STANDARDS AND SPECIFICATIONS FOR TURF AND LANDSCAPE IRRIGATION SYSTEMS

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FOREWORD

The Florida Irrigation Society (FIS), a non-profit corporation, was founded in 1965 for the purpose of advancing the design, manufacture and use of irrigation equipment and systems in the State of Florida.

To meet this purpose, FIS continually disseminates information on the latest concepts, techniques and design data to irrigation designers, installers and users through statewide programs and technical publications.

The primary objective of this "Standards and Specifications" document is to enable the irrigation professional to improve design, installation, and operational procedures for of irrigation products and systems. It is intended to provide the professional designer and installer with sufficient information to permit the safe design and installation of irrigation products and systems in accordance with commonly accepted industry practice.

Although irrigation has been practiced for many years, it continues to advance at a rapid pace. As a result, the Standards and Specifications include procedures and practices that may not be common to all areas. Some of the recommendations are under further review and study by FIS committees or are the subject of ongoing research. The designer and installer must recognize that no standard or code can substitute for experienced judgment.

Efforts have been made to ensure that data and information in the Standards and Specifications are accurate. However, FIS cannot accept responsibility for any errors or oversights in the use of material or in the preparation of irrigation plans. This publication is intended for use by professional personnel competent to evaluate the significance and limitations of its contents and able to accept responsibility for the application of the material it contains.

Users of the Standards and Specifications are encouraged to offer comments to FIS on the contents of this publication and suggestions for changes in the next edition. Questions concerning the source and derivation of any material in the Standards and Specifications should be directed to FIS.

STANDARDS AND SPECIFICATION FOR TURF AND LANDSCAPE IRRIGATION SYSTEMS

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STANDARDS AND SPECIFICATIONS FOR TURF AND LANDSCAPE IRRIGATION SYSTEMS

PART 1: GENERAL

1.01 Description

A. Purpose

The purpose of this document is to establish standards for the design and installation of safe, cost effective, reliable irrigation systems for turf and landscape areas and to promote the efficient use and protection of water resources.

B. Definition – Irrigation System

Turf and landscape irrigation systems apply water by means of permanent above-ground or subsurface sprinkler or micro-irrigation equipment under pressure.

C. Scope

These standards and specifications apply to all irrigation systems used on turf and landscape areas. They address the design requirements, water quality, materials, installation, inspection, testing, and warranties for such systems. These standards and specifications do not apply to irrigation systems for nurseries, greenhouses, or agricultural production systems.

D. Exceptions

Deviations from these standards will at times be necessary. Any deviation should at no time contradict the purpose stated above.

1.02 Definitions: See Glossary of Irrigation Terminology.

1.03 References: See “Reference List and Agencies Developing Standards and Procedures for Irrigation Practices included in this publication.”

1.04 Pre-Construction Submittals

A. Plans or Drawings

1. **Commercial, Industrial, Municipal and Residential**

   Provide design drawings, where none exist, for installation prior to start of construction. Design drawings shall be clearly readable, to reasonable scale, and shall include but not be limited to: date, scale, revisions, legend, water source, design operating pressure and flow rate per zone, average application rate per zone (listed in inches per hour), watering schedule, locations of pipe, controllers, valves, sprinklers, backflow prevention devices, elevation, electrical supply, roadways, sidewalks, structures and other relevant site conditions.

   Irrigation design drawings shall consider existing and/or proposed landscaping plant materials in the design layout.

   The owner or their representatives should supply the following site information, including but not limited to; high voltage electrical wires, water lines, telephone, cable and other utility lines, septic tanks, drain fields, well fields and easements.

B. **List of Materials:** The Contractor shall provide manufacturer's product description sheets for all major components with specific models and/or items numbers highlighted.

C. **Deviations from Specifications:** Any deviation from the specified brands, models or sizes shall be clearly identified and manufacturer's product description sheets for the proposed replacement materials shall be submitted to owner or the owner's representative. Material deviations or design changes must be shown to comply with the system design intent and identify any necessary performance changes that are resultant from the deviation.

1.05 Post Construction Documentation

A. Commercial, Industrial, Municipal and Residential:

1. Provide the manufacturers' recommended operating instructions for all major components incorporated into the irrigation system.

2. Provide system operation manuals, maintenance schedules, recommended schedule of operation including average application rates, with seasonal adjustments for each zone.

3. Provide all required testing and inspection certificates to the owner or owner's representative.

B. **Record Drawings:** Provide drawings and plans showing all changes in the design to indicate the actual installation and location of all equipment and materials with the application for final payment.

The following specific items must be included:

1. Mainline and lateral pipes and their types and sizes.
2. Control valve locations, sizes, zone numbers and areas of coverage.
3. Sprinklers, controller, rain shutoff device, filter, and backflow prevention equipment.
4. Point of connection including type of water source, size, flow rates, and operating pressure range.
5. Date and scale.
6. Contractor's name, address, and telephone number.
7. Contractor's license number (where applicable).
8. Designer's name, address, and telephone number.
9. Designer's professional registration number (where applicable).

C. **Testing and Inspection Certifications:** Provide all required testing and inspection certifications to the owner or prime contractor with the final application for payment. (See Part V, Testing and Inspections)

1.06 Materials and Equipment Warranties

The irrigation system contractor shall assume full responsibility for the proper installation of the system. The irrigation system contractor shall make all necessary, reasonable efforts to handle any warranty claims in a reasonable time period. Contractor shall guarantee the installation workmanship for a minimum period of one year from date of completion.

END OF PART 1

PART 2: DESIGN CRITERIA

2.01 Design Defined

Within the scope of this document, irrigation system design is defined as the science and art of properly selecting and applying all components within the system utilizing them to comply with proper pipe hydraulics and to match precipitation rates to site conditions and other necessary design criteria.

2.02 Water Supply

A. The water source shall be adequate from the standpoint of volume, flow rate, pressure, quality and other applicable factors to meet the irrigation requirements of the area to be irrigated for the expected life of the system.

B. Review all potential water supplies as part of the irrigation system design, and advise the owner concerning cost and suitability of each. When using reclaimed water as the water supply, consult with governing agencies regarding setback requirements and special nozzles or other equipment as required by State or Local codes.

C. Available Pressure and Capacity:

1. Metered water systems: Determine the available pressure and flow rate at the water supply meter. Fluctuations in the supply pressure and available flow should be considered.

2. Design flow rate through the meter shall be no greater than 75% of the maximum safe flow capacity as stated by the meter manufacturer. In no case shall the flow be outside the meter manufacturer's recommended operating range.

3. Other systems: Assess the adequacy of surface water, well water or water purveyor to meet both flow rate and total irrigation water requirements.

4. Irrigation systems shall be designed with the capacity to meet peak water requirements that are used. The design shall also incorporate sufficient capacity to provide the necessary water for plant establishment.

5. The system designer shall review applicable codes and water restrictions. The system shall be designed to apply the necessary water while also complying with these regulations.

6. See also sections 2.08 Wells and 2.09 Pumps

2.03 Application Rate

Application rate is the rate at which water is applied to the irrigated area, normally measured in inches per hour or millimeters per hour.

A. Use application rates that avoid runoff and permit uniform water infiltration into the soil. Land slope, soil hydraulic properties, vegetative ground cover, and prevailing winds will be considered when application rates are specified.

PART 2: DESIGN CRITERIA CONTINUED

B. Calculate sprinkler application rates using one of the following formulas:

***FORMULA ONE* - Application Rate – Individual Head Method**

$$\textbf{Application rate} = \frac{\textbf{34650 x GPM (for any arc)}}{\textbf{Degrees Arc x Head Spacing x Row Spacing}}$$

Where:

Application rate	=	precipitation rate in inches per hour
GPM	=	flow for given sprinkler of any arc, in gallons per minute
Degrees Arc	=	the arc of the given sprinkler in degrees
Head Spacing	=	the space between the heads in a row, in feet
Row Spacing	=	the space between rows of heads, in feet
34650	=	constant for conversion of area and flow into common units

***FORMULA TWO* - Average Application Rate – Total Area Method**

$$\textbf{Application Rate} = \frac{\textbf{96.25 x Total GPM}}{\textbf{Total Area}}$$

Where:

Average Application rate	=	precipitation rate in inches per hour
Total GPM	=	total flow of all sprinklers in the given area in gallons per minute
Total Area	=	the given area irrigated in square feet
96.25	=	constant for conversion of area and flow into common units

C. Calculate micro-irrigation application rates using one of the following formulas:

FORMULA THREE - Where tubing is installed in such a manner as to wet an entire area:

$$\textbf{Appl. Rate} = \frac{\textbf{231.1 x Dripper flow (GPH)}}{\textbf{Dripper spacing (inches) x Dripperline spacing (inches)}}$$

where:

Appl. Rate	=	application rate in inches per hour
Dripper flow	=	gallons per hour flow of one dripper
Dripper spacing	=	spacing in inches of drippers inside tubing
Dripperline Row Spacing	=	inches between tubing laterals

***FORMULA FOUR* -** When irrigating individual shrubs or trees, express the application rate on a "per plant" basis in gallons per day per plant. The following formula may be used for this calculation:

Appl. Rate = Q Ne T

where:

Appl. Rate	=	application rate (gpd per plant),
Q	=	emitter discharge rate (gph per emitter)
Ne	=	number of emitters per plant, and
T	=	operating time per day (hours)

PART 2: DESIGN CRITERIA CONTINUED

FORMULA FIVE **-** To calculate the average application rate for a micro irrigated zone, the following equation can be used:

Appl. Rate = QNzT

where:

Appl. Rate	= average zone application rate (gpd per zone)
Q	= emitter discharge rate (gal per hour per emitter)
Nz	= number of emitters per zone
T	= operating time per day (hours)

2.04 Irrigation Uniformity

Irrigation uniformity describes how evenly water is distributed within an irrigation zone. Irrigation system uniformity is the uniformity of the zone with the lowest uniformity coefficient.

