VANDEVANTER ENGINEERING
A COGENT COMPANY

Pump Station Maintenance For Operators

Prepared by Jack Kemper
Dan Pagano, and Mike Rynd

- **Be sure to consider safety when working on and around Lift Stations**
- **Do not overlook the obvious**

Consider:

1. **Electrical Hazards**
2. **Confined Space Entry**
3. **Toxic and Flammable Gases**
4. **Trip and Fall Hazards**

It Is Imperative to Understand How Your Lift Stations Operate, If You are Going to Perform Maintenance on Them

You Don’t Know What You Don’t Know?

It is Difficult at Best to Maintain and Operate a Lift Station if You Don’t Know How it Works….

One of the Most Important Tools You can Have is Access to a Good Electrical Multi-Meter, and Know How it is Used, to Troubleshoot Problems in the Control Panel and Pumps at Your Lift Stations

When working on Pumps or Control Panels, Make Sure that the Power Is Off at the Main Disconnect Switch (LOTO) Better Safe than Sorry when it comes to Electricity!

It is Important to Use all of The Tools in Your Tool Box when Performing Operation and Maintenance on Your Lift Stations.

Don’t Forget:

1. **Your Hands (Touch / Feel)**
2. **Your Eyes (Do Things Look Normal)**
3. **Your Ears (Do Things Sound Normal)**

The More Familiar Your Are with “Your” Lift Stations, The Easier it is to Keep them Running Like they Should Be

The Most Difficult Item to Understand at a Lift Station is the Control Panel.

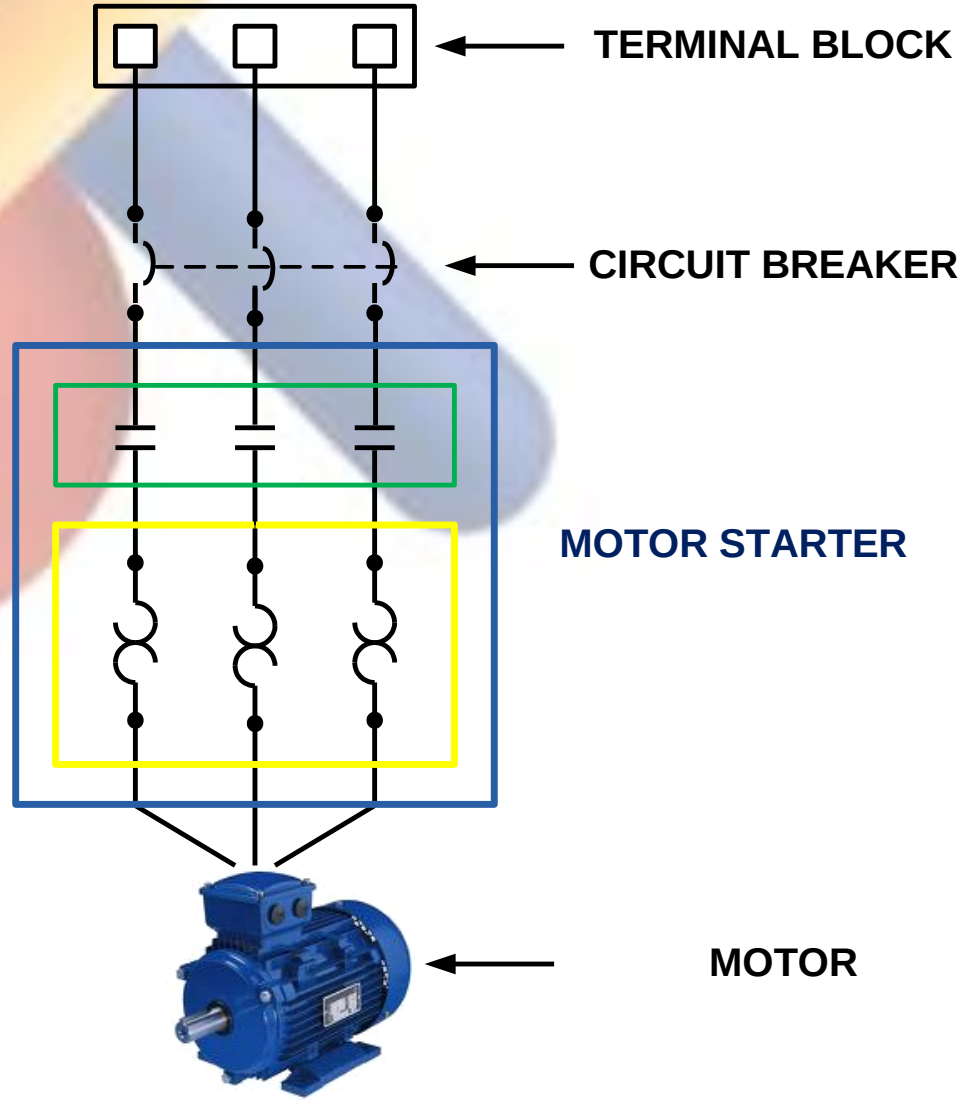
Control Panels Have 5 Distinct Systems that Operate together to Control the Pumps in a Lift Station.

These Five Systems Are:

1. HIGH VOLTAGE DRIVE TRAIN

- **Incoming Power Distribution Block**
- **Main Circuit Breaker**
- **Pump Circuit Breakers**
- **Pump Motor Starter**

1. HIGH VOLTAGE DRIVE TRAIN



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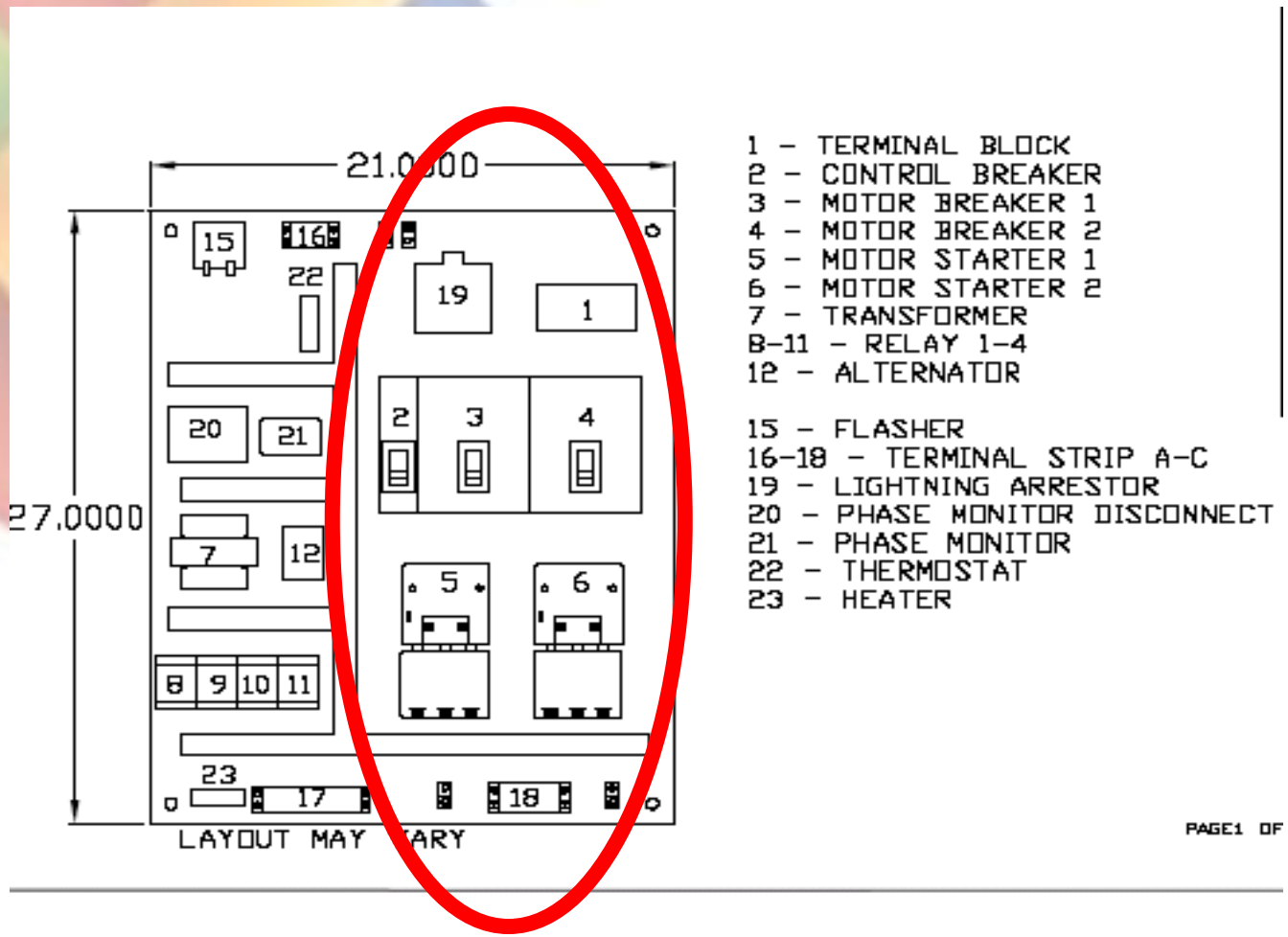

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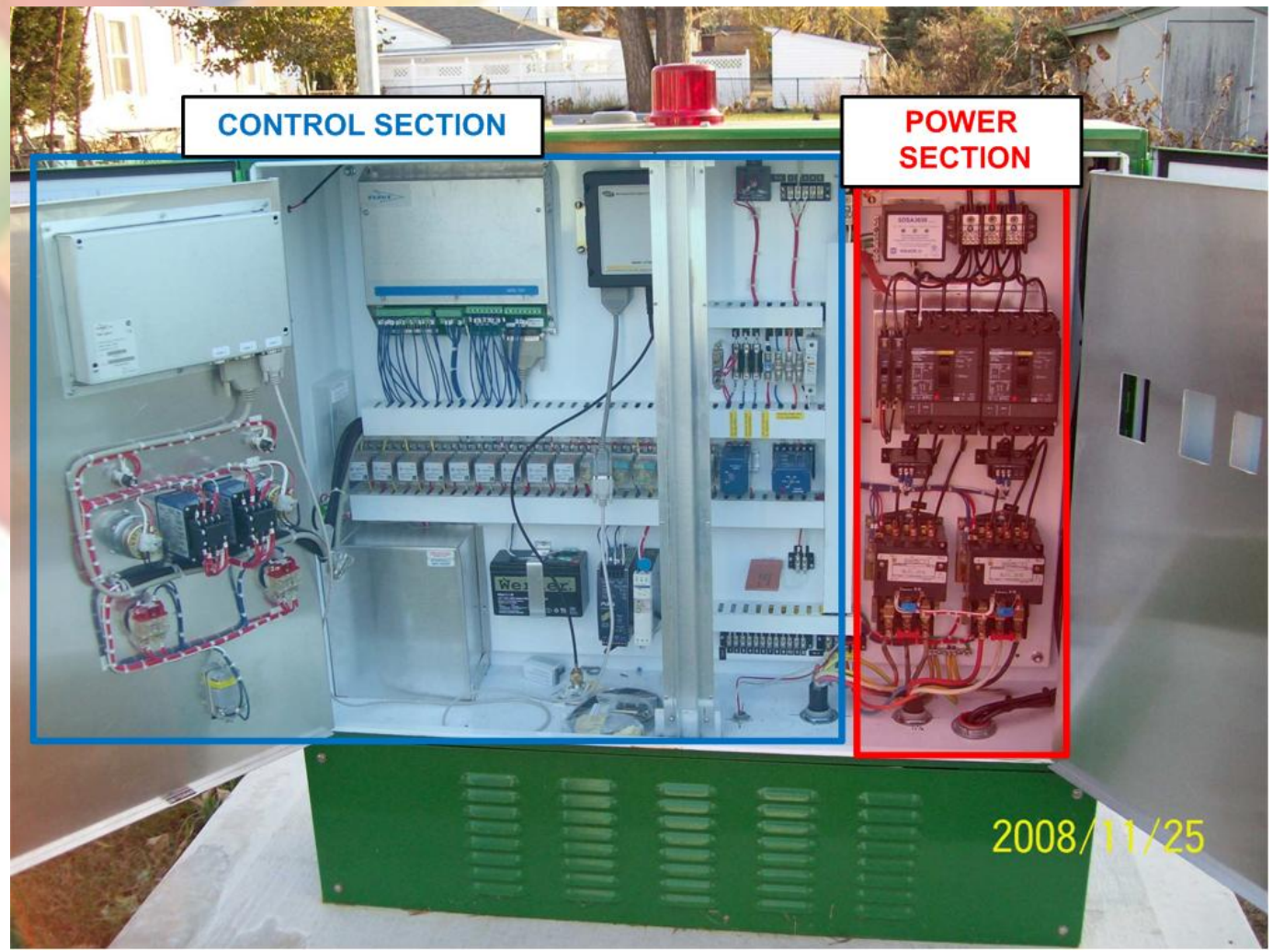
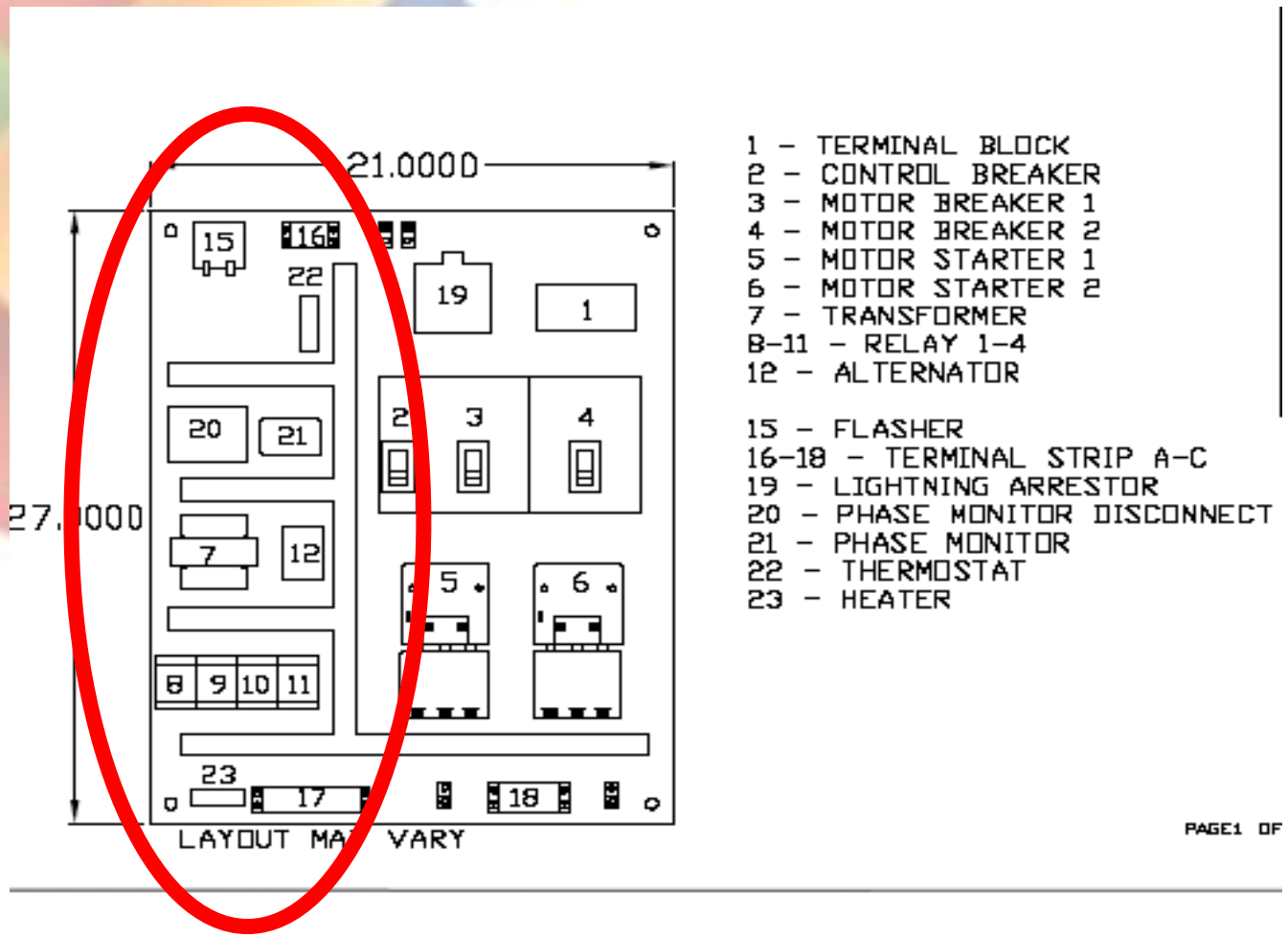


