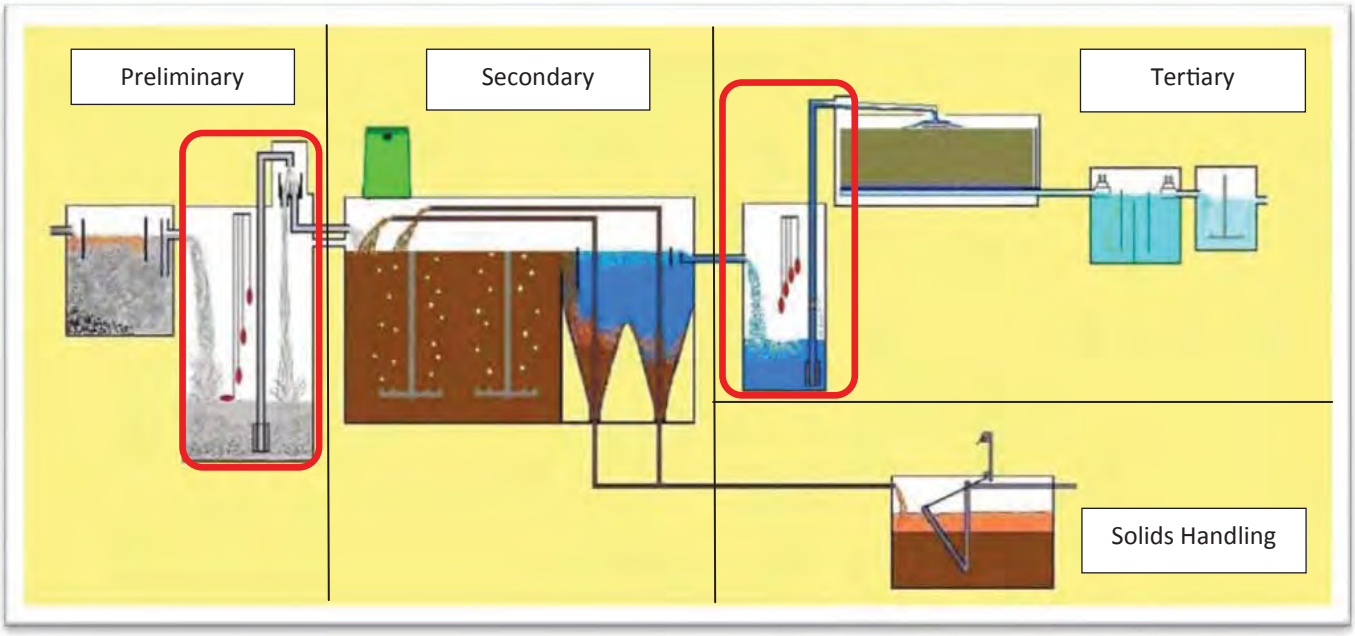
Maintenance

Maintaining operational control of the treatment system requires making the correct operational decisions, but it also requires the equipment to be operational. Knowing that the aeration tank needs more aeration does not prevent upset conditions if the equipment is unavailable for use.

There are three general areas which this maintenance section will address; pumping equipment, aeration equipment and infrastructure. Again, this will be a general overview of the equipment necessary to maintain control, which will include the basic units of a pumping or aeration system and protection of the treatment system. As an Operator in Responsible Charge (ORC) of a treatment system, you should become familiar with your specific equipment and their mechanical maintenance requirements. You don't need to be a certified electrician or mechanic to operate a treatment system, however, you are responsible for understanding the maintenance requirements to contract for services which you are unqualified to perform. Knowing a problem exists, or is pending, is key. As the ORC, it is your decision to contract repair/maintenance to a professional, or perform the work yourself.

Pumping Equipment: control panels, pumps, floats



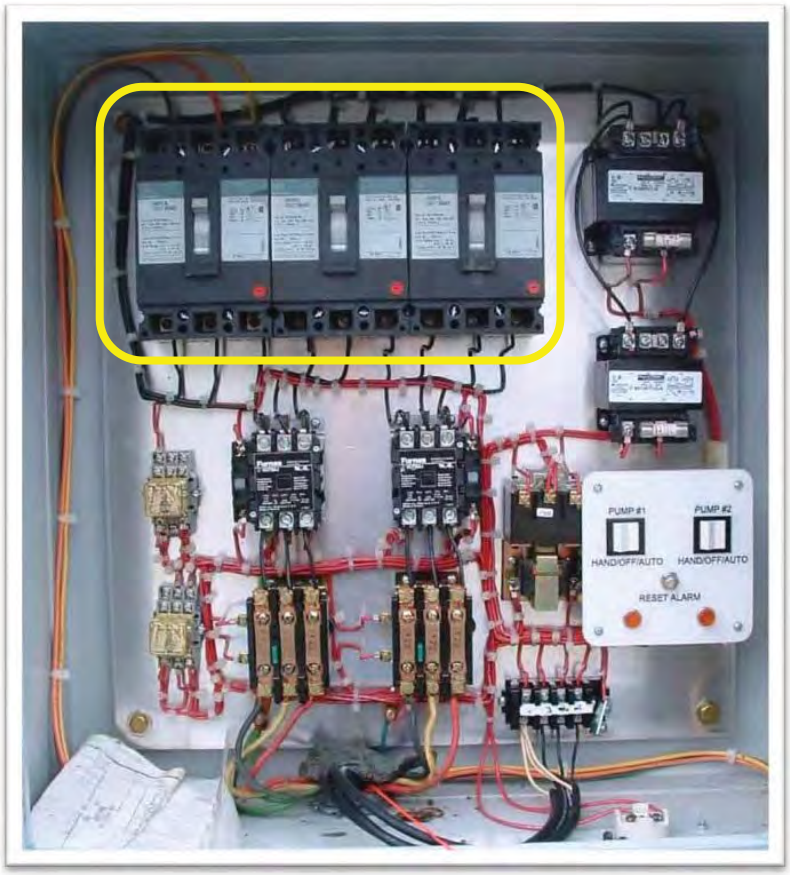
The flow EQ tank and the dosing tank are usually equipped with submersible pumps for raising the water to a higher elevation to gravity flow through the treatment system.

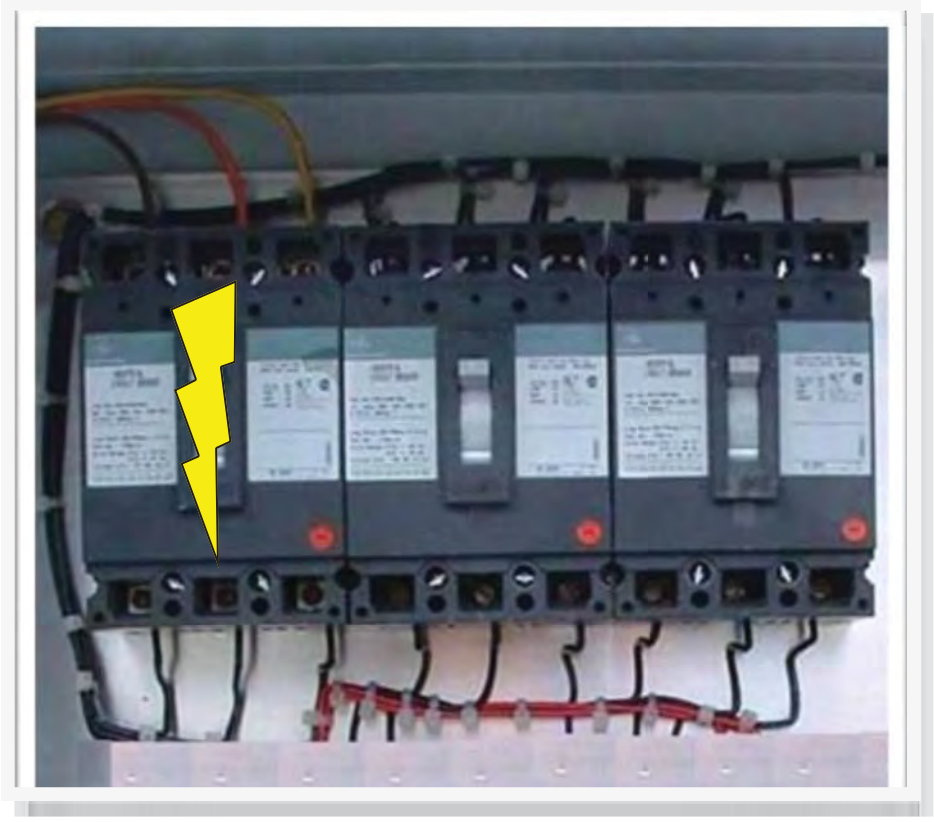
An electronic control panel is located near the pumps and used to activate the proper pumping sequence. Most control panels contain an audible alarm or light to indicate if there is a mechanical failure with the pumping system.

Control Panel

Control panels will contain similar components. Power supplied from the incoming feed line enters the control panel and must first pass through the circuit breakers.

If any work is to be performed on the electrical components, the circuit breakers must be opened to prevent an electrical hazard. To protect yourself from electrical injury, lock out the control panel while working on the mechanical components of the system, so no one can re-energize the system while it is being serviced.