A. Sprinkler Systems:

1. Within any given zone, the maximum variation in sprinkler flow rates should be less than 5% and must be less than 20% of the average flow rate for all sprinklers with the same areas of coverage i.e. (maximum flow rates – minimum flow rates)/(average flow rates of all sprinklers).

2. For this design calculation, flow rates of part circle sprinklers shall be normalized to that of a full circle sprinkler when both are used within a zone.

3. It is recommended within any given zone that the maximum pressure variation be 10% or less to limit flow rate variation to approximately 5%.

4. Irrigation systems should be designed with consideration for the types of plant being grown and the type of soil found in that area. The general watering of different types of plants as one group without regard to their individual water requirements is to be avoided if at all possible.

5. In general, the uniformity of coverage in an irrigation system should be in excess of 60 (sixty) percent.

6. In the absence of manufacturers' data required to calculate Uniformity Coefficients, it is recommended that when using square spacing, sprinklers should not be spaced farther apart than 55 percent of their manufacturer-specified diameters of coverage for prevailing wind speeds of 5 miles per hour (mph) or less.

7. Spacing should not exceed 50 percent of sprinkler diameters of coverage for wind speeds of 5 to 10 mph, and 45 percent for prevailing wind speeds greater than 10 mph.

8. When using triangular spacing the above overlap percentages can be increased by five percent.

B. Micro-irrigation systems should be designed using the Emission Uniformity concept.

FORMULA SIX

$$EU = 100\% \, (1.0 - 1.27\, Cv / \sqrt{n}) \, (Qmin/Qave)$$

where:

EU	=	emission uniformity (percent) which ranges from 0% (low uniformity) to 100% (perfect uniformity)
Cv	=	coefficient of manufacturing variation for the emitter used when operated at the average system operating pressure
n	=	number of emitters per plant (for example, the number of drip emitters per tree for drip-irrigated tree crops) or 1.0, whichever is less
Qmin	=	minimum emitter flow rate calculated for an irrigated zone
Qave	=	average emitter flow rate within an irrigated zone

The number, type and spacing of micro-irrigation emitters should be determined based on the plant water requirements, root zone size and soil conditions.

2.05 System Zoning

A. The irrigation system should be divided into zones based on consideration of the following:

1. Available flow rate/pressure.
2. Economic factors.
3. Cultural use of the area.
4. Type of vegetation irrigated, i.e., turf, shrubs, native plants, etc.
5. Soil characteristics.
6. Exposure.
7. Topography.

2.06 Sprinkler/Emitter Spacing and Selection

Sprinkler/Emitter spacing will be determined considering the irrigation requirements, hydraulic characteristics of the soil, and water quality with its effect on plant growth, sidewalks, buildings, and public access areas. Water conservation will be emphasized by minimizing irrigation of non-vegetated areas.

A. It is recommended that the sprinklers and emitters be spaced according to the guidelines laid out in the "Application Rate" section of Part 2.03 above.

B. Each zone of the irrigation system shall be designed to conform to Part 2.04 Application Uniformity.

C. Do not install riser-mounted sprinklers or emitters in areas subject to vehicular or pedestrian traffic.

D. When using sprays or rotors, select nozzle sizes to match application rates within each zone.

E. Space micro-irrigation emitters to respond to plant root zone size, plant water requirements, and soil type.

PART 2: DESIGN CRITERIA CONTINUED

F. Sprinkler and emitter locations on systems using reclaimed water shall conform to S62-610FAC regarding setbacks, drift, over spray and runoff.

G. Individual Drip Emitters (also known as point-source emitters with flows that generally do not exceed 4 GPH per emitter) – Emitters systems shall be designed to apply water directly to the plant root zone to maintain soil moisture.

H. In Line Tubing (also known as line source emitters with flows that generally do not exceed 4 GPH per emitter) – Emitters shall come preinstalled from the factory in the tubing at defined intervals. The design intent is to provide an overlapping continuous wetting pattern. Tubing emitter spacing and flow shall be selected based on soil type and manufacturer's recommendation.

I. Microsprays (Generally does not exceed 30 GPH per emitter) – Microspray nozzles with matched application rates should be used in dense or uniform plantings. For mixed or sparsely spaced plantings, design criteria must consider individual plant needs rather than overall average application rate.

J. Bubblers (Range from .5 GPH to 4 GPM) - Bubblers may be classified as micro irrigation or as conventional irrigation based upon their flow rate. Caution should be used in selecting this equipment due to the wide range of flow rates. Bubblers less than 30 GPH may be considered as micro irrigation. All other bubblers should be zoned separately from other types of micro irrigation products.

K. Note: The above definitions or descriptions apply to micro irrigation used in landscape applications. Nursery and agricultural micro irrigation products may be covered by other industry guidelines.

2.07 Pipelines

Pipelines will be sized to limit pressure variations so that the working pressure at all points in the irrigation system will be in the range required for uniform water application as defined in Part 2.03 and 2.04.

A. Mainline Pipe Selection

1. Working pressure of the mainline pipe should not exceed 72 percent of the pressure rating of the pipe nor should the design velocity exceed 5 feet per second.

If water temperatures exceed 73 degrees Fahrenheit pipe pressure ratings shall be adjusted in accordance with ASAE S-376.2. To avoid damage due to cyclic pressure variations in pressurized mains the total pressure variation should be minimized.

2. Total Pressure Developed/Surge Pressures: Surge pressures shall not exceed 2.5 times the adjusted working pressure of the mainline pipe.

3. To calculate surge pressures use the following equation:

FORMULA SEVEN

$$Pt = \frac{Po + (V \times L \times 0.07)}{t}$$

Where

Pt	=	the total pressure developed
Po	=	the operating pressure at the time of the water hammer, in psi.
V	=	velocity at the time the reduction in velocity occurred, in fps
L	=	Length straight pipe (i.e. without tees or elbows) measured in feet between source and point where reduction in velocity occurred in feet. This would be the longest section.
t	=	seconds during which the velocity was reduced.
0.07	=	constant used to convert velocity, length and time into pressure.

B. Thrust Restraint

Thrust blocks are required on all unrestrained (for example, push-on gasketed joints) pipe joints and fittings at dead ends and whenever the line changes direction of 30 degrees or more. Concrete having a compressive strength of 2000 psi or higher will be specified. Thrust blocks will be formed against solid, unexcavated earth that has been undamaged by mechanical equipment. The space between the pipe and trench wall will be filled to the height of the outside diameter of the pipe. Size thrust blocks in accordance with ASAE Standard S-376.2.

2.08 Wells

A. Select well diameters and depths according to the irrigation system demand and in consultation with a Florida licensed well driller. Give consideration to the hydraulic properties of the source aquifer to reduce excessive drawdowns. Refer to NRCS Code FL-642 and local water management district regulations.

B. Well location and depth shall be in compliance with applicable State, water management district and local codes.

C. All wells constructed to recover water from unconsolidated aquifers shall be equipped with manufactured screen sections, well points or perforated sections meeting the criteria stated in NRCS Code FL-642 to prevent aquifer materials from entering the water system.

2.09 Pumps

A. Pump and motor combinations shall be capable of satisfying the total system demand without utilizing the service factor of the motor at any flow the pump is capable of producing.

B. Pumps shall be sized to ensure that the net positive suction head required (NPSHr) for proper pump operation is achieved. All factors effecting NPSHr shall be considered and these shall include but not be limited to the following:

1. Pump position relative to water surface.
2. Intake line sizing and type.
3. Check valve sizing and type.
4. Discharge equipment.
5. Pump or intake submergence.

C. The pumping system should be protected against the effects of the interruption of water flow also known as a “dead head condition.”

D. The system demand shall not be less than 25% of the pump’s best efficiency point.

2.10 Control Valves and Systems

2.10.01 – Control Valves

A. Control valve size shall be based on the flow rate through the valve. Friction loss through the valve should not exceed 10% of the operating pressure upstream of the valve except where the valve includes a factory provided pressure regulator device.

B. In control systems using hydraulic communication between controller and valve(s), consult the manufacturers' recommendations for maximum distance between controller and valve both horizontally and vertically (elevation change).

C. Size electrical control wire in accordance with the valve manufacturer's specifications, based on the solenoid in-rush amperage and the circuit length, considering the number of solenoids operating on the circuit.

D. Electrical control wire to be direct-buried shall be UL approved for direct burial. If electrical control wire is not UL approved for direct burial, it must be installed in watertight, electrical, conduit and be UL listed TWN or THHN as described in the National Electric Code.

E. Locate manually operated control valves so they can be operated without wetting the operator.

2.10.02 - Two Wire Systems

A. Two wire or decoder systems use a single pair of wires to operate a large number of stations with individual decoders.

B. Contractor shall follow manufacturer’s instruction for determining wire path, wire layout, size, etc.

C. Where multi zone decoders are used, the manufacturer should be consulted to determine the appropriate wire sizing method and maximum length of wire runs.

2.11 Automatic Irrigation Controller

A. Automatic irrigation controllers must have an adequate number of stations and power output per station to accommodate the irrigation system design.

B. Automatic irrigation controllers must have adequate programming flexibility to respond to the needs of the irrigation devices being used.

C. Automatic irrigation controllers must have an adequate number of stations and power output per station to accommodate the irrigation system design.

PART 2: DESIGN CRITERIA CONTINUED

2.11 Automatic Irrigation Controller - continued

D. Automatic irrigation controllers must have adequate programming flexibility to respond to the needs of the irrigation devices being used.

E. Considerations shall be given to governmental agency water restrictions.

F. Considerations shall be given to seasonal and environmental factors.

2.12 Chemical Injection

A. Chemical injection systems for the injection of fertilizer, pesticides, rust inhibitors, or any other injected substance will be located and sized according to the manufacturers' recommendations.

B. Injection systems will be located downstream of the applicable backflow prevention devices as required by Florida Statutes, Sections 487.021 and 487.055; the Environmental Protection Agency (EPA); Pesticide Regulation Notice 87-1; or other applicable codes.

