Preparing Activity: USACE Superseding without Revision
UFGS-32 84 23 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
****

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 84 23

UNDERGROUND SPRINKLERS

02/21

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.3 SUBMITTALS
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.1.1 Standard Products
2.1.2 Nameplates
2.1.3 Additional Stock
2.2 PIPING MATERIALS
2.2.1 Copper Tubing and Associated Fittings
2.2.2 Red Brass Pipe and Associated Fittings
2.2.3 Galvanized Steel Pipe and Associated Fittings
2.2.4 Polyvinyl Chloride (PVC) Pipe, Fittings and Solvent Cement
2.2.4.1 PVC Pipe
2.2.4.2 PVC Fittings
2.2.4.3 Solvent Cement
2.2.5 Polyethylene (PE) Plastic Piping
2.2.6 Dielectric Fittings
2.2.7 Emitter Hose and Distribution Tubing
2.3 SPRINKLER AND EMITTER HEADS
2.3.1 Pop-Up Spray Heads
2.3.1.1 General Requirements
2.3.1.2 Shrubbery Sprinkler Heads
2.3.2 Rotary Pop-Up Sprinklers
2.3.3 Bubbler Sprinkler Heads
2.3.4 Surface Connected Lawn Sprinkler Heads
2.3.5 Emitter Heads
2.4 VALVES

2.4.1 Gate Valves, Less than 80 mm 3 Inches
2.4.2 Gate Valves, 80 mm 3 Inches and Larger
2.4.3 Angle Valves, Less Than 65 mm 2-1/2 Inches
2.4.4 Angle Valves, 65 mm 2-1/2 Inches and Larger
2.4.5 Quick Coupling Valves
2.4.6 Remote Control Valves, Electrical
2.4.7 Drain Valves
2.4.7.1 Manual Valves
2.4.7.2 Automatic Valves
2.4.8 Pressure Regulating Master Valve
2.4.9 Backflow Preventers
2.4.9.1 Pressure Type Vacuum Breaker
2.4.9.2 Reduced Pressure Type Backflow Preventers
2.5 ACCESSORIES AND APPURTENANCES
2.5.1 Valve Keys for Manually Operated Valves
2.5.2 Valve Boxes and Concrete Pads
2.5.2.1 Valve Vaults
2.5.2.2 Concrete Pads
2.5.3 Pressure Gauges
2.5.4 Service Clamps
2.5.5 Water Hammer Arresters
2.5.6 Emitter Head Accessories
2.5.6.1 Strainer
2.5.6.2 Pressure Regulator
2.5.6.3 Riser Adapters
2.5.6.4 Tubing Stakes
2.5.6.5 Emitter Outlet Check Valve (Bug Cap)
2.5.6.6 Access Sleeve
2.5.6.7 Closure Caps
2.6 AUTOMATIC CONTROLLERS, ELECTRICAL
2.7 ELECTRICAL WORK
2.8 CONCRETE MATERIALS
2.9 WATER SUPPLY MAIN MATERIALS
2.10 INSULATING JOINTS

PART 3 EXECUTION

3.1 EXAMINATION
3.2 INSTALLATION
3.2.1 Trenching
3.2.2 Piping System
3.2.2.1 Cover
3.2.2.2 Clearances
3.2.2.3 Minimum Slope
3.2.3 Piping Installation
3.2.3.1 Polyvinyl Chloride (PVC) Pipe
3.2.3.2 Soldered Copper Tubing
3.2.3.3 Threaded Brass or Galvanized Steel Pipe
3.2.3.4 Insulating Joints
3.2.3.5 Grooved Mechanical Joints
3.2.4 Installation of Valves
3.2.4.1 Manual Valves
3.2.4.2 Automatic Valves
3.2.4.3 Drain Valves
3.2.5 Sprinklers and Quick Coupling Valves
3.2.6 Installation of Drip Irrigation System
3.2.6.1 Emitter Hose
3.2.6.2 Emitter Heads
3.2.6.3 Tubing Stakes

3.2.7 Backflow Preventers
3.2.7.1 Pressure Type Vacuum Breaker
3.2.7.2 Reduced Pressure Type
3.2.8 Control Wire and Conduit
3.2.8.1 Wires
3.2.8.2 Loops
3.2.8.3 Expansion and Contraction
3.2.8.4 Splices
3.2.9 Automatic Controller
3.2.10 Thrust Blocks
3.2.11 Backfill
3.2.11.1 Minimum Cover
3.2.11.2 Restoration
3.2.12 Adjustment
3.2.13 Disinfection
3.2.14 Cleaning of Piping
3.3 FRAMED INSTRUCTIONS
3.4 FIELD TRAINING
3.5 FIELD TESTS
3.5.1 Hydrostatic Pressure Test
3.5.2 Leakage Tests
3.5.3 Operation Test
3.6 CLEANUP

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC / NASA **UFGS-32 84 23 (February 2021)**