2. CONTROL LOGIC AND WIRING

- **Hand-Off-Automatic Switches**
- **Control Relays – 120VAC and 24VAC**
- **Alternating Relays**
- **Control Power Circuit Breakers**
- **Control Power Transformers**
- **Control Power Fuses and Fuse Block**

2. CONTROL LOGIC AND WIRING



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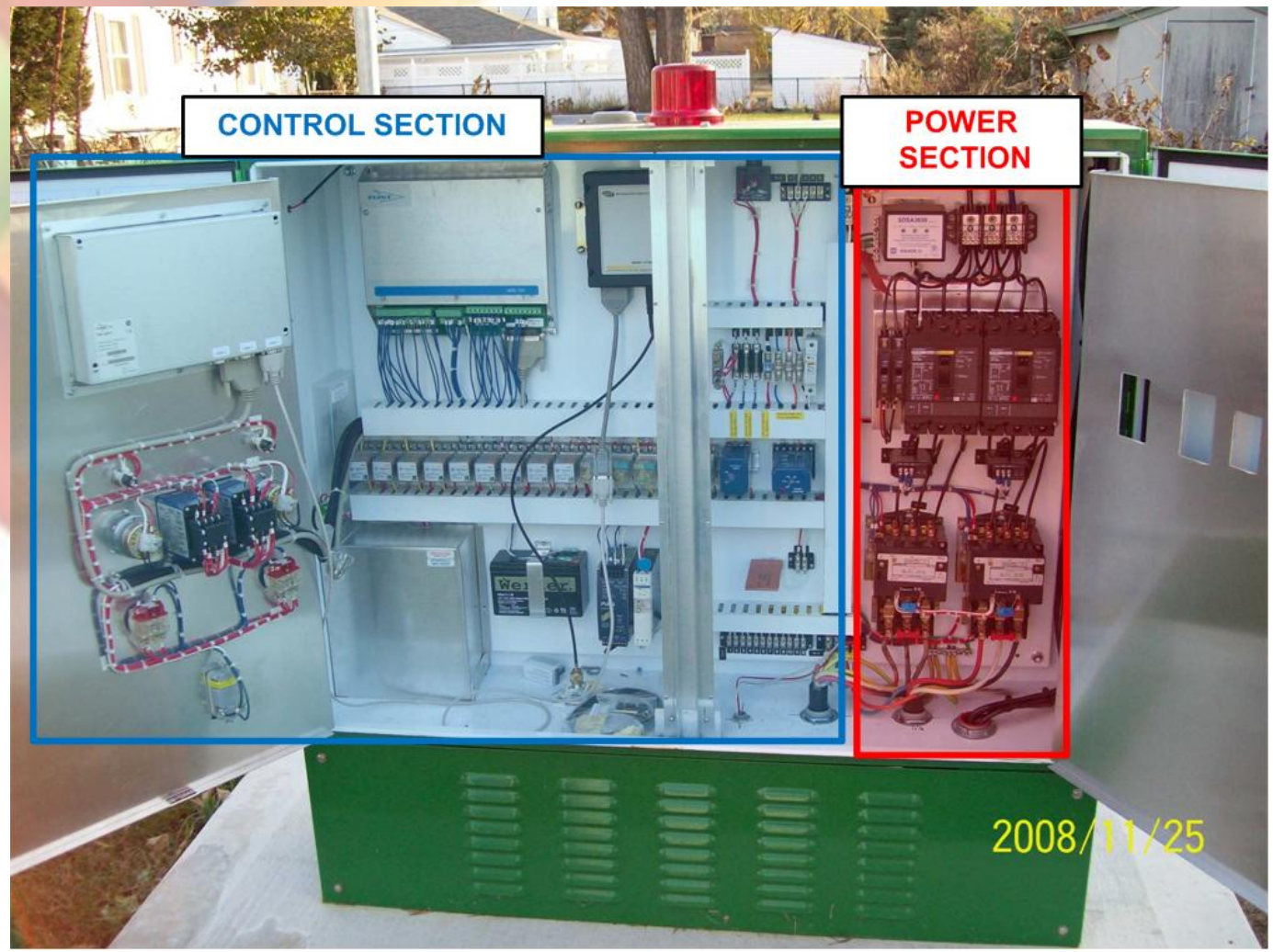
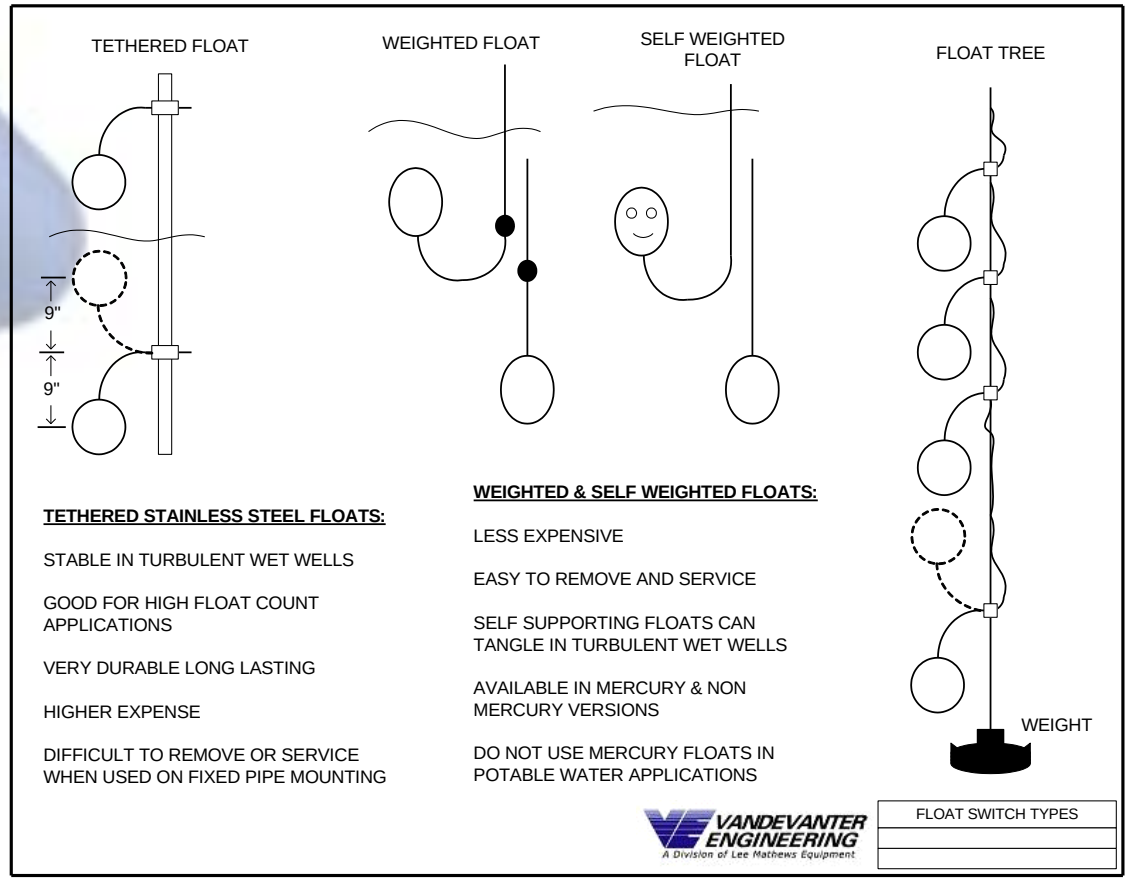


3. LEVEL SENSING EQUIPMENT

- **Float Switches and Intrinsically Safe Relays**
- **Transducers and 24VDC Power Supplies**
- **Conductivity Probes and Probe Relays**

3. LEVEL SENSING EQUIPMENT

Float Switches and Intrinsically Safe Relays



3. LEVEL SENSING EQUIPMENT

Transducers

BULLET NOSE

(CLEAN WATER APPLICATIONS)

WATER WELLS

SAMPLING WELLS

WATER TANKS

LAKES & RIVERS

DIAPHRAGM FACE

(WASTE WATER APPLICATIONS)

PUMP STATION

WETWELLS

FLANGE MOUNT

DIAPHRAGM

(TANK MOUNT APPLICATIONS)

3. LEVEL SENSING EQUIPMENT

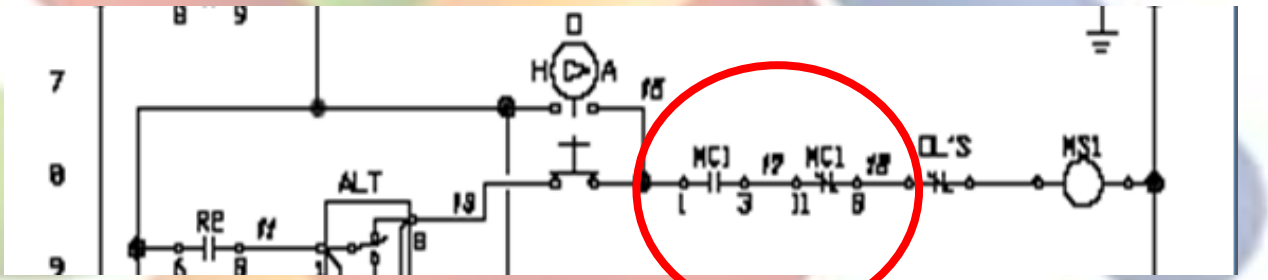
Conductivity Probes and Relays

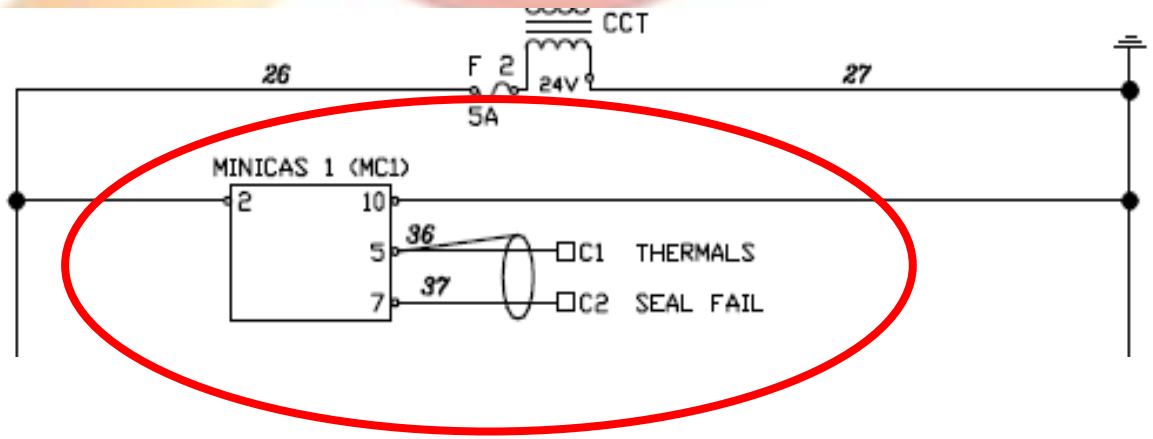
4. SAFETY & PROTECTION DEVICES

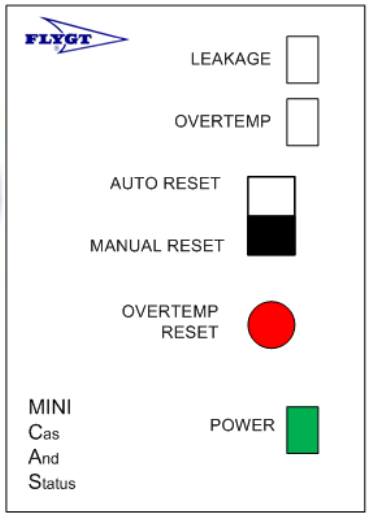
- **Leakage Detector Relays**
- **Latching Temperature Relays**
- **Overload Relays (Motor Starter)**
- **Phase/Voltage Monitor Relays**
- **Control Power Circuit Breakers and Fuses**

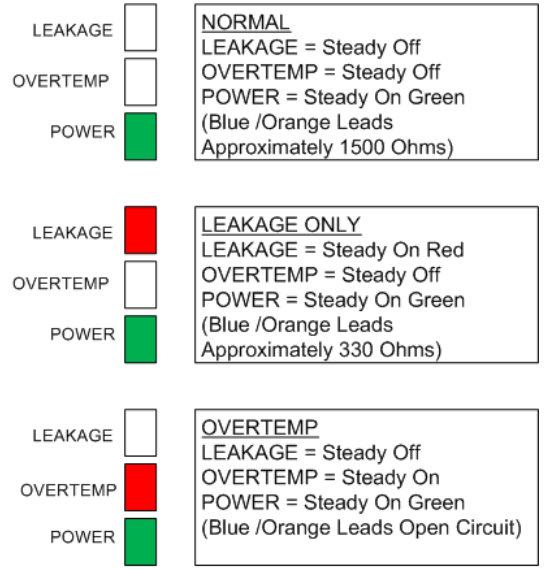
4. SAFETY & PROTECTION DEVICES

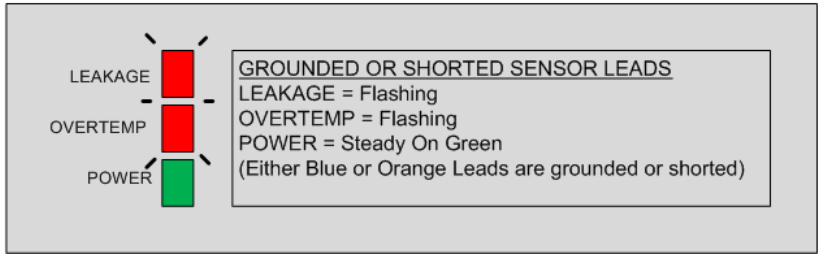
Leakage Detector Relays
Latching Temperature Relays