C. If an irrigation water supply is also used for human consumption, an air gap separation or an approved reduced pressure principal backflow prevention device is required.

2.13 Filters and Strainers

A. The filter element, strainer, or filtration media must be sized to prevent the passage of foreign material in sizes or quantities which would obstruct the sprinkler/emitter outlets, typically 1/4 the diameter of the smallest outlet or the mesh size recommended by the irrigation device manufacturer and/or the filter manufacturer.

B. Under clean conditions the pressure loss across the filter will be no greater than 5 psi or the amount recommended by the manufacturer, whichever is less.

C. Provide sufficient filtering capacity so that backwash time is 20% or less of the system operation time. Within the 80% non-backwash time period, the pressure loss across the filter must remain within the manufacturer's specifications. Specifically designed continuous flushing type filters are exempt from this 20% requirement. These systems must, however, remain at all times within the manufacturer's specifications concerning head loss across the filter.

D. For manually flushed filters and strainers, it is recommended that a pressure gauge and isolation valve be installed both upstream and downstream of the filters/strainers.

2.14 Backflow Prevention

Provide backflow prevention assemblies at all cross connections with all water supplies in accordance with county, municipal, or other applicable codes. Determine acceptable backflow prevention assembly types and installation procedures for each application. At a minimum, provide a pressure vacuum breaker. Atmospheric vacuum breakers or dual check valves alone are not acceptable. In the event of conflicting regulation provide the assembly type that gives the highest degree of protection.

A. Install backflow prevention assemblies upstream of any outlets from the irrigation system, upstream of any chemical injection points, and in locations that allow for inspection, testing and servicing.

B. Types of Backflow Prevention Assemblies:

1. Air gap separation: This method consists of a physical separation between the water supply and the irrigation system, so that there is no possibility of the discharged water flowing back into the water supply. The air gap separation must be a minimum of twice the diameter of the discharge pipe or one inch whichever is larger.

2. Atmospheric Vacuum Breakers (AVB) (not acceptable alone)

    a. Installed downstream of the last shut-off valve. AVBs must not be constantly pressurized.
    b. Must be at least 12-inches above the highest outlet.
    c. Must not be exposed to back-pressure.
    d. Must only be used in low hazard applications.

3. Pressure Vacuum Breakers (PVB)

    a. Must be installed upstream of all control valves.
    b. Must be at least 12 inches above highest outlet.
    c. Must not be exposed to back-pressure.
    d. May be used in high hazard or low hazard applications.

4. Dual Check Valves (not acceptable alone)

    a. Must be installed upstream of all control valves.
    b. Do not require installation above the highest outlet. These devices may be buried. However, they should be installed in valve boxes to facilitate removal for testing and service.
    c. Must not be used for backflow prevention under high hazard conditions.

5. Double Check Valve Assemblies (DCA)

    a. Must be installed upstream of all control valves.
    b. Do not require installation above the highest outlet. These devices may be buried. However, they should be installed in valve boxes to facilitate removal for testing and service.
    c. Must not be used for backflow prevention under high hazard conditions.

6. Reduced Pressure Principal Assemblies (RPA) or (RPZ)

    a. Must be installed upstream of all control valves.
    b. Must be installed so that the vent is a minimum of 12-inches above grade in locations that are well drained so that the assembly will not become submerged during rainfall or irrigation.
    c. Should be used for high hazard (chemical injection) applications.

C. Irrigation systems into which chemicals are injected shall conform to Florida state law (Florida Statutes 487.021 and 487.055) and Environmental Protection Agency Pesticide Regulation Notice 87-1, which requires backflow prevention regulations to be printed on the chemical label.

D. For municipal water supplies, chemical injection equipment must be separated from the water supply by an approved air gap separation or a reduced pressure principle assembly that is approved by the Foundation for CCC and the Hydraulic Research Institute. The equipment must also comply with ASSE Standard #1013 to protect the water supply from back-siphonage and back-pressure.

E. For other water supplies, Florida state law, EPA regulations, or other applicable local codes must be followed. A PVB should be used in the absence of legal guidelines to provide minimal protection.

2.15 Rain Shutoff Device

All automatic control systems shall be equipped with a rainfall shutoff device as required by State Code (FS373.62).

A. Rain shutoff device shall be placed on the top of the fascia or parapet if at all practical. It can also be placed on other stationary structures, such as walls, posts or fences.

B. The device shall not be located where rainwater is channeled, to avoid false readings.

C. The vertical area directly above the rain shutoff device shall be unobstructed to the sky.

D. The rain shutoff device shall not be installed over or within 5 feet of the edge of either an air conditioner's compressor or a pool heater unit.

E. Rain shutoff devices shall not be installed on a backflow preventer.

F. Rain shutoff devices shall be installed above the height of the sprinkler spray. When this is not possible, locate the sensor in the last zone to operate.

G. Rain shutoff devices shall be installed as close as possible to the control equipment.

H. Devices that use UV resistant wire may be left exposed to sunlight. The first 18 inches where the wire leaves the ground shall be encased in a conduit. If the wire is not UV resistant, its entire above-ground length shall be encased in a conduit.

I. Device that use UL wire listed for direct burial may be installed in the ground without a conduit, but the first 18 inches where the wire leaves the ground shall be encased in a conduit. Wire that is not so rated must be encased in a conduit.

J. In systems where a pump is used to supply irrigation water, a rain shutoff device shall deactivate pump control circuits as well as valve circuits.

2.16 General Safety

A. Reasonable care should be taken selecting sprinkler equipment to avoid the devices and methods of application that would present a hazard to people using the area in a normal manner.

B. Irrigation systems using reclaimed water shall be designed to comply with S62-610FAC regarding cross connection, signage, color codes and misapplication of the water.

END OF PART 2

PART 3: MATERIALS

3.01 General Pipe and Fittings

Pipe bearing reclaimed water shall be purple colored or identified by other accepted method as described in S62-610FAC to differentiate reclaimed water from domestic or other water.

3.02 PVC Pipe and Fittings

A. PVC pipe should comply with one of the following standards: ASTM D-1785-99, ASTM D-2241-00, AWWA C-900-97, or AWWA C-905-97. SDR-PR pipe shall have a minimum wall thickness as required by SDR-26.

B. All solvent-weld PVC fittings shall, at a minimum, meet the requirements of Schedule 40 as set forth in ASTM D-2466-01.

C. Threaded PVC pipefittings shall meet the requirements of Schedule 40 as set forth in ASTM D-2464-99**.**

D. PVC gasketed fittings shall conform to ASTM D-3139-98. Gaskets shall conform to ASTM F-477-99.

E. PVC flexible pipe should be pressure rated with standard outside diameters compatible with PVC IPS solvent-weld fittings.

F. PVC cement should meet ASTM D-2564-96a. PVC cleaner should meet ASTM F-656-96a.

3.03 Ductile Iron Pipe and Fittings

A. Gasket fittings for iron pipe should be of materials and type compatible with the piping material being used.

3.04 Steel Pipe and Fittings

A. All steel pipe shall be rated Schedule 40 or greater and be hot-dipped galvanized or black in accordance with ASTM A-53-01.

B. Threaded fittings for steel pipe should be Schedule 40 Malleable Iron.

3.05 Polyethylene Pipe

A. Swing joints shall be thick-walled with a minimum pressure rating of 75 psi in accordance with ASTM D-2239-99.

B. Low pressure polyethylene pipe for micro irrigation systems shall conform to ASAE S435.

C. Use fittings manufactured specifically for the type and dimensions of polyethylene pipe used.

3.06 Sprinklers, Spray Heads and Emitters

A. Select units and nozzles in accordance with the size of the area and the type of plant material being irrigated.

B. Use equipment that is protected from contamination and damage by use of seals, screens, and springs where site conditions present a potential for damage.

C. Support riser-mounted sprinklers to minimize movement of the riser resulting from the action of the sprinkler.

D. Swing joints shall be constructed to provide a flexible, leak-free connection between the sprinkler and lateral pipeline to allow movement in any direction and to prevent equipment damage.

E. Sprinklers and emitters used with reclaimed water shall be colored purple or identified by other accepted means as described in S62-610FAC to differentiate reclaimed water from domestic or other water.

3.07 Valves

A. Valves must have a maximum working pressure rating equal to or greater than the maximum pressure of the system, but not less than 125 psi. This requirement may be waived for low mainline pressure systems (30 psi or less).

B. Use valves that are constructed of materials designed for use with the water and soil conditions of the installation.

C. Use valves that are designed to be protected from debris buildup in the control passages if there is a potential for such contamination from the water supply.

D. Use valves that are constructed from materials that will not be deteriorated by chemicals injected into the system and/or water characteristics such as pH, mineral content, etc.

E. Valves used with reclaimed water shall be colored purple or identified by other accepted means as described in S62-610FAC to differentiate reclaimed water from domestic or other water.

3.08 Valve Boxes

A. Use valve boxes that are constructed to withstand traffic loads common to the area in which they are installed. At a minimum valve boxes should be sized to allow manual operation of the enclosed valves without excavation. Where possible, valves boxes should be sized to allow routine maintenance without excavation.

B. Each valve box should be permanently labeled to identify its contents.

C. Valve boxes used with reclaimed water shall be purple or identified by other accepted means as described in S62-610FAC to differentiate reclaimed water from other waters.

3.09 Low Voltage Wiring

A. All low voltage wire, which is directly buried, must be labeled for direct burial. Wire not labeled for direct burial must be installed in watertight conduits, and be UL listed TWN or THHN type wire as described in the NEC.

B. Connections are to be made using UL approved devices specifically designed for direct burial.

PART 3: MATERIALS CONTINUED

3.10 Irrigation Controllers

A. All irrigation controllers shall be UL listed, conform to the provisions of the National Electric Code, and properly grounded in accordance with manufacturer's recommendations.

B. The controller housing or enclosure shall protect the controller from the hazards of the environment in which it is installed.