Preparing Activity: USACE **Superseding without Revision UFGS-32 84 23 (April 2008)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 32 84 23

UNDERGROUND SPRINKLERS
02/21

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NOTE: This guide specification covers the requirements for underground sprinkler irrigation systems.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Irrigation system requirements depend upon rainfall factors for the project area, plant selections, the quality of growth desired, and budgetary constraints. The area factors will be determined by a registered landscape professional. Reference is made to UFC 3-201-02 Landscape Architecture. While the design of a system with pop-up heads may be justified in some geographic areas, bubbler type systems may be required in areas where water conservation methods are being practiced. If source of water supply is from base water main through a service line and water meter, determine amount of water available for irrigation

system from static pressure at point of connection to water main. In many cases, water supply is adequate for short durations only. The amount of water required is determined from the type of turf to be irrigated, climate, terrain, and soil conditions. System piping layout, pipe sizes, and selection and spacing of heads and emitters must provide the required amount of water and complete coverage of the irrigated areas. Provide valves to allow irrigation of each area separately.
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.2	(1983; Errata 1992; R 2017) Gages and Gaging for Unified Inch Screw Threads
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.15	(2018) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1012	(2023) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent
ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies
ASSE 1020	(2020) Performance Requirements for Pressure Vacuum Breaker Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C509	(2015) Resilient-Seated Gate Valves for Water Supply Service
AWWA C606	(2022) Grooved and Shouldered Joints
AWWA C901	(2020) Polyethylene (PE) Pressure Pipe and Tubing, 3/4 In. (19mm) Through 3 In. (76 mm), for Water Service

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B43	(2020) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2241	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

ASTM D2287	(2019) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM D2464	(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2774	(2021) Underground Installation of Thermoplastic Pressure Piping
ASTM D2855	(2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3261	(2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM F441/F441M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR Manual	(10th Edition) Manual of Cross-Connection Control

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(2010) Water Hammer Arresters Standard

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-51145	(Rev D; Notice 1; Notice 2; Notice 3; Notice 4) Flux, Soldering, Non-Electronic, Paste and Liquid

1.2 SYSTEM DESCRIPTION

****

NOTE: In the design of the sprinkler system reference will be made to UFC 3-230-01 Water Storage, Distribution, and Transmission. For a site where specific pipe or material is required or where certain material will not be acceptable, the requirements will be specified and any restricting locations will be shown on the drawings. The following information will be shown on the drawings:

a. An irrigation legend.

b. The extent, size, type, and location of underground sprinkler irrigation system and all appurtenances including all piping, sprinkler heads, emitters, control valves, and controllers. Indicate obstacles that might interfere with the layout or operation of the system. Indicate where pipe under walks and drives must be bored.

c. All required slopes and elevations.

d. Detail of drain pockets.

e. Flow rates and diameter of coverage for individual sprinkler heads and emitters.

f. Minimum irrigation rates.

g. Size, variety, and assembly of backflow prevention units.

h. Number and extent of electrical or hydraulic controller circuits, if required.

i. Automatic valve schedule and timing, along with valve identification key or legend.

****

Provide a system that operates with a minimum water pressure of [_____] kPa psi at connection to [main] [meter] [building] [backflow prevention device] and [_____] kPa psi at the last head in each zone. Submit Design Analysis and Calculations verifying that system will provide the irrigation requirements.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Sprinkler System

SD-03 Product Data

Framed Instructions

Field Training

Sprinkler System

Spare Parts

Design Analysis and Calculations

SD-06 Test Reports

Field Tests

SD-07 Certificates

Sprinkler System

SD-10 Operation and Maintenance Data

Sprinkler System; G[, [_____]]

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity, and temperature variation; direct sunlight (in the case of plastic or rubber materials); and dirt, dust, or other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than the start of the field tests. Include with the data a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer who has produced similar systems that have performed well for a minimum period of 2 years prior to bid opening. Furnish equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Secure a plate to each item of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.1.3 Additional Stock

Provide the following extra stock: Two sprinkler heads of each size and type, two valve keys for operating manual valves, two wrenches for removing and installing each type of head, two quick coupler keys and hose swivels, and four irrigation controller housing keys.

2.2 PIPING MATERIALS

****

NOTE: Select piping materials according to project requirements. Verify soil and water conditions onsite, use proper materials where corrosion

problems exist.
****

2.2.1 Copper Tubing and Associated Fittings

Provide tubing coforming to requirements of ASTM B88M ASTM B88, Type K. Provide fittings conforming to ASME B16.22 and ASME B16.18, solder joint. Provide solder conforming to ASTM B32, 95-5 tin-antimony. Provide flux conforming to CID A-A-51145, Type I. Design grooved mechanical joints and fittings for no less than 862 kPa 125 psig service and that are the product of the same manufacturer. Provide ductile iron grooved fitting and mechanical coupling housing conforming to ASTM A536. Use gaskets in grooved joints that are molded synthetic polymer of pressure responsive design and conforming to ASTM D2000 for circulating medium up to 110 degrees C 230 degrees F. Provide grooved joints conforming to AWWA C606. Use steel coupling nuts and bolts in grooved joints and conforming to ASTM A183.

