

SECTION 32 84 00
PLANTING IRRIGATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies materials and procedures for furnishing and installing a complete automatically-controlled irrigation system, controllers and all other appurtenances necessary to serve specified landscape and plant bed areas.

1.2 RELATED WORK

- A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.
- B. Concrete Work, Reinforcing, Placement and Finishing: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- C. General plumbing, protection of Materials and Equipment, and quality assurance: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- D. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- E. Plant materials: Section 32 90 00, PLANTING
- F. Metering: SECTION 25 10 10, ADVANCED UTILITY METERING SYSTEM.

1.3 DEFINITIONS

- A. Circuit Piping: Downstream from control valves to sprinklers, specialties, and drain valves.
- B. Drain Piping: Downstream from circuit-piping drain valves.
- C. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves.
- D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 volts or for remote-control, signaling power-limited circuits.

1.4 ABBREVIATIONS

- A. FPT: Female pipe thread
- B. HDPE: high-density polyethylene plastic
- C. NPT: National pipe thread
- D. PTFE: Polytetrafluoroethylene
- E. PVC: Polyvinyl chloride plastic
- F. WOG: Water, oil and gas

1.5 PERFORMANCE REQUIREMENTS

- A. Irrigation zone control shall be automatic operation with controller and automatic control valves.

B. Location of sprinklers and specialties on Drawings is approximate.

Contractor to make minor adjustments necessary to avoid plantings and obstructions such as signs, utilities and light standards. Provide 100 percent irrigation coverage of areas indicated.

C. Delegated Design: Provide a 100 percent coverage irrigation system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

D. Minimum Working Pressures: The following are maximum pressure requirements for piping, valves and specialties unless otherwise indicated.

~~1.~~ Irrigation Main Piping: 100 psi (640 kPa)

2. Circuit Piping: 80 psi (520 kPa)

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic piping protected from direct sunlight. Support pipe to prevent sagging and bending.

1.7 QUALITY ASSURANCE:

A. Products Criteria:

1. When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.

2. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

B. Installer Certification:

1. Installer should be an employer of workers that include a certified irrigation designer qualified by The Irrigation Association to perform specified work, and have provided irrigation installations for 10 years.

2. Service provider qualifications shall be maintained and/or trained by the manufacturer to render satisfactory service within 8 hours of service request notification.

C. System Requirements:

1. 100 percent irrigation coverage of specified areas is required. The Contractor shall, at no additional cost to the Government, make minor adjustments necessary to avoid plantings and obstructions such as signs, utilities and light standards and achieve full and complete coverage of irrigated areas without overspray on roadways, sidewalks, window wells, or buildings and to protect trees from close high spray velocity.

1.8 SUBMITTALS

- A. Submit product data as one package for each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Submittal must demonstrate compliance with spec section 01 81 11, including water reuse and recycling, to reduce outdoor potable water consumption by a minimum of 50 percent over that consumed by conventional means.
- B. Submit the proposed irrigation system design signed and sealed by the qualified professional engineer licensed in the State where the project is located and responsible for document preparation.
- C. Submit complete detailed irrigation layout covering design of system showing pipe sizes and lengths; fittings; locations; types and sizes of sprinklers; controls; backflow preventers; valves; location and mounting details of electrical control equipment and connections to water supply main. Do not start work before final shop drawing approval.
- D. Provide qualification data for:
 1. A qualified irrigation Installer.
 2. A qualified service provider, maintained and/or trained by the manufacturer to render satisfactory service within 8 hours of service request notification.
- E. Include a zone chart and controller timing schedule showing each irrigation zone and its control valve; and show the time settings for each automatic controller zone.
- F. Provide operation and maintenance data for sprinklers, controllers, and automatic control valves to include in operation and maintenance manuals.

1.9 EXTRA MATERIALS

A. Furnish extra materials, as called out below, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Rotary and Spray Head Sprinklers.

1.10 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society Of Mechanical Engineers (ASME):

B16.18-2001.....Cast Copper Alloy Solder Joint Pressure
Fittings

B16.22-2001.....Wrought Copper and Copper Alloy Solder Joint
Pressure Fittings

B16.24-2006.....Cast Copper Alloy Pipe Flanges and Flanged
Fittings: Classes 150, 300, 600, 900, 1500 and
2500

B18.2.1-2010.....Square, Hex, Heavy Hex, and Askew Head Bolts
and Hex, Heavy Hex, Hex Flange, Lobed Head, and
Lag Screws (Inch Series)

B40.100-2005.....Pressure Gauges and Gauge Attachments

C. American Society Of Sanitary Engineering (ASSE):

1013-2009.....Reduced Pressure Principle Backflow Preventers
and Reduced Pressure Principle Fire Protection
Backflow Preventers

D. American Society For Testing And Materials (ASTM):

B32-08.....Solder Metal

B61-08.....Steam or Valve Bronze Castings

B62-09.....Composition Bronze or Ounce Metal Castings

B88/B88M-09.....Seamless Copper Water Tube

B813-10.....Liquid and Paste Fluxes for Soldering of Copper
and Copper Alloy Tube

D1785-06.....Poly(Vinyl Chloride) (PVC) Plastic Pipe,
Schedule 40, 80, and 120

D2241-09.....Poly(Vinyl Chloride) (PVC) Pressure Rated Pipe
(SDR Series)