C. Use controllers that are programmable for varying irrigation durations that are consistent with the water to be applied in each zone.

D. Equip commercial installations using solid-state controls with surge suppressors on the primary and secondary wiring.

3.11 Pumps and Wells

A. Irrigation pump electrical control systems must conform to NEC and local building codes.

B. The pumping system shall be protected from the hazards of the environment in which it is installed.

C. Use electric motors with a nominal horsepower rating greater than the maximum horsepower requirement of the pump during its operation. Motors 5hp and greater shall have a minimum service factor of 1.15.

D. The well shall be constructed following local water management district regulations and county codes to protect the aquifer from contamination.

E. Casings for drilled wells may be steel, reinforced plastic mortar, plastic, or fiberglass pipe. Only steel pipe casings shall be used in driven wells. Steel pipe must have a wall thickness equal to or greater than Schedule 40. See NRCS code FL-642. Steel casings shall be equal to or exceed requirements of ASTM A-589-96.

3.12 Chemical Injection Equipment

A. Chemical injection equipment must be constructed of materials capable of withstanding the potential corrosive effects of the chemicals being used. Equipment shall be used only for those chemicals for which it was intended as stated by the injection equipment manufacturer.

3.13 Backflow Prevention Methods

A. Air gap separation: This method consists of a physical separation between the water supply and the irrigation system, so that there is no possibility of the discharged water flowing back to the water supply. The air gap separation must be a minimum of twice the diameter of the discharge pipe or 1-inch, whichever is larger. Refer to local plumbing codes for non-standard air gap installations.

B. Backflow Prevention Assemblies**:**

1. An atmospheric vacuum breaker consists of an air inlet port and a float type check valve. This device must meet ASSE Standard 1001.

PART 3: MATERIALS CONTINUED

2. A pressure vacuum breaker consists of an air inlet port, one positive seating check valve and an internally force loaded disc float assembly downstream of the check valve, installed as a unit between two resilient seated shutoff valves and fitted with properly located test cocks. This device must meet ASSE Standard #1020.

3. A dual check consists of independently acting, spring-loaded check valves in a corrosion resistant material. Dual checks usually have to be removed for testing. They are not recommended for high hazard conditions. This device must meet ASSE Standard #1024 and be approved by the Foundation for Cross Connection Control and Hydraulic Research of the University of Southern California. Dual checks are not acceptable in Florida irrigation systems according to the Florida Building Code.

4. A double check valve assembly consists of two positive-seating check valves installed as a unit between two resilient-seated shutoff valves and fitted with properly located test cocks. This device must meet ASSE #1015 and be approved by the Foundation for Cross Connection Control and Hydraulic Research of the University of Southern California.

5. A reduced pressure principle backflow prevented consists of two positive-seating check valves and an automatically-operating pressure differential relief valve integrally located between the two check valves, installed as a unit between two tightly closing, resilient-seated shutoff valves and fitted with properly located test cocks. This device must meet ASSE standard #1013 and be approved by the Foundation for Cross Connection Control and Hydraulic Research of the University of Southern California.

3.14 Filters and Strainers

A. Use filtration equipment and strainers constructed of materials resistant to the potential corrosive and erosive effects of the water, and sized in accordance with the manufacturer's recommendations.

B. Use the equipment that is constructed of materials capable of withstanding the potential mechanical damage caused by contaminants (for example, sand) in the water.

C. The filter element, strainer, or filtration media must be sized to prevent the passage of foreign material in sizes or quantities which would obstruct the sprinkler/emitter outlets, typically 1/4 the diameter of the smallest outlet or the mesh size recommended by the emitter manufacturer.

3.15 Rain Shutoff Device

A. Rain shut off devices shall be capable of being incrementally adjusted to activate at a range of rainfall amounts.

B. Shall be attachable to roof eaves, post or other mounting structures.

C. The device shall be UV resistant.

END OF PART 3

PART 4: INSTALLATION

4.01 Pre-Installation

A. Verify location of existing utilities with municipal and private utilities and with the property owner.

B. Obtain all necessary permits and licenses.

C. Inspect the site for existing conditions that will affect the irrigation system design or installation, and develop a plan to minimize disturbance of existing and/or proposed structures and landscape.

4.02 Installation of Backflow Prevention Assemblies

A. Flush all lines before installing backflow prevention assemblies.

B. Provide protection of backflow prevention assemblies if they are installed in a manner that subjects them to annual damage by freezing temperatures.

C. Install with adequate clearance to allow for servicing and testing per local codes.

D. DCA and RPZ devices must be installed horizontally unless approved for vertical installation by a recognized testing authority.

E. After installation, backflow prevention assemblies shall be inspected and/or tested according to applicable local codes.

4.03 Pipe Installation

A. Flag the location of all sprinklers, valves, controllers, source of water and electrical components in the field prior to installation.

B. Conduct all necessary excavation for the proper installation of pipelines and accessories. Dewater, shore, and brace as needed to completely install the pipe.

C. Pipe shall be installed at sufficient depth below ground to protect it from hazards such as vehicular traffic. Landscape vehicular traffic areas are those landscaped areas subject to vehicular use such as traffic crossings, parking areas, etc. Depths of cover shall conform to NRCS-FL- 430-DD, Water Conveyance, as follows:

1. **Landscaped Vehicle Traffic Areas** – Landscaped areas subject to routine automotive or heavy equipment traffic.

Pipe Size (Inches)	Depth of Cover* (inches)
½" – 2 ½"	18"
3"-5"	24"
6" and larger	36"

2. Non-Traffic and Non-Cultivated Areas

Pipe Size (Inches)	Depth of Cover* (inches)
½" – 1 ½"	6"
2"-3"	12"
4"-6"	18"
More than 6"	24"

Note: The Contractor should notify the Owner or their representative when technical compliance with these guidelines may result in damage to property such as existing trees, structures etc. In such cases, the Contractor in cooperation with the Owner should seek to change the route of the pipe around such obstacles or reach other such reasonable accommodations

D. The trench bottom must be uniform, free of debris, and of sufficient width to properly place pipe and support it over its entire length. Blocking or mounding shall not be used to bring the pipe to final grade.

E. Make all pipe joints and connections according to the material manufacturer's recommendations. Perform all solvent-weld connections in accordance with ASTM D-2855. Caution should be used to prevent entry of foreign materials into pipes during installation.

F. Where pipe or fitting manufacturers recommend the use of thrust blocks, they must be formed against a solid, hand-excavated trench wall undamaged by mechanical equipment. They shall be constructed of concrete, and the space between the pipe and trench wall shall be filled to the height of the outside diameter of the pipe.

G. After installation of pipe, flush lines as follows:

1. Flush supply line prior to installing backflow preventers.
2. Flush main line before installing control valves.
3. Flush lateral lines prior to installation of sprinkler heads or emitters.
4. Inspect all lines and joints. Repair any leaks.

H. After installation, flushing, and inspection or testing, backfill and compact the excavated soil to minimize post-construction settlement in the pipe trench.

1. Native excavated material may be used to backfill the pipe trench. However, the initial backfill material shall be free from rocks or stones larger than 1-inch in diameter. At the time of placement, the moisture content of the material shall be such that the required degree of compaction can be obtained with the backfill method to be used.

2. The initial backfill material shall be placed so that the pipe will not be displaced, excessively deformed, or damaged. The initial fill shall be compacted firmly around and above the pipe to the density specified by the designer to provide adequate lateral support to the pipe.

3. If the water packing method of compaction is used, fill the pipeline first with water. The initial backfill before wetting shall be of sufficient depth to insure complete coverage of the pipe after consolidation. Water packing is accomplished by adding enough water to diked lengths of the trench to thoroughly saturate the initial backfill without excessive pooling. The wetted fill shall be allowed to dry until firm before beginning the final backfill. The pipeline shall remain full of water until after the final backfill is made.

PART 4: INSTALLATION CONTINUED

I. Pipe sleeves must be used to protect pipes or wires installed under pavement or roadways. Use pipe sleeves at least two pipe sizes larger than the carrier pipe or twice the diameter of the wire bundle to be placed under the paving or roadway, and extending a minimum of 3 feet beyond the paved area or as required by the Florida Department of Transportation (FDOT). Use sleeve pipe with wall thickness at least equal to the thickness of schedule 40 or PR 160 pipe, whichever is thicker.

Piping under paved traffic areas shall be encased in full lengths of sleeving material to avoid placement of joints under pavement if possible. Use the same techniques to place pipe sleeves to serve as conduits for automatic control wires or tubing. Sleeve material may be steel or plastic pipe, suitable to slide pipe, wire or tubing through. Proper backfill and compaction procedures should be followed.

J. Pipes conveying reclaimed water shall be separated from other piping or utility services by 3 feet horizontal distance. An 18-inch vertical separation shall be maintained where reclaimed lines cross other piping or utility services.

4.04 Valve Installation

A. Valve installation shall allow enough clearance for proper operation and maintenance. Where valves are installed underground, they shall be provided with a valve box with cover extending from grade to the body of the valve. The top of the valve body should have a minimum of 6 inches of cover in non-traffic and non-cultivated areas and 18 inches of cover in traffic areas.

B. All valves installed underground shall be installed in a valve box. If an automatic valve is installed under each sprinkler, then the valve box may be omitted. Valves must be installed with enough clearance for operation and maintenance.

C. Install valve boxes so that they do not rest on the pipe, the box cover does not conflict with the valve stem or interfere with valve operation and so that the valve box lids are flush with the ground surface.

D. Install quick coupling valves on swing joints or flexible pipe with the top of the valve at ground level, however, installation in a valve box is recommended.

E. Valves bearing reclaimed water shall be purple colored or identified by other accepted method as described in S62-610FAC to differentiate reclaimed water from domestic or other water.

4.05 Sprinkler Installation and Micro irrigation installation

4.05.01 Sprinkler installation

A. On flat landscaped areas, install sprinklers plumb. In areas where they are installed on slopes, sprinklers may be tilted as required to prevent erosion.