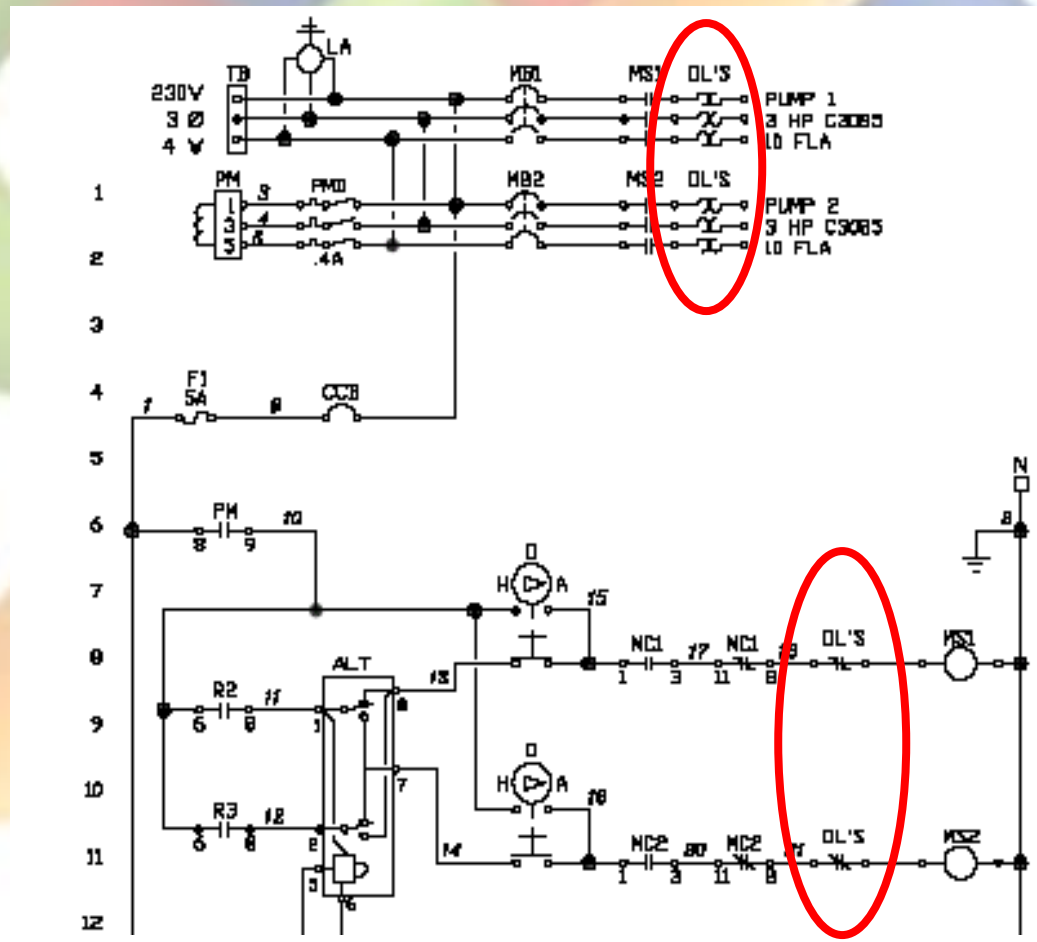






4. SAFETY & PROTECTION DEVICES

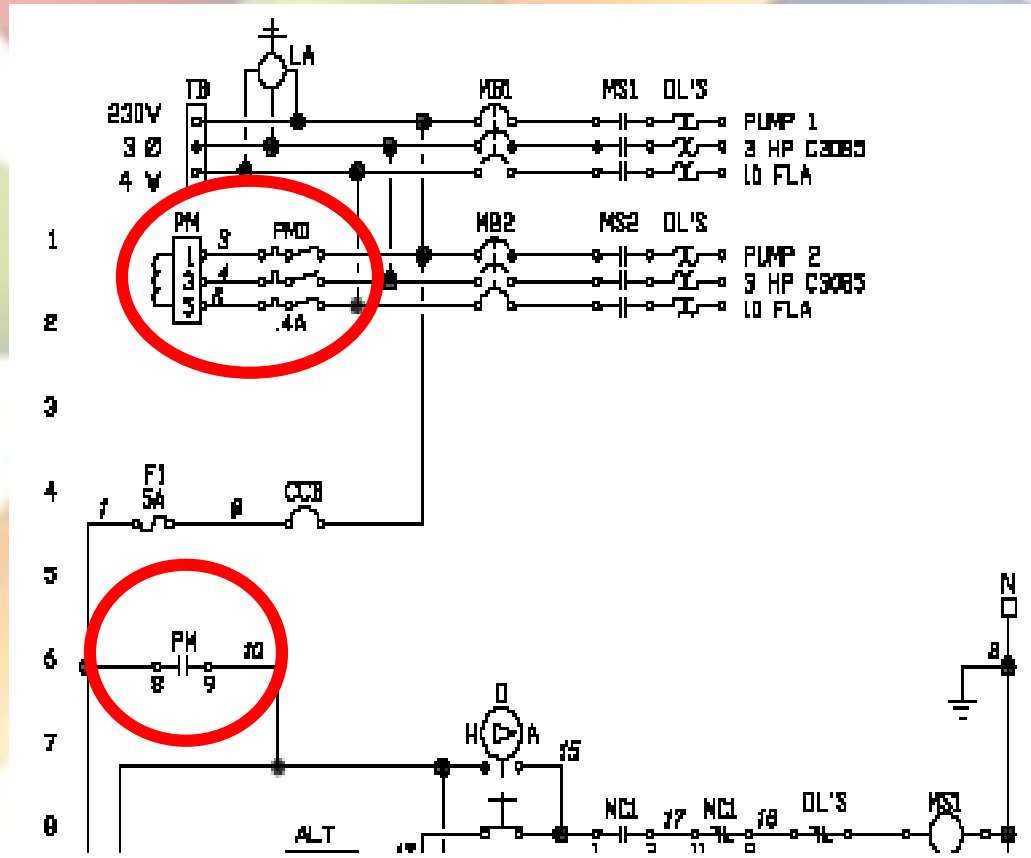
Overload Relays



TRAINING	QUOTE NO.	DATE	DRAWN BY	REVISION
	KFJ	8/18/2004	D.J.L.	

4. SAFETY & PROTECTION DEVICES

Phase/Voltage Monitor Relays



4. SAFETY & PROTECTION DEVICES

Control Power Circuit Breakers and Fuses

5. ALARM & WARNING SYSTEM DEVICES

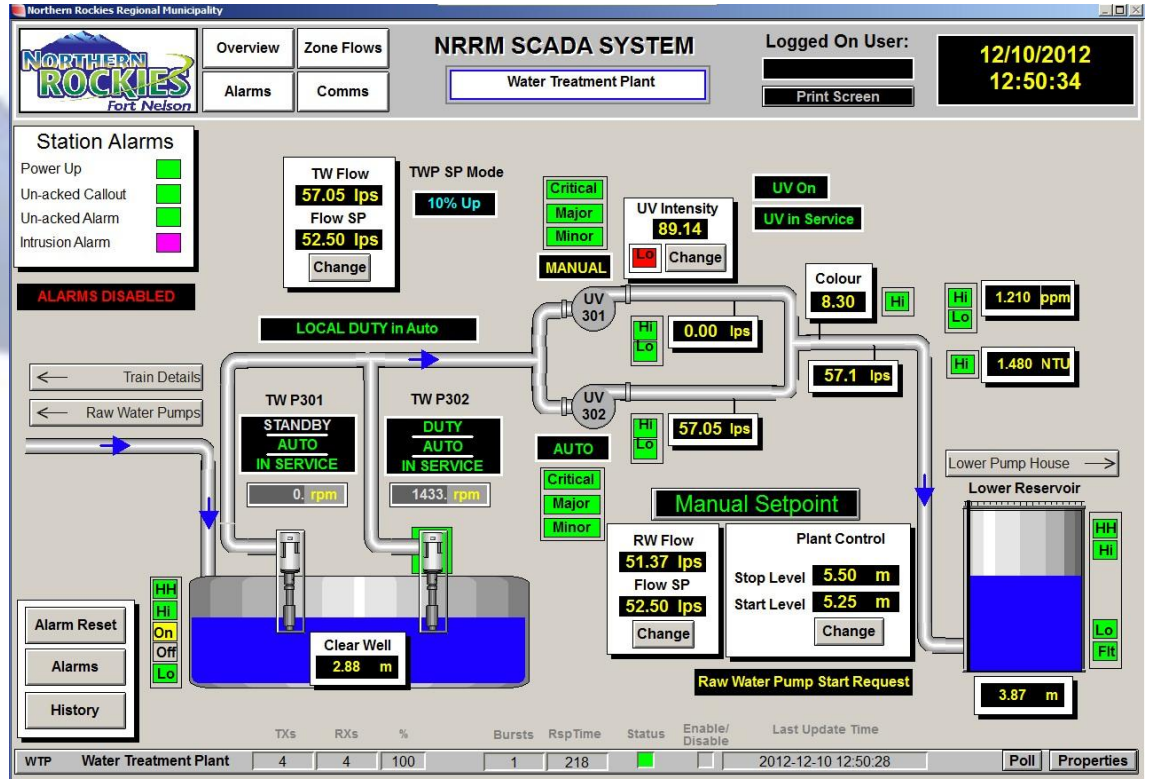
- **Visual Alarm Devices (Lights)**
- **Audible Alarm Devices (Horns)**
- **Remote Telephone Alarm Devices**
- **Remote Radio Alarm Devices (SCADA)**

5. ALARM & WARNING SYSTEM DEVICES

Visual / Audible Alarm Devices

5. ALARM & WARNING SYSTEM DEVICES

Remote Alarm / SCADA



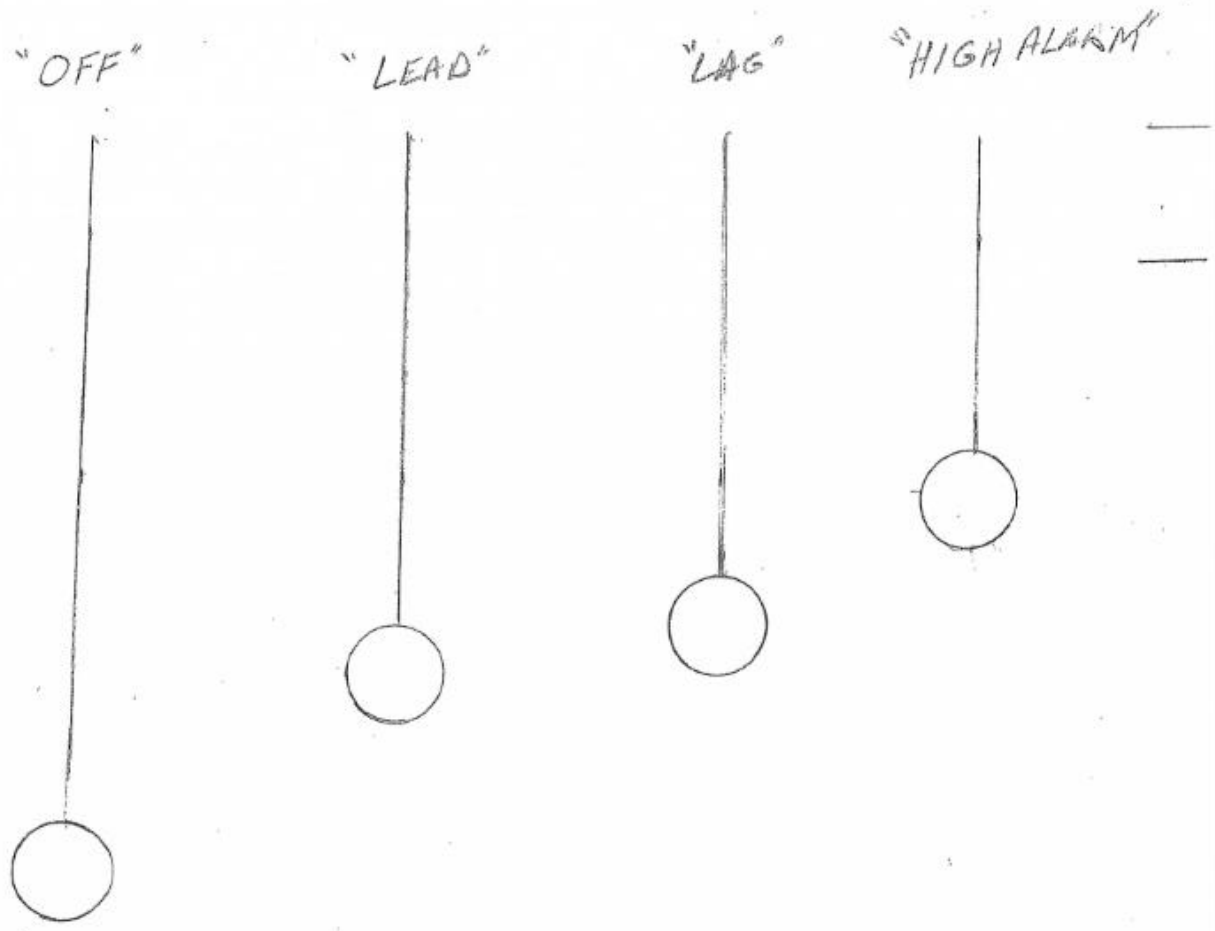
Alarm and Warning System Devices Include:

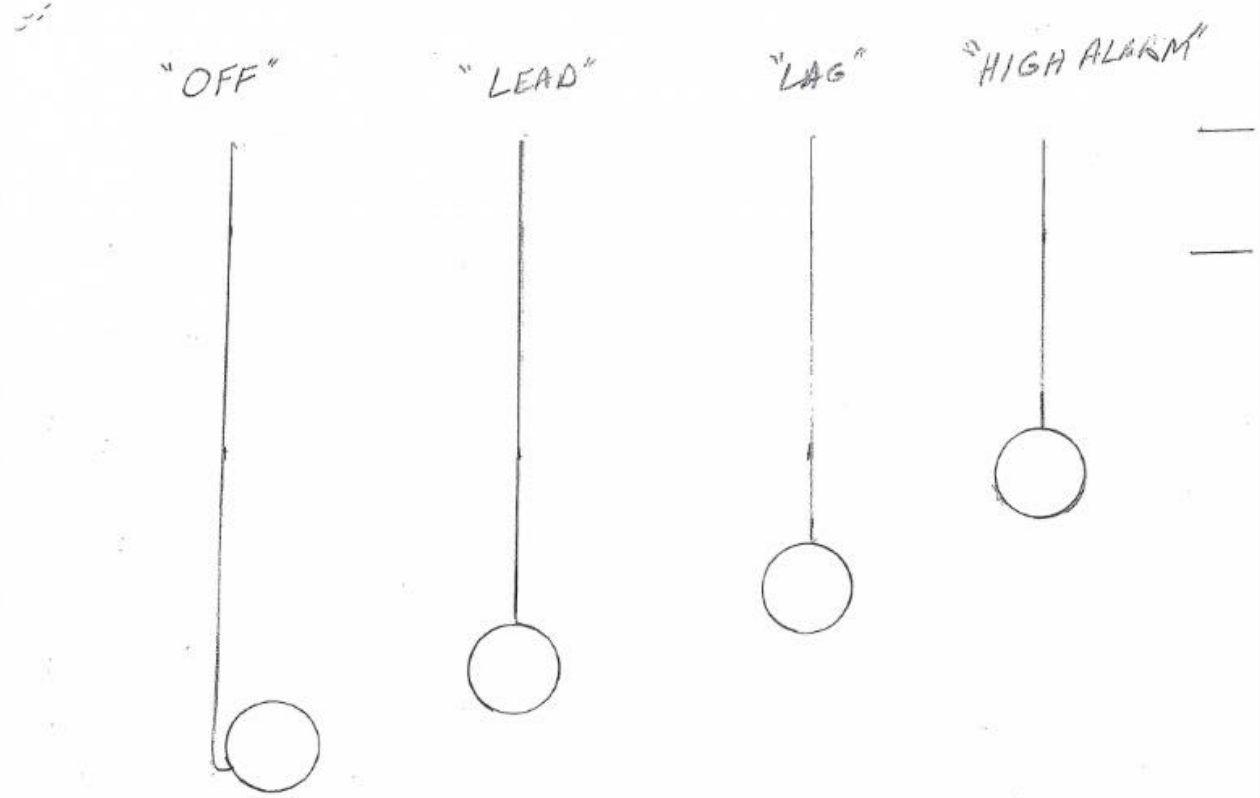
Visual Alarm Devices (Alarm Lights)
Audible Alarm Devices (Alarm Horns)
Remote Telephone Alarm Devices
Remote Radio Alarm Devices (SCADA)