D2464-06.....Threaded Poly (Vinyl Chloride) (PVC) Plastic
Pipe Fittings, Schedule 80

D2466-06.....Poly(Vinyl Chloride) (PVC) Plastic Pipe
Fittings, Schedule 40

D2467-06.....Poly(Vinyl Chloride) (PVC) Plastic Pipe
Fittings, Schedule 80

D2564-04(2009)e1.....Solvent Cements for Poly (Vinyl Chloride) (PVC)
Plastic Piping Systems

D2609-02(2008).....Plastic Insert Fittings for Polyethylene (PE)
Plastic Pipe

D2683-10.....Socket-Type Polyethylene Fittings for Outside
Diameter-Controlled Polyethylene Pipe and
Tubing

D2855-96(2010).....Making Solvent Cemented Joints with Poly (Vinyl
Chloride) (PVC) Pipe and Fittings

D3261-10a.....Butt Heat Fusion Polyethylene (PE) Plastic
Fittings for Polyethylene (PE) Plastic Pipe and
Tubing

F477-10.....Elastomeric Seals (Gaskets) for Joining Plastic
Pipe

F656-10.....Primers for Use in Solvent Cement Joints of
Poly(Vinyl Chloride) (PVC) Plastic Pipe and
Fittings

F771-99(2005).....Polyethylene (PE) Thermoplastic High-Pressure
Irrigation Pipeline Systems

E. American Water Works Association (AWWA):

C504-06.....Rubber-Seated Butterfly Valves

C906-07.....Polyethylene (PE) Pressure Pipe and Fittings, 4
in. (100 mm) Through 63 in. (1600 mm), for
Water Distribution and Transmission

F. American Welding Society (AWS):

A5.8/A5.8M:2004.....Filler Metals for Brazing and Braze Welding

G. General Services Administration:

A-A-60005.....Frames, Covers, Gratings, Steps, Sump and Catch
Basin, Manhole

H. Manufacturers Standardization Society (MSS):

SP-70-2006.....Gray Iron Gate Valves, Flanged and Thread Ends

I. National Fire Protection Association (NFPA):

70 2011 Edition.....National Electrical Code

1.11 WARRANTY

A. The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of one year from final acceptance. Further, the Contractor will provide all manufacturers' and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

PART 2 - PRODUCTS

2.1 PIPES, TUBES AND FITTINGS

A. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

B. Soft copper tube shall be ASTM B88, Type L water tube, annealed temper.

1. Copper Pressure Fittings shall be ASME B16.18 cast-copper-alloy or ASME B16.22 wrought-copper solder-joint fittings. Furnish wrought-copper fittings if indicated.

2. Bronze flanges shall be ASME B16.24, Class 150, with solder-joint end.

3. Copper unions shall be cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

C. Hard Copper Tube: ASTM B88, Type L water tube, drawn temper.

1. Copper pressure fittings: ASME B16.18, cast-copper-alloy.
 2. Bronze flanges: ASME B16.24, Class 150, with solder-joint end.
 3. Copper unions: Cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- D. PE pipe with controlled ID shall be ASTM F771, PE 3408 compound; SDR 11.5 or SDR 15.
1. Insert fittings for PE pipe: ASTM D2609, nylon or propylene plastic with barbed ends. Include bands or other fasteners.
- E. PE pressure pipe: AWWA C906, with DR of 7.3, 9, or 9.3 and PE compound number required to give pressure rating not less than 160 psi (1100 kPa).
1. PE butt, heat-fusion fittings shall be ASTM D3261.
 2. PE socket-type fittings shall be ASTM D2683.
- F. PVC pipe: ASTM D1785, PVC 1120 compound, Schedule 40.
1. PVC socket fittings shall be ASTM D2466, Schedule 40.
 2. PVC threaded fittings: ASTM D2464, Schedule 80.
 3. Swing joints: Threaded fittings with elastomeric seals that allow 360 degree rotation, and designed for minimum 200 psi (1375 kPa) working pressure, may be used in lieu of standard threaded fittings.
 4. PVC socket unions: Both headpiece and tailpiece shall be PVC with socket ends.
- G. PVC Pipe: ASTM D2241, PVC 1120 compound, SDR 21 or SDR 26.
1. PVC socket fittings: ASTM D2467, Schedule 80.
 2. PVC socket unions: Both headpiece and tailpiece shall be PVC with socket or threaded ends.

2.2 PIPE JOINING MATERIALS

- A. Metal, pipe-flange bolts and nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- B. Brazing filler metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- C. Solder filler metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- D. Solvent cements for joining PVC piping: ASTM D2564. Include primer according to ASTM F656.
- E. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.3 VALVES

A. Underground Shut-Off Valves:

1. Butterfly valves 2 inches (50 mm) and larger: AWWA C504, iron body, bronze mounted, double disc with parallel seats, non-rising stem turning clockwise to close, 150 psi (1025 kPa) minimum working pressure.
2. Ball valves, isolation valves, 1-1/2 inch (38 mm) and smaller: Full-port ball valves with bronze body, PTFE seats, and 90 degree on/off handle. Ball valves to have NPT female end connections.