B. Sprinklers should be adjusted to avoid unnecessary discharge on pavements and structures.

C. Provide a minimum separation of 4 inches between sprinklers and pavement. Provide a minimum separation of 12 inches between sprinklers and buildings and other vertical structures or as local codes dictate.

D. Piping must be thoroughly flushed before installation of sprinkler nozzles. Surface mounted pop-up heads shall be installed on swing joints, flexible pipe, or polyethylene (PE) nipples. Above-ground (riser mounted) sprinklers shall be at a minimum mounted on Schedule 40 PVC or steel pipe, manufacturer's risers or rigid copper pipe. Risers shall be effectively stabilized.

4.05.02 Micro Irrigation Installation

A. Micro-irrigation devices shall be installed according to the manufacturer's recommendations for the specific application.

B. Drip Emitters (point source emitters) - Individual emitters shall be inserted into polyethylene supply tubing (normally 3/8" or larger). Emitters may be combined into one device known as multi-outlet emitters or manifolds. Such devices may be installed using either polyethylene or PVC. Emitters shall be extended to the plant utilizing distribution tubing (Generally ¼" nominal size). Distribution tubing should be covered with a minimum of three inches of mulch or soil. Supply tubing and distribution tubing shall be secured or buried where the shrub beds are susceptible to disturbance from foot traffic, impact or tubing movement, etc.

C. Emitters and distribution tubing should be installed in a way that minimizes damage due to vandalism, insects, animals and landscape maintenance.

D. In-Line Drip Tubing (in line – emitters) - Tubing spacing, emitter spacing and length of run shall not exceed manufacturer's recommendations. Tubing shall be secured with stakes or staples every three to six feet depending on site conditions and manufacturer's recommendations.

E. Micro-sprays – Micro sprays may come with fixed, adjustable or interchangeable nozzles. Spray pattern should be appropriate for given plant materials or irrigated area. Nozzle selection criteria may include: pattern, radius of coverage, direction of spray, or flow rates

F. Supply tubing and inline tubing installation shall include the capability to flush the tubing laterals. Flush valves or other devices shall be able to deliver a flush rate of one to two feet per second.

G. Air/vacuum release valves are recommended to be installed in areas with changing topography or unusual site conditions.

H. Pressure regulating devices shall be used where water source pressure exceeds equipment manufacturer's rating.

Pressure compensation devices should be considered where there exist significant elevation changes, long tubing runs or where relative uniform flow at emitters is desirable.

4.06 Pump Installation

A. The well shall be developed until it stops producing detrimental quantities of solid particles at a continuous discharge rate of approximately 20% greater than the anticipated normal production rate (see NRCS-FL-642) prior to setting the permanent pump.

B. Set pumps plumb and secure to a firm concrete base. There should be no strain or distortion on the pipe and fittings. Pipe and fittings should be supported to avoid placing undue strain on the pump.

PART 4: INSTALLATION CONTINUED

C. Pumps must be installed in a manner to avoid loss of prime. Install suction line to prevent the accumulation of air pockets. All connections and reductions in suction pipe sizes should be designed to avoid causing air pockets and cavitations.

D. Pumps must be located to facilitate service and ease of removal. Appropriate fittings should be provided to allow the pump to readily be disconnected.

E. The installer should verify that the electrical connection produces correct rotation of the pump motor and that the electric power source is of the proper voltage and phase.

4.07 Low Voltage Wire Installation

A. Install low voltage wire (30 volts or less) with a minimum depth of cover of 12 inches.

B. Where wire is to be installed below grade, use only UL listed direct burial wire. In all other cases install wire in water-tight conduit.

C. Use wire connectors that are approved for direct burial. A valve box shall be used for all underground wire splices.

D. Provide a sufficient length of wire at each connection to allow for thermal expansion/shrinkage. As a minimum, provide a 12-inch diameter loop at all splices and connections. Terminations at valves will have 24" minimum free wire.

E. Install all above-ground wire runs and wire entries into buildings in conduit.

F. Provide common wires with a different color than the power wires (white shall be used for common wires).

G. On two wire systems where decoders operate individual valves, the decoder and the valve shall be installed in appropriately sized valve box. Splices used on this wire shall be approved for use with their product by the manufacturer. The contractor will determine prior to installation whether the manufacturer's wire may or may not be "looped."

4.08 Hydraulic Control Tubing

A. For hydraulic control systems, use a water supply that is filtered and free of deleterious materials, as defined by the hydraulic control system manufacturer.

B. Install a backflow prevention device where the hydraulic control system is connected to potable water supplies.

C. Install tubing in trenches freely and spaced so that it will not rub against pipe, fittings, or other objects that could score the tubing, and with a minimum 12-inch diameter loop at all turns and connections. Provide a minimum depth of cover of 12-inches.

D. Connect tubing with couplings and collars recommended by the tubing manufacturer. All splices should be made in valve boxes.

E. Pre-fill tubing with water; expel entrapped air; flush particulates and test for leaks prior to installation.

F. Install exposed tubing in a protective conduit manufactured from Schedule 40 PVC or electrical conduit.

PART 4: INSTALLATION CONTINUED

4.09 Rainfall Shutoff Device

A. Rain sensor shall be installed on building fascia or parapet if at all practical. The rain sensor can also be placed on a wall but must extend out a minimum of 18 inches from the wall. Sensors can also be placed on other stationary structures, such as posts or fences.

B. The device shall not be located where rainwater is channeled, to avoid false readings.

C. The vertical area directly above the rain sensor shall be unobstructed to the sky.

D. The rain sensor shall not be installed over or within 5 feet of the edge of either an air conditioner's compressor or a pool heater unit.

E. Rain sensor shall not be installed on a backflow prevention assembly.

F. Rain sensors shall be installed above the height of the sprinkler spray. When this is not possible, locate the sensor in the last zone to operate.

G. Rain sensors shall be installed as close as possible to the control equipment.

H. Rain sensor wire that is UV resistant may be left exposed to sunlight. The first 18 inches where the wire leaves the ground shall be encased in a conduit. If the wire is not UV resistant, its entire above ground length shall be encased in a conduit.

I. Rain sensor wire that is UL listed UF wire for direct burial may be installed in the ground without a conduit, but the first 18 inches where the wire leaves the ground shall be encased in a conduit. Wire that is not so rated must be encased in a conduit.

J. In systems pressurized by a pump, provision shall be made to ensure shutoff device does not allow pump to activate.

4.10 Signage - Re-use

A. Provide all necessary signs and or labeling necessary for reclaimed water in accordance with FAC – S62-610.

END OF PART 4

PART 5: TESTING & INSPECTIONS

5.01 Scope

This section addresses items that are to be provided to the owner by the installing contractor prior to scheduling an inspection by a governing agency.

5.02 Periodic Inspections

Periodic inspections will be performed throughout the duration of the installation. These inspections will be made by the contractor to insure that the installation is in compliance with the design intent, specifications, these standards, local and state codes and ordinances. Inspections will be made on the following items:

A. **Sprinkler/emitter Layout and Spacing:** This inspection will verify that the irrigation system design is accurately installed in the field. It will also provide for alteration or modification of the system to meet field conditions. To pass this inspection, sprinkler/emitter spacing should be within ± 5% of the design spacing.

B. **Pipe Installation Depth:** All pipes in the system shall be installed to depths as previously described in this standard.

C. **Cross Connection Control And Backflow Prevention:**

1. Public or domestic potable water systems: Check that an approved backflow prevention assembly is properly installed and functioning correctly. Review the location of the assembly to check that it is not creating a hazard to pedestrians or vehicular traffic.

2. For water systems other than public or domestic water systems, check that the proper backflow prevention assemblies and/or cross connection prevention device(s) are provided.

D. **Inspection Log:** Where applicable, an inspection log shall be kept at the job site. This log will show signatures and dates with description of inspections performed. This log may be required to be submitted to the governing agency upon their request.

5.03 Leakage Testing

A. **Single Family Residential Systems –** Generally these systems are not subject to “formal” leakage tests.

1. At a minimum fill the completely installed mainline slowly with water to expel air. Visually check for leaks.

B. Where additional testing is specified by the designer, owner or required by code, the following shall be included in the leakage testing:

1. Backfill the pipe prior to filling with water to confine the pipe to the trench.

2. If the trench is not completely backfilled because of additional testing requirements, it should have a minimum cover of 1-1/2 times the diameter of the pipe prior to testing.

3. Fill the mainline and allow the pipe to sit full of water for 24 hours to dissolve remaining trapped air.

4. Using a metering pump, elevate the water pressure to the maximum static supply pressure expected and hold there for a period of 2 hours, adding water as needed to maintain the pressure.

5. Record the amount of water added to the system over the 2 hour period.

6. Use the following formulas to determine the maximum allowable leakage limit of gasketed pipe.

FORMULA EIGHT
DUCTILE IRON:

$$L = S D \sqrt{P} / 133{,}200$$

where:

L = allowable leakage (gph),
D = nominal diameter of pipe (inches),
P = average test pressure (psi), and
S = length of pipe (ft).

FORMULA NINE
PVC, GASKETED JOINT:

$$L = \frac{N D \sqrt{P}}{7400}$$

where:

L = allowable leakage (gph),
N = number of joints,
D = nominal diameter of pipe (inches),
P = average test pressure (psi).

C. PVC solvent-weld pipe connections shall have no leakage. Polyethylene control tubing lines shall have no leakage. Where site conditions such as long runs where small pipe-soil movement is possible, combination of solvent weld and oring fittings are used, temperature variations during testing, etc. then formula eight may be used to determine allowable leakage.

D. When testing a system which contains metal-seated valves, an additional leakage per closed valve of 0.078 gph/inch of nominal valve size is allowed.

E. Pressure testing requirements shall not exceed manufacturer's recommended pressure for the elements being tested. Such elements may include pipe, isolation valves, solenoid valves, backflow preventer, etc.