These Systems Work Together to Provide a Working System that Controls the Pumps in a Lift Station and Alert the Operator to Possible Problems in the Lift Station, When they Occur

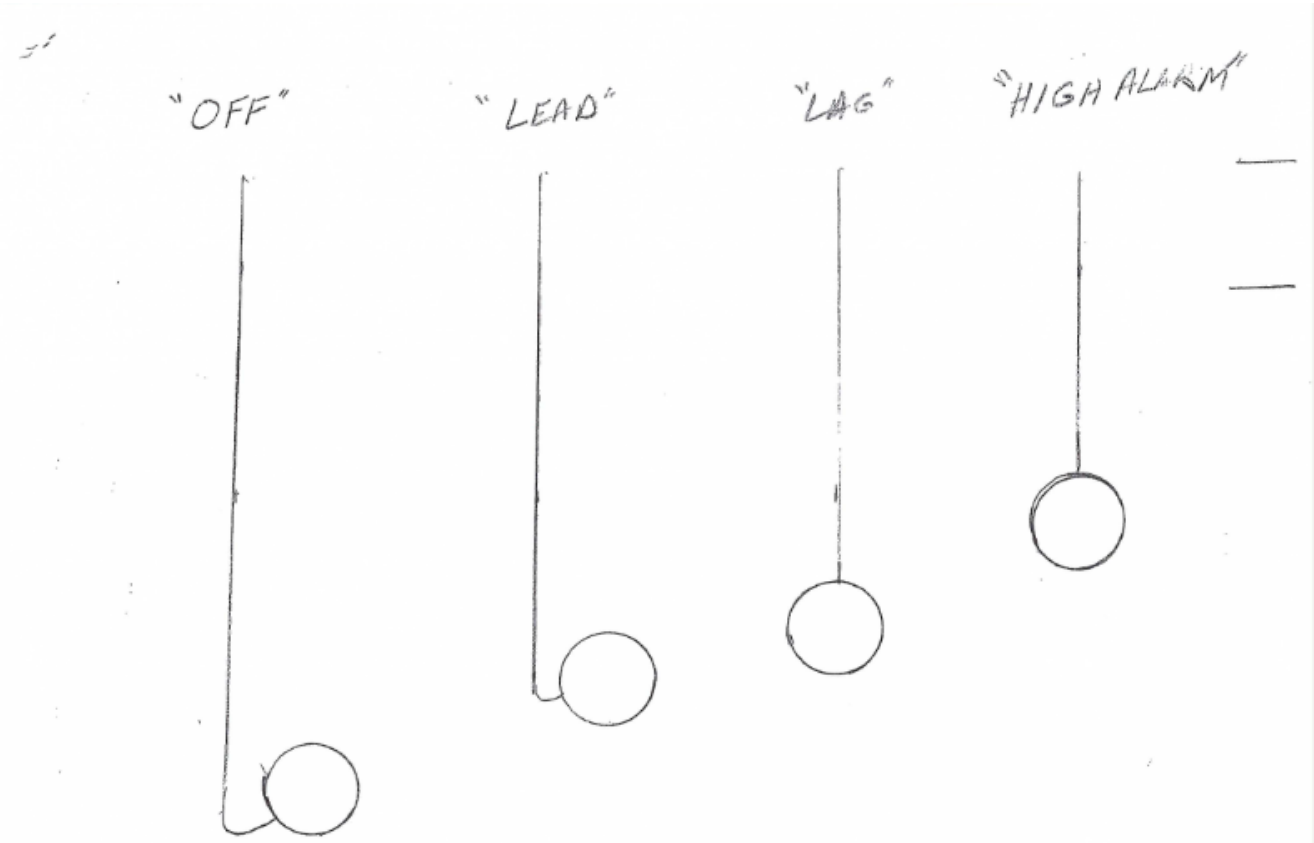
The Majority of Lift Stations are Duplex (Two Pump) Systems, that Typically Use Four Float Switches to Control the Operation of the Two Pumps In that Station

The “Off” Float Switch is Typically the Lowest In The Wet Well. It Would Typically Turn all Pumps Off. This Float is Typically Set to Turn the Pumps Off from About Half Way Up the Pump, to the Top of the Pump

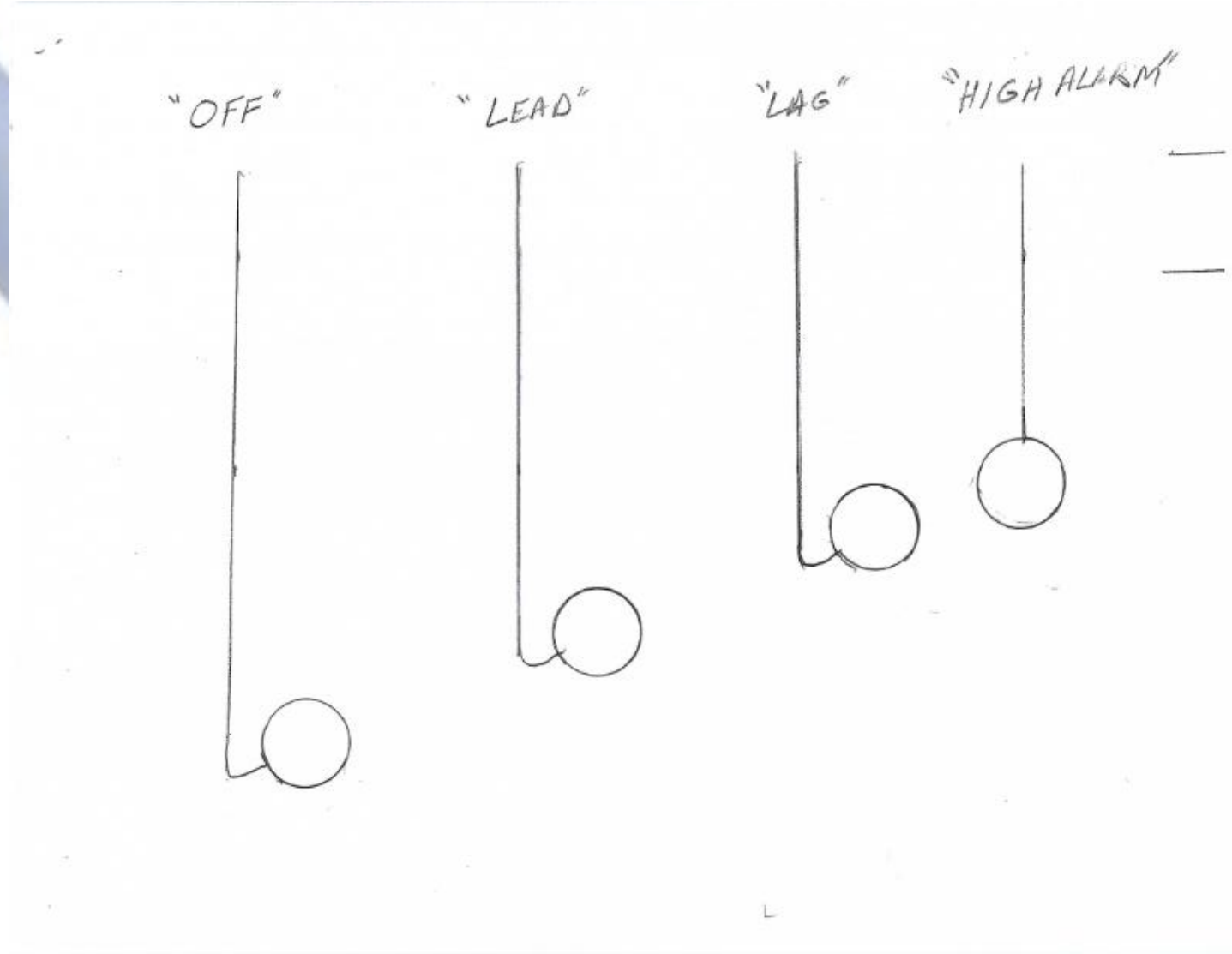

"OFF"
"LEAD"
"LAG"
"HIGH ALARM"


"OFF"
"LEAD"
"LAG"
"HIGH ALARM"

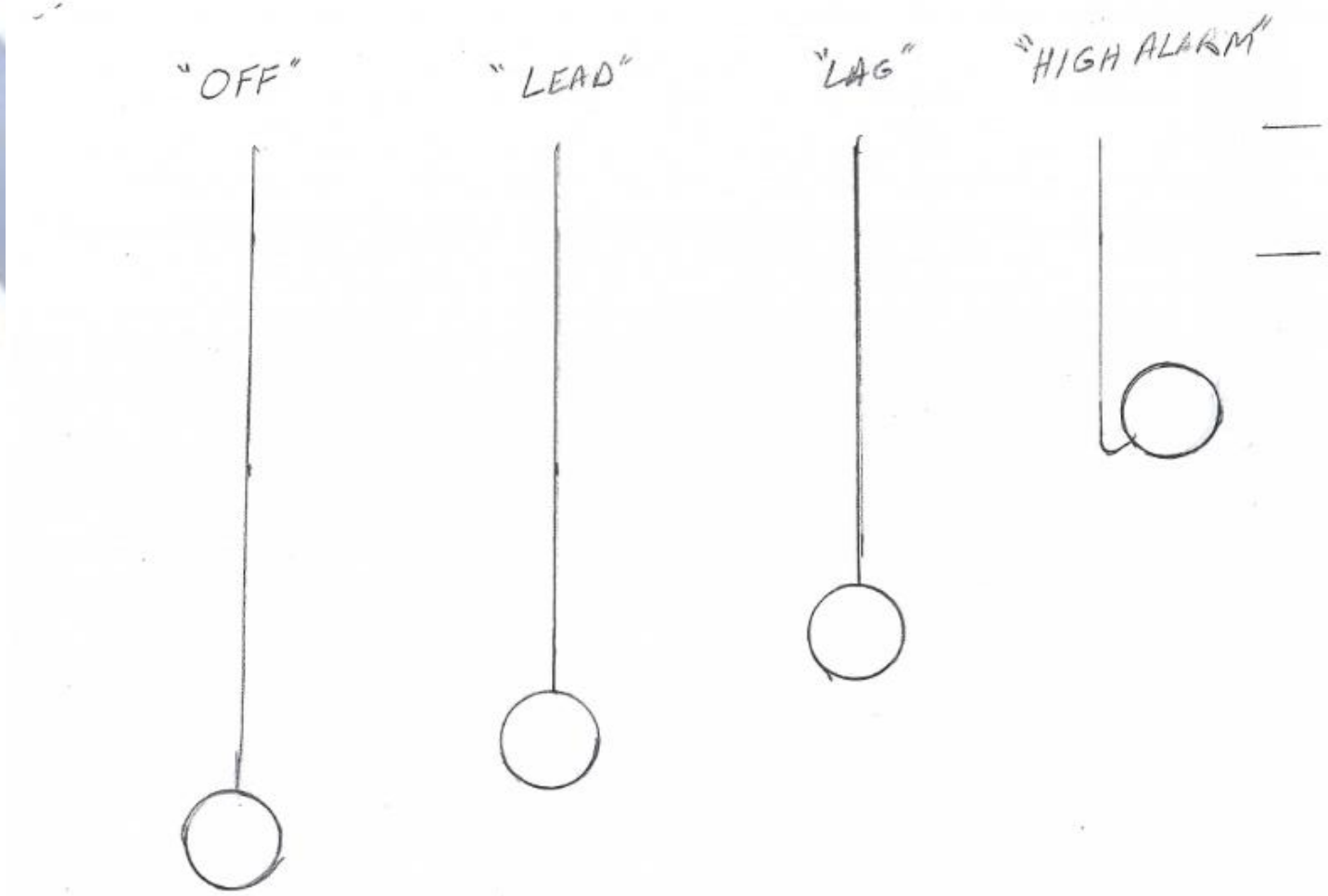
The “Lead On” Float Switch is Typically The 2nd Lowest Float in the Wet Well. It Turns the “Lead” (First) Pump On. This can be Either Pump #1 or Pump #2, Depending on which Pump the Alternating Relay is Calling For. This Float is Normally Set between 18” and 24” Above the Off Float


"OFF"
"LEAD"
"LAG"
"HIGH ALARM"

The “Lag On” Float Switch is Typically the 2nd Float from the Top. It Turns The Backup (Lag) Pump on, and This is whichever Pump is not already Running as called for By the Alternating Relay as the Lead Pump. This Float is Normally Set 6” to 12” above the Lead On Float Switch


"OFF"
"LEAD"
"LAG"
"HIGH ALARM"

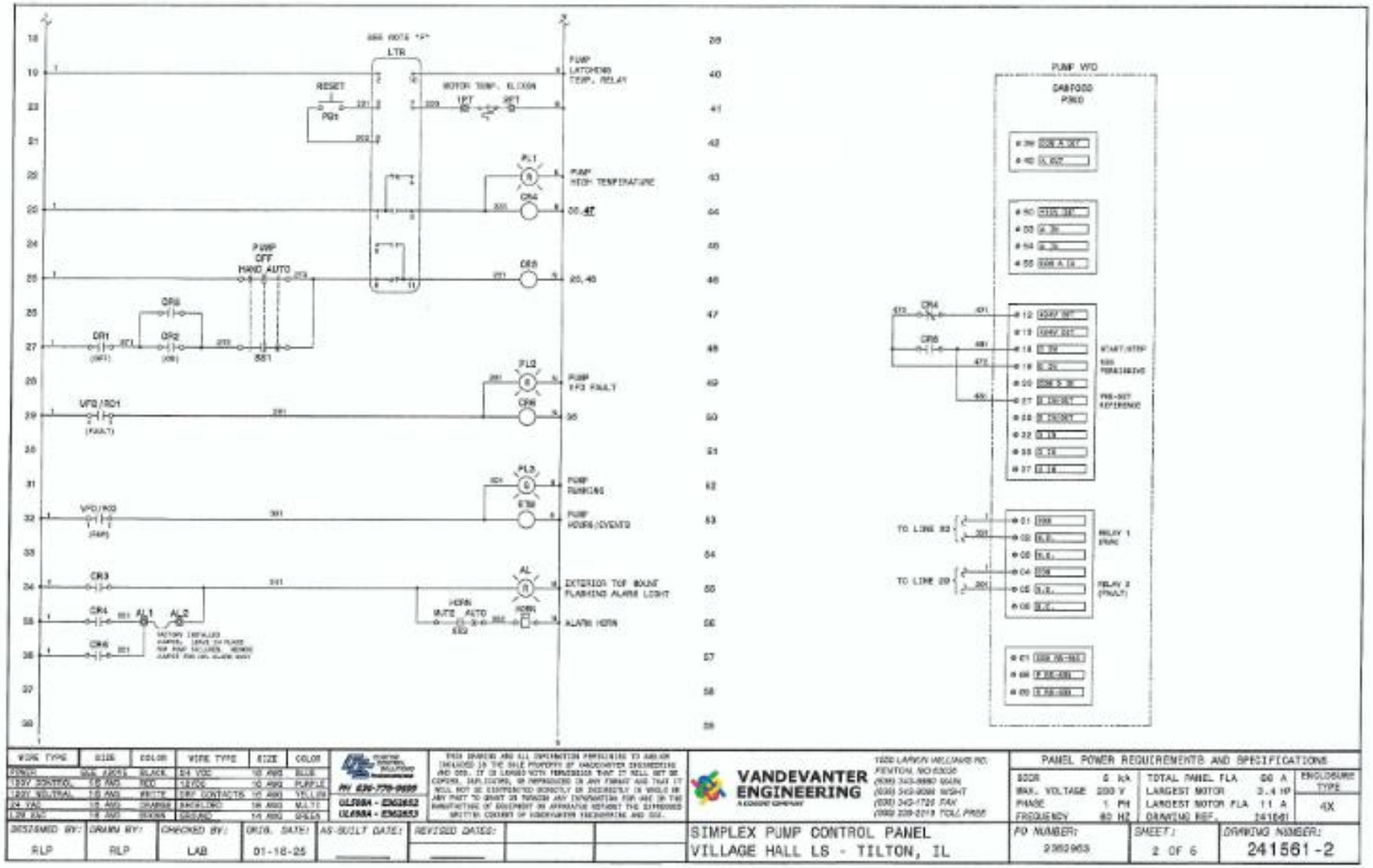
The High Alarm Float is Normally the Highest Float in the Wet Well. When Operated, it indicates that there is a Problem or Pump/Pumps Failure or Other Problem that is Not allowing the Pumps to Keep Up with the Flow Coming into the Lift Station.