2.2.2 Red Brass Pipe and Associated Fittings

Furnish pipe conforming to requirements of ASTM B43, regular. Provide fittings that are Class 250, cast bronze threaded conforming to the requirements of ASME B16.15.

2.2.3 Galvanized Steel Pipe and Associated Fittings

****
NOTE: Use of pipe is limited to fixed shrub head risers and reduced pressure type backflow preventers.
****

Provide pipe conforming to requirements of ASTM A53/A53M, Schedule 40. Provide Class 150 fittings conforming to requirements of ASME B16.3.

2.2.4 Polyvinyl Chloride (PVC) Pipe, Fittings and Solvent Cement

****
NOTE: PVC pipe may be used where frost line is less than 300 mm 12 inches deep or in areas where piping system can be winterized. Use Schedule 40 PVC fittings with solvent weld; do not use threaded Schedule 40 pipe. For risers use brass pipe or Schedule 80 PVC pipe with Schedule 80 PVC threaded fittings. Locate all risers away from walks. Use solvent cement for unthreaded PVC pipe and fittings. ASTM D1785, PVC 1120, Schedule 40 is Type I, Grade 1 and wall thickness of Schedule 40. ASTM D1785, PVC 1120, Schedule 80 is Type I, Grade 2 and wall thickness of Schedule 80. ASTM D2241, PVC 1120, SDR 21 is Type I, Grade 1 and standard dimension ratio of 21.
****

2.2.4.1 PVC Pipe

Provide pipe conforming to the requirements of ASTM D1785, PVC 1120 Schedule [40] [80]; or ASTM D2241, PVC 1120 SDR 21, Class 200.

2.2.4.2 PVC Fittings

Provide solvent welded socket type fittings conforming to requirements of ASTM D2466, Schedule 40. Provide threaded type fittings conforming to requirements of ASTM D2464, Schedule 80.

2.2.4.3 Solvent Cement

Provide solvent cement conforming to the requirements of ASTM D2564.

2.2.5 Polyethylene (PE) Plastic Piping

Provide pipe conforming to AWWA C901, outside diameter base with dimension ratio (DR) of 9.3 to provide 1034 kPa 150 psi minimum pressure rating. Provide fittings conforming to ASTM D3261, DR of 9.3.

2.2.6 Dielectric Fittings

****
NOTE: Provide dielectric fittings between copper and ferrous metal piping materials.
****

Provide dielectric fittings conforming to ASTM F441/F441M, Schedule 80, CPVC threaded pipe nipples, 100 mm 4 inch minimum length.

2.2.7 Emitter Hose and Distribution Tubing

Provide emitter hose and distribution tubing conforming to ASTM D2287, maximum inside diameter of 13 mm 1/2 inch, minimum wall thickness of 2.286 mm 90 mils, vinyl plastic extruded from non-rigid chloride, integrally algae-resistant, homogeneous throughout, smooth inside and outside, free from foreign materials, cracks, serrations, blisters and other effects. Provide slip fittings.

2.3 SPRINKLER AND EMITTER HEADS

2.3.1 Pop-Up Spray Heads

2.3.1.1 General Requirements

Pop-up spray heads lay flush with housing, then pop up when water pressure 138 kPa 20 psi is activated in system. The rising member supporting the nozzle must be identical on full, half, third or quarter pattern sprinklers so that nozzles will be interchangeable. Design the sprinkler head to be adjustable for coverage and flow. Provide removable nozzle so head does not have to be removed for flushing or cleaning. Nozzle rises a minimum of 100 mm 4 inches above the body. Construct the body with a 13 mm 1/2 inch female thread for installation in a fixed underground pipe system.

2.3.1.2 Shrubbery Sprinkler Heads

****
NOTE: Shrubbery sprinkler heads are recommended for flower beds, shrubs, and ground covers.
****

Provide conical spray sprinkler heads with adjustable or non-adjustable

coverage and designed for permanent aboveground mounting on riser or pop-ups at a height compatible with ground covers. Provide brass nozzles.

2.3.2 Rotary Pop-Up Sprinklers

****
NOTE: Rotary pop-up sprinklers lay flush with housing, then pop up when water pressure is activated in system. Head rotates to direct water spray over a pattern of 360 degrees or a prescribed arc. Primarily used for watering large turf area.
****

Provide sprinklers that are capable of covering [_____] m feet diameter at [_____] kPa psi with a distribution rate of [_____] L/second gpm, [_____] pop-up, trajectory of [_____], and maximum height of spray of [_____]. Construction must be high impact molded plastic with filter screen, reducible watering radius, and choice of [_____] nozzles and have adjustable radius capabilities.