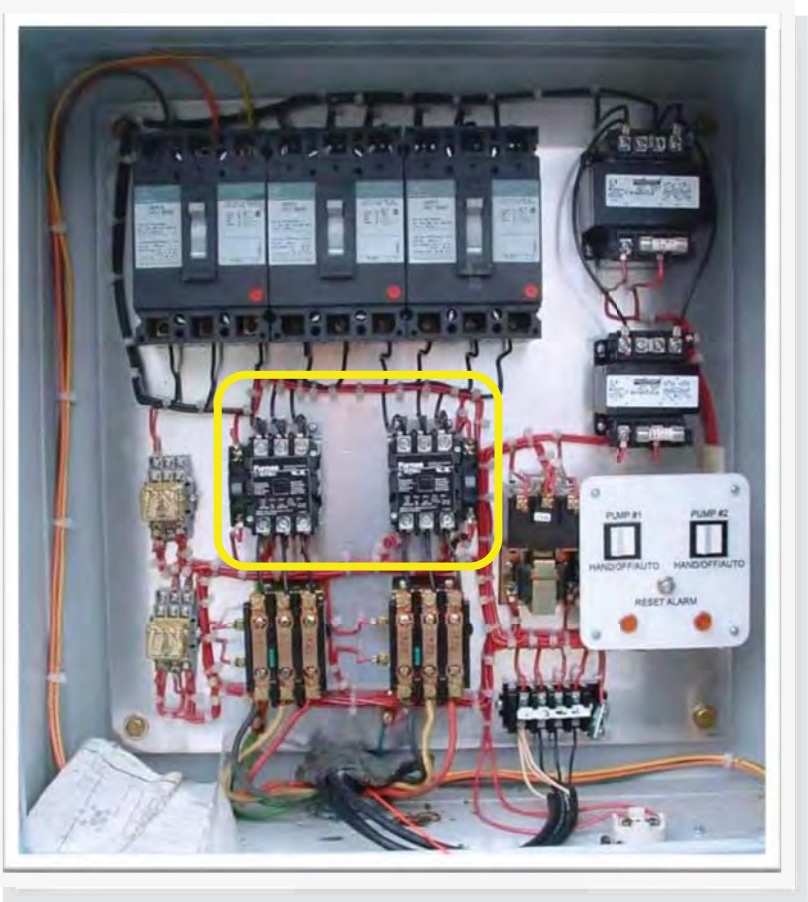




If the breakers are in the closed position, power passes through the breakers to the contactors.

Control Panel

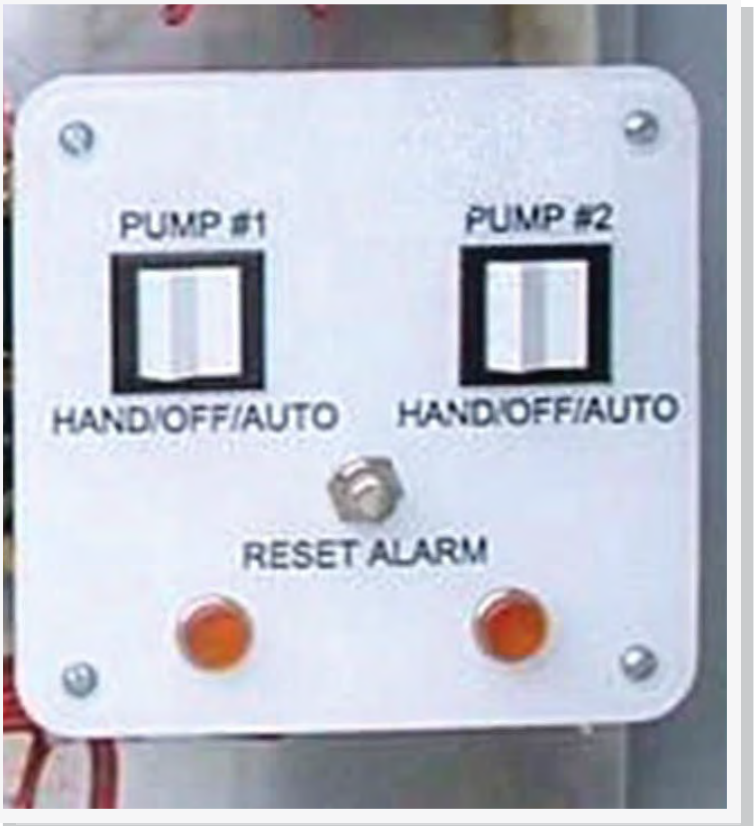
Power next passes through the contactors. The contactors are either in the open or closed position based, on the position of the control switches.



The pump controls determine if the contactors are in the open or closed position.

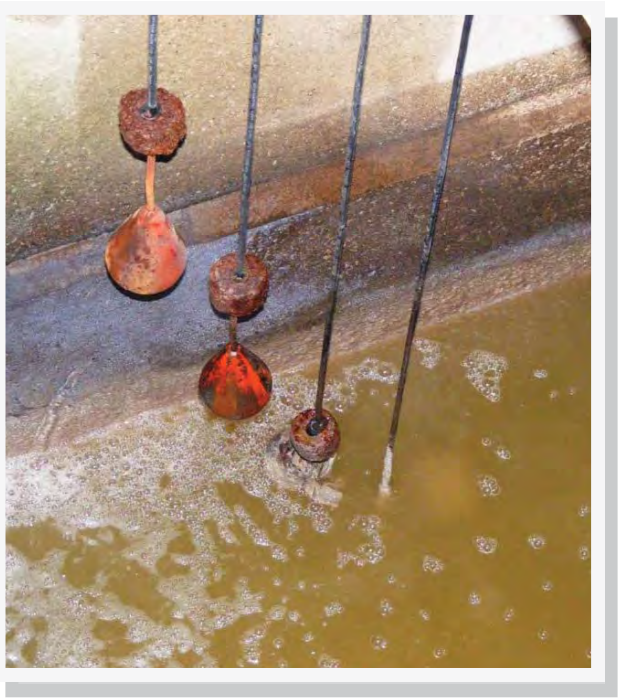
When in the "HAND" or ON position the contactor is closed, completing the circuit and allowing the pump to be energized.

If the controls are in the "OFF" position, the contactor is in the open position and the pump is not energized. When performing maintenance on the pump, disconnect the power with the breaker and not the pump controls.



Control Panel

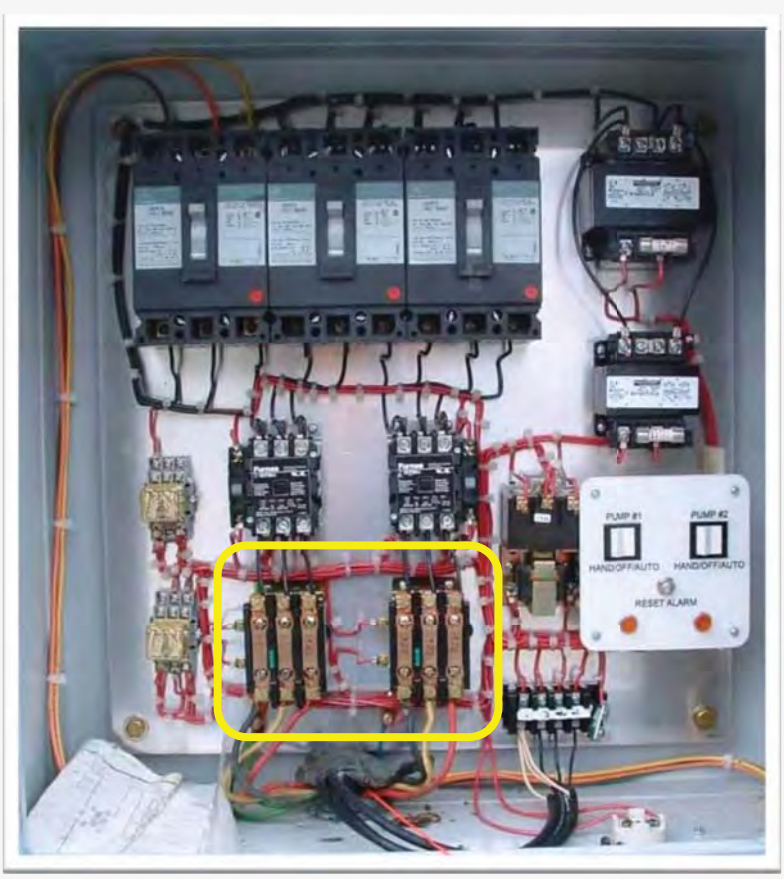
If the pump controls are in the AUTO position then the position of the contactor is controlled by the float switches in the tank. As the float switches are activated by the water elevation in the tank, the contactor is closed and the pump is energized. As the water elevation in the tank decreases, the float switches open the circuit and the pumps shut off.



If power passes through the contactors, it must also pass through the overload. The overload provides protection of the pump and/or wiring if the pump begins to draw too high of an amperage load.

If the pump impeller becomes obstructed, it will draw more amps. This increase in amperage could lead to the pump burning up or damage to electrical wiring. To prevent excessive amperage draw, the overload will open the circuit and power will be discontinued to the pump.

In the overload above, the green pin (above) will "kick" out to open the circuit. Sometimes the overload will kick out due to fluctuations from the power feed. Resetting the overload can be achieved by pushing the green pin back in. If the overload kicks out again, evaluate the source of the increased amperage draw.