"OFF"
"LEAD"
"LAG"
"HIGH ALARM"

The “High Alarm” Float Switch Normally Triggers an Audio (Sound) and Visual (Sight) alarm at the Lift Station, and Is Meant to Give a Warning Locally for an Alarm Condition.
It Can Also trigger a Remote Alarm Phone Dialer or SCADA System of the Problem.
This Float is Normally Set 6” to 12” Below the Lowest Inflow Pipe into the Station

Many Modern Control Panels are Somewhat Complex, and Require at Least a Basic Ability to Read Schematic Drawings, to Effectively Troubleshoot these Control Panels. There are Classes Available that Can Help You Better Understand Reading the Schematic Drawings and Knowing what the Symbols on the Drawing Mean.

Schematics are “The Road Map” to a Control Panel



As an Operator, You Should Develop a Routine for Inspection and Checking the Lift Stations You are Responsible For. These Items Might Include the Following Items:

Develop a Set Routine or Day to Perform Lift Station Inspections. On that Day, Record the Run Time of Each Pump in a Log Book that is Kept at the Lift Station.

Each Pump Should be Run in Hand at Each Inspection. If the Pump will Not Run in Hand, it Likely will Not Run In Automatic Either

Perform a Visual Inspection of the Wet Well. On a Four Float System, If It is Operating Correctly, the Level Should be Between the Bottom Float Switch (Off) and the 2nd Float from the Bottom (Lead On)

Make Sure that the Float Switches are Free from Grease and Rags, and are Not Tangled Up. If Floats Need Cleaning, Use Proper PPE to Remove Rags and Grease from the Float Switches. Lower the Floats Back into the Well GENTLY into Position in the Wet Well. Make sure that the Float Switches are Secured to the Cable Holder and Cannot fall into the Wet Well, and are Not Tangled Up.

Run the Pumps In Manual (Hand) until the Water Level is at the Top of the Volutes (Pump Housings). This is the Best Way to Remove Solids from the Wet Well. The Last 12” of Water Level removes Most Solids from the Wet Well. Look for Spraying at the Pump Discharge.

When The Pumps are Shut Off, Look for the Following Items in the Wet Well

Look for the Rapid inrush of Water Back into the Wet Well when the Pumps are Shut Off. This Might Include a Swirling of Water Draining Back into the Wet Well, or a Rapid Filling of the Wet Well that cannot be Seen coming in the Influent Lines to the Station. This may indicate there is a Problem with one or Both Check Valves in the Station.

Open the Valve Pit on At Least a Monthly Basis The Valve Pit Should be Free of Standing Water. You Can Normally Hear the Water Running through the Valve if the Pump is Running. You should not hear it Running when the Pumps are Off. If You hear it running when the Pumps are Off, it may indicate a Check Valve Problem

If The Valve Pit has a Sump Pump, It should be Tested on a Quarterly Basis, unless it appears that It is Not Working. Make Sure that the Float Switch is Moving Freely and does Not hang Up. Water Level should be in the Sump if it is Working Correctly. You Can Test Operation with a 5 Gallon Bucket of Water.

The Gate Valves at a Lift Station Should be Operated to Full Closed and then Back to Full Open, at Least Two Times a Year. When the Valve is at Full Open, Close Valve ¼ Turn to Keep the Valve Off of the Seat/Stop.

(If You Don't Use it, You Lose it)

Working on Check Valves in Not a Pleasant Job if the Gate Valves will not Close.

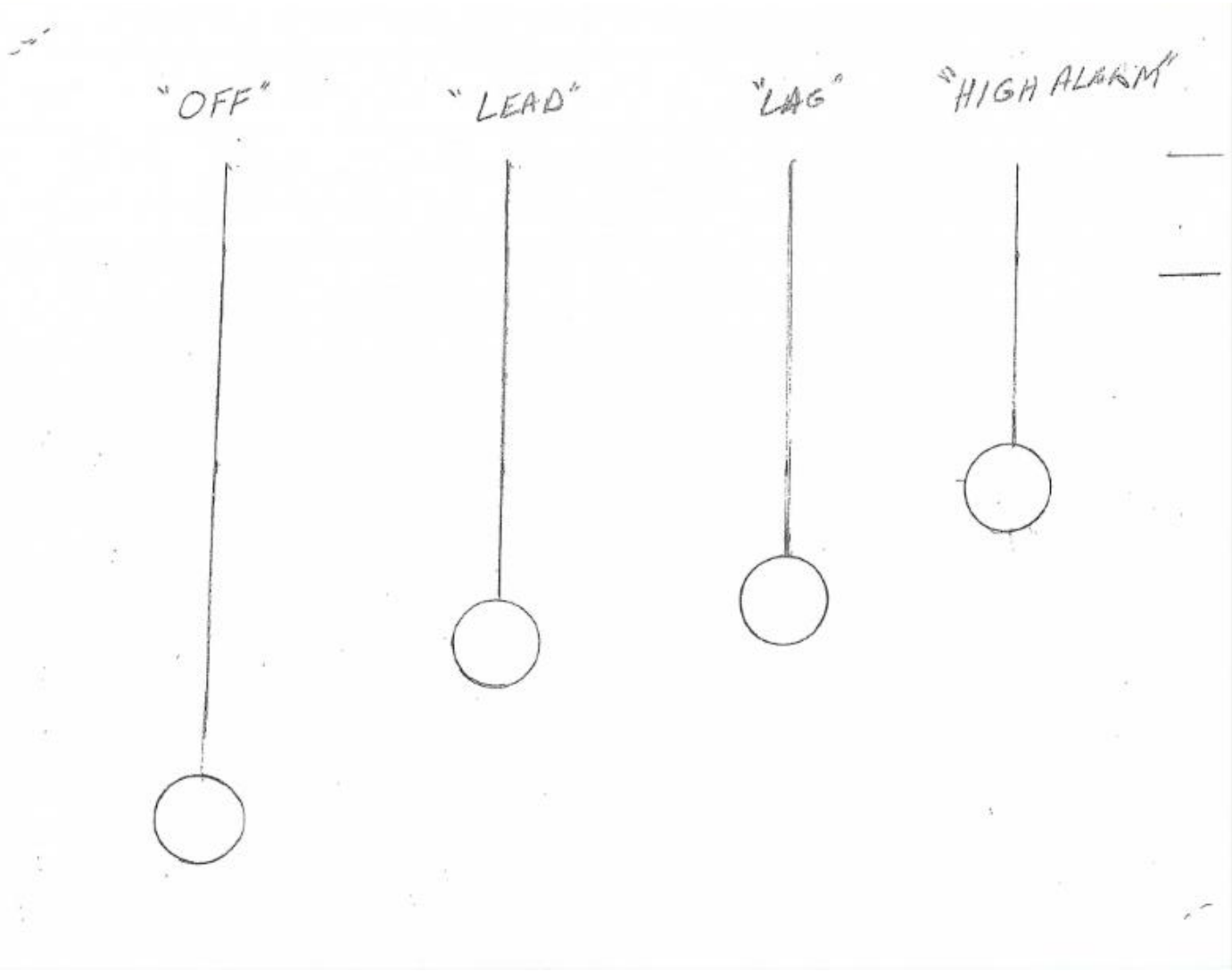
At Least Once a Month, You should try to Check the Operation of the Float Switches and the Automatic Operation of the Lift Station. On Many Panels, this can be Performed with the Pump Circuit Breakers in the Off Position, so the Contactor or Motor Starter will Pull In to Simulate the Pump Starting and Running, without Cycling the Pumps.
Place Both Hand-Off-Auto Switches to Automatic
This May Require Two People to do this.

Bring All Floats Out of the Wet Well and Hang them, In Order from “Off” to “High Alarm. When All Floats Are Hanging, there should not be any Pumps “On” at this Point.

Tip and Hold the “Off” Float (Lowest in the Wet Well) in the Tilted Position. All Pumps Should Remain Off.

Liquid at lowest level

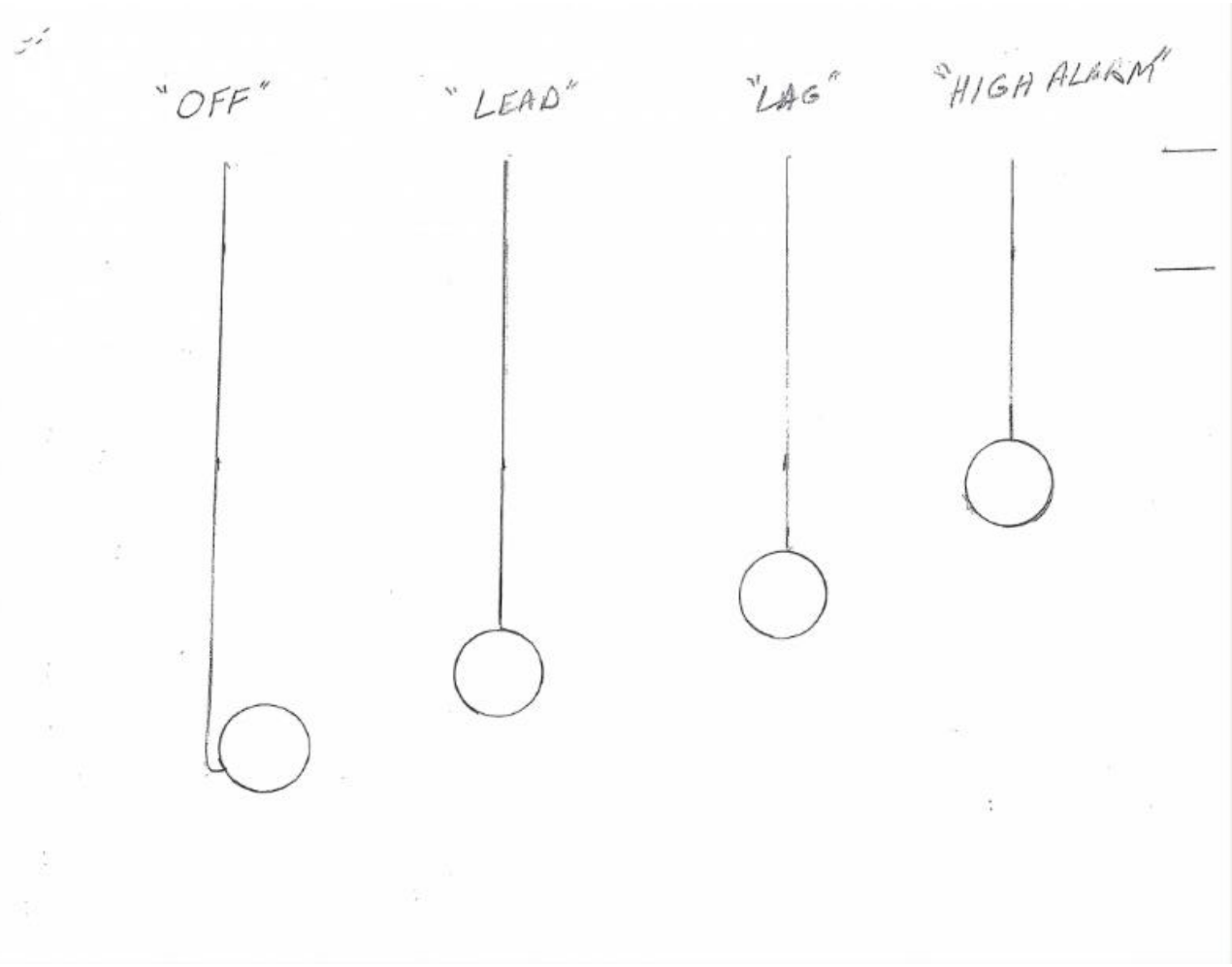
All pumps should be off



Liquid Level is rising

Off Float is tipped

All Pumps should be off



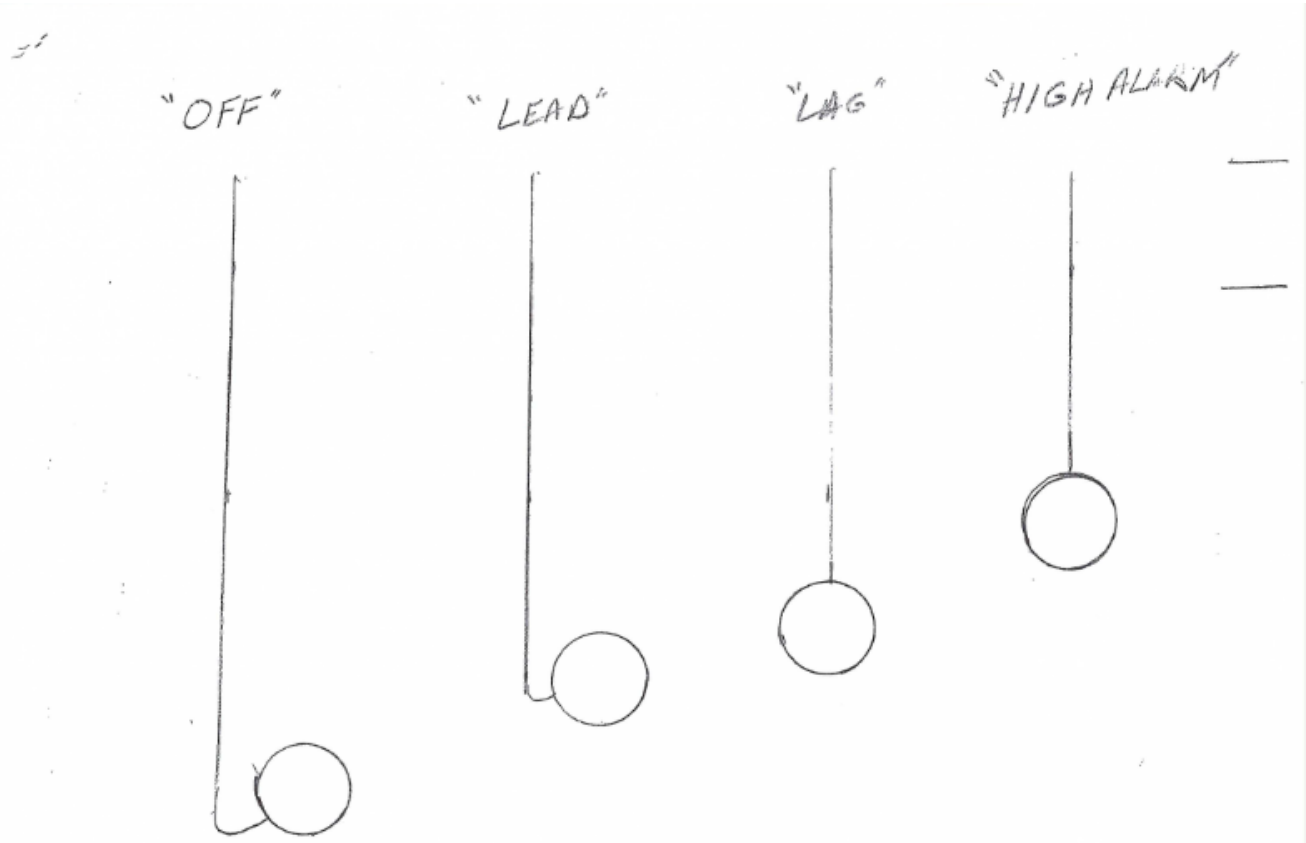
While Holding the “Off” Float in the Tipped Position, Tip the “Lead On” Float at the Same Time. One of the Pumps Should Start if the Hand-Off-Auto Switches for Both Pumps are in the Automatic Position.