F. Where possible, it is recommended that testing should not include individual solenoid valves.

G. Repair all leaks and retest the pipeline until it passes the test.

PART 5: TESTING AND INSPECTION CONTINUED

5.04 Application Uniformity Testing

A. The uniformity of application is a measure of system performance. Factors affecting uniformity shall include but not be limited to:

1. Wind.
2. Spacing of sprinklers.
3. Water pressure at the sprinkler.
4. Nozzle sizes and compatibility between sprinklers.
5. Sprinkler discharge pattern.
6. Speed and uniformity of rotation of rotary sprinklers.
7. Radius adjustment.

B. Application uniformity testing is not mandatory. However, if it is desired to conduct a uniformity test, in addition to the other tests described herein, it should be conducted in accordance with ASAE S-398.1, Procedure for Sprinkler Testing and Performance Reporting. The uniformity of microirrigation systems can be tested by direct measurement of the emitter discharge rates.

C. The application uniformity can be determined by collecting field data and calculating the coefficient of uniformity (**Cu**) using either the Christiansen or Statistical Uniformity Coefficient methods described in the following section. For sprinkler systems, a minimum of three locations within a zone should be selected for data collection. These locations should be selected near the beginning, middle and end of the sprinkler lateral. For microirrigation systems, a minimum of 18 to 24 data points or locations should be randomly collected across the field being evaluated. If the resulting coefficient of uniformity is low, then additional field data should be taken to improve the statistical reliability of the estimate.

D. Uniformity coefficients should be calculated using the Christiansen Uniformity Coefficient Cu_c given in equation 10 or the Statistical Uniformity Coefficient CU_s) given in equation 11. For randomly distributed data, both methods will produce approximately the same result.

FORMULA TEN

$$Cu_c = (100)\ [\ 1.0 - \ (\ Ex\ /mn)\ ]$$

where:

Cu_c = Christiansen's Uniformity Coefficient (percent), which ranges from 0% (low uniformity) to 100% (perfect uniformity);

n = number of measurements, observation points, or calculated water applications at points beneath the irrigation system;

m = the mean value of all observations, and

Ex = the sum of the deviations of the individual observations from the mean value.

FORMULA ELEVEN

$$CU_s = 100\% - 80\%\ (s/x)$$

where:

CU_s = the Statistical Uniformity Coefficient (percent) which ranges from 0% (low uniformity) to 100% (perfect uniformity),

s = standard deviation of the number of observations, measurements or calculated water applications at points beneath the irrigation system, and

x = average depth or volume of water measured at all observation points.

PART 5: TESTING AND INSPECTION CONTINUED

E. Distribution Uniformity

Measurement of Distribution Uniformity may be used as an alternate means of measuring uniformity.

FORMULA TWELVE

$$DU = \frac{\text{Average collected volume of lower quarter of catch cans}}{\text{Average collected volume of all catch cans}} \times 100\%$$

F. Distribution Uniformity (DU) is the measure of how evenly water is applied across the landscaped area. Obtaining a DU for a given system requires the use of a catch can test. When conducting a catch can test, the cans are placed throughout the zone. The irrigation is operated long enough to apply a measurable quantity of water. The amount of each can is recorded. The average of all the cans is computed and the average of the lowest quarter is computed. Formula twelve is than used to compute the distribution uniformity.

5.05 Sprinkler/emitter Testing

A. All sprinklers must be adjusted to minimize over-spray onto buildings and paved areas.

B. All sprinkler controls must be adjusted to minimize runoff of irrigation water.

C. All sprinklers must operate at their design radius of throw.

D. Spray patterns must overlap as designed.

E. Verify that the sprinklers are connected to the appropriate zone.

F. Verify that nozzle or emitter sizes and types called for in the system design have been used.

5.06 Pressure Distribution Testing

A. **Pressure head loss tests:** The design operating pressure of the system shall be stated on the plan. The pressure at any point in the system shall not be more than plus or minus 10% of the design operating pressure at that point.

B. **Testing Will Be Performed as Follows:**

1. Zones to be tested will include, at minimum, the largest zone, smallest zone, the zone closest to the source in terms of mainline distance, and the zone farthest from the source in terms of mainline distance.

2. Testing of each zone will be done by measuring pressure at a minimum of 2 points. One pressure will be measured at the sprinkler closest to the zone control valve and the second will be measured at the sprinkler farthest from the zone control valve.

5.07 Backflow Prevention Assembly Testing

A. A certified technician will test all assemblies that can be tested prior to being placed into service.

PART 5: TESTING AND INSPECTION CONTINUED

5.08 Site Restoration

A. Verify that all existing landscaping, pavement, and grade of areas affected by work were restored to original condition or to the satisfaction of the system owner.

B. Verify that the pipeline trenches have been properly compacted to the densities required by the plans and specifications.

5.09 Rainfall Shutoff Device

The device shall be tested to ensure proper shut-off of control equipment.

5.10 Certification

A. All inspections and tests described herein will be certified to the owner in writing by the installing contractor. Certification will include the following:

1. The date on which inspections and/or tests were performed.
2. List of attendees at inspections/tests.
3. The signature of the contractors.
4. Record drawing.

B. It is suggested that, upon receipt of the letter of certification, the governing inspection authorities perform at least the following inspections:

1. Inspect backflow prevention assemblies to verify that the make, model, and size conform to specifications, and it was installed and functions in conformance with applicable code.
2. Inspect valves to verify they are properly housed and installed to grade. Wire splices and connections shall be made using appropriate methods.
3. Inspect controlling devices to verify that they function, and to assure that they conform to applicable codes.
4. Observe the system operating through one complete cycle (with abbreviated irrigation periods) of the control system.

C. Where certification is not required by designer, owner, or by local code, the Contractor shall still provide at a minimum, a record drawing and warranty information.

END OF PART 5

LIST OF ABBREVIATIONS

cfs: cubic feet per second

FAC: Florida Administrative Code

ft: feet

fps: feet per second

gal: gallons

gph: gallons per hour

gpm: gallons per minute

hr: hour

I.D.: inside diameter of a pipe

L: liters

m: meters

min: minute

NIR: net irrigation requirement

O.D.: outside diameter of a pipe

POC: Point of Connection

psi: pounds per square inch

sec: second

GLOSSARY OF IRRIGATION TERMINOLOGY

Absorption Rate (aka percolation rate): The rate at which a soil will absorb water. It is not a constant rate for a given soil because it includes the infiltration rate and the water-holding capacity of the soil.

Air Release Valve: A valve that will automatically release to the atmosphere accumulated small pockets of air from a pressurized pipeline. A small orifice is used to release air at low flow rates. Air release valves are normally required at all summits of mainline and submain pipelines in an irrigation system.

Anti-Siphon Device: A safety device used to prevent backflow of irrigation water to the water source by back-siphonage.

Application Efficiency (Ea): The percentage of water applied by an irrigation system that is stored in the root zone and available for plant material use.

Application Rate: The average rate at which water is applied by an irrigation system, also called precipitation rate. Units are typically inches/hr or mm/hr.

Arc (aka pattern): The angle of coverage of a sprinkler in degrees from one side of throw to the other. A 90-degree arc would be a quarter-circle sprinkler.

Atmospheric Vacuum Breaker: An anti-syphon device that consists of an air inlet port and a float type check valve. Water draining back from irrigation lines is directed to the atmosphere to protect the potable water supply.

Automatic Control Valve: A valve in a sprinkler system that is activated by an automatic controller by way of hydraulic or electrical control lines.

Automatic System: An irrigation system that operates following a program using an automatic controller.

Available Soil Water (AW): The amount of water in the root zone that can be extracted by plants before permanent wilt. This is the difference between the water stored between field capacity (FC) and the permanent wilting point (PWP).

Backflow: Water which drains from an irrigation system back to the water source by back-pressure or back-siphonage.

Backflow Prevention Device: A safety device used to prevent pollution or contamination of the irrigation water supply due to backflow from the irrigation system.

Belled (Pipe): Pipe which is enlarged at one end so that the spigot end of another length of pipe can be inserted into it during the assembly of a pipeline.

Bid Proposal: Written price proposal presented to an irrigation system purchaser to provide all materials, equipment, and labor for a completely installed and operational system.

Block (of sprinklers): A group of sprinklers controlled by one valve. Also sometimes called zones or subunits.

Block System: An irrigation system in which several groups of sprinklers are controlled by one valve for each group.

Body (of a sprinkler): The exterior case or shell of the sprinkler.

Border: The edge of an area that is to be irrigated.

Bubbler Irrigation: The application of water to the soil surface or a container as a small stream or fountain. Bubbler emitter discharge rates are greater than .5 gph characteristic of drip emitters, but generally less than 4 gpm (240 gph). Because the infiltration rate of the soil is normally exceeded, a basin or container is usually required to contain or control the water.

Capillary Water: Water which remains in the soil pore spaces after gravity drainage has occurred. This water resides in the soil pores where capillary forces balance gravity forces so that further drainage is negligible.

Check Valve: A valve that permits water to flow in one direction only.

Chemical Water Treatment: The addition of chemicals to water to make it acceptable for use in irrigation systems. Chemical water treatment is primarily required for micro irrigation systems. Treatment may include the use of acids or biocides for pH adjustment or to prevent clogging of micro irrigation emitters, staining.

Chemigation: The application of water soluble chemicals by mixing or injecting with the water applied through an irrigation system.

Christiansen's Uniformity Coefficient (C_u): A measure of the uniformity of water application calculated as 100% times the sum of the absolute values of the deviations of individual measurements from the mean, divided by the mean.

Control Lines: Hydraulic or electrical lines that carry signals (to open and close the valves) from the controller to the automatic valves.

Control Station: The assembly of components used to apply irrigation in an effective and timely manner. The control station may include facilities for water measurement, filtration, chemigation, pressure regulation, backflow prevention, scheduling of irrigations, and weather stations.