B. Operations:

1. Underground applications shall use valves with 2 inch (50 mm) nut for T-Handle socket wrench operation.
2. Aboveground and valve pit applications shall use valves, with handwheels.
3. All butterfly valves 6 inches (150 mm) and above shall have enclosed gear drive operators.
4. Valve ends shall accommodate the type of main pipe adjacent to valve.

C. Swing Check Valves:

1. Valves smaller than 4 inches (100 mm): ASTM B61 or ASTM B62, 125 psi (850 kPa) bronze body and bonnet.
2. Valves 4 inches (100 mm) and larger: ASTM B61 or ASTM B62, 200 psi (1375 kPa), iron body, bronze trim, vertical or horizontal installation, flange connection.

D. Pressure Reducing Valve: Cast steel body with renewable seats, with stainless steel trim. Flow passages and all parts should be designed to withstand high velocity applications, flange connected.

E. Remote Control Valves:

1. Valves shall be globe type of heavy duty construction and shall have manual shut-off and flow control adjustment and provide for manual operation.
2. Brass Valves: Straight or angle pattern type or valve body shall be cast iron with brass bonnet, trim and renewable seat and have two inlet taps (furnish with one inlet tap plugged) to allow installation as either a straight or angle pattern valve.
 - a. Install valves with unions on each side to allow for easy removal.
 - b. Valves shall have a minimum of 150 psi (1025 kPa) working pressure.

- c. Each sprinkler section shall be automatically operated by a remote control valve installed underground and operated by a 24 volt AC electric solenoid.
 - d. Each valve shall be in a valve vault.
- 3. Molded-plastic body, furnished as straight or angle pattern type, normally closed diaphragm type with manual shut off and flow control adjustment.
 - a. Install valves with unions on each side to allow for easy removal.
 - b. Each sprinkler section shall be automatically operated by a remote control valve installed underground and operated by a 24 volt AC electric solenoid.
 - c. Each valve shall be in a valve vault.
- F. Valves shall be completely serviceable from the top without removing valve body from the system. Valves to operate at no more than 7 psi (50 kPa) pressure loss at manufacturers maximum recommended flow rate.

2.4 VALVE BOX

- A. Butterfly valve boxes shall be precast concrete boxes with a compressive concrete strength in excess of 4000 psi (30 Mpa). Box dimension shall be adapted to depth of cover required over pipe at valve location. Mark box cover to say "Irrigation" and set flush with finished grade. Provide "T" handle socket wrenches of 5/8 inch (15 mm) round stock with sufficient length to extend 2 feet (600 mm) above top of deepest valve box cover.
- B. Remote control valve boxes in pavement shall be precast concrete with a compressive concrete strength in excess of 4000 psi (30 MPa).
- C. In plant bed areas, valve boxes shall be HDPE structural foam Type A, Class III, tan in color. Box shall be minimum 19 inches (475 mm) long by 14 inches (350 mm) deep with key-lockable hinged cast iron cover.
- D. After installation of boxes:
 - 1. Label boxes with two 3 inch (80 mm) size stencils designated controller and circuit numbers with permanent white epoxy paint. Numbers shall be placed at center of valve cover and shall face nearest main road or service road.
 - 2. Furnish 30 inch (750 mm) long valve adjustment keys.

2.5 BACKFLOW PREVENTER

- A. Reduced pressure principle backflow preventer: ASSE 1013, at each new connection to water distribution system.

2.6 WATER METER

A. Meters shall comply with Section 25 10 10, ADVANCED UTILITY METERING SYSTEM. Connect irrigation system to:

1. Use existing building water meter.

2.7 CONCRETE PIT

Reinforced poured in place concrete structure or approved precast concrete unit.

2.8 FRAMES AND COVERS FOR CONCRETE PIT

A. For roadway applications, use traffic rated frame and cover for AASHTO H20-44 loading.

B. For non-roadway applications, provide:

1. Cast-iron cover with cast-in identification symbol "IRR-WATER".
2. Frame: Type I, Straight Traffic Frame, Style A, Size 30A.
3. Cover: Type A, Size 30A.

2.9 STRAINERS

Brass strainer basket: Bodies smaller than 2-1/2 inch (70 mm) shall be brass or bronze. Bodies 2-1/2 inch (70 mm) and larger shall be cast iron or semi-steel. Strainer cover shall be furnished with blow-off connection and shut-off valve to accommodate 3/4 inch (20 mm) diameter hose connection.

2.10 PRESSURE GAUGES

Pressure gauges: ASME B40.100, 4-1/2 inch (114 mm) diameter, all metal case, with bottom connection. Dial shall be white lacquered throughout with maximum graduations of 2 psi (10 kPa). Provide shut-off cocks.

2.11 AUTOMATIC CONTROL EQUIPMENT - ELECTRIC FIELD SATELLITES

A. The electric automatic control system: Central computer system that provides irrigation starting controls and overriding capabilities of field satellite units in turn operating individual remote control valves in accordance with timing schedules programmed into the field units. The number of units and location of the installations are shown on the drawings.

B. The Central Computer Control System shall consist of a central computer, flow meter, moisture sensor, ET (evapotranspiration) measurement device, rain measurement device, wind measurement device, central control software, field controller and all accessories necessary to operate the irrigation system. All of these components and

software shall be a standard package as recommended and supplied by the irrigation control manufacturer.

