “V” ON YOUR METER
- PUT RED LEAD TO L1 TERMINAL IN CONTROL PANEL
- PUT BLACK LEAD TO “L2” TERMINAL FOR 230VAC PUMPS, OR “N” TERMINAL FOR 120VAC PUMPS IN CONTROL PANEL



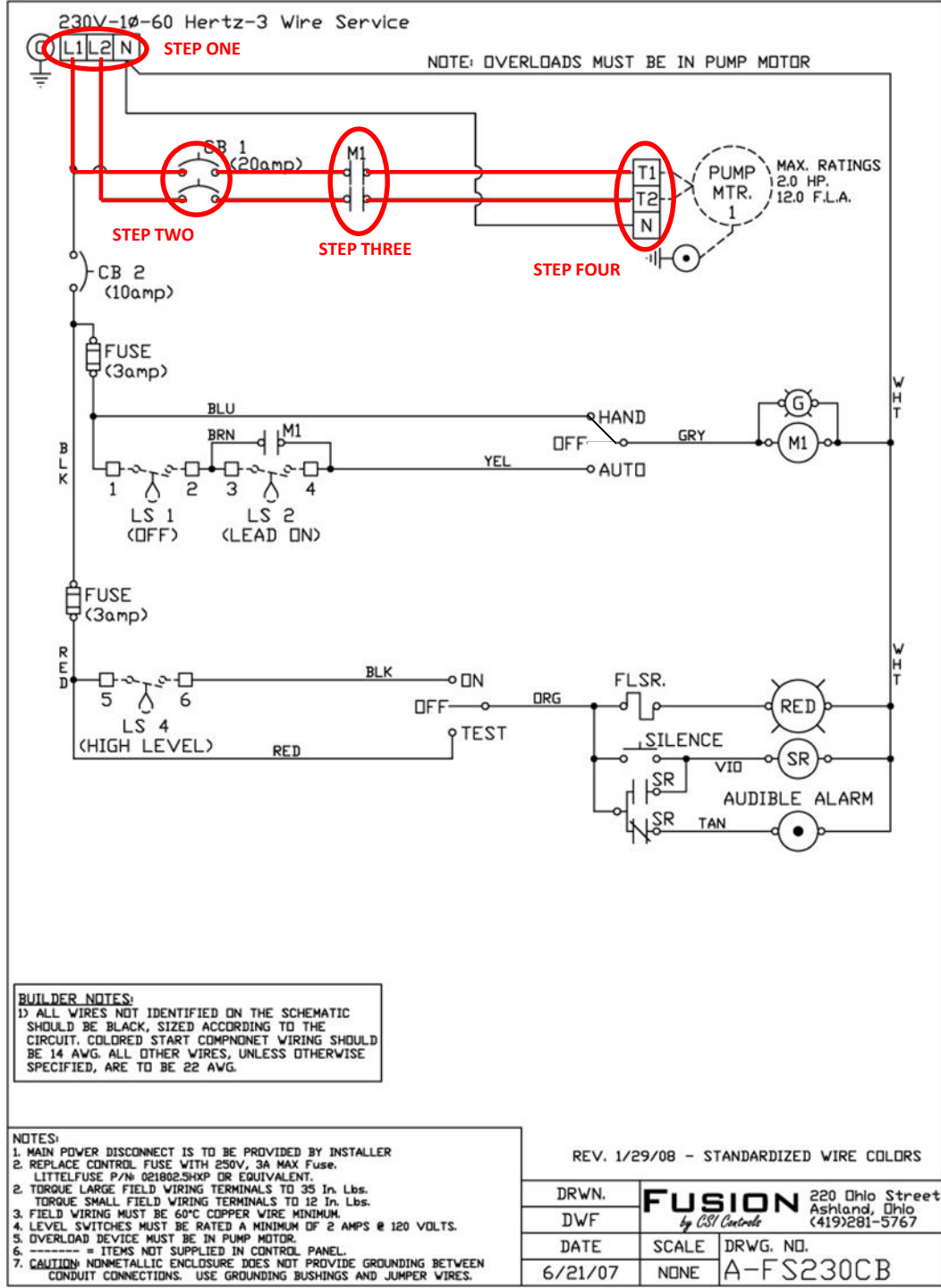
IN THIS EXAMPLE OUR PUMP WILL NOT RUN IN HAND OR AUTO, CONTACTOR DOES PULL IN.