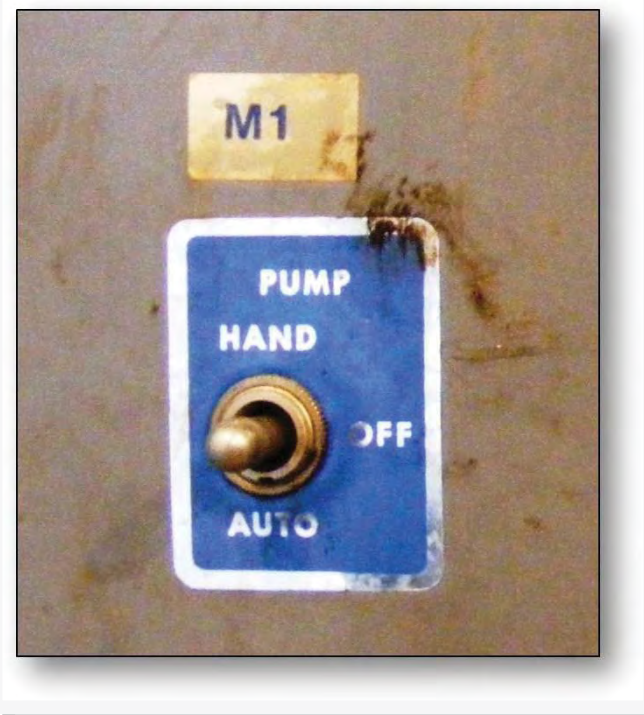


Control Panel

Measuring the actual amperage being drawn by the submersible pump can be achieved with an amp meter. It is best to measure the amp draw when a new pump is installed and record this value in the control panel. Periodic evaluation of the amp draw will allow you to determine when a problem is occurring by comparing the initial amp reading to future amp readings.

To verify the pumps are operational, switch the controls to the HAND or on position. If the pump is not energized, there is a problem with the pump or the controls.

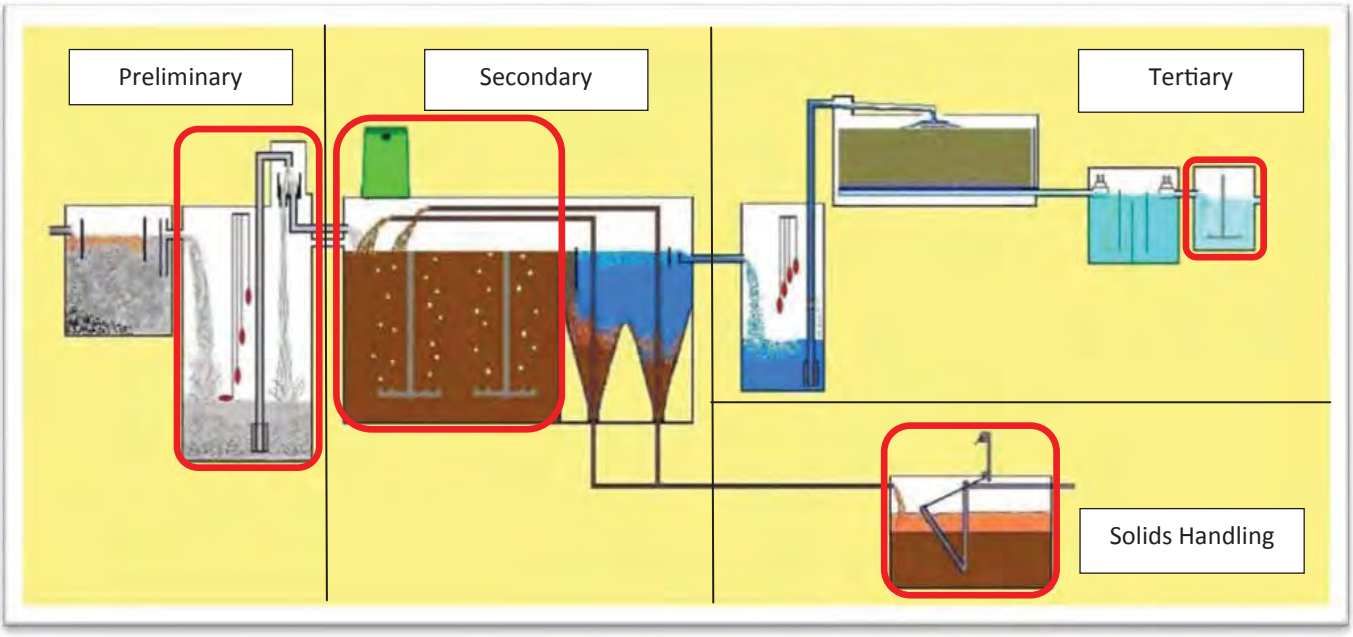
Next switch the controls to AUTO and manually raise the floats to actuate the contactors. The proper sequence should be first activating the bottom float and then activating the next higher float. The lead pump should be energized and begin pumping. By activating the next higher float, a second or lag pump should be energized. If there is a problem with the pumps being energized, there could be a problem with the pump, the controls or the float switches.



The electrical controls for the flow EQ tank and the dosing tank are similar, and troubleshooting either will be similar. Power from the line first passes through the breakers. The system needs to be de-energized before working on the pumps. Contactors are controlled by the pump controls settings (HAND/OFF/AUTO), which are also controlled by the float switches if in the AUTO position. The overload prevents excessive amperage draw to protect the equipment from damage.

Aeration Equipment: Control Panels, Motors, Blowers, Piping

A second important area requiring monitoring and maintenance is the aeration equipment. Aeration is required in the aeration tank for conversion of pollutants to bacteria. However, aeration is also provided in the flow EQ tank for mixing of suspended pollutants and post aeration to increase the dissolved oxygen levels to achieve compliance with the effluent limit. Aeration is also provided in the solids holding tank or digester to maintain an aerobic environment while storing excess bacteria.



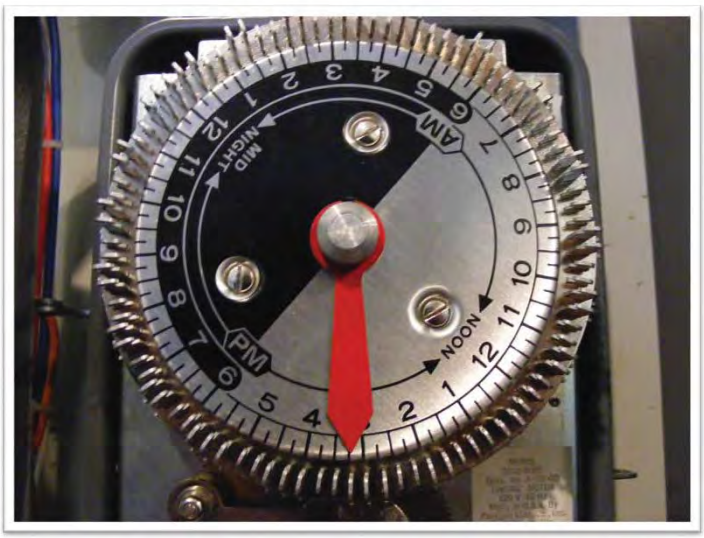
Often the aeration for the post aeration tank or digester is provided by the blower which also supplies diffused air to the aeration tank. Care must be taken to insure proper adjustments when these tanks are connected by the same blower. The compressed air will take the path of least resistance, so water depth above the diffusers, friction loss through the pipes, and clogged diffusers or piping will affect the aeration that can be applied.

Similar electrical components are used in the control panel for the blowers as is used in the control panel for the submersible pumps. A look inside the panel will reveal breakers, contactors, and overloads. The main difference will be the blower controls operate off of a timer instead of float switches.

Aeration Equipment: Control Panels

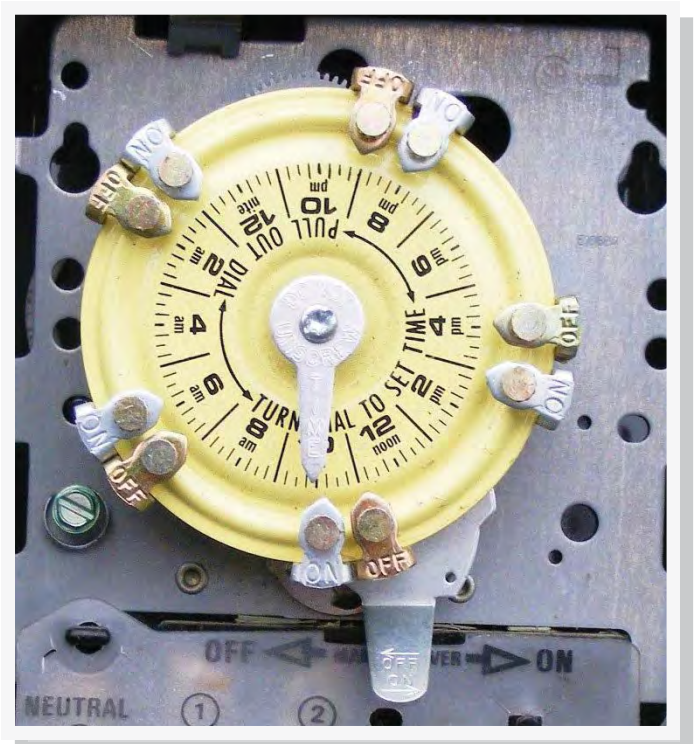
With the blower controller set to the "HAND" position, the blower motor will not operate until the time clock closes the contactor to energies the motor.

A typical time clock contains 96 pins which can be used to determine motor run time at 15 minute increments. Some time clocks have fewer pins and are less expensive, but you are sacrificing control, especially if you are working with a time clock with only a few settings available.