Note Which Pump is Running (Pump #1 or Pump #2) during this Step. You will Want to See if the Other Pump starts and Runs During the Next Cycle of the Float Switches

Level is rising

Off float and lead float are tipped

The lead pump should come on



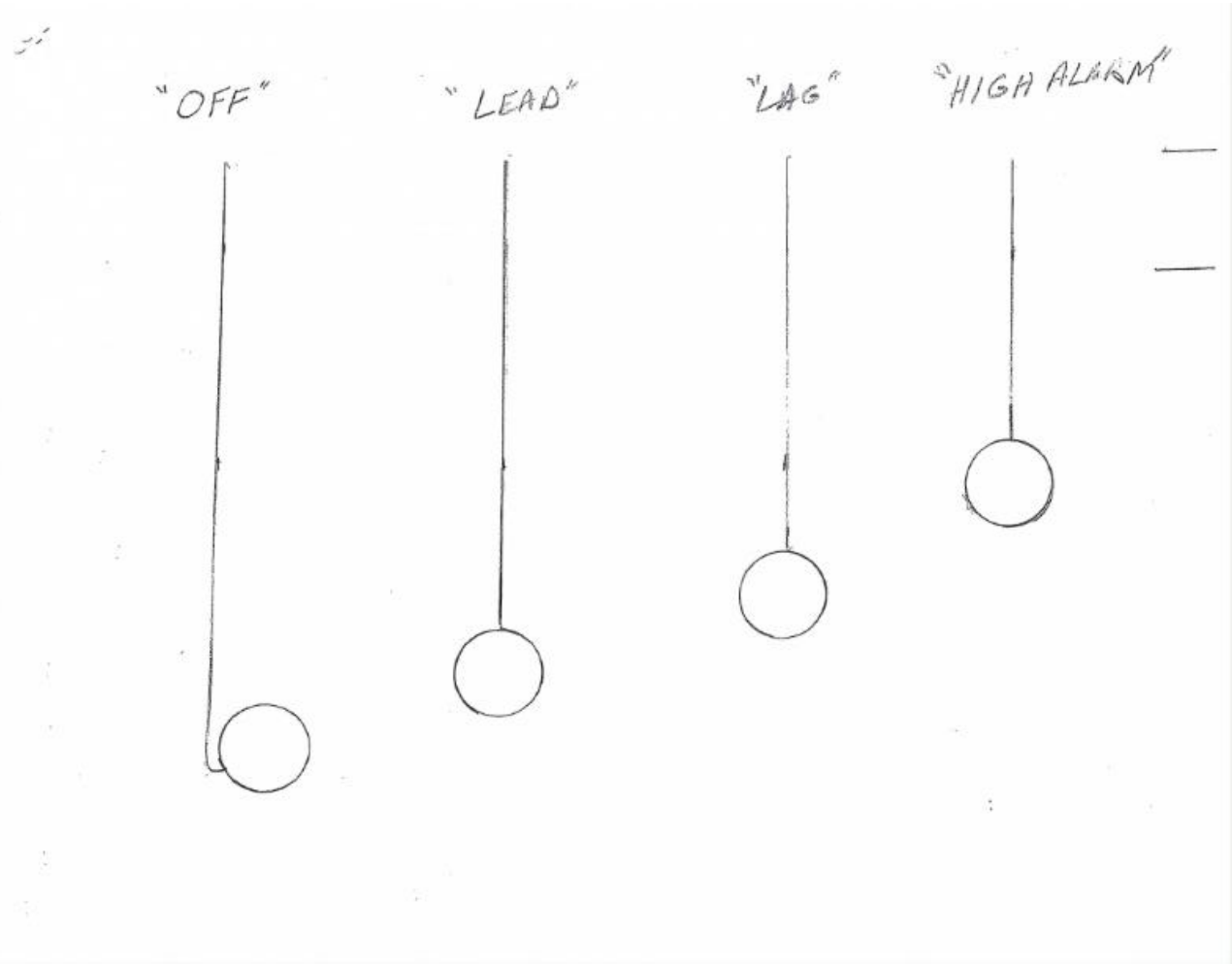
While Holding Both Floats in the Tipped Position, Lower the “Lead On” Float Only to the Hanging Position. The Pump that is Running Should Continue to Run.

Lower the “Off” Float to the Hanging Position. Whichever Pump that was Running, Should Shut off when the “Off” Float is Lowered

Level is falling

The lead on float has dropped to normal

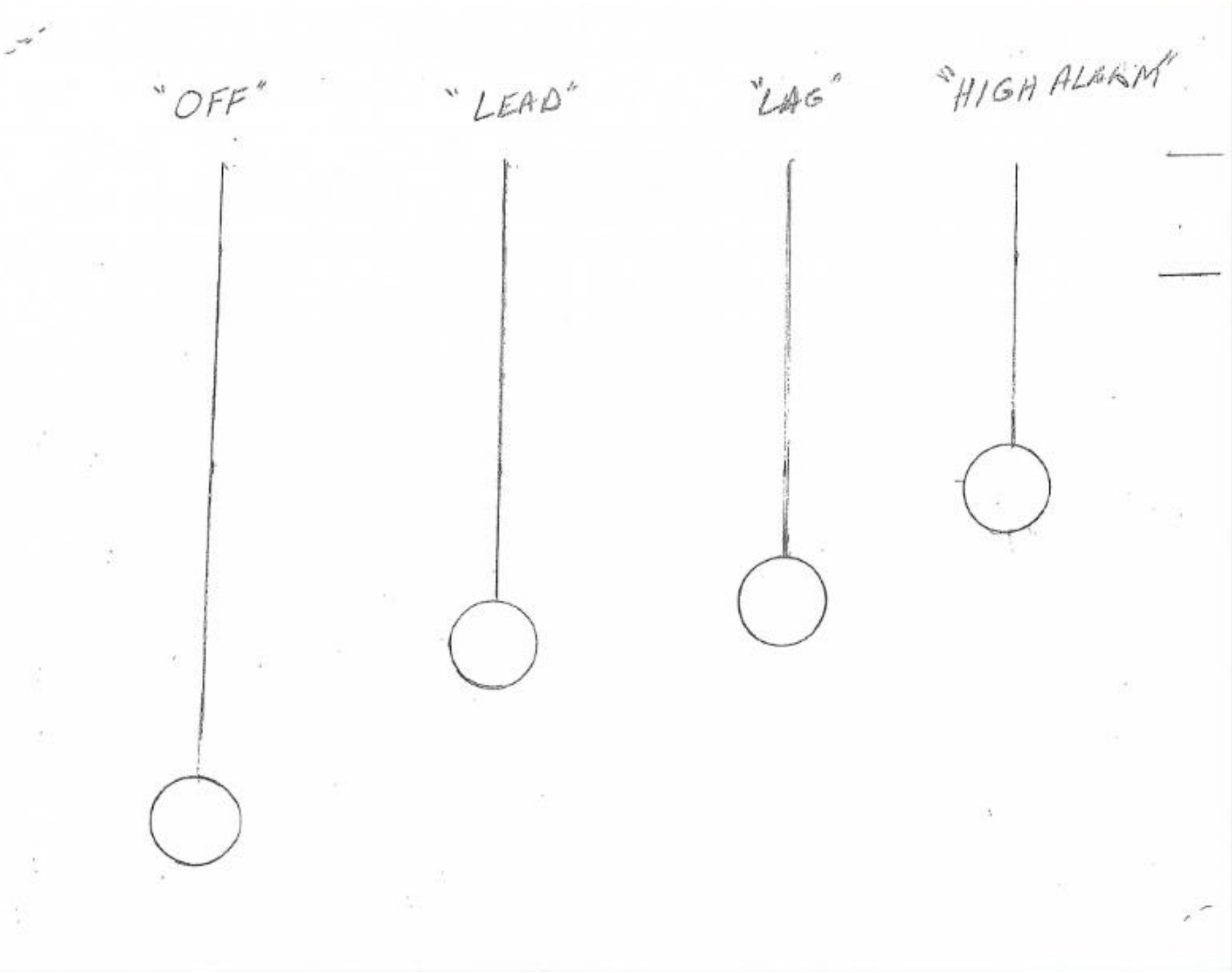
Lead pump should still stay on



Liquid level has dropped to lowest level

All floats are hanging in normal position

Lead pump should be OFF

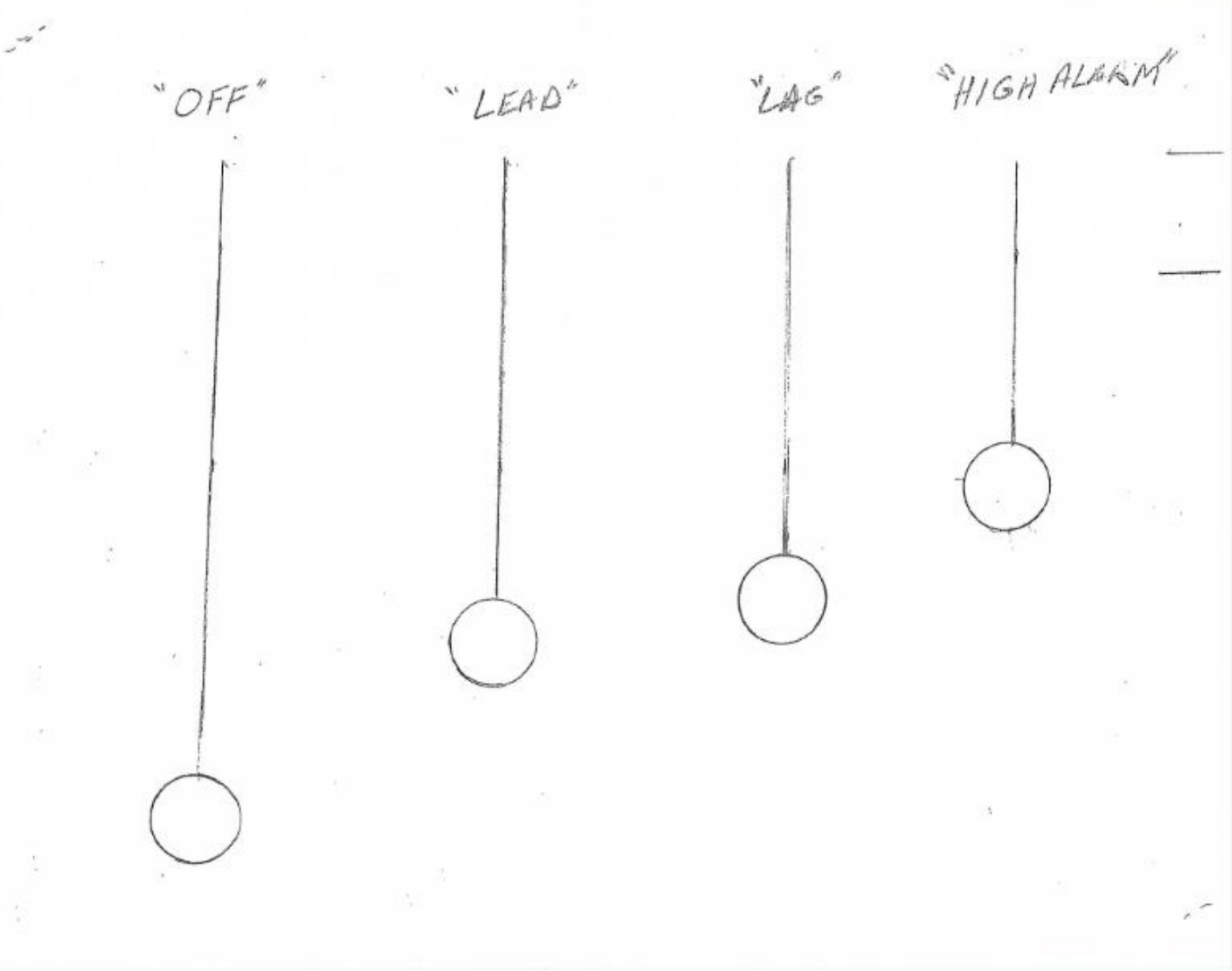


Repeat the Previous Steps above with the “Off” Float and the “Lead On” Float. When the “Lead On” Float is Tipped, You are Looking for the Other Pump to Start (Whichever one did not Run During the First Cycle) so You Know that the Alternating Relay is Working Correctly.