STEP 1: WITH THE HOA SWITCH IN THE "OFF" POSITION WE CAN START BY CHECKING INCOMING POWER

STEP 2: CHECK VOLTAGE AT THE NEXT STOP (CIRCUIT BREAKER), CHECK BOTH THE TOP AND BOTTOM.

STEP 3: PUT THE HOA SWITCH TO "HAND" AND CHECK VOLTAGE ON EACH SIDE OF THE MOTOR CONTACTOR CONTACTS, FIRST THE TOP, THEN THE BOTTOM.

STEP 4: CHECK VOLTAGE AT THE PUMP CONNECTIONS.



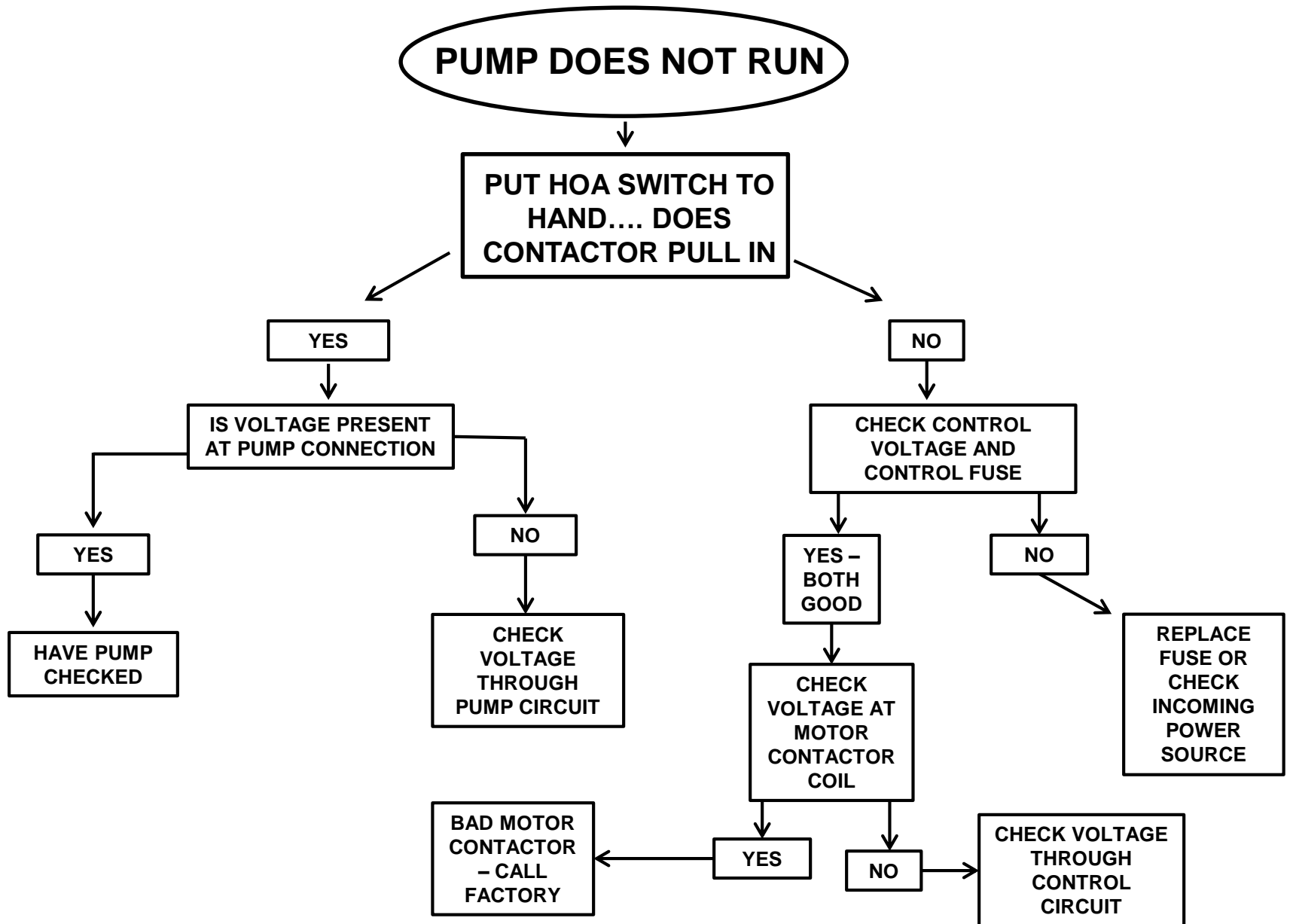
TROUBLESHOOTING A PUMP CIRCUIT

- **PUT PUMP HOA SWITCH INTO “HAND” AND CONFIRM THAT THE CONTACTOR IS PULLING IN – YOU SHOULD HEAR AN AUDIBLE “CLUNK”. IF SO, PROCEED TO NEXT STEP – IF NOT CHECK VOLTAGE THROUGH THE CONTROL CIRCUIT (COULD BE A BAD M.C. COIL).**
- **CHECK VOLTAGE AT THE MOTOR CONNECTIONS IN THE PANEL – IF NO VOLTAGE TURN HOA TO “OFF” AND PROCEED TO NEXT STEP.**
- **CHECK PUMP INCOMING VOLTAGE – IT SHOULD MATCH PUMP RATED VOLTAGE. IF YES THEN PROCEED TO THE NEXT STEP.**