Controller: The timing mechanism used to control signals to the automatic control valves to open and close on a scheduled program or based on sensor readings.

Contractor: Any person who engages in the fabrication and installation of any type of irrigation system on a contractual basis.

Consultant: Any person who engages in the professional practice, receiving his compensation in the form of professional fees, including but not limited to: for the purpose of consulting, preparing plans, working drawings, specifications, budgeting, and estimating, on-site inspection of work in progress, conducting final inspection of completed work, or undertaking any other professional services related to irrigation systems.

Coverage: Refers to the way water is applied to an area. Typically coverage refers to the fraction of the volume of the root zone that is irrigated, or the fraction of the soil surface that is irrigated.

Cycle: Refers to one complete run of a controller through all programmed controller stations.

Deep Percolation: The amount of water that drains through the bottom of the root zone and is thus lost with respect to potential plant material use.

Demand (or irrigation demand): Refers to the irrigation requirements of the irrigated area. Demand primarily depends on the type of plant material, stage of growth, ET, soils, or other environmental conditions.

Design Area: The specific land area to which water is to be applied by an irrigation system.

Design Emission Uniformity: An estimate of the uniformity of water application with an irrigation system.

Design Pressure: The pressure at which the irrigation system or certain components are designed to operate. The irrigation system design pressure is that measured at the pump discharge or entrance to the system if there is no pump, and a zone design pressure is the average operating pressure of all sprinkler/emitters within a zone.

Direct Burial Wire/cable: Plastic-coated, single copper wire that is approved for direct burial by the NEC.

Discharge Head: The difference in elevation between the center line of the discharge pipe and the average point of discharge from the irrigation system, plus the friction head losses between these points, plus the subunit operating pressure, plus the velocity head. This is equivalent to the gauge pressure measured at the center line of the discharge pipe, in feet or meters.

Discharge Rate: The instantaneous flow rate of an individual sprinkler, emitter, or other water emitting device, or a unit length of line-source micro irrigation tubing. Also, the flow rate from a pumping system. Discharge rates are expressed in units of volume per time such as gpm, gph, lph, or lpm.

Distribution Uniformity (DU): A measure of the uniformity of water application calculated as 100% times the average depth of water infiltrated or applied in the lowest 1/4 of the area tested, divided by the average depth applied.

Double Check Valve: An assembly of two single, independently-acting check valves with test ports to permit independent testing of each check valve.

Drain Valve: A valve used to drain water from a line. The valve may be manually or automatically operated.

Drawdown: The difference between the pumping and static water levels as water is pumped from a well. Units are usually in feet or meters.

Drip Irrigation: The precise low-rate application of water to or beneath the soil surface near or directly into the plant root zone. Applications normally occur as small streams or discrete or continuous drops measured gph. Emitters may be classified as point source, line source, or microsprays.

Dual Check Valve – A device consisting of independently acting, spring-loaded check valves usually requiring removal to test.

Dynamic Head: See Total Dynamic Head.

Effective Rainfall: That portion of rainfall that infiltrates into the soil and is stored in the plant root zone where it is available for plant use. Units are typically inches or millimeters.

Effective Root Zone: The depth of soil in which most of the plant roots actively involved in water extraction are located. This is usually the upper 50% to 75% of the plant root zone rather than the depth to which the deepest root penetrates. It is this zone in which irrigations should be concentrated.

Electric Valves: Valves actuated by electric current.

Elevation Head: The difference in pressure between two points of elevation. Usually expressed in feet or meters.

Emitters: Devices that are used to control the discharge of irrigation water from lateral pipes or tubing. This term is primarily used to refer to the low flow rate devices used in micro irrigation systems.

Emitter Operating Flow: The instantaneous discharge rate at a given operating pressure from a point-source emitter or from a unit length of line-source emitter, expressed as a volume per unit time such as gph, gpm.

Evapotranspiration (ET): The combined losses of water by evaporation from the soil and other surfaces and transpiration from plants, normally expressed in inches or millimeters per day. Also called water use rate or consumptive use rate.

Fertigation: The application of soluble fertilizers and/or nutrients with the water applied through an irrigation system.

Field Capacity (FC): The water content of the soil in the plant root zone after most gravity drainage has occurred, generally one to two days after rain or irrigation. FC is usually defined as the water content that exists when soil water tension is in the range of 0.1 bars (for sandy soils) to 0.33 bars (for heavier soils).

Filtration System: The assembly of physical components used to remove suspended solids from irrigation water. These include both pressure and gravity type devices, such as settling basins, screens, media filters, and centrifugal force units (vortex sand separators).

Flow Meters: Devices used to measure the volume of flow of water (typically in gallons), or flow rates (typically in gpm), and to provide data on system usage.

Friction Head (Hf)check: Friction head is expressed in units of feet or meters of water.

Friction Loss: The loss of pressure incurred when water is moving through pipelines. Losses depend on the smoothness of pipe, length and diameter of pipe, orifice sizes in components, mechanical restrictions, and flow velocity. Units are usually psi.

Gravity Flow: The flow of water due to gravitational forces only, i.e., water flowing downhill.

Gravitational Water: Water that moves into, through, or out of a soil under the influence of gravity forces. Gravitational water rapidly drains from the soil and is normally not available for plant use.

Gauge (Wire): Standard specification for wire size. The larger the gauge number, the smaller the wire diameter. Gauge is expressed as the American Wire Gauge (AWG) based on the circular mil system of one mil equals 0.001 inches.

Head: A sprinkler head. Sometimes used interchangeably with and in conjunction with "Sprinkler".

Head: Pressure per unit weight of water, a measure of pressure in terms of the height of a column of water that can be supported by that pressure. A 1.0 ft column of water is equivalent to .433 psi, or 2.31 ft of water = 1.0 psi.

Header (header pipeline): See manifold.

Hydraulic Control Valve: An automatic valve that is controlled by supplying and releasing water pressure to the diaphragm or piston of the valve through the use of hydraulic control tubing.

Hygroscopic Water: Water that is strongly bound to the soil particles, and which is thus unavailable for plant use.

Infiltration Rate (aka percolation rate): The rate of water flow from the surface of the soil and into the soil profile. Units are usually inches/hr.

Irrigation: Application of water by artificial means, that is, means other than natural precipitation. Irrigation is practiced to meet plant requirements, leach salts, apply chemicals, and for environmental control including plant cooling and freeze protection.

Irrigation Interval: The time period between the start of successive irrigations.

Irrigation Frequency: The numbers of irrigation cycles per day, week, or other time period

Irrigation Schedule: The watering plan or procedure which sets forth the operating time and frequency for each irrigation system zone.

Irrigation Water Requirement or Irrigation Requirement: The quantity of water that is required for plant growth, exclusive of effective rainfall. Irrigation requirement includes water needed for leaching, plant cooling, freeze protection, and other uses beneficial to plant growth. Irrigation requirement is normally expressed in units of inches. Net irrigation requirement (NIR) is the amount of water that must be supplied to the plant root zone. Gross irrigation requirement is the amount that must be diverted (pumped) from the water source and includes losses during conveyance and application.

Irrigation Water Use Efficiency (Eu): The ratio of water beneficially used in plant growth to water applied, expressed as a percentage.

Landscape: Refers to any and all areas that are planted, including but not limited to turf, ground covers, flowers, shrubs, trees, and similar plant materials as opposed to agricultural crops grown and harvested for monetary return.

Leaching Requirement (LR): The amount of water in excess of that which can be stored in the soil profile, to be applied during irrigation to ensure that excess salts are removed from the root zone by drainage. Units are usually inches.

Lateral: The water delivery pipeline that supplies water to emitters or sprinklers downstream from a control valve or manifold or header pipeline.

Licensing Program: A comprehensive legislated program, whereby any person desiring to do business serving the general public in a given craft, trade, or profession must obtain a license granted upon proof, through a qualifying examination, of compliance with experience requirements, and the meeting of other reasonable criteria, of his capability to satisfactorily perform such work plus proof of his capability and intentions of meeting such other requirements as may be deemed necessary for the protection of the health, safety, and general welfare of the public; and further providing suitable means of enforcement of the licensing regulations so established.

Line-Source Emitters: Lateral pipelines which are porous or contain closely-spaced perforations so that water is discharged as a continuous band or in overlapping patterns rather than discrete widely-spaced points along the pipeline length. Individual emitter flow rates do not genrally exceed 4 GPH.

Looped System: A piping system that allows more than one path for water to flow from the supply to the emitters or sprinklers.

Mainline: A pipeline that carries water from the source to submains, control valves, manifolds or header pipelines of the water distribution system.

Manifold: The water delivery pipeline that conveys water from the main or submain pipelines to the laterals or control valves. Also sometimes called a header pipeline.

Manual System: A system in which control valves are manually operated rather than operated by automatic controls.

Manufacturer's Coefficient of Variation (Cv): A coefficient which describes the variation in discharge rate (standard deviation divided by the mean discharge rate) for a sample of new emitters or unit lengths of line-source emitter tubing when operated at design operating pressures. This term is also used to describe the expected variability in functioning of other irrigation system components, such as the variability in pressures from pressure control valves, discharge rates from flow control valves, etc.

Meter Box (aka valve box): A concrete or plastic box buried flush to grade which houses flow (water) meters or other components.

Microirrigation: The frequent application of small quantities of water directly on or below the soil surface, usually as discrete drops, tiny streams, or miniature sprays through emitters placed along the water delivery pipes (laterals). Micro irrigation encompasses a number of methods or concepts, including drip (Previously known as trickle irrigation, subsurface, bubbler, and micro spray irrigation. .

Micro spray irrigation – Water is applied by by a small spray or mist to the soil surface. Discharge rates generally do not exceed 30 GPH)

Microirrigation System: The physical components required to apply water by micro irrigation. System components may include a pumping station, control station, filtration, pressure regulation, main and submain pipelines, lateral pipelines, emitters, valves, fittings, safety devices, and other items.