To the left is another time clock with a 96 pin on/off options.

To the right is a time clock with limited on/off options. This clock will allow the operator only five on/off cycles in a 24 hour period. Most aeration systems would benefit with more flexibility in aeration cycles, both in frequency and duration.



Aeration Equipment: Motors

The control panel houses the electrical equipment to control and power the motor. The motor/blower assembly uses this power to provide the compressed air necessary for treatment.

Because the motor can be energized automatically, based on the control settings, you should approach any motor/blower assembly as a potential safety hazard. A guard must be in place to protect yourself from accidents when the motor is energized.

Some motor/blower assemblies are designed so the housing unit is also the guard assembly. Here is a motor/blower assembly in which the housing is removed to prevent heat buildup. The danger here is the housing unit is also the guard for the moving pulley/belt. This has now become a safety issue.

Aeration Equipment: Motors

Remember, if performing any maintenance or repair work on the motor or the blower, disconnect the power source at the breaker, then lock out the control panel so it can not be energized without your knowledge.

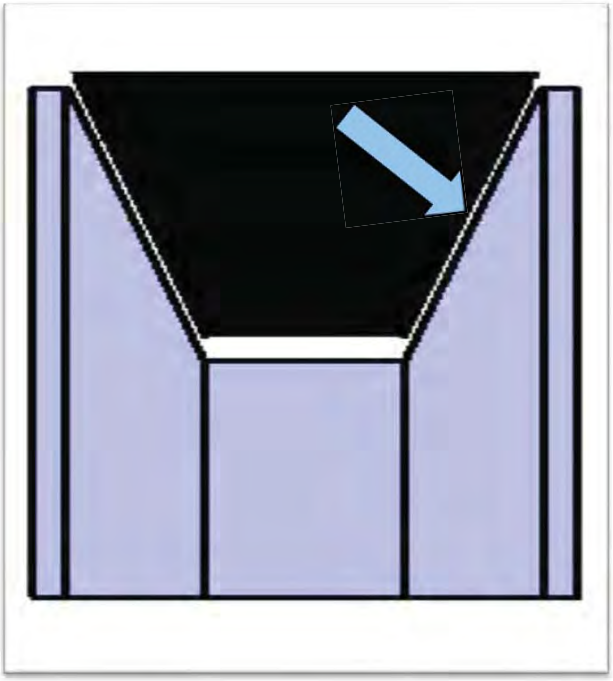
The electrical motor driving the blower needs to be maintained for the highest efficiency and longest life. Some electrical motors require lubrication on a regular schedule. There are several manufactures of electrical motors and each manufacturer is the best resource on when lubrication is necessary and the type of lubricant to be used. Consult the equipment manufacturer's recommendation on the frequency and type of lubrication for optimum performance.

Aeration Equipment: Motors

Electrical energy is transformed into mechanical energy in the motor, which is then transferred to the blower by pulleys and v-belts.

The incorrect combination of pulley or belt could lead to loss in efficiency in transferring the mechanical energy from the motor to the blower, decreased belt life, or damage to bearings in the motor or blower.

Belt tension and alignment is critical in prevention of mechanical problems from the motor/blower assembly.

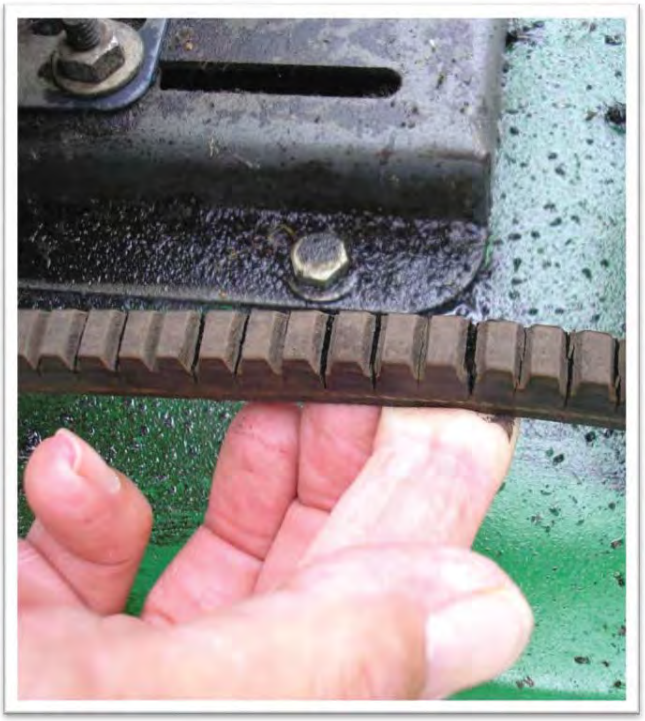


Energy is transferred from the motor to the blower by a v-belt. The power transfer occurs between the sidewall of the v-belt and the pulley. If the v-belt sits low enough in the pulley to ride against the base of the pulley, power will be lost and slippage will occur.

A sign that the v-belt is riding too low in the base of the pulley is if this area has a "polished" look to it. The friction of the belt on the base will produce a polished look to the base.

Aeration Equipment: Motors

A visual inspection of the belt will prevent many unexpected mechanical issues. Before physically examining the v-belt, open the electrical breaker to prevent the motor from being energized and lock out the control panel.



A simple inspection of this v-belt indicates it is running on electricity or luck. These cracks are deep and the belt needs to be replaced.

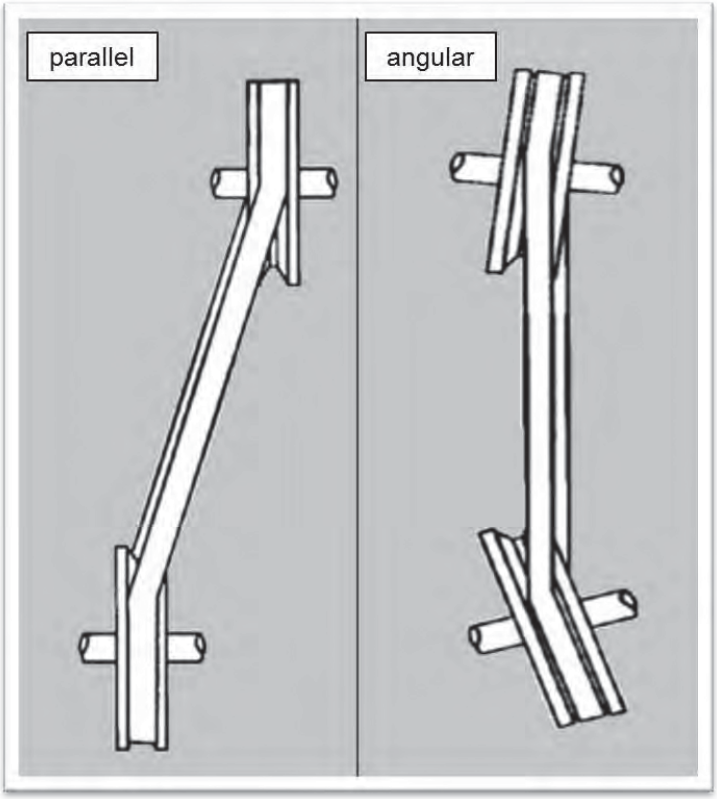
Belt tension is also an important factor in transferring power to the blower unit. When tension is insufficient power is lost through slippage of the v-belt. If belt tension is too tight it will decrease belt life, increase pulley wear and exert a load on the bearings of the motor and blower. Increased bearing loads lead to expensive equipment repairs.

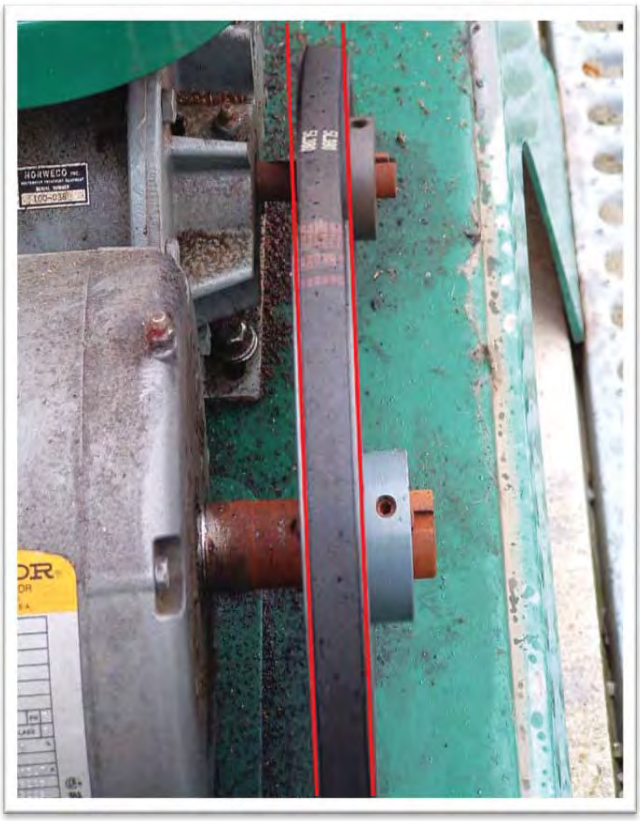
A belt tension tester is inexpensive and provides an accurate measurement of the belt tension.

Measuring the belt tension is significantly cheaper than replacing a motor or blower.