TROUBLESHOOTING A PUMP CIRCUIT CONT.

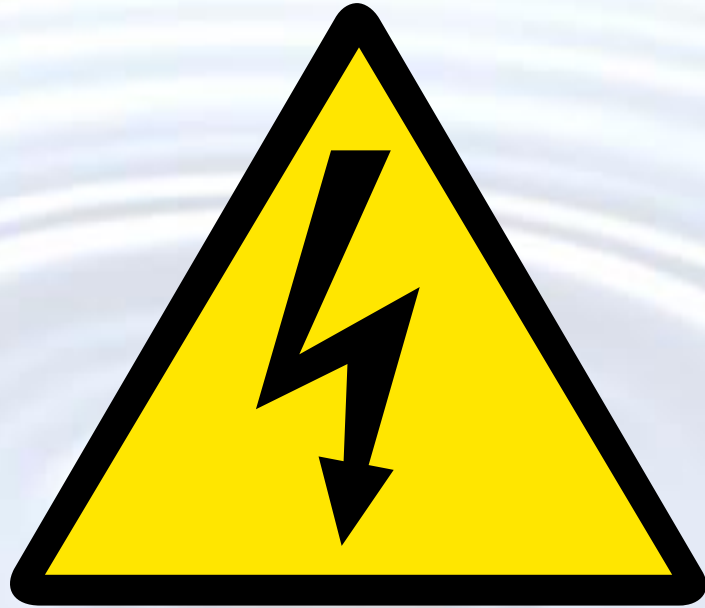
- **IF THERE IS A CIRCUIT BREAKER IN THE PANEL FOR THE PUMP CONFIRM THAT IT IS TURNED ON – NOT TRIPPED**
- **CHECK VOLTAGE ON BOTH SIDES OF THE CIRCUIT BREAKER.**
- **CHECK VOLTAGE AT THE TOP (LINE SIDE) OF THE MOTOR CONTACTOR.**
- **PUT HOA INTO HAND AND CHECK VOLTAGE ON BOTTOM (LOAD SIDE) OF THE MOTOR CONTACTOR. IF NO REPLACE CONTACTOR, IF YES PROCEED TO NEXT STEP.**
- **CHECK VOLTAGE AT MOTOR CONNECTION TERMINAL BLOCK.**

TROUBLESHOOTING A MOTOR CIRCUIT



The background of the slide features a series of concentric, light blue ripples on a white surface, resembling water droplets. The ripples are centered and spread outwards, creating a sense of depth and movement. The word "QUESTIONS?" is superimposed in the center of these ripples.

QUESTIONS?



THANK YOU