2.3.3 Bubbler Sprinkler Heads

****
NOTE: A water outlet that does not spray water but permits water to bubble and flow to surrounding plants.
****

Provide multiple-spray bubbler heads with adjustable flow and designed for permanent aboveground mounting on risers.

2.3.4 Surface Connected Lawn Sprinkler Heads

Provide impulse type heads with or without sled, ring, or wheel base; multiple T Type; a rotary type with sled, spike or wheel base; or oscillating type with wheel or sled base.

2.3.5 Emitter Heads

****
NOTE: Emitter head is an outlet device that permits water to drip or trickle from small tubings. Drip irrigation is frequent, slow application of water to specific root zone area of plants. The goal is to provide a constant level of subsurface moisture to the root ball of plant for most favorable growth.
****

Provide self-cleaning, pressure compensating diaphragm with one or six self-piercing barbed outlets emitter heads; each capable of emitting from 1 to 8 L/hour 1/4 to 2 gallons/hour flow. Flurnish emitter body ultraviolet stabilized, algae, and heat resistant plastic construction.

2.4 VALVES

2.4.1 Gate Valves, Less than 80 mm 3 Inches

Provide gate valves conforming to the requirements of MSS SP-80, Type 1, Class 150, [threaded] [soldered] ends.

2.4.2 Gate Valves, 80 mm 3 Inches and Larger

Provide gate valves conforming to the requirements of AWWA C509 and have encapsulated resilient wedge, parallel seats, non-rising stems, and open by counterclockwise turning. End connections must be flanged. Interior construction of valves must be bronze including stem containing a maximum 2 percent aluminum and maximum 16 percent zinc.

2.4.3 Angle Valves, Less Than 65 mm 2-1/2 Inches

Provide angle valves conforming to the requirements of MSS SP-80, Type 3, Class 150 [threaded] [soldered] ends.

2.4.4 Angle Valves, 65 mm 2-1/2 Inches and Larger

Provide angle valves conforming to the requirements of MSS SP-85, Type II, Class 250 [threaded] [flanged] ends.

2.4.5 Quick Coupling Valves

****
NOTE: A quick coupling device is an effective method of keeping sprinkler out of the way when not in use, eliminating the possibility of damage, injury or theft.
****

Provide quick coupling valves consisting of brass parts and is a two-piece unit consisting of a coupler water seal valve assembly and a removable upper body to allow spring and key track to be serviced without shutdown of main. Provide lockable vinyl lids with spring for positive closure on key removal.

2.4.6 Remote Control Valves, Electrical

****
NOTE: An activated open and shut-off device for controlling water flow to sprinkler branch line.
****

Provide remote control valves that are solenoid actuated globe valves of 19 to 80 mm 3/4 to 3 inch size, suitable for [24] [_____] volts, [60] [50] cycle, and designed to provide for shut-off in event of power failure. Valve must be cast bronze or brass or plastic housing suitable for service at 1034 kPa 150 psi operating pressure with external flow control adjustment for shut-off capability, external plug at diaphragm chamber to enable manual operation, filter in control chamber to prevent valve body clogging with debris, durable diaphragm, and accessibility to internal parts without removing valve from system.

2.4.7 Drain Valves

2.4.7.1 Manual Valves

Furnish manual valves conforming to requirements of MSS SP-80, Type 3, Class 150 [threaded] [soldered] ends for sizes less than 65 mm 2-1/2 inches and MSS SP-85, Type II, Class 250 [threaded] [flanged] ends for sizes 65 mm 2-1/2 inches and larger.

2.4.7.2 Automatic Valves

****

NOTE: This saves water to prevent draining 50 to 100 mm 2 to 4 inch diameter lines during irrigation cycles and avoid continuously saturated soil at drain joints. Automatic drains are necessary for cold climate areas to prevent freeze damage to sprinklers and pipes. PVC or ABS drain valves may be used with PVC systems.

Delete automatic drains for warm climate areas.

****

Furnish automatic valves that are brass or plastic, spring loaded ball drip type, Class 150 150 pounds and threaded ends, designed to close at 18 kPa 6 foot pressure head with positive seal at 21 kPa 3 psi pressure or greater and be open to drain at less than 21 kPa 3 psi pressure.

2.4.8 Pressure Regulating Master Valve

****

NOTE: Master valve automatically reduces a higher inlet pressure to a constant lower pressure regardless of supply fluctuations.

****

Provide pressure regulating master valve that is automatic mechanical self-cleaning, self-purging control system having an adjustable pressure setting operated by a solenoid on alternating current with [0.70] [_____] amperes at [18] [24] volts. Valve must close slowly and be free of chatter in each diaphragm position, have manual flow stem to adjust closing speed and internal flushing, and [one] [two] inlet tappings capable of being installed as a straight pattern valve. Provide cast bronze or brass body with removable brass seat serviceable from top without removing valve body from system. Operate valve at 1034 kPa 150 psi working pressure and pilot range from 70 to 875 kPa 10 to 125 psi.