Liquid level has dropped to lowest level

All floats are hanging in normal position

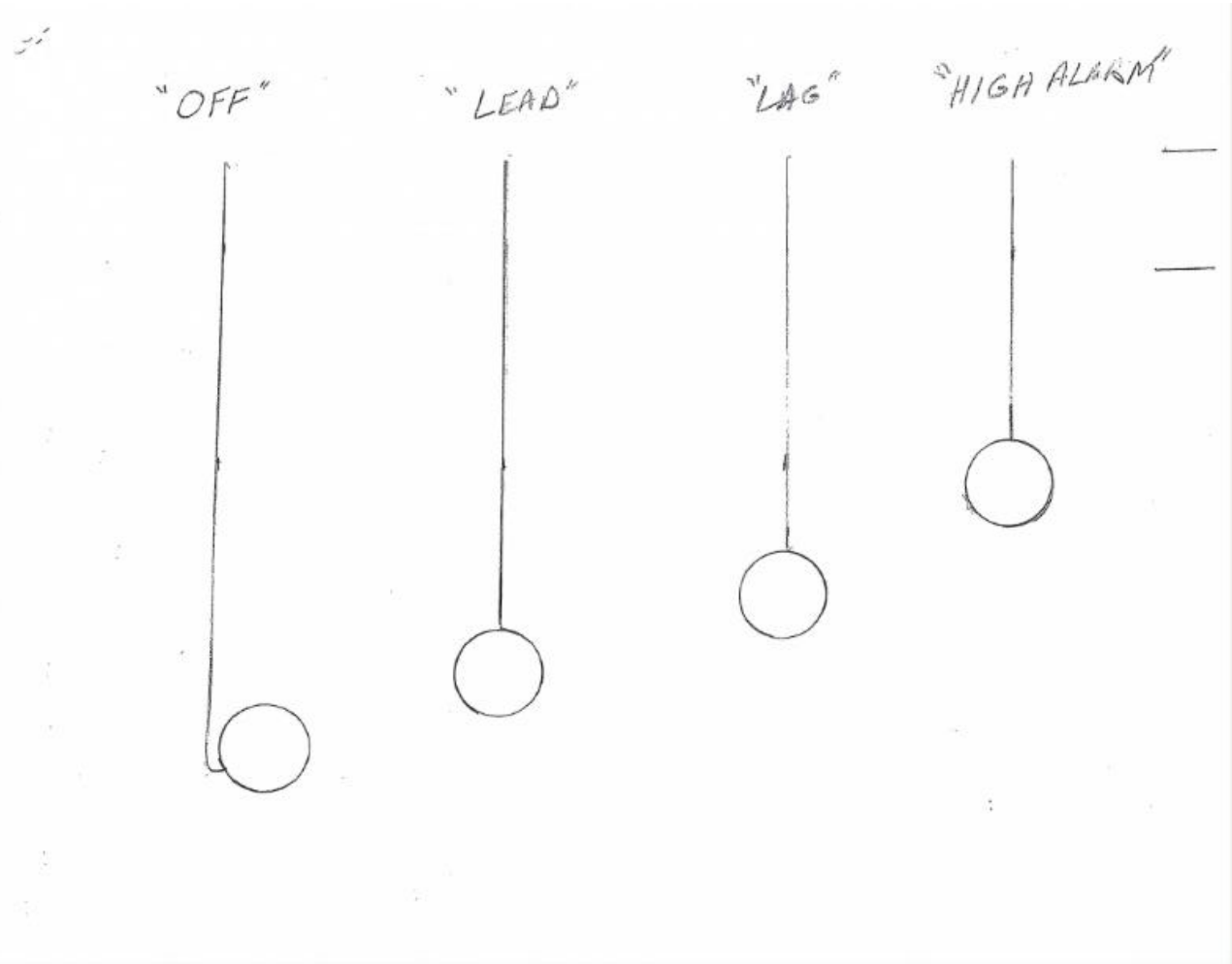
All pumps should be OFF



Level is rising

The OFF float has tipped

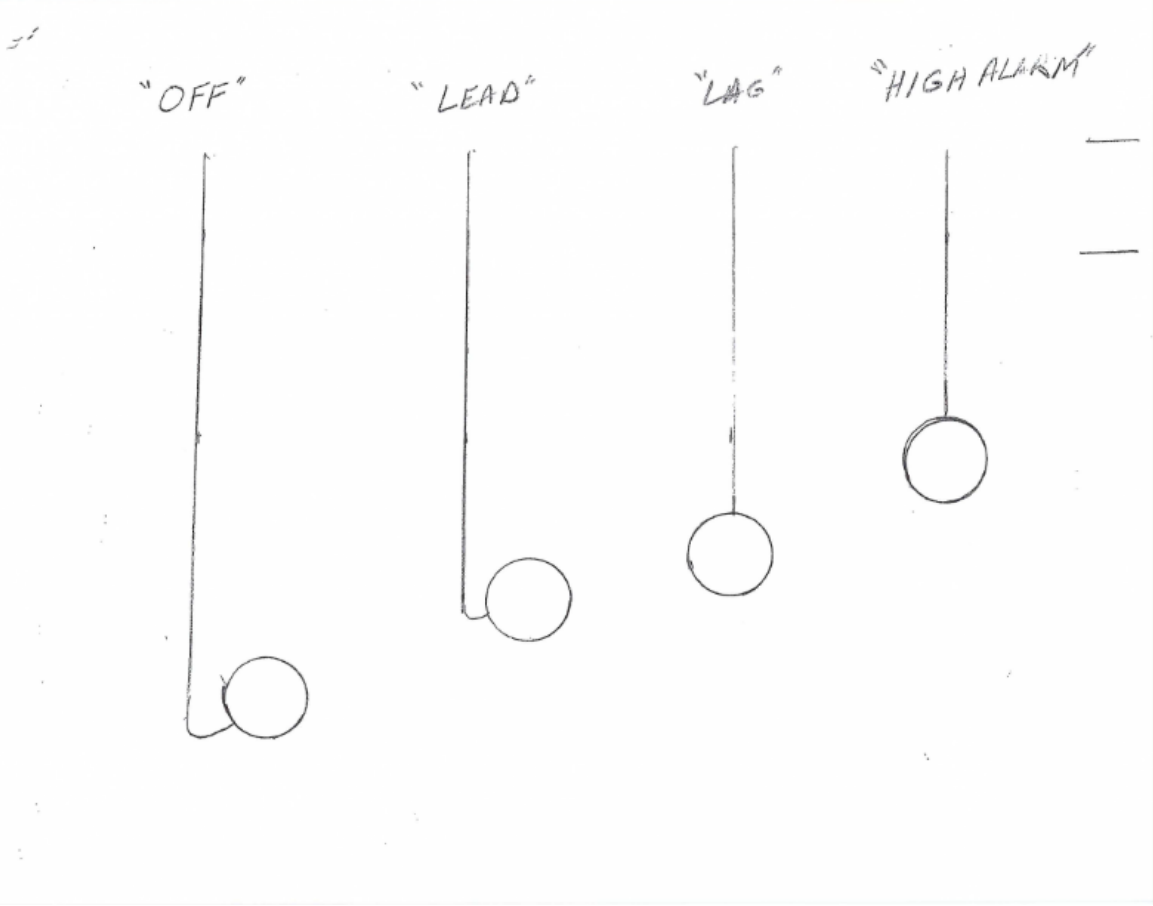
Lead pump should still be OFF



Level is rising

Off float and lead float are tipped

Pump 2 should come on



With Both of the “Off” and the “Lead ON” Floats Still Tipped, Tip the “Lag On” Float while the Other Two are Tipped and the Other Pump (Whichever One was Not Running) Should come On, and Both Pumps Should Be Running.

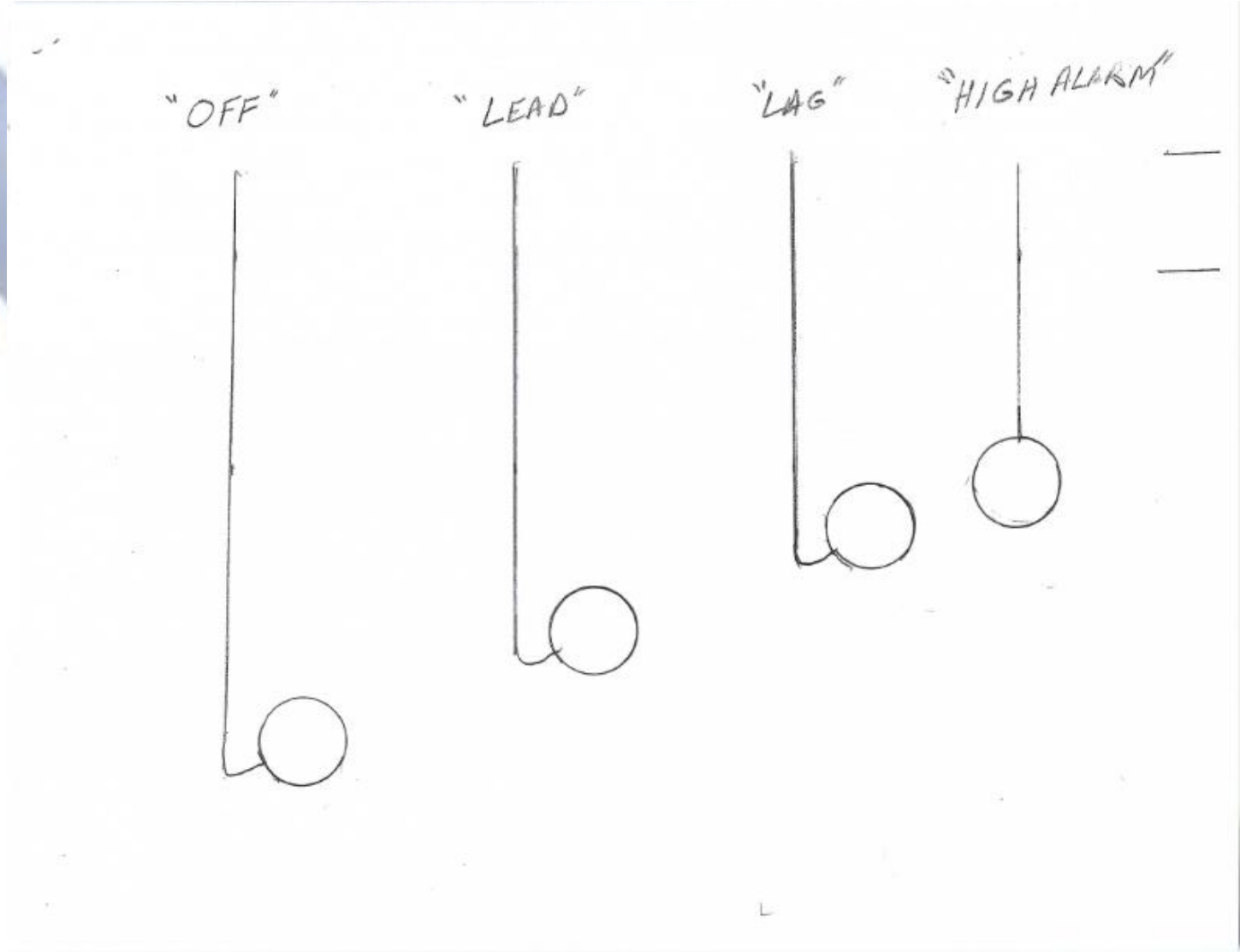
Let the Floats Down in Reverse Order.

When You Let the “Lag On” Float Down Only, The Pumps Should continue to Run.

Level is still rising

Number 2 pump was called for lead and running

Number one pump was called for LAG and Starts

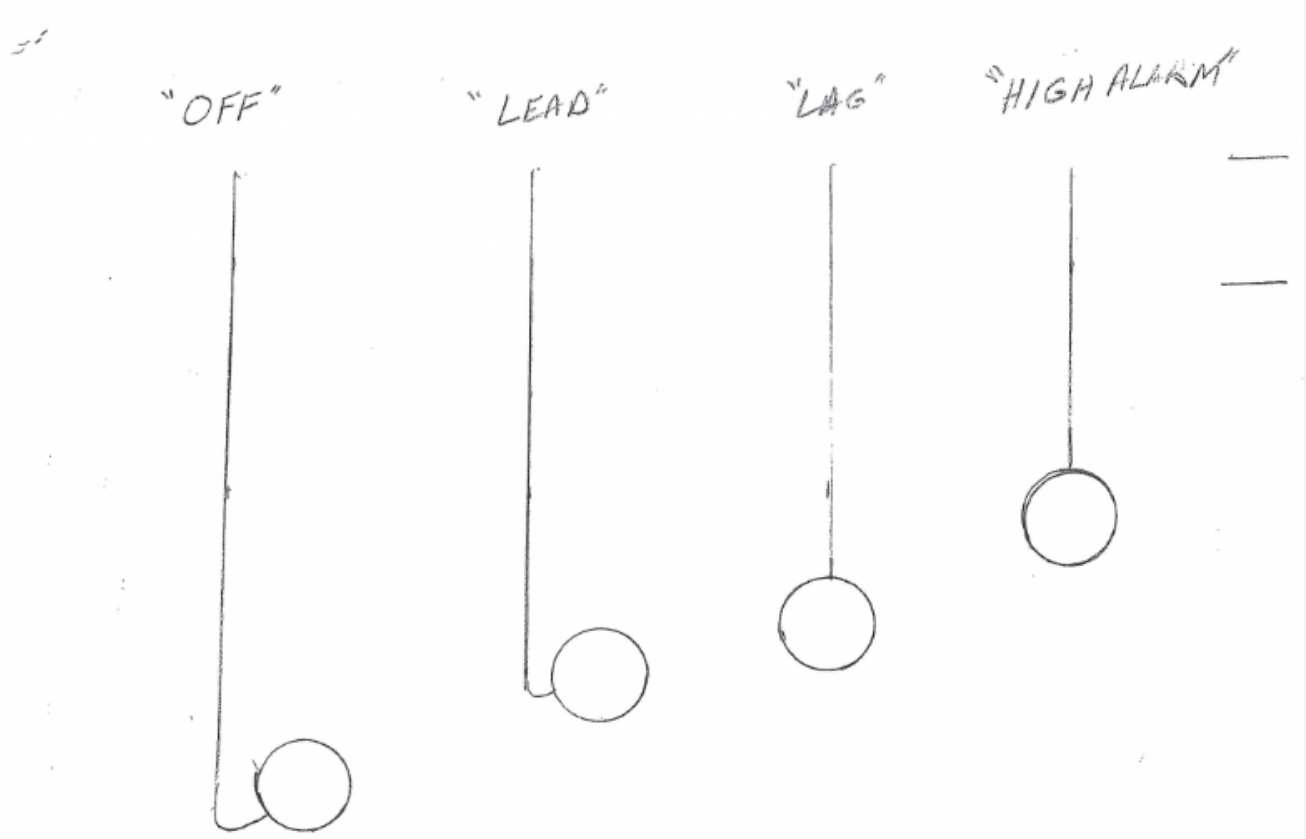


Both pumps are running

Level is falling

LAG float drops to normal

Both Pumps continue to run



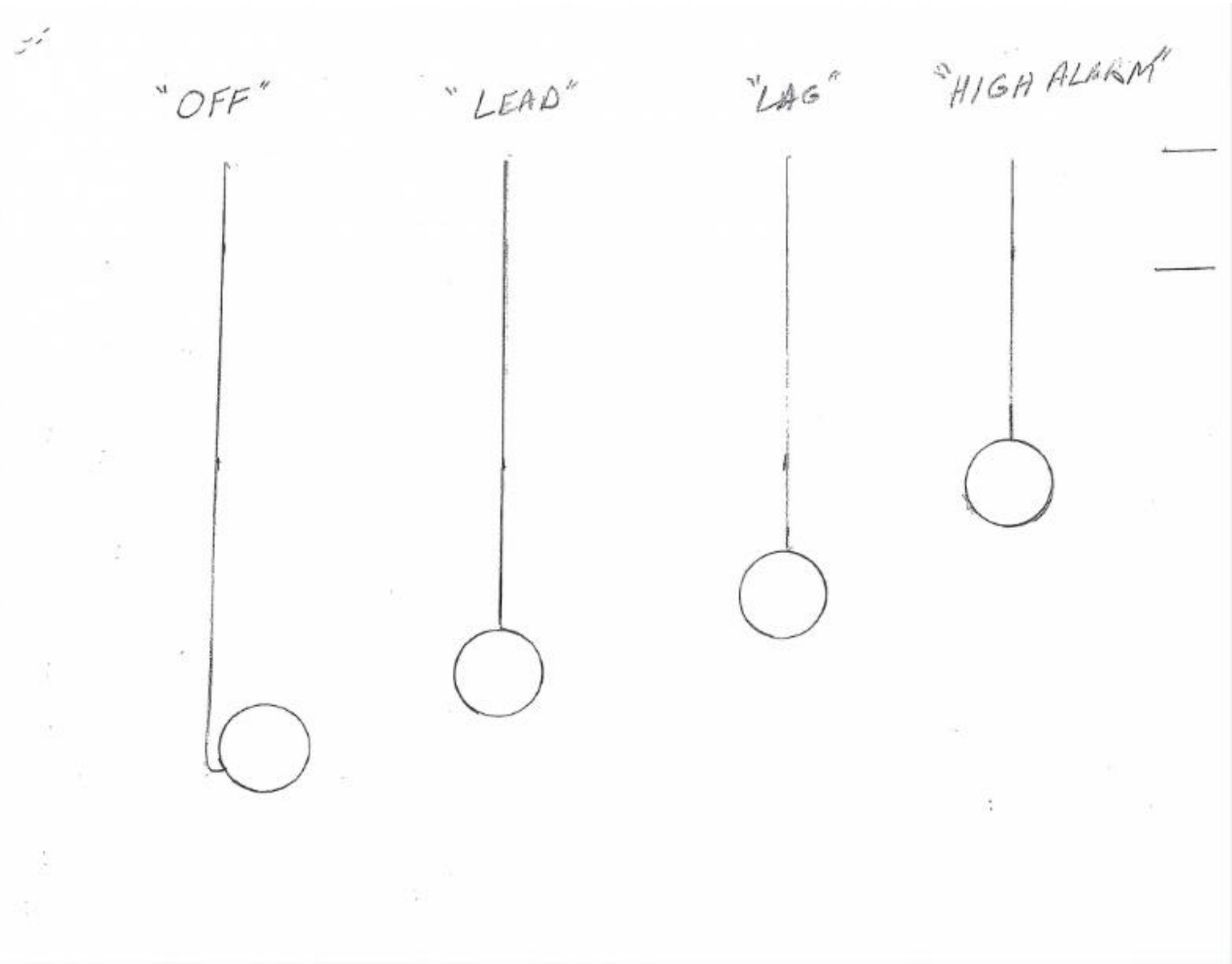
When You Let the “Lead On” Float Down with the Off Float Still Tipped, the Pumps Should Continue to Run.