C. Central Computer Control System components:

1. The Field Controller shall have the following characteristics and capabilities:
 - a. Read a flow meter and "learn" the historical flow average for each station, without the use of additional "control units", "encoders" and "decoders".
 - b. Receive on-site, daily ET weather data and automatically determine station run times, without the use of additional "control units", "encoders" and "decoders".
 - c. Account for accumulated rainfall and determine station run-times, without the use of additional "control units", "encoders", and "decoders".
 - d. A minimum of 12 master schedules to allow 12 month programming.
 - e. Monthly water volume budgets proportionate to historical ET and interactive with all programs.
 - f. Alert user when controller's usage is more than at budget.
 - g. Cycle and soak watering.
 - h. 12 month historical ET tables built-in and interactive with programs.
 - i. Complete English and Spanish operators manual built-in.
 - j. Irrigate in minutes, inches (millimeters) per week, percent of ETO and/or moisture content.
 - k. Electrical fault detection and bypass - logs all alerts.
 - l. Program no water days by station, by program or by controller from 0 to 31 days.
 - m. Log for each station for the last 30 water days shall have the following information:
 - 1) Time and date irrigation ran.
 - 2) Number of repeat cycles run.
 - 3) Programmed minutes.
 - 4) Actual minutes run.
 - 5) Inches (Millimeters) applied manual / test minutes.
 - 6) Hold-over time.
 - 7) No water days.
 - 8) Alert flags.

- n. Programmable rain shut down.
 - o. Activate / deactivate master valve control.
 - p. Calculate cycle & soak finish times for each program.
 - q. Stacked or simultaneous program operations.
 - r. Optional integrated Radio Remote compatible.
 - s. Display station and equipment descriptions for each station.
 - t. Select Pump output by program.
 - u. Hydraulic Limit setting to maintain flow within operator-set parameters when running simultaneous programs.
 - v. Built-in transient protection with increased lightning protection available.
 - w. 4 additional outputs provided for auxiliary (light, gate, etc.) control. Programming of these devices is independent from irrigation programs.
 - x. Control irrigation by measuring moisture levels for various hydrozones as compared to user-programmed moisture set points at the controller.
 - y. Use existing field wires for valve operation to receive moisture level information back at the controller.
 - z. Skip stations when sufficient levels of moisture are reached.
- D. The flow meter shall have the following characteristics:
- 1. A housing of Schedule 80 polyvinyl chloride tee or bronze tee.
 - 2. A pulsing output which operates at 9 volts DC and a pulse rate which is proportional to the GPM (LPM).
 - 3. Fully compatible with the internal interface at each field controller.
 - 4. Powered by the controller.
 - 5. Replaceable metering insert.
 - 6. Output wire shall be underground 14 AWG feeder wire.
 - 7. Flow meter data can be accurately read by the controller up to 2000 feet (610 m).
 - 8. Produced by the same manufacturer as the irrigation controller.
 - 9. Feature a six-bladed design with a proprietary, non-magnetic sensing mechanism.
- E. Moisture sensors shall have the following characteristics and capabilities:
- 1. Solid-state tensiometer type.

2. Include data transmission circuitry to send moisture level readings back to the irrigation controller using valve field wires.
3. Entire unit encased in epoxy.
4. Require no calibration for the life of the sensor.
5. Unaffected by temperature, salinity or changes in pH.
6. Accurately transmit moisture levels up to 3000 feet (914 m) across 14 AWG wire.

F. ET (Evapotranspiration) Measurement Device shall be:

1. Powered by the field controller.
2. Measure ET directly in 0.01 inch (.254 mm) increments and sends pulses directly to field controller.
3. Fully compatible with the internal interface at the field controller.
4. Mounted inside a stainless steel, vandal-resistant enclosure specifically designed for the device.

G. Rain Measurement Device shall:

1. Accurately measure rainfall in 0.01 inch (.254 mm) increments by means of a tipping and emptying device mounted below the center of the collection dish.
2. Fully compatible with the internal interface at the field controller.
3. Operate between 32 deg F and 125 deg F (0 deg C and 51.6 deg C).
4. Anodized aluminum construction.
5. The controller shall provide the following programming parameters for rain.
 - a. Stop Irrigation.
 - b. Maximum Rain in One Hour.
 - c. Maximum Rain in 24 hours.
 - d. Let Rain only build up.

H. Wind Measurement Device shall be:

1. Powered by the field controller.
2. Accurately measures wind in 0.1 mph (.161 kph) increments.
3. Fully compatible with the internal interface at the field controller.
4. Operate between -58 deg F and + 122 deg F (-50 deg C and + 50 deg C).
5. Anodized aluminum construction.
6. Provide wind speeds up to 140 mph (225 kph).
7. The controller shall provide the following programming parameters for wind:
 - a. Pause Irrigation

b. Resume Irrigation.