2.4.9 Backflow Preventers

****

NOTE: Backflow preventer is designed to keep contaminated water from flowing back into potable water distribution system when some temporary abnormality in system causes higher pressure in contaminated part of system than in potable water piping.

****

Test, approve, and list reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers in accordance with FCCCHR Manual. Furnish backflow preventers with intermediate atmospheric vent in accordance with ASSE 1012. Furnish reduced pressure principle backflow preventers in accordance with ASSE 1013.

2.4.9.1 Pressure Type Vacuum Breaker

****

NOTE: Vacuum breaker is designed to prevent back siphonage only, and is not effective against backflow due to back pressure. A vacuum breaker located above flood elevation is adequate when located aboveground and higher than highest sprinkler head.

****

Provide vacuum breaker conforming to the requirements of ASSE 1020 and consisting of [bronze] [brass] construction, with one or two check valves, vacuum relief, inlet and discharge shut-offs valves, field test cocks, and vacuum relief opening of greater diameter than unit.

2.4.9.2 Reduced Pressure Type Backflow Preventers

****

NOTE: Reduced pressure type backflow preventer is designed to prevent either back siphonage or back pressure from causing a reverse flow and subsequent contamination of potable water piping. Delete this requirement when system is connected to non-potable water supply system, or when sewage is injected into sprinkler system. When effluent pumps are down, add a fresh water connection with a reduced pressure backflow preventer.

****

Provide backflow preventers that are Class [150] [_____] [150] [_____] pound flanged [cast iron], [bronze] [brass] mounted gate valve [and strainer], [304] [_____] stainless steel or bronze, internal parts. Total pressure drop through complete assembly must be a maximum of 70 kPa 10 psi at rated flow. Provide [red brass] [galvanized steel] pipe and fittings. Provide strainers consisting of bronze or brass construction with gasket caps. Provide units that have 200-mesh stainless steel screen elements.

2.5 ACCESSORIES AND APPURTENANCES

2.5.1 Valve Keys for Manually Operated Valves

Provide valve keys that are 13 mm 1/2 inch diameter by 1 m 3 feet long, tee handles and keyed to fit valves.

2.5.2 Valve Boxes and Concrete Pads

2.5.2.1 Valve Vaults

Provide valve boxes that are cast iron, plastic lockable, or precast concrete[manufactured in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION] for each gate valve, manual control valve and remote control valve. Use adjustable vault sizes. Cast the word "IRRIGATION" on the cover. Shaft diameter of vault must be minimum 130 mm5-1/4 inches. Cast iron vault must have bituminous coating.

2.5.2.2 Concrete Pads

Provide concrete pads that are precast[manufactured in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION] or cast-in-place reinforced concrete construction for reduced pressure type backflow preventers.

2.5.3 Pressure Gauges

Provide pressure gauges conforming to requirements of ASME B40.100, single style pressure gauge for water with 115 mm 4-1/2 inch dial brass or aluminum case, bronze tube, gauge cock, pressure snubber, and siphon. Scale range must be suitable for irrigation sprinkler systems.

2.5.4 Service Clamps

Provide service clamps that are bronze flat, double strap, with neoprene gasket or "O"-ring seal.

2.5.5 Water Hammer Arresters

Provide water hammer arrester conforming to the requirements of PDI WH 201; stainless steel construction with an encased and sealed bellows compression chamber.

2.5.6 Emitter Head Accessories

2.5.6.1 Strainer

Provide strainer at inlet to each drip line. Provide strainer with stainless steel screen having equivalent of 140-mesh filtration capacity and incorporate flush valves within strainer to clean screen without disassembling unit.

2.5.6.2 Pressure Regulator

Provide pressure regulator at each drip system if supply pressure exceeds 350 kPa 50 psi.

2.5.6.3 Riser Adapters

Provide riser adapters with a rigid piping system.

2.5.6.4 Tubing Stakes

Provide plastic coated steel tubing stakes, or other non-corrosive strong material to secure tubing.

2.5.6.5 Emitter Outlet Check Valve (Bug Cap)

Provide check valves at end of each emitter outlet distribution line. Permit free flow of water with minimum restriction; prevent back siphoning, entry of insects, and contamination into outlet ports.

2.5.6.6 Access Sleeve

Provide access sleeve at buried emitters placed in covered boxes. Secure lids of access sleeve with removable lugs. Secured drip hose in both vertical and horizontal axis.

2.5.6.7 Closure Caps

Provide closure caps in accordance with manufacturer's recommendations.