When You Let the “Off” Float Down so that All are Hanging in the Air, Both Pumps Should Shut Off

Level is falling

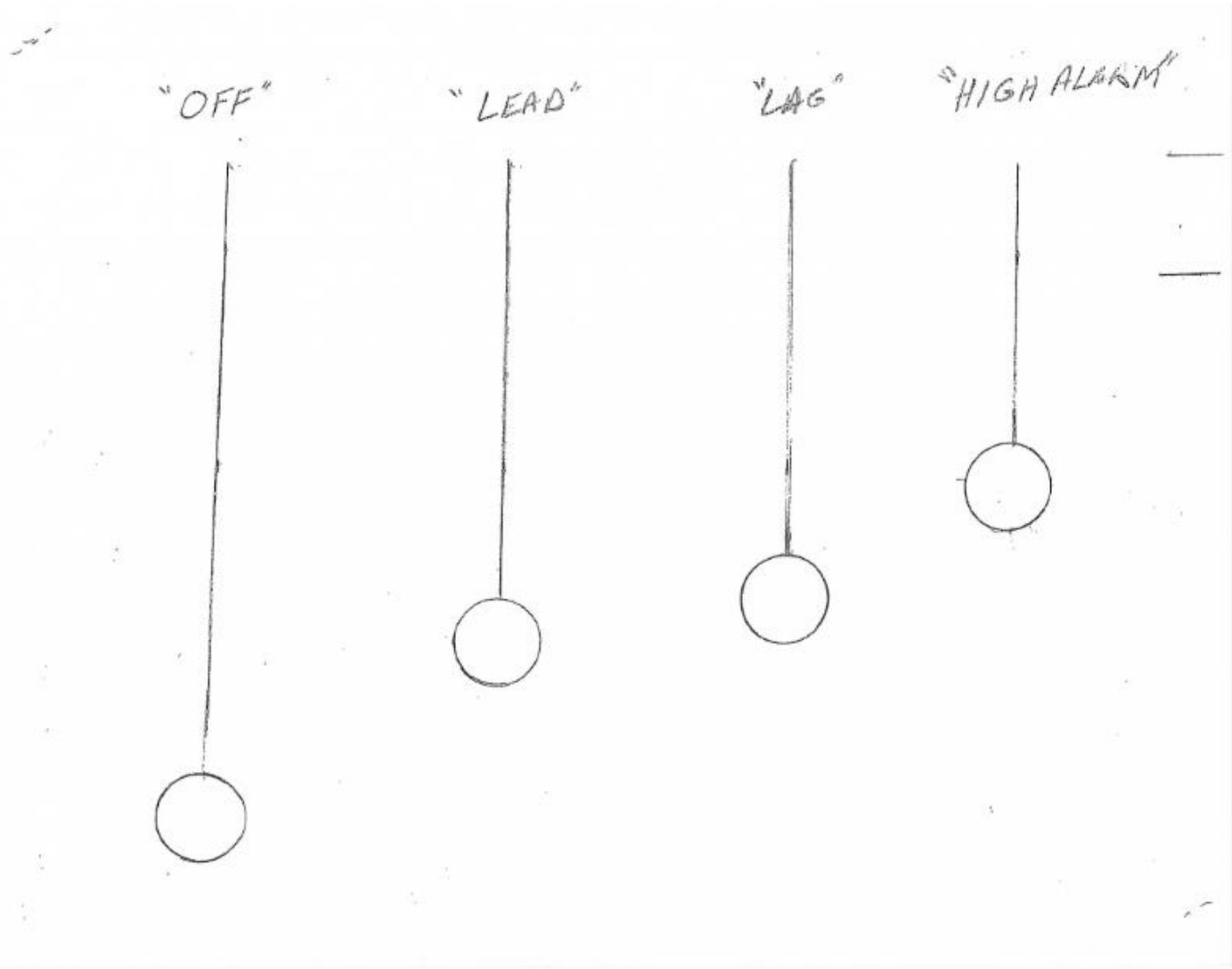
LEAD on and LAG on floats are hanging normal

Both pumps should continue to run



Liquid is at lowest level

Both pumps should have turned OFF



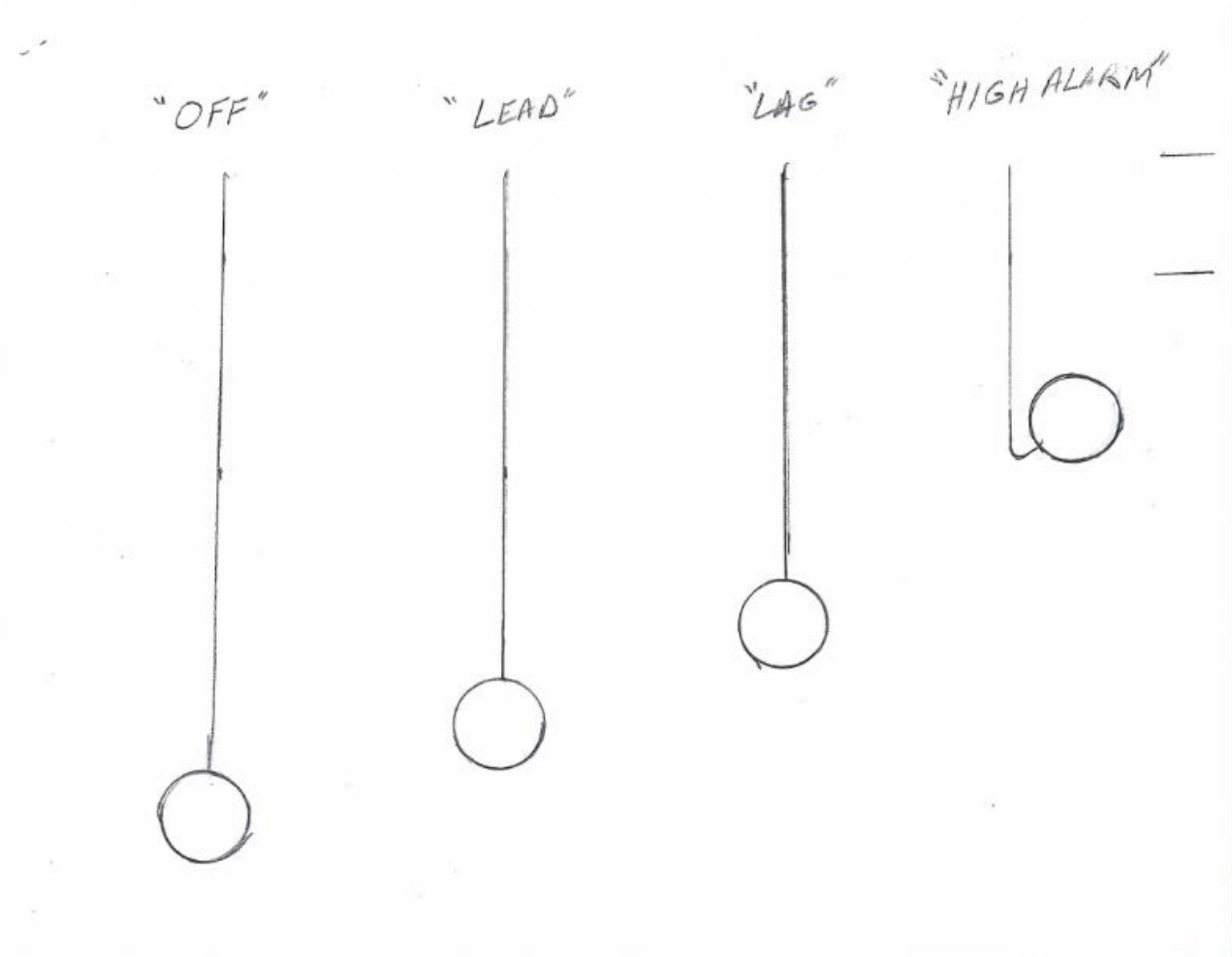
Tip the Alarm Float (The Highest in the Wet well) and The Local Alarm System on the Control Panel should Activate. These would include the Alarm Light and the Alarm Horn, and the Alarm Silence Button.

Make Sure that These are all in Proper Working Condition.

If You have a Remote Alarm System Installed (Telephone Dialer System or SCADA)

The Local Alarm light and horn should activate

If telephone dialer or SCADA is used, test the operation of the system



Make Sure to Test the Call Out Function of the Dialer System, along with the Ability to Acknowledge the Alarms. It is Prudent to Allow the Alarm Call to go Out to All Contact Phone Numbers and Have the Last Person Acknowledge the Alarms.

Use a Similar Test to Verify the SCADA and Radios are Working Properly. Make Sure the Radio Contacts the Operator with a High Alarm Call from the Station You are Testing.

Submersible Pump Operation and Maintenance

When Sized Properly, and Installed Correctly, Most Submersible Pumps are Very Quiet in Operation, when Under the Water.

Noisy Operation Could Indicate a Problem with the Pump or the System, that Needs Attention.

Possible Problems Could Be:

A Mechanical Failure (Bearing Failure)

Wet End Clogged with Debris

Wear On Pump Components, which are Affecting the Performance of the Pumps

Starved Suction on the Intake of the Pumps

To Perform Maintenance Properly, It is Important to Have a Copy of the Owner's Operation and Maintenance Manuals for the Equipment in Your System. You Will need these to Properly Perform the Service for the Pumps in Your System. These Contain Important Information Including Oil Type, Oil Quantity, Gaskets or O-rings Needed, ETC.

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Installation, Operation, and Maintenance Manual

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Some Tips for Servicing the Pumps

Use the Correct Grade of Oil

Use the Correct Quantity of Oil and Measure the Oil in a Container that Measures in Ounces

Keep the Oil Storage Containers Clean

Use Clean Funnels and Filling Containers

Replace O-Rings and Gaskets on Oil Plugs Every Time the Oil in the Pump is Changed

Tips on Inspecting the Wet End of a Pump

Look for the Following:

Wear Or Damage to the Impeller & the Wear Ring on Pump

Be Careful – These May Have Sharp Edges

Wear or Damage to the Hard Iron Impeller or Insert Ring on the Pump

Check for Any Leakage out of The Outer Seal on the Pump

When the Pump is Re-assembled, check the Following Items:

Does the Impeller Turn Free and Smooth?
Is the Impeller adjusted to the Wear Ring or Insert Ring Correctly?
Any Wear to the Pump Housing or the Face of the Volute?

Check the Power Cable for Cuts or other Visible Damage:

Are there Cuts to the Outer Jacket or the Conductors on the Cable?
Any Bulging or Deformation in Cable?
Any Damage to Cable at the Cable Entry of the Pump

Use Your Eyes to Look for Damage
Use Your Hands/Fingers to Feel for Damage
Is the Cable Stiff or Brittle?

Before Re-Installing the Pumps, the Following Items Should be Checked:

Is the Pump Running in the Correct Rotation?
When Installed, is There Abnormal Leakage between the Pump and the Discharge Connection?
When the Pump is Turned to Hand, does the Pump Operate Correctly and Quietly?
Does the Pump Move Water after Installation?

Remember that Maintenance that is Performed Incorrectly, Even with the Best Intentions, Could Cause Damage to the Equipment, Injuries to Operating Personnel, or Possible System Failure that Could Lead to Property Damage in the Surrounding Area

If You Do Not have the Ability or the Manpower to Perform Maintenance On the Equipment in Your System, there Are Businesses Out there that Can Provide this Service.

Vandevanter Engineering Is One of the Companies that Can Provide this Service.

Some Lift Stations have the Pumps in a Dry Well and do not Use Submersible Pumps.
These Stations have Other Items that Require Maintenance and Your Attention:
These Items May Include the Following Items:
By Definition, a Dry Well Is a Confined Space Per OSHA and the Illinois Department of Labor.
Correct Confined Space Protocols Must be Followed when Working on these Stations.

The Motors Normally Have Grease Zerks for the Upper and Lower Bearings.
Use the Correct Grease for the Motor Bearings, and Keep the Grease Gun Clean.
“Do Not Over Grease” The Bearings. Follow the Manufacturers Instructions.
Seal Water Systems
Keep the Filters Clean and the Seal Water Cavity Full. Keep Spare Filter Elements in Stock.

Sump Pumps – Since Most of these Stations have Electricity and The Control Panels Down in the Lift Station, A Correctly Operating Sump Pump is a Must.

Dehumidifier Systems – These Keep the Station Walls From Sweating due to Humidity. A Correctly Operating System Increases the Life of the Dry Well Walls and Floors

Vent Fans – Most Dry Can Lift Stations Use a Blower that will Pull Air from the Bottom of the Can and Exhaust it Near the Top of the Can. As Part of this Process, Clean Air is Drawn Down the Tube, Resulting in The air in the Station “Changing Over”
Correct Operation of this System is a Must.
Your Life May Depend on it!

Many of these Stations use Air Compressors and a Pressure Switch or Bubbler System for Automatic Control of the Pumps. Some Items to Pay Attention To Are:

Drain the Compressor Air Tank Once a Month

Turn the Pumps to the Off Position, and Let the Water Climb in the Station. Make Sure All Pressure Switches Change State on Rising Water Levels.

There are Normally Three Pressure Switches Used in this Style of System – “Lead”, “Lag” And “High Alarm”

These Switches Usually have a Differential Setting on them so they are not Bouncing On and Off, or Short Cycling

Testing these can be a Time Consuming Process, so Be Patient

If the Pump/Pumps in a Dry Can Lift Station are Noisy in Operation, They May Be Clogged with Debris. In this Instance, You may be Well Served to Contact a Service Company that Has Experience in Pulling this Style of Pump. If this Work is not Performed Correctly, You Run the Risk of Flooding the Dry Well. Vandevanter Engineering can provide this service.

Remember the Following Safety Items:
Turn Power Off At the Main Disconnect Switch when Servicing Lift Station Controls and Pumps.
Be Aware of the Slip and Trip Hazards Associated with this Work, Especially during Cold Weather.
If Possible, Perform Maintenance with a Two Person Crew. Two Sets of Eyes are Better than One Set of Eyes,
Be Careful. If You Fall into a Wet Well, Chances Are You will Be Critically Injured, or Die, from the Fall

Summary

Performing Maintenance Correctly, On a Regular Basis, Should Increase the Service Life Of Your Equipment, and Allow More Reliable Operation of the Equipment that You Operate.

Be Careful when Performing the Operation and Maintenance, So You go Home to Your Family at the End of the Day.

Keep Records of the Maintenance You Perform in a Log with the Pertinent Information, Such as Date of Service, Work Performed, and any Comments.

Any Questions?

On Behalf of the Employees of Vandevanter Engineering and the Illinois Rural Water Association,

Thank You for Your Attendance at this Session, and Have a Great Conference this Year!