Aeration Equipment: Motors

Alignment of the v-belt between the pulleys is critical to prevent decreased belt life. When the belt is not aligned it creates pinch points which causes a wear pattern leading to a belt failure and also places uneven loading on the bearings of the motor or blower.





A misaligned belt can be parallel or angular. The photo above is an angular misalignment.

A simple way to determine if the pulleys are misaligned is to use a straight edge and measure if the belt is aligned. (Even a piece of string will indicate if an adjustment is necessary.)

Again, remember to open the circuit breaker and lock out the control panel before exposing fingers to potential moving assemblies.

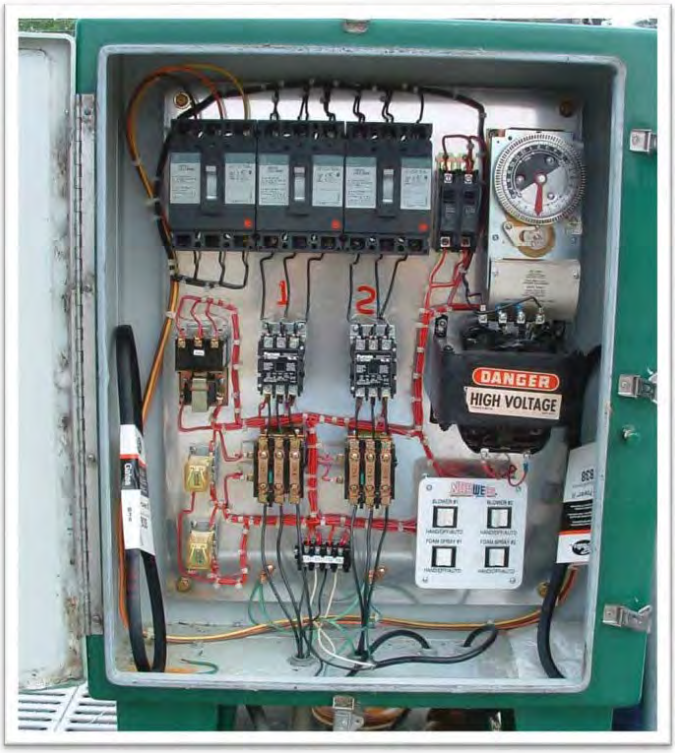
Aeration Equipment: Motors

Improper belt tension and misalignment will decrease belt life, so measure the tension and alignment to extent belt life. However, one thing is certain, no matter how well you maintain the motor/blower assembly, belt failure will eventually occur. The aerobic treatment process will not function unless aeration is provided, so it is critical to have replacement belts available to decrease the down time of the aeration system.

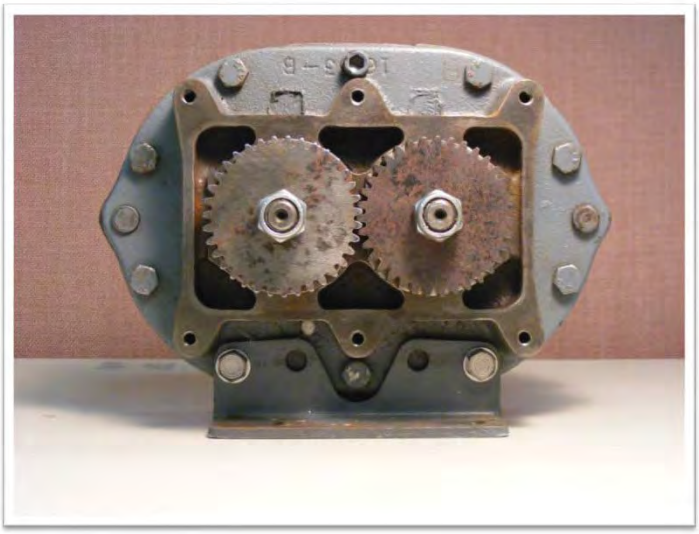
When replacing v-belts a "run-in" time is required, since belts will stretch after a short period of operation. It is best to run the new belt and return to readjust the tension of the belt.

If a system has multi-belts it is recommended to replace all the belts and not just the one that broke.

Belts tend to reach a failure point at the most inconvenient time. Having replacement belts onsite allows you to initiate repair immediately.



Aeration Equipment: Blowers



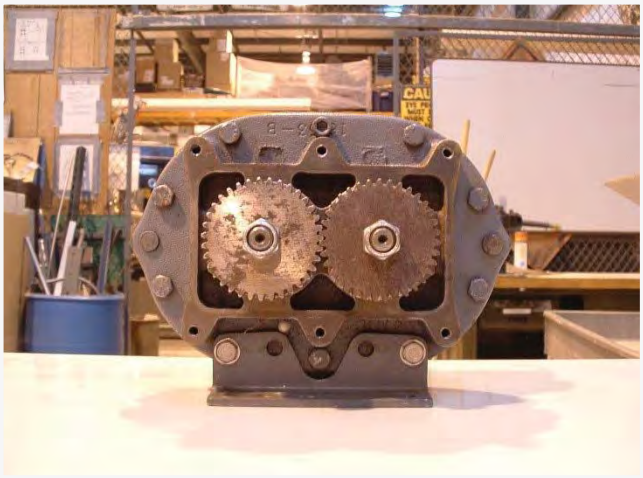
Power is delivered to the blower to rotate timing gears that generate the compressed air necessary for the aeration tank. These timing gears need to be lubricated according to the manufacturer's specifications. Each manufacture will specify the type and volume of lubrication required for optimum performance.

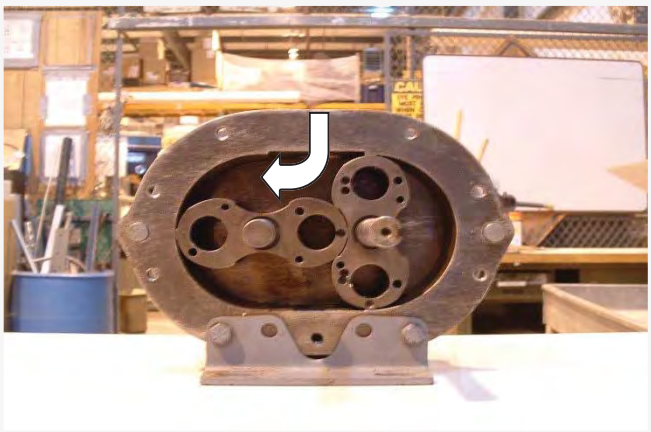
Insufficient lubrication will decrease blower life from friction. Too much lubricant will cause a foaming effect, which can damage seals on bearings.

If the motor/blower mounting table is kept clean of excess oil and grease, it becomes more obvious if problems are developing.

Aeration Equipment: Blowers

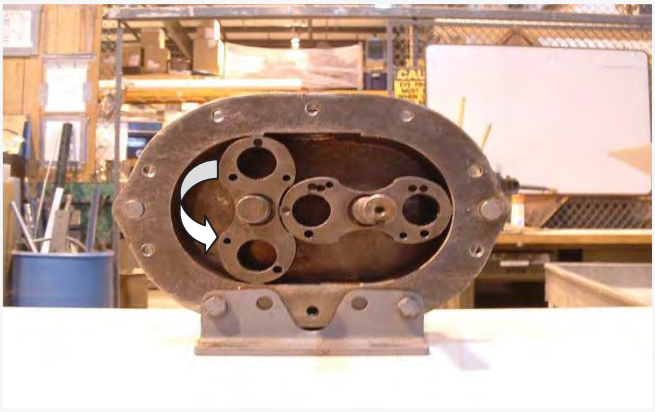
The timing gears on one side of the blower drive the lobes on the other side, which is where the inlet air is compressed and discharged into the piping to deliver air to the aeration tank diffusers.

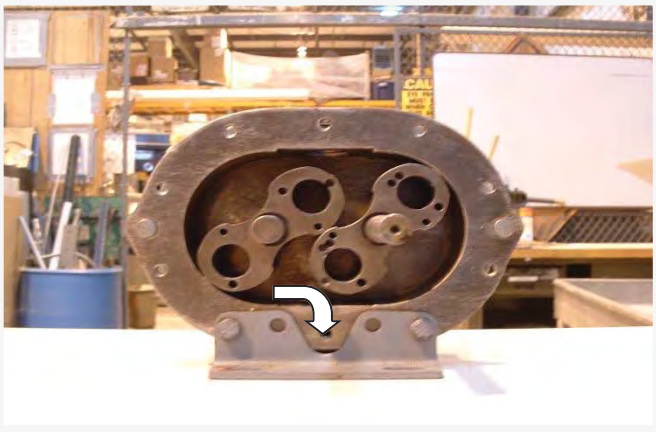




As the lobes rotate, they draw atmospheric air through an air filter located on top of the blower.

The rotating lobes push the air through the open cavity of the blower.