2.6 AUTOMATIC CONTROLLERS, ELECTRICAL

****
NOTE: Automatic electrical controller is used to control timing and quantity of water to sprinkler or emitter heads. Use 3 to 60 minutes for sprinkler heads and 0 to 3 hours for emitter heads.
****

Provide controller conforming to the requirements of NEMA ICS 2 with [120] [220]-volt single phase service, operating with indicated stations, and grounded chassis. Provide enclosure conforming to NEMA ICS 6 Type 3R, with locking hinged cover, [pedestal-mounted] [wall-mounted]. Program controller for various schedules by setting switches and dials equipped with the following features: A switch for each day of week for [one] [two] [three] schedules, allowing each station to be scheduled individually as to days of watering; a minute switch for each station with a positive increment range of [3 to 60 minutes] [0 to 3 hours], set time within one percent; a switch allowing selected schedules to be repeated after each completion of initial watering schedule and allowing each operation to be scheduled throughout a 24-hour day; a circuit breaker for surge protection; and circuit for a 9-volt rechargeable NiCad battery.

2.7 ELECTRICAL WORK

Provide wiring and rigid conduit for electrical power in accordance with NFPA 70, and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.8 CONCRETE MATERIALS

Furnish concrete with a compressive strength of [17] [_____] MPa [2500] [_____] psi at 28 days as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.9 WATER SUPPLY MAIN MATERIALS

Provide tapping sleeves, service cut off valves, and connections to water supply mains in accordance with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

2.10 INSULATING JOINTS

Provide insulating joints and dielectric fittings in accordance with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install Sprinkler System after site grading has been completed. Perform excavation, trenching, and backfilling for sprinkler system in accordance with the applicable provisions of Section 31 00 00 EARTHWORK, except as modified herein.

a. Submit detail drawings for valves, sprinkler heads, backflow preventers, automatic controllers, emitter heads, and water hammer arresters. Include on the drawings a complete list of equipment and materials, and manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Also show on the drawings complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will function as a unit. Show on the drawings proposed system layout, type and number of heads and emitters, zone valves, drain pockets, backflow devices, controllers, and mounting details of controllers.

b. Submit detailed procedures defining the Contractor's provisions for accident prevention, health protection, and other safety precautions for the work to be done. Submit the material supplier's or equipment manufacturer's statement that the supplied material or equipment meets specified requirements. Each certificate must be signed by an official authorized to certify in behalf of material supplier or product manufacturer and must identify quantity and date or dates of shipment or delivery to which the certificates apply. Include As-built Drawings which provide current factual information showing locations of mains, heads, valves, and controllers including deviations from and amendments to the drawings and changes in the work.

c. Submit [6] [_____] copies of operation and [6] [_____] copies of maintenance manuals for the equipment furnished. One complete set prior to field testing and the remainder upon acceptance. Manuals must be approved prior to the field training course. Detail the step-by-step procedures required for system startup, operation, and shutdown. Include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features.

d. List routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include piping and equipment layout, simplified wiring and control diagrams of the system as installed, and system programming schedule.

3.2.1 Trenching

Hand excavate trench around roots to pipe grade when roots of 50 mm 2 inches diameter or greater are encountered. Provide trench width of 100 mm 4 inches minimum or 1.5 times diameter of pipe, whichever is wider. Hand tamp backfill over excavation. When rock is encountered, excavate trench 100 mm 4 inchesdeeper and backfill with silty sand (SM) or well-graded sand (SW) to pipe grade. Keep trenches free of obstructions and debris that would damage pipe. Do not mix subsoil with topsoil. Bore existing concrete walks, drives and other obstacles at a depth conforming to bottom of adjacent trenches. Provide pipe sleeves for bored pipe that is two pipe diameters larger than sprinkler pipe.

3.2.2 Piping System

3.2.2.1 Cover

Install underground piping to meet the minimum depth of backfill cover specified.

3.2.2.2 Clearances

Provide minimum horizontal clearances between lines of 100 mm 4 inches for pipe 50 mm 2 inches and less; 300 mm 12 inches for 65 mm 2-1/2 inches and larger. Provide 25 mm 1 inch minimum vertical clearances between lines.

3.2.2.3 Minimum Slope

Provide minimum slope of 50 mm per 10 m 6 inches per 100 feet in direction of drain valves.

3.2.3 Piping Installation

3.2.3.1 Polyvinyl Chloride (PVC) Pipe

a. Provide solvent-cemented joints conforming to the requirements of ASTM D2855.

b. Provide full cut threaded joints with a maximum of three threads remaining exposed on pipe and nipples. Make threaded joints tight without recourse to wicks or fillers, other than polytetrafluoroethylene thread tape.

c. Join piping to conform with requirements of ASTM D2774 or ASTM D2855, and pipe manufacturer's instructions. Install pipe in a serpentine (snaked) manner to allow for expansion and contraction in trench before backfilling. Install pipes at temperatures over 5 degrees C 40 degrees F.