Net Irrigation Requirement (NIR): Water, in addition to that provided by precipitation, required to be provided to the plant root zone by irrigation to meet the plant water requirements.

Nozzle: The discharge orifice of the sprinkler head.

Operating Cost: The cost of operating an irrigation system, including the cost of water, pumping, repairs and labor.

Operating Pressure: The nominal or average pressure at which defined components of an irrigation system operate. Also see system operating pressure and subunit operating pressure.

Overlap: The amount one sprinkler pattern overlaps another. Expressed as a percentage of the diameter of coverage.

Overwatering: Applying more water than necessary to meet the design intent.

PE Pipe: Flexible polyethylene pipe for use in irrigation systems, normally manufactured with carbon black for resistance to degradation by ultraviolet radiation.

Permanent Wilting Point (PWP): Also called wilting point, PWP is the water content in the soil in the plant root zone when the plant can no longer extract water from the soil, and the plants die (permanently wilt).

Point-Source Emitters: Individual water emitting devices that are widely spaced and discharge water at discrete points rather than by seepage along a porous pipe. Multiple-outlet point source emitters may discharge water at two or more emission points. This term is primarily used in reference to micro irrigation systems. Individual emitters generally do not have flow rates that exceed 2 GPH.

Potable Water: Water that is suitable in quality for human consumption.

Precipitation: The natural deposition on the earth's surface of water in the forms of rain, hail, sleet, snow, or mist (fog). In Florida, this term is often used as a synonym for rain.

Precipitation Rate: The average rate (in inches per hour) that precipitation occurs or which an irrigation system applies water to the irrigated surface.

Pressure: The energy contained in water due to confinement in an enclosed system (pipeline, pressure tank, etc.), specifically the energy per unit volume of water, measured in psi.

Pressure Loss: The loss of water pressure under flow conditions, primarily caused by friction or elevation changes.

Pressure Rating (PR): The estimated maximum pressure that water in a pipe can exert continuously with a high degree of certainty that failure of the pipe will not occur.

Pressure Relief Valve: A valve that will open and discharge to atmosphere when the pressure in a pipeline or pressure vessel exceeds a pre-set point to relieve the high pressure condition.

Pressure Vacuum Breaker: A backflow prevention device that includes a spring-loaded check valve and a spring-loaded vacuum breaker to prevent the backflow of irrigation system water to the water source.

Pumping Station: The pump or pumps that provide water to an irrigation system, together with all of the necessary accessories such as bases or foundations, sumps, screens, valves, motor controls, safety devices, shelters and fences.

PVC Pipe: Polyvinyl chloride plastic pipe made in standard thermoplastic pipe dimensions and pressure rated for water.

Rainswitch: See rainfall shutoff device.

Rainfall Shutoff Device: A device designed to interrupt or cease automatic irrigation operation after a pre-determined amount of rainfall.

Readily Available Soil Water (RAW): The amount of water in the plant root zone that can easily be extracted by the plants. This is the amount of water that is often allowed to be extracted before an irrigation is scheduled. RAW is often assumed to be 1/3 to 2/3 (typically 1/2) of the available soil water (AW).

Reclaimed Water: The use of this term in these standards shall refer to water as defined under C62-610FAC for public access areas.

Record Drawing: A finished plan of an installed irrigation system designating valve, sprinkler and controller locations, routing of piping and control lines, and all other pertinent information.

Riser: A pipe to which sprinklers or other emitters are attached.

Root Zone: The depth of soil profile occupied by the roots of the plant being irrigated. Also see effective root zone.

Soil Water Content (WC): Also called the soil moisture content, WC is a measure of the water stored in the soil. WCv is the volumetric soil water content, which is the ratio of the volume of water stored per unit volume of soil, expressed as a percentage. WCg is the gravimetric water content, which is the ratio of the mass (weight) of water stored per unit mass (weight) of soil, expressed as a percentage. The volumetric soil water content is the preferred method of expressing soil water- holding capacity for irrigation purposes because, when WCv is multiplied by the soil depth, the result is the depth of water stored in that soil depth.

Sleeve: A pipe used to enclose other pipes, wire, or tubing usually under pavement, sidewalks, planters or concrete structures.

Spacing: The distance between sprinklers or other emitters.

Spray Irrigation: The conveyance of water by fixed arc or rotors where the conveyance of water is through the air.

Sprinkler: The sprinkler head. Sometimes called "Head".

Standard Dimension Ratio (SDR): For O.D. controlled pipe, the ratio of the pipe O.D. to the wall thickness. For I.D. controlled pipe, the ratio of the pipe I.D. to the wall thickness.

Static Head: See elevation head.

Static Pressure (Water Supply): The pipeline or municipal water supply pressure when water is not flowing.

Statistical Uniformity Coefficient (CUs): A measure of uniformity of water application calculated from 100% times (1.0 - Cv), where Cv is the statistical coefficient of variation calculated as the ratio of the standard deviation to the mean depth of application or flow rate measured.

Subunit Operating Pressure: The average operating pressure of all sprinklers or other water emitting devices operating simultaneously in an irrigation system subunit.

Suction Head (Hs): The elevation difference between the water supply (including drawdown, when pumping from a well) plus the friction head losses upon entrance and within the suction pipeline. Units are typically feet or meters of water.

Supply (Water Source): The origin of the water used in the irrigation system.

Surge: An energy wave in pipelines, caused by sudden changes in water velocity, which causes a rapid increase or decrease in pipe pressure. Sudden velocity changes are caused by sudden opening or closing of valves, startup or shutdown of pumps, sudden air release, rapidly filling an empty pipeline, etc. Also called water hammer.

Swing Gate Check Valve: A check valve that allows water flow in only one direction by means of a hinged gate in the valve.

Swing Joint: A flexible connection between the lateral pipe and the sprinkler that allows the sprinkler to move when force is applied to it. This protects the lateral pipe and is used to easily position sprinklers at final grade.

System Operating Pressure: The average operating pressure at the inlet to the irrigation system control station, that is at the pump discharge, well discharge, or discharge from a public water system, typically given in psi. The system operating pressure must be greater than the subunit or emitter operating pressures because of pressure losses through system components as water flows through the irrigation system.

Total Available Soil Water (TAW): TAW is the total depth of water in the plant root zone that is available for plant use. It is calculated as the available water (AW) multiplied by the effective plant root zone depth. Units commonly used are inches.

Total Dynamic Head (TDH): TDH is the total irrigation system head when the system is in operation. TDH includes the sum of the static head, plus the friction head losses, plus elevation head, plus the irrigation distribution system operating pressure, plus drawdown when pumping from a well. Units are typically feet of water.

Trickle Irrigation: See Microirrigation.

Tubing: Generally used to refer to flexible plastic hydraulic lines that are usually constructed of PE or PVC.

Two Wire Systems: Two wire or decoder systems use a single pair of wires to operate a large number of stations with individual decoders.

Uniformity Coefficient (C_u): A coefficient that expresses the degree of uniformity of water application or storage in an irrigated field. See also Christiansen's Uniformity Coefficient, Statistical Uniformity Coefficient, and Distribution Uniformity.

Uniformity of Water Application: A measure of the spatial variability of water applied or stored over an irrigated field. The irrigation uniformity is usually expressed as a percentage, with 100% representing perfect uniformity.

Usable Water: See Available Water.

Vacuum Breaker: A type of backflow prevention device that reduces the potential for backflow of water by opening the pipeline to atmospheric pressure.

Velocity (of Water): The average speed at which water travels through pipe or tubing.

Velocity Head (Hv): The energy contained in flowing water because of its velocity or the energy required to accelerate the water to a given velocity. Hv is calculated from V*V/2.0*g, where g is the acceleration of gravity (32.2 ft/sec/sec). Hv is a relatively small factor and need not be considered in design of most pressurized irrigation systems. Hv must be considered in the design of very low pressure, surface, and seepage irrigation systems.

Water Amendment: The addition of fertilizers, herbicides, insecticides, or other additives to irrigation water for the enhancement of plant production or to reduce emitter clogging or otherwise enhance irrigation system performance.

Water Applied: The amount of water actually applied during an irrigation cycle, expressed as a volume or depth. The water applied can be either more or less than the irrigation requirement.

Water Demand: The water requirements of an irrigation system necessary to operate the irrigation system.

Water Requirement: See Irrigation Requirement.

Watering Schedule: See Irrigation Schedule.

Water Stored: The amount of water that is stored in a plant root zone as the result of irrigation or rainfall, usually expressed as a depth of water in inches.

Watering Time: The duration of an irrigation cycle which is calculated from the system application rate, the net irrigation requirement, and the irrigation system application efficiency.

Wilting Point: See Permanent Wilting Point.

Working Pressure: The maximum pressure (psi) required at the water source when the irrigation system is in operation. Also see operating pressure.

FLORIDA IRRIGATION SOCIETY
IRRIGATION STANDARDS – 2001

REFERENCE LIST

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1. Florida & National Governmental requirements and listings:

   FAC – S62–610, Part III (sub-sections 450 thru 491) : **Florida Administrative Codes** — Slow-Rate Land Application Systems; Public Access areas, Residential irrigation, and Edible crops

   Florida Building Code

   FS – Sec. 373.62: Florida Statutes Sections — Rainfall Devices

   FS – Sec. 487.021 & 487.055: Florida Statutes Sections — Chemical Injections

   NRCS – FL–430–DD: The new 1998 revision of the older Soil Conservation Service Codes by the National Resources Conservation Services – for water conveyance

   NRCS – FL–642: The new 2000 revision of the older Soil Conservation Service Codes by The National Resources Conservation Services – for Wells and Pumps

2. American Society of Agricultural Engineers (ASAE) Partial listing of standards and practices:

   ASAE S376.2 (JFEB04) — Design, Installation and Performance of Underground Thermoplastic Irrigation Pipelines

   ASAE S397.2 (FEB03) — Electrical Service and Equipment for Irrigation

   ASAE S398.1 (FEB04) — