Chapter 12

Irrigation System — Maintenance, Inspection and Repair

In this Chapter

- **What does irrigation maintenance and repair involve?**
- **How do I receive replacement parts/components?**
- **What are the components of a typical irrigation system?**
- **How do I program and maintain controllers?**
- **How do I detect and repair a break in the mainline?**
- **How do I detect and repair a break in the lateral line?**
- **How do I use a "Quik-fix™" to repair a broken line or sprinkler head?**
- **How do I inspect and maintain sprinkler heads?**
- **How do I diagnose some basic irrigation problems?**
- **When do I need to manually water plants?**
- **What can I do to reduce soil water loss?**
- **What do I need to report?**

What does irrigation maintenance and repair involve?

Most of the rights-of-way in Hawaii do not have irrigation systems installed. The sections that do have irrigation may be temporary or permanent installations, usually in locations with high value landscaping.

Wherever an irrigation system has been installed, you must maintain it in good working order. Repairs must start within 48 hours of detecting damage, or from the time of notification by the Engineer.

Normal work shall be performed during daylight hours, Monday through Friday (except State holidays).

<u>Contractors are responsible for bringing the irrigation up to specifications</u> within thirty (30) days of the contract's Notice to Proceed date. If you are unable to bring the project up to specifications within thirty (30) days, you shall request a time extension from the Engineer. Failure to bring the project up to specifications or to request a time extension may result in an unsatisfactory rating for this period (and a deduction in pay). It is your responsibility to ensure that adequate labor, equipment and tools are provided for irrigation maintenance.

Contractors are required to provide

- A minimum of one English-speaking sprinkler technician who will do sprinkler maintenance.
- This technician must have completed the Certificate for Landscape Training (CLT) Irrigation Training Program and/or maintain a valid CLT/Irrigation certification.

Every month contractors will be required to report on the water consumption for irrigation, the time spent doing irrigation maintenance work, and the detection, repair and replacement costs of broken components. See Chapter 14, "Reporting."

Every month the inspector will check to ensure that the various components and functions of the irrigation system, including but not limited to dry spots, leaking valves, stuck valves and broken risers, laterals or mains, are functioning properly. You will also be required to accompany the Engineer to perform a comprehensive annual inspection of the irrigation system. See Chapter 15, "Inspecting Vegetation Maintenance Work."

Irrigation Systems Specification

Proper maintenance of an irrigation system involves having a working knowledge of the functionality of the basic components that are common in all systems. This knowledge can be directed toward detecting and preventing problems associated with improperly functioning systems, thus preventing deterioration of landscapes.

Irrigation work involves the maintenance and repair of all the components of the irrigation system. The scope of work includes, but is not limited to, the point of connection, piping system, electrical system and the sprinkler heads that apply water to the landscape area.

How do I receive replacement parts/ components?

Contractors and HDOT maintenance personnel involved in irrigation maintenance are responsible for ordering all replacement parts. The Engineer must approve the ordered parts before they are bought, and determine whether HDOT or the contractor will pay.

Reuse of materials

The reuse of salvageable material, wherever feasible, is authorized if it is accepted by the DOT inspector. The reuse of materials is authorized for the purpose of maintaining the same product type on the site/ system.

Cost associated with the replacement of unsalvageable materials damaged through negligence or from normal wear and tear is the responsibility of the contractor.

Replacement of original parts

Replacement of irrigation system components **must** be made with materials of the same manufacturer and model as the original equipment. Substitutions of materials other than the original equipment brand will be approved only when the original equipment has been discontinued and is no longer available for purchase at any location. The substituted component must be completely compatible with the original and must be approved in advance by the Engineer. All repairs to the system shall be identical to the original installation unless otherwise approved in advance by the Engineer.

Tip
All replacement parts must have the same output and coverage specifications as the previous equipment.

Changes to existing irrigation system

If changes to the irrigation system components will result in lower future maintenance costs, less frequent breakage, or an increase in public safety, you may request authorization from the Engineer.

What are the components of a typical irrigation system?

An efficient irrigation system consists of a carefully engineered assembly of pipes, valves, sprinkler heads, electrical wires and other hardware. There are seven main components that are involved with all automatic sprinkler systems currently in use. The types and functions of these components are discussed below:

Point of Connection (POC)

The point of connection is the location where an irrigation system taps into an available water supply/source. The source of water for the entire irrigation system is controlled by some type of master shut-off valve, typically a gate valve near the POC. This valve is normally buried in a valve box and should be tested periodically to make sure it remains operational.

Backflow Prevention Device

The point at which a non-potable water source connects to the main water supply is referred to as a **cross-connection**. This occurs at the POC (described above) for an irrigation system. Since water in an irrigation system is subject to contamination, the potable water supply is in danger of contamination if water from the irrigation system flows back into the city piping system. This situation, called **backflow**, is the unwanted reversal of the water flow through a cross-connection. To prevent backflow from occurring, all irrigation systems are required to have an approved **backflow prevention** device.

Backflow preventers should be installed in an accessible location to facilitate servicing, testing and inspection. They are usually installed immediately downstream near the POC. Backflow prevention devices allow flow in one direction only. It is important to make sure the arrow points in the direction of flow when these devices are installed. Backflow preventers contain seals, springs and moving parts that are subject to wear and fatigue; therefore, periodic testing is required.

Remember
Annual inspections are a requirement of the Department of Health. These inspections are to be schedule by you. The work is to be done by a qualified backflow prevention inspector. You must provide a backflow inspection report as a part of your annual inspection.

Although you may not be required to repair backflow prevention devices, it is your responsibility to report any noticeable problems with them. For example, reduced pressure backflow devices should not leak water. If water is dripping from the unit, that is a sign of a problem with one of the check valves. The device is actually functioning properly (alarming you that there is a problem with a backflow that needs repair).

Backflow can occur in two different ways:

From backpressure – This occurs when the pressure in the irrigation system (downstream) is greater than the pressure in the water supply (upstream). This can be caused by a decrease in pressure in the water supply, an increase in the downstream pressure, or both. A booster pump in the irrigation system can cause backpressure.

From back-siphonage – This is caused by negative or reduced pressure in the water system. Some possible causes include undersized piping, a line break lower than the service connection or a high water withdrawal rate from firefighting, pipe flushing, etc.

Four basic types of backflow prevention devices in common use today. Each is described below.

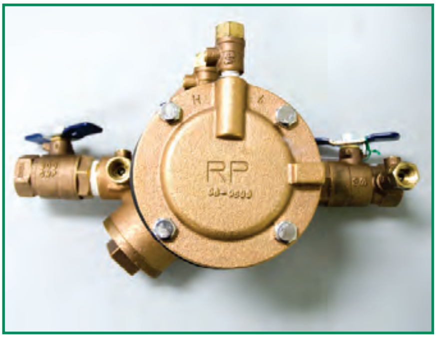
Pressure vacuum breaker (PVB) – PVBs have a spring-loaded check valve and a spring-loaded air inlet valve. They are designed to prevent backflow from back-siphonage only and are not effective against backflow due to backpressure. Shut-off valves are located at each end of the assembly and the units are equipped with test cocks. Install PVBs at least 12 inches above the highest outlet or sprinkler head in the system.

Atmospheric vacuum breaker (AVB) – AVBs have a float check, a check seat, and an air inlet valve. The air inlet valve opens if there is a loss of pressure in the supply pipe. This allows air (atmosphere) into the outlet piping, preventing backflow. AVBs should not be under constant pressure for more than 12 consecutive hours. Like PVBs, AVBs are designed only to prevent backflow caused by back-siphonage and must be installed at least 12 inches above the highest outlet or sprinkler head in the system.

Pressure vacuum breaker

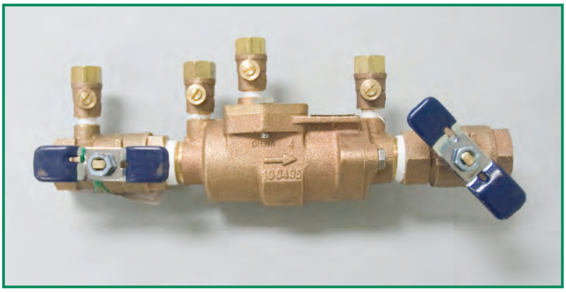
Atmospheric vacuum breaker

Reduced pressure assembly (RPA) – RPAs have two spring-loaded check valves with a pressure differential relief valve between them. They maintain a pressure differential of not less than 2 PSI between the supply (upstream) side and outlet (downstream) side. If pressure builds up on the outlet side, the relief valve discharges water to relieve pressure. Shut-off valves are located at each end of the assembly and the units are equipped with test cocks. RPAs are effective against both backpressure and back-siphonage and are approved to protect water systems from substances hazardous to health. They should be installed 12 inches above the ground, but do not have to be higher than sprinklers or other outlets.



Reduced pressure assembly

Double-check valve assembly (DCA) – DCAs have two spring-loaded check valves. Shut-off valves are located at each end of the assembly and the units are equipped with test cocks. These backflow preventers are effective against both backpressure and back-siphonage. However, they are not approved to protect water systems from substances considered health hazards. They should be installed 12 inches above the ground, but do not have to be higher than sprinklers or other outlets.



Double-check valve assembly

Remember
RPA and DCA backflow devices are normally used on larger irrigation systems. Department of Health regulations require they be inspected annually by a licensed irrigation specialist or plumber.

Mainlines

The mainline is a pipe that carries water from the POC, through the backflow prevention device and then to the remote control valves. Typically, this pipe is made of polyvinyl chloride or PVC (a semi-rigid plastic), although copper or galvanized steel pipe has been used in the past. The mainline is placed in a trench at a recommended depth of 18 to 24 inches. The mainline is **under constant water pressure** and is commonly the largest pipe in an irrigation system.

Irrigation controllers

Types of controllers
- AC controllers
- Battery-operated/valve box and wall or pedestal mounts
- Solar-powered/valve box and wall or pedestal mounts

AC controller

The **controller** is also called a **time clock**; it makes the whole system operate efficiently. It is the brains of the system, instructing control valves when to supply water to the sprinklers and for how long. Controllers are connected to control valves by electrical wires. The function of all controllers or time clocks is to implement an irrigation schedule.

An irrigation schedule consists of a start time(s), days to water, and duration to water. This schedule is determined by the type of plant material, soil type, slope, availability of water, the season and current weather conditions.

- Periodic electrical tests are required to insure the system is working properly.

Types of AC controllers

Electro-mechanical controllers have been in use for many years. They are driven by motors and gears and are considered dependable, but have limited features. These types are relatively inflexible as far as scheduling is concerned. They do not support different schedules within the same clock, which means they basically have limited capabilities to irrigate properly in most of the variables described above. Although there are still many of these older types of controllers in use, they are no longer being manufactured. All replacements available are the newer solid-state electronic models.

Electronic controllers are newer, more complex and are controlled by microprocessors. They are also called solid-state controllers. They have more sophisticated programming capabilities, allowing you to develop more flexible irrigation schedules. Most, if not all, controllers in operation on the ROW are the electronic types.

Electronic controller

Battery-operated and solar controllers

These types of controllers are present where AC power is not available. They are a good alternative to manual watering. These controllers do require a fair amount of maintenance due to the life span of batteries and the functionality of solar panels. They all require some type of DC latching solenoid.

Battery-operated controllers

Solar controllers

Valves

Valves are devices that regulate the flow of water in an irrigation system. There are many types of valves, including main valves, flow valves, isolation valves and drain valves. Some valves are operated manually, while others are electrically controlled.

Most valves are directional; so, when installing a valve, make sure the arrow points in the direction of flow. Valves are usually installed in a buried valve box – a plastic box with a green lid – providing easy access for maintenance or repair. Several valves often share the same valve box.

Valve boxes

All valves are required to be installed below ground level in protective valve boxes. A valve box may contain one or many valves. On slopes where no vehicles traverse, plastic valve boxes are acceptable. Concrete valve boxes with metal covers are required where vehicles and mowers may be operated.

Remember
You are required to maintain the bottom of all valves in the valve box a minimum of 1 inch above the gravel base. Remedy all valves not 1 inch above gravel base by excavating all dirt from valve box to a depth of 4 inches below the bottom of the valve and installing filter fabric and a 3-inch layer of #3 gravel.

Commonly used valves

Remote control valves

The controller irrigates an area by turning remote **control valves** on or off. Each control valve operates a group of sprinklers in an area called a **station** or **zone**. These valves are installed in a valve box. A valve box may contain one to several control valves. The stations/zones are laid out according to available water supply, plant type, and plant location.

The valve can be manually opened and closed either by twisting the solenoid to an on/off position, or by opening a **bleed port** located somewhere on the valve housing.

Remote control valves are available with or without a **flow control**. Valves with flow control have a stem on the top that allows water flow to be manually adjusted. The flow control should be adjusted to *match the flow of the zone.*

In most cases, the controller will operate the valves sequentially, and only one at a time. When a valve has completed its watering, it will switch to the next station that has been programmed. This process is called the **watering cycle**. The information pertaining to the watering duration, start times and watering days of the individual stations is called a **program**.

Most valves used today are called "normally closed" control valves. This means that the control valve is in a "closed" position until power is supplied to it by a time clock/controller. When this occurs, the valve will open and water enters the lateral pipe lines that supply water to the sprinkler heads and emitters.

Another less common type of valve is called a "normally open" control valve. This valve remains in an open position with water flowing through it. The valve shuts down only when a controller sends power to it. These types of valves, often called "master valves" are used to shut down the water supply to an entire system in case of an unscheduled excessive flows and/or breakage. These types of valves (normally open) are only found on more sophisticated types of systems.

Wiring of control valves

Wiring is necessary to connect the controller (time clock) to the solenoid of each individual remote control valve.

AC voltage from a 120-volt electrical line is reduced by a transformer in the time clock from 120 volts to 24 volts. This 24-volt current runs along the wires to the solenoid of the control valves.

Each control valve is connected by two **electrical wires** to a terminal strip inside of the controller (time clock).

One wire, called the **hot wire** is connected to a numbered terminal strip that corresponds to the valve's station number.

The other wire, called the **common**, joins other control valves and is connected to a single terminal in the controller designated as common.

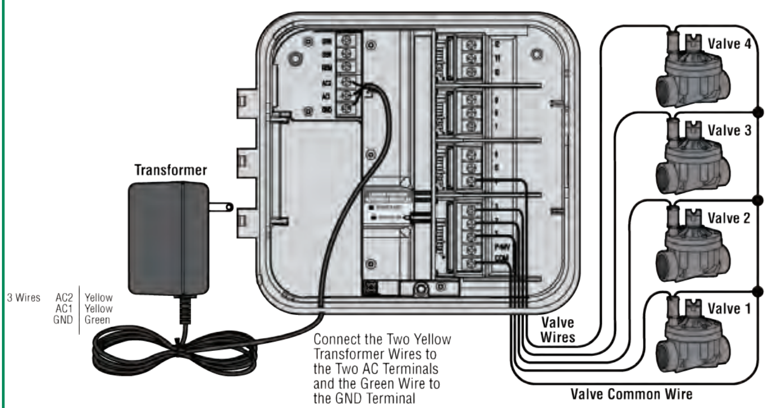
The common and hot wires are connected to a **solenoid** located at the top of the valve.

Connecting Valves and AC Power

1. Route valve wires between control valve location and controller.
2. At valves, attach a common wire to either solenoid wire of all valves. This is most commonly a white colored wire. Attach a separate control wire to the remaining wire of each valve. All wire splice connections should be done using waterproof connectors.
3. Route valve wires through the conduit and attach conduit to one of the openings on the bottom of the cabinet.
4. Strip ½" (13 mm) of insulation from ends of all wires. Secure valve common wire to **"COM"** (Common) terminal. Attach all individual valve control wires to appropriate station terminals.

Indoor Cabinet

Route transformer cable through the hole on the bottom left side of the controller and connect one Yellow Wire to each of the screws marked **AC** and the Green Wire to **GND**.



Remember
All wire connections and splices must be made with watertight connectors and housed within a valve box. When splicing wire, always use wire that matches the gauge and color of existing wire.

DOT standard for wire splices

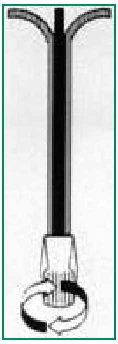
- The electrical connector used for all splices, up to 600 volts and with wire gauges ranging from 18 to 10 AWG, shall be the 3M™ DBR/Y-6. The connector shall include a gel-filled tube that incorporates a lid and locking mechanism which, when closed, applies pressure onto the insulation of the wires to create strain relief. The tube shall incorporate three channels, spaced 90° apart, for positioning the wires for strain relief.

- It shall also include a 3M™ "Performance Plus" R/Y+ twist-on connector with an aggressive quick-bite to allow making a fast and reliable mechanical connection over a wide temperature range. The R/Y+ twist-on connector shall lock in place when inserted into the gel-filled tube. The connector shall be re-enterable but not re-usable.

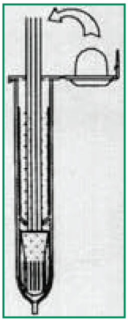
- The wire connector shall be sunlight resistant and installed above ground, inside irrigation valve box, or directly in the dirt.

- The connector shall be "Listed" under Standard UL486D for USA and Canada, File E102356. It shall also meet Directive 2006/95/EC and IEC standards EN61984:2009, EN60998-1:2004, and EN60998-2-4:2005. It shall be made in the USA by the 3M™ Company. Paige Electric 270672, no equal.

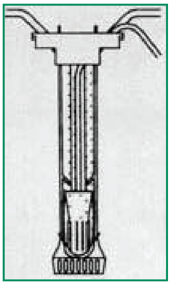
Easy as 1, 2, 3



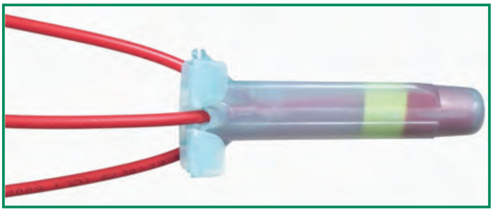
1. Strip wires, apply the Scotchlok electrical connector and twist in a clockwise direction.



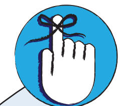
2. Insert the splice into the gel-filled insulator tube. Push past the locking fingers to hold the Scotchlok connector in place.



3. Position wire channels and snap insulator tube cover closed.



Electrical connector for wire splices



Remember

All electrical wiring to the solenoids of control valves carry low voltage, which is not life threatening.

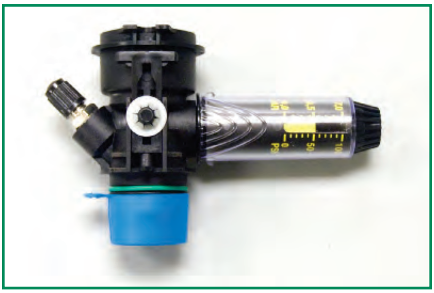
Two types of wire are typically used for irrigation systems, depending on the type of installation. Single strand (12 or 14 gauge) is generally used for commercial installations. Single strand wire is available in a variety of colors. Multi-strand (16 or 18 gauge) wire, which consists of multi-colored, individually jacketed wires encased together, is normally used for residential and light commercial installations. Colored wires are used to connect individual remote control valves to the controller. A common wire ties all valves in series to the controller. White wire is generally used to designate the common wire.

Wire is installed along the mainline for easy access. Wire for irrigation must be jacketed with an approved direct burial coating. Wire should be snaked under piping. This provides extra wire to prevent stretching or breaking as the ground expands and contracts due to moisture and temperature changes. It is also a common practice to include one or two extra wires for maintenance or expansion of the system.

The flow control can be used to shut off water flow in case of emergency only. If the flow control is not re-opened after an emergency, the valve will not operate.

Pressure-regulating devices on control valves

All control valves in irrigation systems should be equipped with special pressure regulating devices when available. If not equipped at original installation, a pressure regulator can be easily added to most models of control valves. This will allow the water pressure for that zone to be checked and adjusted on a regular basis to ensure the irrigation system is operating efficiently.



Pressure-regulating device (l) and how it fits into the control valve (r).

A consistent water pressure is required for the entire irrigation system to work properly. This is determined by the size of pipes, number of zones, and number and type of sprinkler heads on each zone. Correct pressures were determined at installation, so it is essential that you try to maintain the original configuration. Major modifications should only be carried out by an experienced irrigation technician, after approved by the Engineer.

Remember

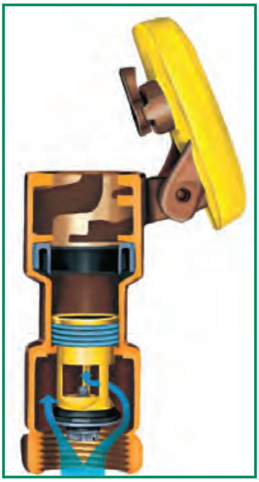
Battery-operated valves are also present within some landscape areas. These 9-volt DC systems require a special DC latching solenoid. Commonly these are controller/valve assemblies located within the valve box. Battery-operated controllers are to be tested each month to make sure the batteries are operating. The contractor is responsible for battery replacements and all costs incurred.

Shut-off valves – These valves are manually operated and include gate valves, ball valves, disk valves, butterfly valves and angle valves. They are typically installed at the point of connection, junctions where the mainline branches off in different directions or at clusters of remote control valves. These valves can shut off parts or an entire system in case work is needed on the mainline or control valves. In some cases, they are shut down in emergencies. **Shut-off valves are not meant to be used to manually operate an irrigation system or regulate flow.** There operating positions are either fully open or fully shut.

Shut-off valves

Quick couplers – These are a special type of valve with a notched key that allows you to quickly connect a hose or sprinkler, even while the system is operating. Quick couplers are always installed on the mainline, allowing water from an irrigation system to be instantly available for a variety of uses.

Quick-coupling valve (l) with cross-section view (r)



Lateral Piping System (laterals)

Laterals are the pipes that carry water from the control valves to the sprinklers heads or drip emitters. They are located downstream from the mainline and are connected to the mainline by remote control valves.

PVC (polyvinyl chloride) or polyethylene pipe is generally used for laterals. PVC is a semi-rigid plastic. Polyethylene (poly pipe or poly tubing) is a flexible plastic that is often used for drip system laterals.

Sprinkler Heads

Usually, the sprinkler heads in a watering zone are uniformly spaced along the lateral piping system (laterals). Each sprinkler delivers a metered amount of water over a part of the entire zone. It is essential that each zone has the same type of sprinkler heads on it because each type of sprinkler head has a specific rate of application. If different types of sprinklers are placed on the same lateral, the distribution will be uneven and dry and/or wet spots will develop.

NEVER mix different types of sprinkler heads in the same zone!

There are four basic types of sprinkler heads:
spray heads · rotors · bubblers · drip emitters

Spray heads discharge a continuous spray of water at distances typically ranging from 5-15 ft. These types of sprinklers have a high rate of application. The two main types of spray head installation are **risers** and **pop-ups**. Both types are available in different spray patterns, including full-circle, half-circle, quarter-circle and fully adjustable. These spray head nozzles are made to deliver matched precipitation rates, meaning that a quarter circle pattern will deliver one fourth as much water as a full circle, half circle will deliver one half as much, etc. The same amount of water is applied to a given area over the same period of time. This allows all sizes of matched precipitation spray heads to be placed on the same watering zone.

- **Risers** are fixed heads mounted on pipes projecting out of the ground. Since they are permanently installed above the height of surrounding plants, they can appear unsightly, create a hazard or be subject to damage; for example, from mowers. They are best suited for planting beds or other non-traffic areas.

- **Pop-up spray heads** are commonly used in lawns and planting beds. They are installed below the turf line. When the water is turned on, they pop up and spray.

Pop-up spray head

When the water is turned off, they retract, allowing mowers to pass over them. In addition to spray head patterns mentioned above:

- Spray nozzles are also available in special patterns for long, narrow strips of grass, such as in narrow medians and between sidewalk and street.

Two basic types of **rotors** are **impact rotors** and **gear-driven rotors**. Rotors rotate in a full or partial circle. They have a larger spraying radius than spray heads; typical throw distances are from 15 to 50 ft., but some can spray to 100 ft. Since rotors have similar water delivery rates as spray heads, from 2-4 gallons per minute (GPM), the resulting application rates are much lower. Therefore, zones with rotors require longer run times than areas with spray heads and are best suited for large turf areas. Rotors do not have matched precipitation rates, requiring full circle, half circle and quarter circle patterns to be placed on separate watering zones for best uniform coverage. Individual rotors tend to be more costly than spray heads, but fewer heads are needed to cover a given area.

Rotors are often more economical and efficient for large open areas. Rotors are available in pop-up models and in fixed versions for mounting on risers.

- **Impact heads** have a spring-loaded arm that swings sideways when contacted by water sprayed through the nozzle. When the arm swings, it impacts the sprinkler body causing it to rotate a small amount. Each time it rotates, a new section of lawn receives water. Impact sprinklers can be adjusted to rotate in a full or partial circle and typically throw water in distances of 25-60 ft. Impact heads are easily recognized by the loud, distinct spurt-spurt noise they make while operating.

- In **gear-driven rotors**, water causes internal gear mechanisms to turn; this causes the head to rotate. They do not have the noise of the impact sprinklers. These heads incorporate interchangeable nozzles that offer varying outputs and distances of throw.

Impact rotor head

Gear-driven rotor head

Tip

Impact heads and gear rotors have a much lower rate of application than spray heads and are much better for slopes. They also have a tendency to resist wind more effectively.

Bubblers are a variation of spray heads. Water is emitted through several nozzles in a steady stream. The water throw pattern ranges in radius from inches to a couple of feet. Bubblers are usually mounted on risers and used in planting beds. They deliver a large volume of water to a small area and require very short run times of just a few minutes. Their output typically is not adjustable but comes in rates from 0.5-4 gallons per minute (GPM). Because this almost always exceeds the soil infiltration rate, they are used to flood small areas. After the bubbler is shut off, water infiltrates the soil. They should only be used in flat areas where standing water is contained.

Bubbler

Low volume irrigation systems or **drip irrigation** require additional equipment compared to spray irrigation systems. The additional components for low volume systems are described below.

Drip valve assembly

- Each zone has a drip valve assembly contained within a valve box. Each assembly is made of the following components:

    1. Remote control valve.

    2. Filter – Low volume systems include emitters with small openings that can easily become clogged. To prevent clogging, filters are usually installed.

    3. Pressure regulator – Most low volume irrigation systems are designed to operate at pressures below that of the typical water supply. To keep water pressure within the design limits of the system, a pressure regulator is installed.

Drip valve assembly

Drip tubing and **piping** are thin-walled poly tubing, 1/8-1 inch in diameter, that supply water to emitters or microsprays (see below).

Emitters are devices that drip water at a slow rate. Output for drip emitters is measured in gallons per hour (GPH) with discharge rates generally ranging from 1/2-2 GPH. Emitters are typically installed in a location that delivers water to the base of plants. On sloping terrain, they should be placed on the uphill side of the area to be watered.

Emitters are purchased separately and installed along drip tubing wherever water is needed. As plants grow, emitters should be added and extended outward in line with the root zone of the plant. Pressure-compensating emitters are available for use where water pressure is reduced on long runs or on sloping terrain.

Microsprays are similar to ordinary spray heads, but operate at lower pressure, have lower discharge rates and a smaller spray radius.

Soaker hoses are porous hoses that continuously sweat water. Soaker hoses can be cut to desired length and plugged with an end cap. They operate best on flat sites.

Microspray

How do I program and maintain controllers?

Two types of AC controllers

1) Electromechanical controllers: are programmed using a series of dials, switches and pins.

2) Electronic controllers: are typically programmed through a keypad and have a visible digital or LCD display.

A valid program must contain the following:

- Watering days – what days watering is to occur
- Start time(s) – when watering is to occur
- Duration – how long watering is to occur (per station or zone)

Remember
For proper programming to occur, be sure that the controller is powered up and that the time of day and calendar year are current.

Once the controller contains a valid program, seasonal adjustments should be made to account for changing weather conditions. This should be done firstly for the pattern of the sun. For example, the days are longer in the summer, thus contributing to more evaporation and transpiration (Evapotranspiration or ET). Watering durations should be longer in the summer versus the winter when the days are shorter.

Many controllers have a water budgeting percent key that is initially set to 100%. This means that if your scheduled run time is set for 10 minutes, then the 100% means it will run for 10 minutes. If you want to double the amount of run time to 20 minutes then you could set the water budget to 200%. The same would apply if you want to cut the time in half: you would set it to 50%. Most controllers will apply this adjustment to all of the stations. Some controllers have the ability to apply this adjustment to individual programs or stations. (Be sure to review manufacturer's instructions pertaining to the controller before making the adjustments.)

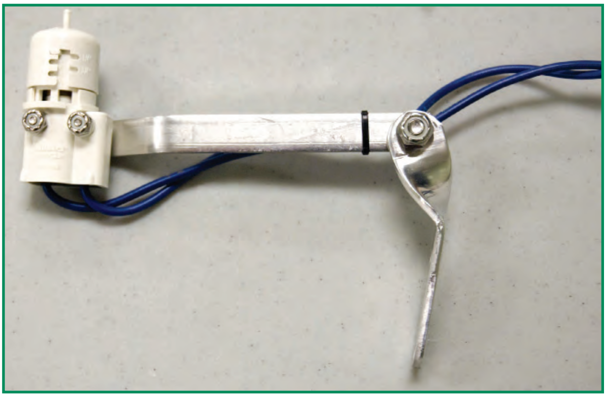
Most controllers also have a semi-automatic mode. This feature allows the user the ability to initiate a watering cycle manually as if the controller did it on its own. This feature allows for additional watering without changing the pre-programmed schedule.

Dual or multiple programming exists within solid state controllers. Simply put, it is like having multiple controllers in one box. This feature allows the user to schedule different watering times and days for zones that may require more or less water. This is useful on a site where there are flat areas and slopes. Also different plant types and soil conditions would benefit from this type of scheduling.

Environmental sensors

Environmental sensors are devices that interface with controllers, shutting down an irrigation system when water is not needed. Different sensors are available that can monitor rainfall, soil moisture, humidity or freezing temperatures.

Rain sensors are the most common type of sensor. These sensors have a collection device that gathers rainwater. When a pre-set or pre-determined threshold of rainwater is collected, the schedule is disabled and watering does not occur. When the rainwater evaporates (mimicking the soil drying out) the controller again operates as programmed. Rain sensors should be maintained so that they are free of debris and insects on the collection device.



Rain sensors collect rainwater and can temporarily shut down the controller for a pre-determined length of time. This prevents watering during rainy weather. Mount rain sensors in an open area without overhead obstructions.

To effectively program the controller you should:

Know your site well

Before scheduling run times, the site should be "walked" and planted areas inspected to observe plant stress and health. Soil moisture levels should be inspected throughout planted areas, and appropriate adjustments made to the irrigation schedule.

Use soil probing methods to determine soil moisture depth, overall moisture levels, and the need to adjust irrigation schedules. If you push a screwdriver into the soil it should enter the soil easily to the depth of water penetration. If it is difficult to push the screwdriver in more than an inch or so, the soil is too dry and needs irrigation. Look for soft muddy spots that would indicate too much water in that area.

Manage start times and run times
Run irrigation cycles only between the hours of 9:00 p.m. to 6:00 a.m. Watering times should be adjusted where needed to eliminate irrigation during heavy commuter hours. All run times should take into account sprinkler precipitation rates, soil conditions, microclimate conditions, evapotranspiration and slope.

Schedule irrigation sessions
Each irrigation session should be scheduled to encourage deep roots through deep watering. This can be achieved through use of multiple short repeat cycles when necessary, especially on slopes and sites with compacted soils. It serves to minimize water wastage and runoff.

Watering times should deliver enough water to soak the ground to a depth of 12 inches. Less water is needed to soak a sandy soil to 12 inches compared to a clay soil. Run times should be adjusted accordingly. Soils should be allowed to dry to a 50% moisture depletion level between irrigations to avoid root rot and allow adequate air to be present in the soil. As a general rule, this will require irrigation every two to three days on typical clay soils. Run times may remain constant throughout the year, but days to water should be adjusted seasonally.

Protect the controller
Controller enclosures are to remain locked. Repair any vandalism or other damage within 10 business days. Controllers must be free of insects and geckos. Employ moth balls if necessary. Keep solar-operated controller lenses clean of dirt and debris.

Report watering schedule
Provide a quarterly watering schedule to the Engineer one month after award of contract. Set the frequency and duration of run times to adequately irrigate plants and turf without causing significant surface runoff or ponding. Each time the schedule is changed due to seasons, or any other reason, provide a revised schedule to the Engineer.

Electrical maintenance
AC controllers must include yearly continuity tests on the wiring systems from the controller to the valves. These tests are to be documented by the contractor and verified by the inspector. An initial test upon award of the contract must be done to establish a baseline on the condition of the system. The resistance measurement must be between 20-60 ohms on each station or zone and must be a stable and constant reading. If the reading is higher or lower than the designated threshold, a repair

must be scheduled to bring the system to code. Yearly reports must be made so that fluctuations and problems are corrected immediately.

How do I detect and repair a break in the mainline?

A break in a mainline normally will result in a high rate of water loss at the location of the break. Sometimes the breaks are not visible. What you should take notice of are wet areas that are present all the time. This may be an indication of a break or small leak. These problems should be taken care of immediately as they will eventually turn into the "high rate of water loss" mentioned earlier. **Mainline breaks require that water be shut off at the POC.**

Mainline Repair Checklist:

- Place locater flag at area of break.
- Turn off water at POC.
- Dig a trench to a depth exposing break. Most mainlines are 18 to 24 inches deep. Remove soil to provide adequate work space around and under the pipe and break. (See note in lateral repair section.)
- Allow any water in the trench to drain and clean any loose soil from around the break.
- Use an approved pipe repair device (see below).
- Check for any leaks and repeat the process if leaks are found.
- Back fill trench, compact the soil by puddling (applying water to the top of the backfill), jetting (injecting water below the surface of backfill) or tamping (compacting soil with some type of compaction device). This may have to be done in several lifts (layers), depending on the depth of excavation.