I. Central Computer Software:

1. The Central Computer Software shall have the following characteristics and capabilities:
 - a. Run on a compatible computer system with sufficient memory available for program operation.
 - b. Require a sufficient amount of hard disk space for irrigation program and files.
 - c. Not conflict with other software programs running on the same computer.
 - d. Function with any combination of hardwired or cellular, phone, CDPD radio, digital radio or local radio interface.
 - e. Allow uploading and downloading of programs and log data by controller or groups of controllers.
 - f. Allow direct real-time access to run stations, run programs, check for flows, check master valve operation, and turn controllers on or off.
 - g. Print alerts each day based on operator-set data filters. This feature prints only program changes and problem flags selected by the operator.
 - h. Automatically create permanent files each time log or program data is uploaded.
 - i. Allow all program data, log data, summary data and alert data for each controller to be selectively printed by controller or group.
 - j. Automatically upload weather data from ET gage or weather station, and a Tipping Rain Bucket and re-distributing it to all field units.
 - k. Operate up to 9,999 controllers.
 - l. Automatically retrieve water usage data monthly from each controller and writing it to text files.
 - m. Allow the user to view and / or override any changes made at field units.
2. The Central Computer shall, when used with digital network radio, have the capability to roam throughout the United States without changing frequencies.

3. Failure of the central control system or communication links to the field controllers shall not affect normal, water management operation of field controllers.

J. Field Controllers with Central Communication:

1. Manufacturer shall conduct an on-site radio test before submitting a bid to customer for any type of radio control.
2. Digital Radio: Radio shall be an internal packet-switched digital radio modem capable of two-way communication.
3. Radio: Radio modem and all interface boards shall be mounted inside the controller and powered by the same 24 volt AC internal transformer.
4. A vandal-resistant epoxy-filled dome antenna shall be used with any type of radio communication.

2.12 AUTOMATIC CONTROL EQUIPMENT - INDEPENDENT ELECTRIC CONTROLLERS

- A. The electric automatic control system shall consist of one or more independent controllers which operate individual remote control valves in accordance with timing schedules programmed into the independent units. The number of units and location of the installations are shown on the drawings.
- B. The Controller System shall consist of an independent controller, flow meter, rain sensor and all accessories necessary to operate the irrigation system. All of these components and software shall be a standard package.
- C. The independent controller shall UL and C-UL approved and have the following equipment, characteristics and capabilities:
 1. A minimum of 4 completely independent programs with 5 start times, for a total of 20 possible start times per day.
 - a. Watering time for each station shall be capable of being set from 1 minute to 9 hours and 59 minutes in 1 minute increments.
 - b. Stations shall allow for a rapid programming of a block of stations with the same watering time.
 - c. Watering days for each program shall be capable of being based on a seven-day week or a skip-a-day routine allowing a program to skip from 1 to 30 days.
 2. A real time clock that retains the actual time during power outages without batteries, eliminating the need to reset the clock in case of power outages.

3. A non-volatile memory that retains the program(s) indefinitely during power outages or seasonal shutdowns.
4. Built-in remote control capability.
5. An automatic field wire fault detection that enables the controller to sense a short in the field wire and instantly turn off that station, report the fault, and move to the next programmed station without overloading a circuit or tripping a reset button.
6. A rain switch that automatically turns off all stations without disturbing the program.
7. A percentage key to increase or decrease all station runtimes on a percentage basis in 1 percent increments from 0 to 300 percent by program.
8. The ability to select cycle and soak.
9. The controller shall have the ability to monitor the flow rate and include the following features:
 - a. Main line break flow detection with the ability to automatically close a normally open master valve on main line breaks or unscheduled overflow.
 - b. Unscheduled flow detection
 - c. Station upper limit flow detection with intelligent upper-limit processing for concurrent station operation
 - d. Programmable flow check delay from 1 to 6 minutes
 - e. Monitor and display measured flow in GPM (LPM)
 - f. Automatic flow learn mode for setting individual station limits or manual entry or semi-automatic monitor/set mode
 - g. Global percentage adjust to automatically factor upper flow limits for stations, automatic station advancement for station overflow
 - h. Audible and visual alert for all flow violations
 - i. A feature for tracking water consumption in gallons (liters) to pinpoint specific water savings and conservation efforts.
- D. The controller shall be furnished with the following programmable features:
 1. Master valve operation, either normally open or normally closed.
 2. Pump controls.
 3. Stacking or no stacking feature.
 4. Timer delay.

5. Rain shut down to allow the selection for the number of days the controller will stay off in rain shut down mode before it goes back to the automatic mode.
 6. Security code.
 7. The option to either enable or disable an audible alarm in the event of a flow violation.
 8. Cycle and soak program option.
- E. Additionally, the controller shall include the following flow sensor options:
1. Option to enable or disable the flow sensor features and to set the appropriate pipe size for the flow sensor.
 2. Main line, upper flow limit from 1 to 999 GPM when there is no scheduled irrigation.
 3. Flow check delay after any station changes, from 1 minute to 6 minutes, during which time no flow limits are checked.
 4. View and clear accumulated gallons (liters).
 5. Flow percentage from 5 to 80 percent provided as an adjustment on all station flow limits.
 6. Individually set station upper flow from 0 to 500 GPM for each station or to run a watering profile during which the upper flow limit for each station will be automatically set based on the measured flow and programmable flow percentage.
 7. A manual activation system furnished with a check cycle to sequentially run stations for a selected time from 1 minute to 9 minutes.
 8. A manually activated program cycle to run a program independent of its programmed start time and water days.
 9. A manually activated cycle to run a single station for a select time.

2.13 AUTOMATIC CONTROL EQUIPMENT - INDEPENDENT ELECTRIC CONTROLLER WITH NO FLOW SENSING (FOR SMALL INSTALLATIONS)

- A. The electric automatic control system shall consist of one controller which operates individual remote control valves in accordance with timing schedules programmed into the independent unit. The location of the controller is shown on the drawings.
- B. The Controller System shall have the following equipment, characteristics and capabilities:
1. A minimum of 4 independent programs.

2. A 7 day calendar, odd/even day or day interval options of 1 to 30 days and a 365 day clock/calendar.
 - a. Exclude a day option to allow for the selection of specific day(s) not to water.
3. Station run times of 1 minute to 10 hours in 1 minute increments with a minimum of 16 total start times and start time stacking within each program.
4. Season adjust setting from 10 to 200 percent in 10 percent increments.
5. Weather-resistant, locking metal cabinet with heavy duty internal transformer.
6. Automatic, semi-automatic, manual and timed-manual operation.
7. 10 position programming dial and LCD display.
8. Self-diagnostic circuit breakers that identify and override electrical malfunction of valves.
9. Non-volatile memory to retain power during power failures of any duration and battery backup to maintain accurate time for up to 90 days.
10. Sensor hook-up with sensor override switch on faceplate.
11. Lightning surge protection.

2.14 AUTOMATIC CONTROL EQUIPMENT - SOLAR-POWERED

- A. The solar-powered automatic control system shall consist of one or more independent controllers which operate individual remote control valves in accordance with timing schedules programmed into the independent units. The number of units and location of the installations are shown on the drawings.
- B. The controller system shall have the following equipment, characteristics and capabilities:
 1. An independent controller, rain sensor, moisture sensor, freeze sensor, and all accessories necessary to operate the irrigation system. All of these components shall be a standard package.
 2. Operate up to 28 stations, plus a master valve or pump start.
 3. Operate between 14 deg F and 140 deg F (-10 deg C to 60 deg C).
 4. All circuitry to be fully protected from electrostatic discharge to 27,000 volts.
 5. Powered by an internal photovoltaic module.
 6. Output to actuators to be digital control pulses at 3.5 volts DC.

7. The photovoltaic module to be protected by a clear polycarbonate lens.

2.15 SPRINKLER HEADS

- A. Sprinkler heads: Heads to be as indicated on Drawings. The entire internal assembly including filter screen, to be capable of removal from the top without removing the sprinkler case from the riser.
- B. Rotary pop-up sprinklers: Gear-driven.
 1. Full circle sprinklers shall be dual or tri-nozzle combination type with positive drive by means of a water-driven gear assembly. Sprinkler head to rotate uniformly and to be driven by means of a train of gears. Sprinklers to be equipped with an integral anti-drain valve to be self-closing at pressures of 10 feet (3.0 m) of head or less. Gears and pinions shall be assembled on stainless steel spindles in a water-lubricated sandproof gear case. An inlet screen shall prevent debris from entering the sprinkler and shall be removable with the internal assembly. Sprinklers outer case shall be constructed of corrosion resistant, impact resistant, heavy-duty ABS.
 2. Part circle sprinklers shall be variable arc type as required with same type drive used for full circle heads.
- C. Shrub spray head nozzle shall be pop-up or fixed spray type of standard, undersize or oversize configuration as noted on plans. The sprinkler body, stem, nozzle and screen shall be constructed of heavy-duty, ultraviolet resistant plastic. It shall have a heavy duty stainless steel retract spring and a ratcheting system for alignment of the pattern. The sprinkler shall have a soft elastomer pressure-activated co-molded wiper seal for cleaning debris from the pop-up stem. The sprinkler shall have a plastic or brass nozzle with an adjusting screw capable of regulating the radius and flow. The sprinkler shall be capable of housing protective, non-clogging filter screens or pressure compensating screens (PCS) under the nozzle.
- D. Drip Emitters shall be of the pressure compensating, permanently assembled type with 1/2 inch (1.25 cm) FPT inlet. Emitters shall be capable of providing 1 GPM (3.8 LPM) at inlet pressures between 15 and 50 psi (105 and 342 kPa).
- E. Emitter distribution tubing shall be constructed of UV resistant vinyl material with a 0.22 inch (5.5 mm) O.D. and a 0.16 inch (4 mm) I.D.

Tubing shall be manufactured by the same manufacturer as the drip emitters.

2.16 QUICK COUPLERS

- A. Quick couplers shall have all parts contained in a two-piece unit and shall consist of a coupler water seal valve assembly and a removable upper body to allow the spring and key track to be serviced without shut down of the main.
- B. Metal parts shall be brass.
- C. Lids shall be lockable vinyl covered and have springs for positive closure on key removal.
- D. Furnish hose swivels and operating keys for each size coupler to the Contracting Officer's Representative.

2.17 LOW VOLTAGE CONTROL VALVE WIRE

- A. Wire shall be solid copper wire, Underwriters Laboratories Inc. approved for direct burial in ground. Size of wire shall be in accordance with manufacturer's recommendations, never less than No. 14.

2.18 SPLICING MATERIALS: EPOXY WATERPROOF SEALING PACKET. LOW VOLTAGE CONTROLLER CABLE

- A. Multi-strand cable, UL-approved for direct burial in ground. Size and type of wire shall be in accordance with manufacturer's recommendations.

2.19 SLEEVE MATERIAL

- A. ASTM D2241, Schedule 40.

2.20 WARNING TAPE

- A. Provide standard, 4-Mil polyethylene 3 inch (76 mm) wide tape, detectable type blue with black letters (if potable water), or purple with black letters (if reclaimed or untreated well water), and imprinted with "CAUTION BURIED IRRIGATION WATER LINE BELOW".

2.21 TRACER WIRES

- A. Tracer Wires shall be No. 14, Green, Type TW plastic-coated copper tracer wire shall be installed with non-metallic irrigation main lines.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine proposed irrigation areas for compliance with requirements and conditions affecting installation and performance.
- B. Set stakes to identify locations of proposed irrigation system. Obtain Contracting Officer's Representative's approval before excavation.

3.2 PIPE INSTALLATION - GENERAL

- A. Layout work as closely as possible to drawings. Swing joints, offsets and all fittings are not shown. Lines are to be in a common trench wherever possible.
- B. Install sprinkler lines to avoid heating, ventilating, and air conditioning trenches; electric ducts; storm and sanitary sewer lines; and existing water and gas mains; all of which have the right of way.
- C. Existing sidewalks and curbs shall not be cut during trenching and installation of pipe. Install pipe under sidewalks and curbs by jacking, auger boring, or by tunneling. Repair or replace any cracked concrete, due to settling, during the warranty period.
- D. Do not lay pipe on unstable material, in wet trenches or, in the opinion of Contracting Officer's Representative, when trench or weather conditions are unsuitable for work.
- E. Allow a minimum of 3 inches (80 mm) between parallel pipes in the same trench.
- F. Clean the interior portion of pipe and fittings of foreign matter before installation. Securely close open ends of pipe and fittings with caps or plugs to protect fixtures and equipment against dirt, water and chemical or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- G. The full length of each section of pipe shall rest upon the pipe bed with recesses excavated to accommodate bells or joints. Do not lay pipe on wood blocking.
- H. Hold pipe securely in place while joint is being made.
- I. Do not work over, or walk on, pipe in trenches until covered by layers of earth, well tamped, in place to a depth of 12 inches (300 mm) over pipe.
- J. Irrigation lines and control wire in cemetery applications shall run at boundaries of graves, through designated utility lanes or beside roadways so that any gravesite may be opened in the future without disruption of the irrigation system.
- K. Irrigation lines and control wire shall run through designated utility lanes or beside roadways where possible.
- ~~L.~~ Connect new system to existing mains.
- M. Concrete thrust blocks shall be installed where the irrigation main changes direction at "L" and "T" locations and where the irrigation

main terminates. Pressure tests shall not be made for a period of 36 hours following the completion of pouring of the thrust blocks. Concrete thrust blocks for supply mains shall be sized and placed in strict accordance with the pipe manufacturer's specifications and shall be of an adequate size and so placed as to take all thrust created by the maximum internal water pressure.

N. Minimum cover over water mains shall be 30 inches (750 mm). Cover laterals to minimum depth of 24 inches (600 mm).

O. Warning tape shall be continuously placed 12 inches (300 mm) above sprinkler system water mains and laterals.

3.3 PLASTIC PIPE INSTALLATION

A. Plastic pipe shall be snaked in trench at least 1 foot per 100 feet (1 meter to 100 meters) to allow for thermal construction and expansion and to reduce strain on connections.

B. Joints

1. Solvent Welded Socket Type: ASTM D2855.

2. Threaded Type: Apply liquid teflon thread lubricant of teflon thread type. After joint is made hand tight (hard), a strap wrench should be used to make up to two additional full turns.

3. Elastomeric Gasket: ASTM F477.

3.4 EMITTER HOSE INSTALLATION

A. Joint: Solvent weld connection.

B. Bushing: Adaptation from PVC Schedule 40 fittings to flex vinyl hose shall be line size by 3/8 inch (10 mm) insert bushings.

3.5 SLEEVE INSTALLATION

A. Furnish and install where pipe and control wires pass under walks, paving, walls, and other similar areas.

B. Sleeves to be twice line size or greater to accommodate retrieval for repair of wiring or piping and shall extend 12 inches (300 mm) beyond edges of paving or construction.

C. Bed sleeves with a minimum of 4 inches (100 mm) of sand backfill above top of pipe in areas where pipe is placed prior to hardscape is installed.

3.6 VALVE INSTALLATION

A. Locations of remote control valves are schematic. Remote control valves shall be grouped wherever possible and aligned at a set dimension back of curb along roads.

- B. No valves shall be set under roads, pavement or walks.
- C. Clean interior of valves of foreign matter before installation.
- D. Pressure control valves installed adjacent to remote control valve shall be housed in the same valve box.
- E. Set valve box cover flush with finished grade.
- F. Control valves shall never be less than 3 inches (80 mm) below finished grade.

3.7 SPRINKLER AND QUICK COUPLER INSTALLATION

- A. Sprinkler heads and quick couplers shall be placed on temporary nipples extending at least 3 inches (80 mm) above finished grade. After turf is established, remove temporary nipples, ensuring that no dirt or foreign matter enters outlet, and install sprinkler heads and quick couplers at ground surface as detailed.
- B. Place part circle rotary sprinkler heads no more than 6 inches (150 mm) from edge, of and flush with top of adjacent walks, header boards, curbs, and mowing aprons, or paved areas at time of installation.
- C. Install all sprinklers, shrub sprays and quick couplers on swing joints, as detailed on plans.
- D. Set shrub heads 8 inches (200 mm) above grade and 1 foot (300 mm) from edge of curb or pavement. Place adjacent to walls. Stake heads prior to backfilling trenches. Support stakes to be parallel to riser.
- E. Each sprinkler section shall drain to waste valves placed at lowest elevation points in the system. Waste valves shall discharge to drainage pits composed of three 1 foot (300 mm) long vertical sections of 24 inch (600 mm) diameter sewer pipe placed under the lawn areas. Fill pipe with gravel and cover with 2 inch (50 mm) precast concrete cover before backfilling. Waste valves may also discharge to storm sewers, where available.