3.2.3.2 Soldered Copper Tubing

Ream pipe and remove burrs. Clean and polish surfaces of joint. Apply flux to male and female ends. Insert end of tube into fittings full depth of socket. After soldering, show a solder bead continuously around entire joint circumference. Remove excess acid flux from tubings and fittings.

3.2.3.3 Threaded Brass or Galvanized Steel Pipe

Prior to installation, ream pipe. Cut threads in conformance with ASME B1.2. Apply pipe joint compound to male end only.

3.2.3.4 Insulating Joints

Provide insulating and dielectric fittings where pipes of dissimilar metal are joined and at connections to water supply mains as shown. Install in accordance with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.2.3.5 Grooved Mechanical Joints

Prepare grooves according to the coupling manufacturer's instructions. Furnish grooved fittings, couplings, and grooving tools that are products of the same manufacturer. Provide pipe and groove dimensions complying

with the tolerances specified by the coupling manufacturer. Measure the diameter of grooves made in the field using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Measure and record groove width and dimension of groove from end of pipe for each change in grooving tool setup to verify compliance with the coupling manufacturer's tolerances. Do not use grooved joints in concealed locations.

3.2.4 Installation of Valves

3.2.4.1 Manual Valves

Install valves in a valve box extending from grade to below valve body, with a minimum of 100 mm 4 inches cover measured from finish grade to top of valve stem.

3.2.4.2 Automatic Valves

Set valve plumb in a valve box extending from grade to below valve body, with minimum of 100 mm 4 inch cover measured from grade to top of valve. Install automatic valves beside sprinkler heads with a valve box.

3.2.4.3 Drain Valves

Entire system must be manually or automatically drainable. Equip low points of system with drain valve draining into an excavation containing 0.03 cubic meter 1 cubic foot gravel. Cover gravel with building paper then backfill with excavated material and 150 mm 6 inches of topsoil.

3.2.5 Sprinklers and Quick Coupling Valves

Install sprinklers and valves plumb and level with terrain.

3.2.6 Installation of Drip Irrigation System

3.2.6.1 Emitter Hose

Bury emitter laterals [150] [_____] mm [6] [_____] inches deep. Solvent weld connections in accordance with manufacturer's recommendation to standard weight Schedule 40 PVC fittings and bushings. Install hose in a serpentine manner. When cutting hose, use a shearing tool such as a pipe cutter, knife, or shears. Follow manufacturer's recommended tool and procedures when punching hose for emitters.

3.2.6.2 Emitter Heads

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NOTE: Installation of water emission points of drip irrigation system above soil surface aids visual checking of system for proper operation and reduces system clogging caused by root intrusion.

****

Install emitters in a plastic emitter box. Connect emitter on a rigid PVC nipple to PVC drip lateral with a tee or elbow. Attach tubing to barbed fitting and daylight distribution tubing at root ball secured with stake, with bug cap at end of secured distribution tubing. After installing emitters and before operating system, open end of drip lateral and flush

clean. Do not exceed manufacturer's recommendations for the number of emitters on a line for that hose or distribution tubing size and length.

3.2.6.3 Tubing Stakes

Secure main irrigation line with stakes where line is aboveground. Space stakes to ensure that hose does not shift location in presence of foot traffic, operations, gravity on slope installations, or environmental effects. Stake discharge of the emitter distribution tubing to ensure that discharge point of emitter will be maintained at specified position in relation to plant material to be irrigated.

3.2.7 Backflow Preventers

Install backflow preventer in new connection to existing water distribution system, between connection and control valves. Install backflow preventer with concrete pads.

3.2.7.1 Pressure Type Vacuum Breaker

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NOTE: Install device in an accessible location to facilitate inspection and servicing. Device can be installed on main line to irrigation system upstream of shut-off valves (valves may be located downstream from device).

****

Install pressure type vacuum breaker 300 mm 12 inches above highest head.

3.2.7.2 Reduced Pressure Type

****

NOTE: Install device in an accessible location to facilitate inspection and servicing. To prevent freezing locate device inside a building and pipe the relief valve port through an air gap to a drain. Install the device 300 mm 12 inches, minimum, above grade.

****

Flush pipe lines prior to installing reduced pressure device; protect device by a strainer located upstream. Do not install device in pits or where any part of device could become submerged in standing water.

3.2.8 Control Wire and Conduit

3.2.8.1 Wires

Low voltage wires may be buried beside pipe in same trench. Provide rigid conduit where wires run under paving. Number tag wires at key locations along main to facilitate service. Provide one control circuit for each zone and a circuit to control sprinkler system.

3.2.8.2 Loops

Provide a 300 mm 12 inch loop of wire at each valve where controls are connected.

3.2.8.3 Expansion and Contraction

Bundle and tape multiple tubes or wires together at [3] [6] m [10] [20] foot intervals with 300 mm 12 inch loop for expansion and contraction.

3.2.8.4 Splices

Provide waterproof electrical splices.