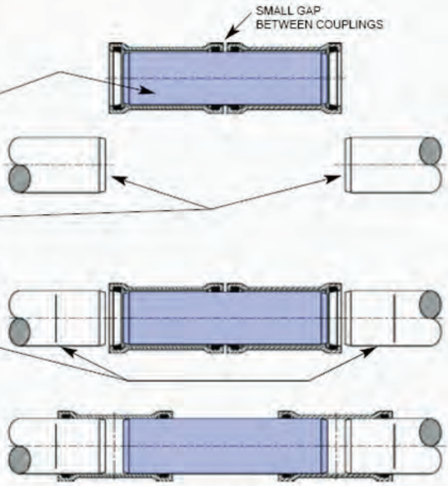
Tip

For mainline pipe sizes larger than 2", do not use Quik-fix repair couplings as they are not able to handle the water pressure spikes due to water hammer in larger systems. Knock-on couplings and mechanical-type couplings are to be used in these situations.

For repair of mainlines larger than 2″ follow the instructions below:

Installation Instructions

1. *Cut out and remove damaged section of pipe as required.*
2. *Cut and bevel new pipe to fit the gap of the repair section, accounting for the overhang of the gasket race of the repair couping as shown.*
3. *Using generous amounts of pipe lube, install repair couplings on pipe section as shown.*
4. *Bevel ends of pipe in ground. Apply pipe lube to pipe ends and coupling gaskets.*
5. *Mark pipe to use as guide to center coupling over joint.*
6. *Align and slide repair couplings over the original pipe to marks centering the couplings over the cut.*

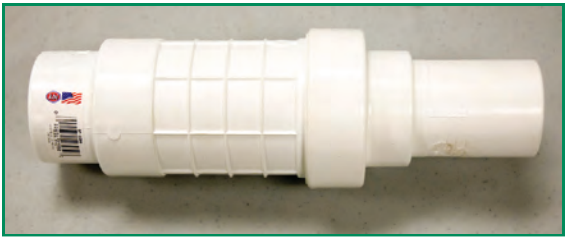


NOTES:

- *Gap between ends of pipe will have no effect on system performance.*
- *In systems using mechanical joint restraint or glue joint fittings, care must be taken with repairs in the restrained lengths to see that proper thrust restraint is maintained.*

Use a KBI Quik-fix™ for mainline applications 2 inches IPS or smaller

PVC repair couplings slip x spigot telescopic Quik-fix. Made of high impact PVC type II material in one-piece cylinder to avoid leaks; no solvent weld necessary. Includes an internal, high quality, self-lubricating EPDM O-ring for long life and smooth movement. Use a 150 psi working pressure rated in all positions. Complies with all applicable ASTM and ANSI standards, NSF approved.



Quik-fix sleeve

- Use a Quik-fix sleeve (shown above) to make the repair.
- Glue a coupling to one end of the Quik-fix.
- Close the Quik-fix and position it evenly over the break.
- Mark the broken mainline at both ends of the Quik-fix.
- Cut the mainline at the marks using a PVC hand cutter or saw.
- Clean and dry the cut ends and remove any burrs if the cut was made with a saw.
- Apply primer to both ends of the Quik-fix and to the cut ends of the pipe.
- Apply glue to both pieces and extend the Quik-fix so that it makes complete contact with the ends of the cut. Give a one quarter turn on the fix and hold in place for 15 seconds.
- Wait until the glue has had time to set (according the glue label) and turn water back on at POC.

How do I detect and repair a break in the lateral line?

Breaks in a lateral will not be evident until the control valve of that zone is activated and water begins to flow through the lateral lines to the sprinkler heads.

Many lateral line breaks occur at the connection to sprinkler heads. Laterals may be repaired any time the zone is not activated; or, if actively running, the water can be temporarily shut off at the control valve by closing the flow control.

Remember
If the flow control is closed to make repair, return it to the proper position (adjusted to the flow demand of the zone) after the repair is complete. If the break is located between sprinkler heads, use the same procedures as for a broken mainline.

Lateral Repair Checklist

- Locate the break.
- If the sprinklers are on, wait until they go off or close flow control on control valve.
- Excavate a hole large enough to have room to reach around the pipe in all directions (see note below) and around the break.
- Using the appropriate size Quik-fix, make the cuts on either

side of the break and complete repair as per the instructions on how to use a Quik-fix.

- Let glue set up and remove the nozzles on the sprinkler heads downstream from the break.
- Activate the zone from the controller or by using the manual bleed on the remote control valve.
- Let water flush from the open sprinkler heads for a few minutes to remove any debris from the lines.
- Check for leaks around the repair before turning water off and filling hole.
- Replace sprinkler nozzles and test the zone one more time.

Excavating for Irrigation Repair

When excavating for irrigation repair it is very important that the hole you dig is large enough so that you have lots of room to get your hands around the pipe. The other concern is that you have a large enough sump below the pipe so that any excess water and mud is not able to go into the cut pipe. The size of the hole will be different depending on the size of the pipe. Another consideration is that you will need enough room for the repair device that you are installing. One tip is that the area you uncover should be at least three times the size of all of the pieces you are replacing. For example, if the repair coupling and piece of pipe you are replacing amount to 12 inches, then you should have at least 36 inches (3 ft.) of pipe uncovered, and at least 6-8 inches around (top, sides and bottom) the pipe. Keep in mind that all of these dimensions will increase as the pipe gets larger.