3.8 AUTOMATIC IRRIGATION - CONTROL SYSTEM INSTALLATION

- A. Install interior controllers on wall.
 - 1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Install exterior freestanding controllers on precast concrete bases.

1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.9 CONTROL WIRE INSTALLATION

- A. Wiring from master controllers to satellites and stub cuts for future extension shall be located in trench with new mains or in separate trench at back of curb, unless cross-country route is shown. Locate in trench with mains when possible on cross-country routes.
- B. Wiring bundles located with piping shall be set with top of the bundle 2 inches (50 mm) below bottom of the pipe. No two wires in any bundle shall be of the same color. Wires shall be bundled, and tied or taped at 15 foot (4.5 m) intervals. A numbered tag shall be provided at each end of a wire, i.e., at valve, at field located controllers and at master controller. The wires at each end of wire to be the same in number and color.
- C. Splicing shall be held to a minimum. A pullbox shall be provided at each splice. No splices will be allowed between field located controllers and remote control valves.
- D. Provide 12 inch (300 mm) expansion loops in wiring at each wire connection or change in wire direction. Provide 24 inch (600 mm) loop at remote control valves.
- E. The power wire(s) for the operation of irrigation system shall not be run in same conduit as the irrigation control wire(s).

3.10 TRACER WIRE INSTALLATION

- A. Tracer wire shall be installed on bottom of trench, adjacent to vertical pipe projections, carefully installed to avoid stress from backfilling, and shall be continuous throughout length of pipe with spliced joints soldered and covered with insulation type tape.
- B. Tracer wire shall follow main line pipe and branch lines and terminate in yard box with gate valve controlling these main irrigation lines. Provide sufficient length of wire to reach finish grade, bend back end of wire to make a loop and attach a plastic label with designation "Tracer Wire."
- C. Record locations of tracer wires and their terminations on project record documents.

3.11 FIELD TEST AND QUALITY CONTROL

- A. Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. Pressure test lines before joint areas are backfilled. Backfill a minimum of 12 inches (300 mm) over the pipe to maintain pipe stability during test period. Test piping at hydraulic pressure of 150 psi (1025 kPa) for two hours. Maximum loss shall be 0.8 gallons/inch pipe diameter/1,000-feet (3 L/25 mm pipe diameter/300 m). Locate pump at low point in line and apply pressure gradually. Install pressure gage shut-off valve and safety blow-off valve between pressure source and piping. Inspect each joint and repair leaks. Line shall be retested until satisfactory.
 - 2. After testing, flush system with a minimum of 150 percent of operating flow passing through each pipe beginning with larger mains and continuing through smaller mains in sequence. Flush lines before installing sprinkler heads and quick couplers.
 - 3. After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 4. After electrical circuitry has been energized and final adjustment of the sprinkler heads to permanent level at ground surface is complete, test each sprinkler section by the pan test and visual test to indicate a uniform distribution within any one sprinkler head area and over the entire area. Operate controllers and automatic control valves to demonstrate the complete and successful installation and operation of all equipment.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Any irrigation product will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 ADJUSTMENTS

- A. Adjust settings of controllers.
- B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.

- C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with, or not more than 1/2 inch (13 mm) above, finish grade.

3.13 DEMONSTRATION AND DOCUMENTATION

- A. Prior to final acceptance, verbal instructions, for a period of not less than 3 hours, shall be provided to the operating personnel.
Provide 2 additional years of software support for one hour each month.
- B. Program controller and satellites according to approved irrigation schedule.
- C. Follow manufacturer's instructions for installation.
- D. Manufacturer of Control Systems shall certify control system is complete, including all related components, and totally operational.
Submit certificate to Contracting Officer's Representative.
- E. Maintain and provide a complete set of as built drawings which shall be corrected daily to show changes in locations of all pipe, valves, pumps and related irrigation equipment. Valves shall be shown with dimensions to reference points.
- F. Controller Drawings and Zone Chart(s):
 - 1. Prepare in digital format a drawing mapping the location of all valves, lateral lines, and route of the control wires. Identify all valves as to size, station, number and type of irrigation. Digital formatted "as built" drawings must be approved before controller zone charts are prepared.
 - 2. Provide one controller zone chart for each automatic controller showing the area covered by the controller. The chart shall be a reduced drawing of the actual "as built" system and fit the maximum size controller door will allow. If controller sequence is not legible when the drawing is reduced to door size, the drawing shall be enlarged to a size that is readable and placed folded, in a sealed plastic container, inside the controller door.
 - 3. The final irrigation "as built" drawings shall be submitted in digital format with a different color code used to show area of coverage for each station. All drawings and zone charts must be completed and approved prior to final inspection of the irrigation system.

---- E N D ---