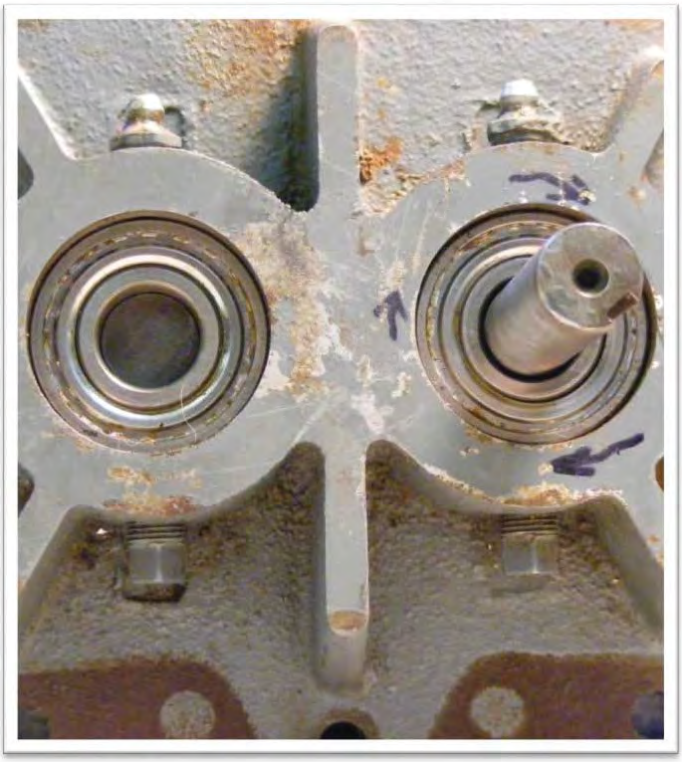


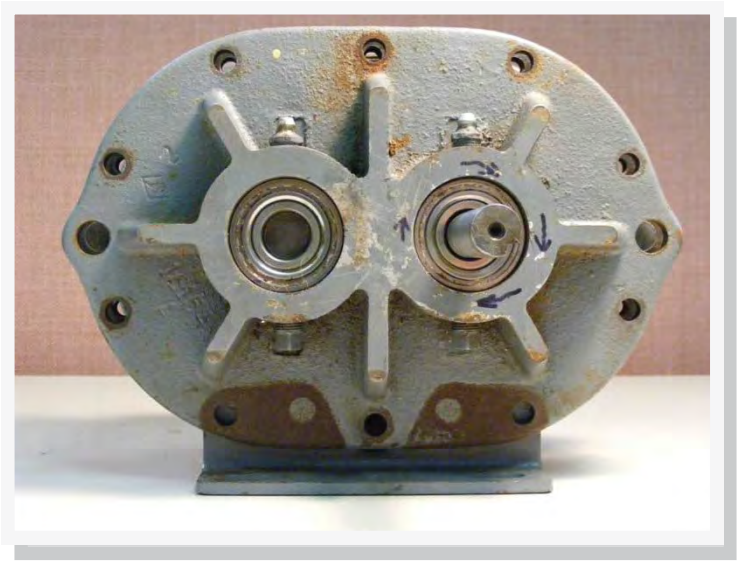


As the lobe rotates, the air is allowed to escape through an opening in the bottom of the blower. The air is forced out of the blower into a piping system, which directs the air to the diffusers in the bottom of the aeration tank.

Aeration Equipment: Blowers

There will be grease ports located for each bearing which requires periodic lubrication.

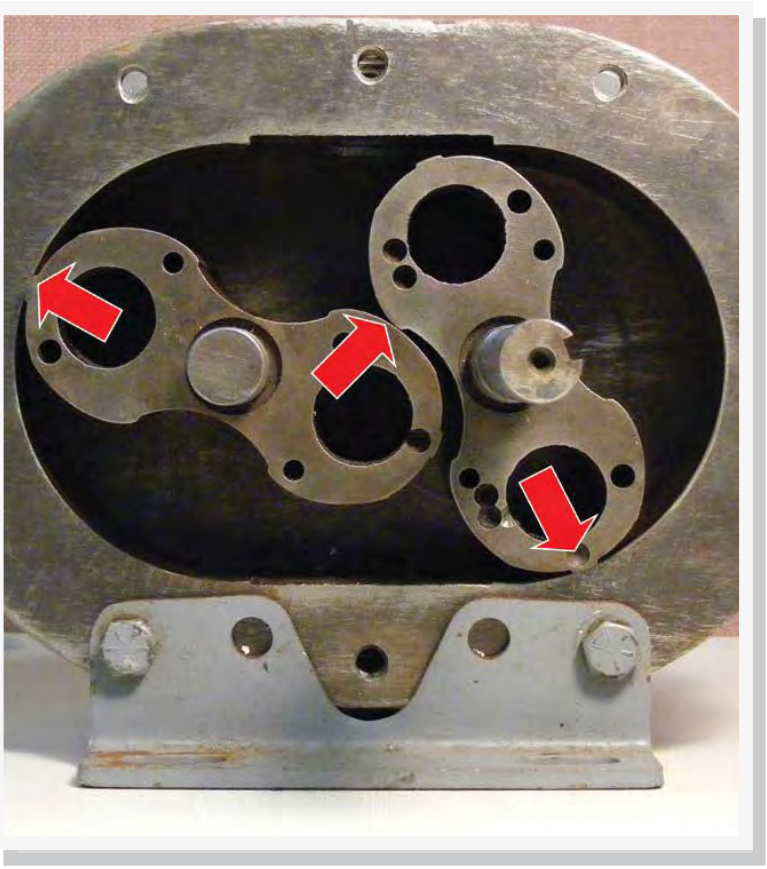




The bearings on both sides of the blower require lubrication. Again, follow the manufacture's recommendations for the type and frequency of lubrication.

Aeration Equipment: Blowers

The tolerances within the rotating lobes are measured to a few thousandths of an inch. To protect the lobes from damage, it is important that the air being drawn into the blower has been filtered to eliminate dust, dirt or foreign particles. Thus, blower units without filters will be unable to protect the blower or achieve an extended operational life.

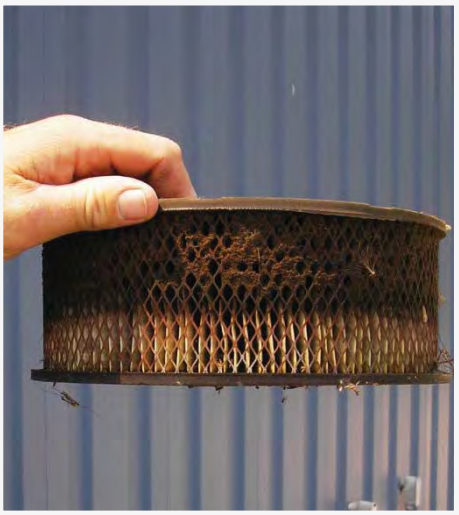


Filtration systems which have been modified from the original design might look impressive and be better than no filter, but will fail to remove particulates smaller than a few thousandths of an inch.

Aeration Equipment: Blowers

A proper motor/blower assembly requires a filtration system to protect the blower. The air filter used should be inspected regularly for indications of needing replaced. It is not adequate to replace the filter based on time in service, because ambient air quality also determines filter life.

Package plant systems are typically located in rural settings. Depending on the time of the year and potential surrounding activities, filter life can be dramatically impacted.



Here a v-belt has been shredded and produced a large volume of charred rubber particles. The intake of the blower created a perfect vacuum effect drawing particles into the filter.

Aeration Equipment: Blowers

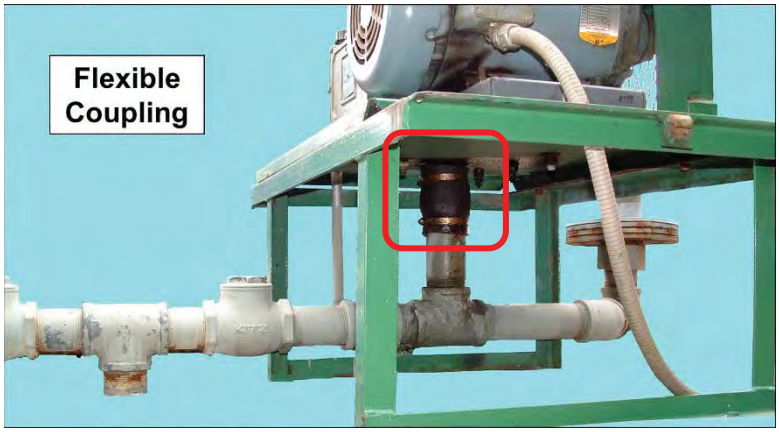
Many older air filtration systems were designed with a fine wire mesh screen to prevent particles into the blower. These older filters were designed to be soaked with oil, which would improve particle capture.

Many of these older filters show strong signs of rust. This could be the worst possible situation, since fine metal flakes will dislodge from the filter and be drawn directly into the blower unit. Contact the equipment manufacture for possible paper filter options .

Another seasonal event that causes filter issues is the summer "snow" from cottonwood trees. These seedlings from trees will cause a filter to be replaced more frequently than the expected calendar replacement date.

Filters should be inspected periodically and more frequently based on ambient air conditions. Replacement filters are inexpensive, so backup filters should be available.