3.2.9 Automatic Controller

Determine exact field location of controllers before installation. Coordinate the electrical service to these locations. Install in accordance with manufacturer's recommendations and NFPA 70.

3.2.10 Thrust Blocks

****
NOTE: Install thrust blocks at bends, tee plugs, and valves of 80 mm 3 inch minimum pipe size.
****

Place concrete so that sides subject to thrust or load are against undisturbed earth, and valves and fittings are serviceable after concrete has set. Provide thrust blocks as specified in Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.2.11 Backfill

3.2.11.1 Minimum Cover

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NOTE: Depths of cover are 300 mm 12 inches for laterals and 450 mm 18 inches for mains in warm climate areas. Use 600 mm 24 inches for mains and laterals where piping can be drained in cold climate areas to protect pipe from frost. Consult local conditions in cold climates to protect against freezing of supply mains.
****

Depth of cover must be [300] [600] [_____] mm [12] [24] [_____] inches for 32 mm 1-1/4 inch pipe or smaller; [300] [450] [600] [_____] mm [12] [18] [24] [_____] inches for 40 to 50 mm 1-1/2 to 2 inch pipe; [450] [600] [_____] mm [18] [24] [_____] inches for 65 mm 2-1/2 inch pipe or larger; [1000] [_____] mm [36] [_____] inches for pipes under traffic loads, farm operations, and freezing temperatures; and [300] [450] mm [12] [18] inches for low-voltage wires. Fill remainder of trench or pipe cover to within 80 mm 3 inches of top with excavated soil, and compact soil with plate hand-held compactors to same density as undisturbed adjacent soil.

3.2.11.2 Restoration

****
NOTE: Insert the section number and title for the restoration of pavements.
****

Fill top 80 mm 3 inches topsoil and compact with same density as

surrounding soil. Restore lawns and plants in accordance with Sections 32 92 19 SEEDING, 32 92 23 SODDING, 32 92 26 SPRIGGING, and Section 32 93 00 EXTERIOR PLANTS. Restore pavements in accordance with Section [_____].

3.2.12 Adjustment

After grading, seeding, and rolling of planted areas, adjust sprinkler heads flush with finished grade. Make adjustments by providing new nipples of proper length or by use of heads having an approved device, integral with head, which will permit adjustment in height of head without changing piping.

3.2.13 Disinfection

Disinfect sprinkler system fed from a potable water system upstream of backflow preventer in accordance with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.2.14 Cleaning of Piping

Prior to the hydrostatic and operation tests, flush the interior of the pipe with clean water until pipe is free of all foreign materials. Flushing and cleaning out of system pipe, valves, and components is not complete until witnessed and accepted by Contracting Officer.

3.3 FRAMED INSTRUCTIONS

Post framed instructions, containing wiring and control diagrams under glass or in laminated plastic, where directed. Frame condensed operating instructions, prepared in typed form, as specified above and posted beside the diagrams. Post the framed instructions before acceptance testing of the system. Submit labels, signs, and templates of operating instructions that are required to be mounted or installed on or near the product for normal, safe operation. After as-built drawings are approved by Contracting Officer, prepare controller charts and programming schedule. Supply one chart for each controller. Chart must be a reduced drawing of actual as-built system that will fit the maximum dimensions inside controller housing. Use black line print for chart and a different pastel or transparent color to indicate each station area of coverage. After chart is completed and approved for final acceptance, seal chart between two 0.505 mm 20 mil pieces of clear plastic.

3.4 FIELD TRAINING

Provide a field training course for designated operating and maintenance staff members for a total period of [_____] hours of normal working time and starting after the system is functionally complete but prior to final acceptance tests. Submit information describing training to be provided, training aids to be used, samples of training materials to be provided, and schedules and notification of training. Cover all of the items contained in the operating and maintenance manuals.

3.5 FIELD TESTS

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NOTE: Delete leakage tests if water supply service main is not part of contract.

****

Provide all instruments, equipment, facilities, and labor required to conduct the tests. Submit performance test reports, in booklet form, showing all field tests performed to adjust each component; and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of control valves.

3.5.1 Hydrostatic Pressure Test

Test piping hydrostatically before backfilling and proved tight at a hydrostatic pressure of 1034 kPa 150 psi without pumping for a period of one hour with an allowable pressure drop of 35 kPa 5 psi. If hydrostatic pressure cannot be held for a minimum of 4 hours, make adjustments or replacements and repeat the tests until satisfactory results are achieved and accepted by the Contracting Officer.

3.5.2 Leakage Tests

Perform leakage tests for service main in accordance with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.5.3 Operation Test

At conclusion of pressure test, install sprinkler heads or emitter heads, quick coupling assemblies, and hose valves and test entire system for operation under normal operating pressure. Operation test consists of the system operating through at least one complete programmed cycle for all areas to be sprinkled.

3.6 CLEANUP

Upon completion of installation of system, remove all debris and surplus materials resulting from the work.

-- End of Section --