Aeration Equipment: Blowers



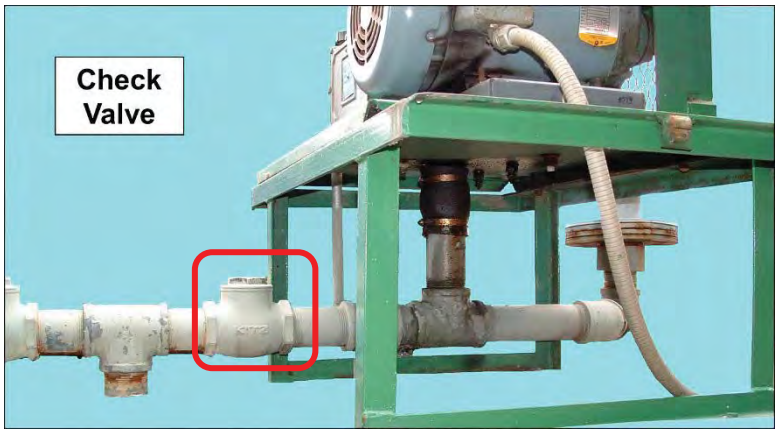
Compressed air is discharged from the blower into the piping to convey the air to its intended discharge point. The motor/blower assembly is fixed, but the unit experiences continual vibrations when in operation. The piping which conveys the air is also fixed. These vibrations from the motor/blower assembly do not allow a fixed connection to the piping, thus a flexible coupling is used.

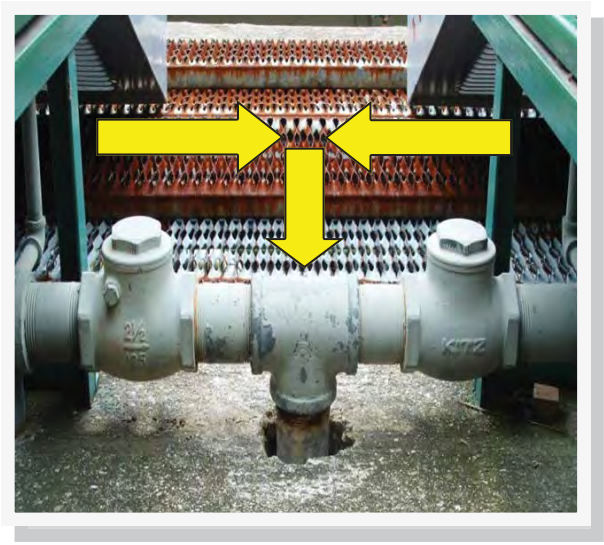
A flexible coupling typically used is a short section of straight hose with a couple of clamps.

The flexible coupling absorbs the vibrations from the motor/blower assembly to maintain integrity of the air distribution system. The coupling is exposed to expansion and an increase in temperature when air is flowing through the piping. In addition, oil and grease will weaken the material and failure will occur. Visual inspection of the flexible coupling for signs of cracking or a weakening of the hose should be performed frequently. If there are any signs of expected failure replace the flexible coupling. Air loss at the coupling may cause system failure, since air will not reach the aeration tank diffusers if it can escape at the coupling.

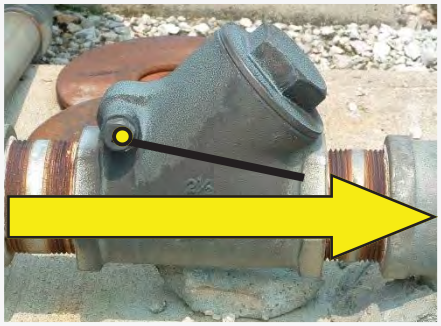
Aeration Equipment: Piping

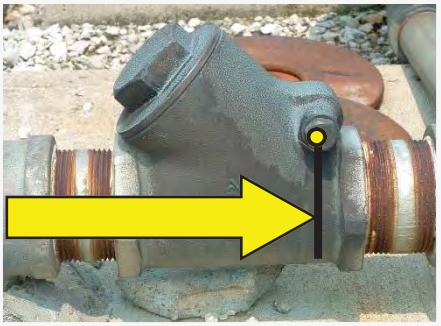
Providing aeration to the treatment system is critical and loss of control will occur without air being provided to the aeration tank. Because of this, treatment systems are required to have a backup motor/blower assembly.





Typically both blowers discharge into the same piping distribution system. The purpose of the check valve is to direct air flow to the diffusers in the aeration tank and not allow air to escape through the piping system to another blower which is not in operation.

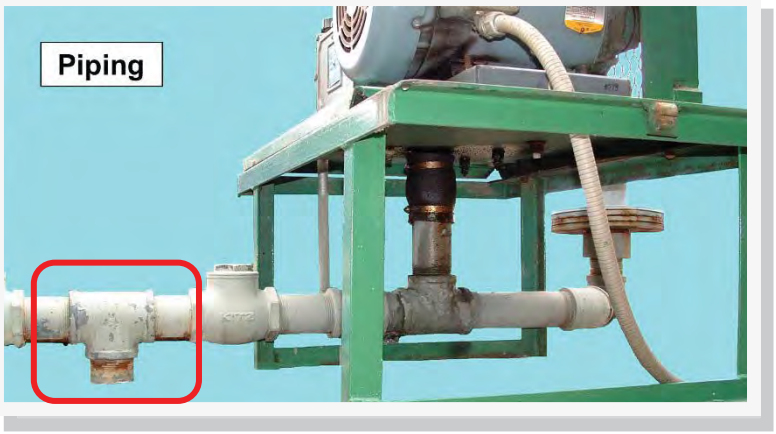




In the photo on the left, neither blower is in operation and the check valve is in a vertical position. In the center photo, the blower feeding from the left pushes the check valve into a horizontal position and allows the air to pass through to the piping leading to the aeration tank diffusers. In the photo on the right, the check valve for the other blower is forced into the vertical position so air flow is restricted and unable to continue back into the blower which is out of service. This causes all air to go to the aeration tank diffusers, but also allows for air flow if both blowers are in operation at the same time.

Aeration Equipment: Piping

The air distribution system can also experience issues which will prevent air flow to be discharged from the aeration tank diffusers.



Plastic, paper and rags which are not removed in the trash trap will combine around diffusers and seal them off. Aeration tank diffusers need to be inspected periodically and cleaned off to prevent clogging of the air flow.

It is obvious if the diffusers need cleaning, but not so obvious is sand, gravel and grit have clogged the inside of the piping system. If the blower is unable to provide sufficient mixing and aeration for conversion and the diffusers are not clogged, it is possible the piping needs to be disassembled and cleaned. Don't try to bring another blower on line to force more air in the aeration tank. The correct response is to clean the air distribution system.

Measuring the air pressure leaving the blower is another way to quantify if air flow is being restricted. Knowing what the blower discharge pressure is when the distribution system is clean will allow you to determine when back pressure (clogging) is increasing.

Not only will the headers which hold the diffusers become clogged, but even the drop pipe which feeds air flow into the headers can become clogged. The photo on the right is of a 90 degree valve used to regulate air flow from the main aeration line to the individual drop pipes in the aeration tank.

Aeration Equipment: Piping

The blowers used in most package plants are positive displacement blowers. If the aeration tank piping experiences clogging, air flow is restricted. This causes a backpressure effect on the blower and will either cause it to trip out or overheat.

To prevent damage to the blower, a pressure relief valve is designed into the aeration distribution system.

The pressure relief valve, PRV, consists of weighted plates which has sufficient weight to hold down the cap. When the cap is in its lowest position, no air is permitted to escape the air distribution system. When pressure in the distribution system increases, the additional pressure will lift the cap upward to expose the discharge ports.

Rotate the cap by turning it by hand on a regular basis. Over time the cap can become rusted and needs to move freely up and down based on air pressure. Using a light oil on the surface of the discharge ports will also prevent the cap from "locking" on.

Infrastructure

A well operated and maintained system will fail if it is not protected from vandals. Installing a barrier around the treatment system is an inexpensive and effective step.

A fence is a strong barrier to prevent intentional vandalism, however, the fence is only as effective as the difficulty it presents to a vandal.

Sometimes vandals are kids that are bored and looking for something "fun" to investigate. Here is a system located in a rural setting which is wide open to explore.

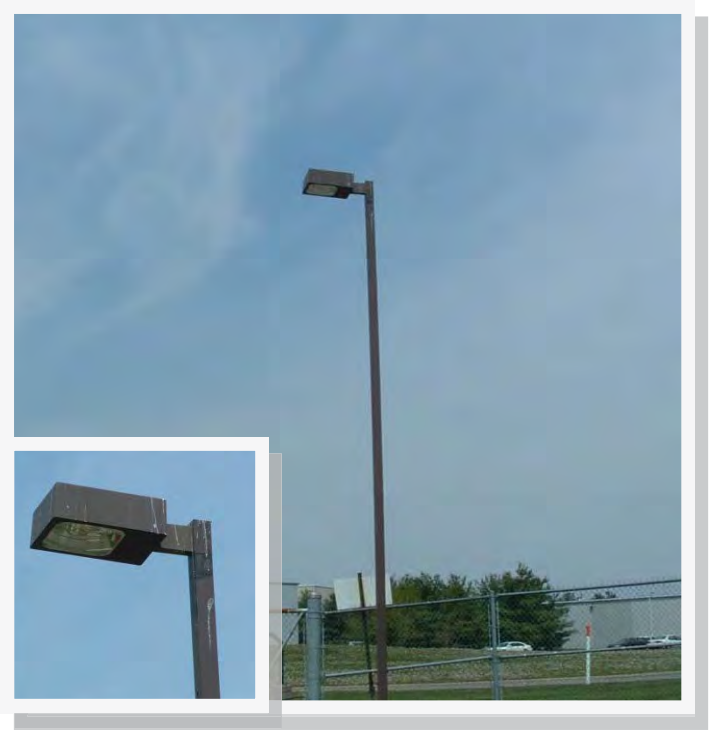
In fact, not even the electrical panel is secure. Everyone knows the combination on this screwdriver lock.

For convenience, many systems are "dummy locked" where it looks like the system is secure, however the padlocks have not been clasped together. There is a reason this is referred to as "dummy locked", because it is a dumb idea.

Infrastructure

Physical barriers like locks and fences will make it difficult for vandals to damage systems. Lighting will also discourage illegal activity. A well lit area provides a spotlight on any activity near the system.

Vandals prefer not to get caught. They will evaluate if an area is easy to get into and if they will be noticed.



A security system which provides lighting and a camera adds to the reasons to pass on by.

Maybe a camera is more expensive than the budget allows. Then again what is the cost of replacement or repair of mechanical equipment. Electronic surveillance equipment is becoming more affordable.

Infrastructure

Besides the infrastructure, the other half of the system that requires protection is you, the operator. The operator is exposed to chemical, biological, mechanical, and electrical hazards. To prevent accidents you need to place a barrier between you and the hazard.

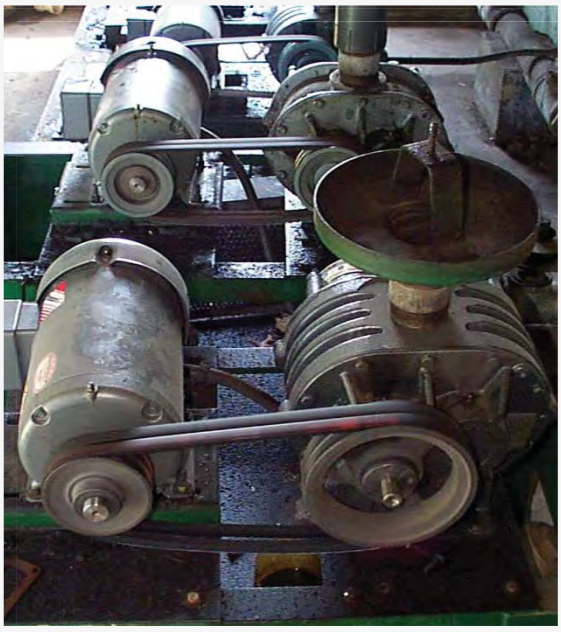
Chemical disinfection of the water in the tertiary stage requires oxidizing and reducing reagents. These compounds are chemical opposites and react when brought into contact with each other. Personal protective equipment (gloves, eye protection) should be worn when handling chemicals.

Biological hazards exist in the treatment system and a barrier should be placed between you and the potential biological hazard.

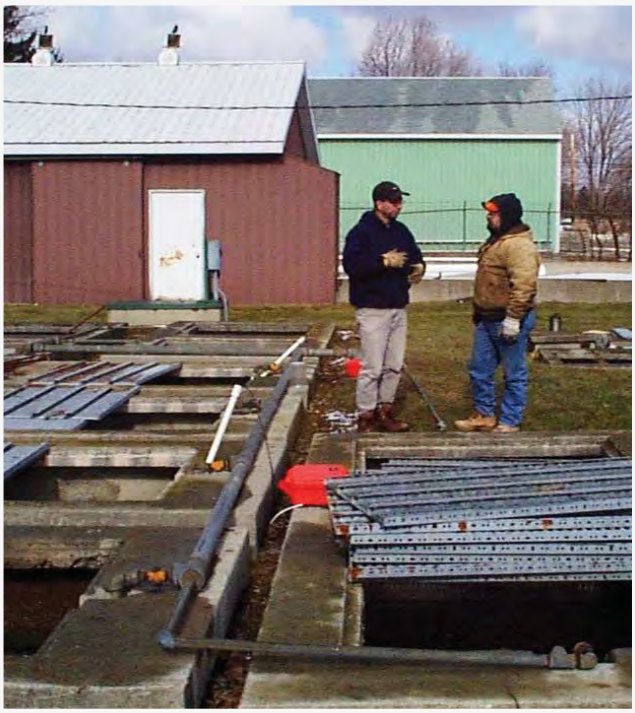
Personal protective equipment should be available for all involved with the treatment process.

Infrastructure

Equipment in which the protective guards have been removed open the door for accidents to happen. Accidents are not intentional, they occur because there was no barrier between the operator and the unsafe condition.



Grates on tanks prevent an operator from accidentally falling in open tanks. In the situation on the right, the operator has removed the grates to expose and open tank and also used the grates as a trip hazard to increase the probability of an accident.

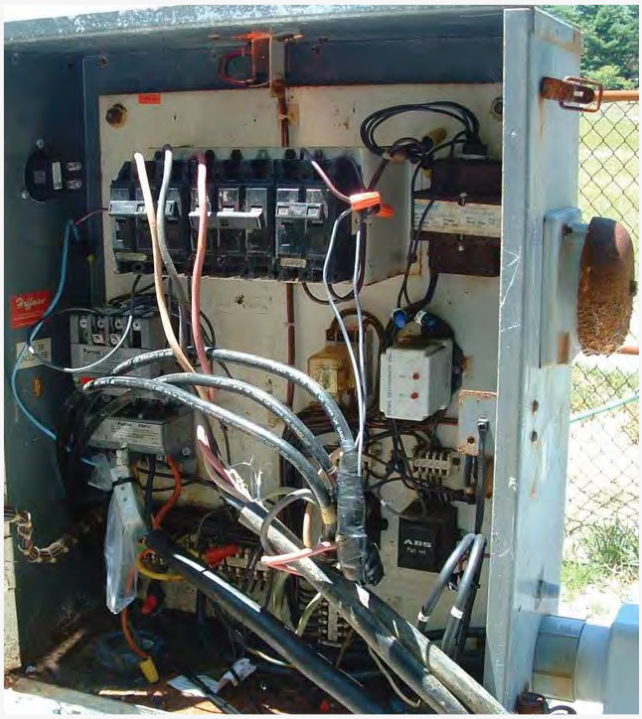


Try standing on this platform to read the daily runtime meter in the dosing tank control panel. Just don't step back.

Infrastructure

Even if the grating is in place, it could provide a false sense of security. Stepping through this screen would cut on the way down, expose the wound to a serious bacterial infection and maybe even cut a second time on the way up.

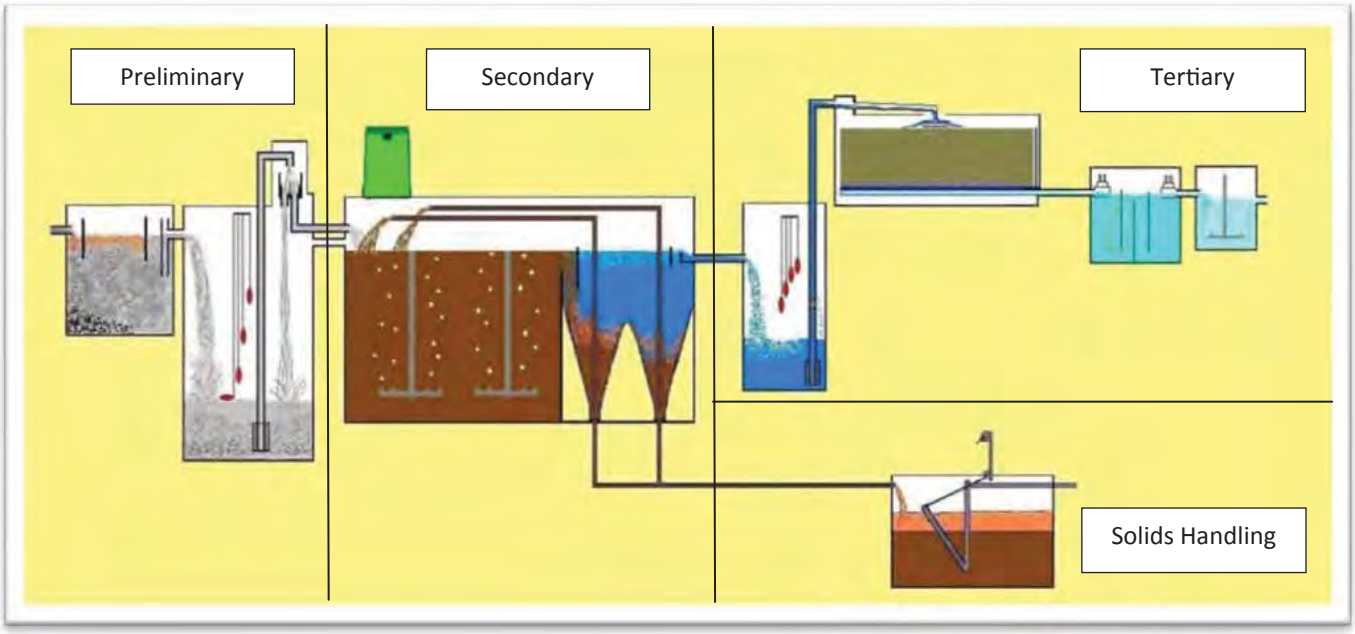
Keep the work area clean and free of trip hazards.



Finding a certified electrician to work on this influent pump station control panel might be the most difficult aspect of the job.

A clean wiring panel with a schematic is ideal. The sign says it all' "**DANGER HIGH VOLTAGE**"

Maintenance: Summary



Maintenance is the task of keeping mechanical and electrical components operational. The two general areas of maintenance are (1) the flow equalization tank and dosing tank pumps and (2) the aeration system for the flow equalization, aeration and post-aeration units.

In addition to maintaining the hardware components, the operator is also responsible for keeping the area secure from vandals and safe for plant personnel.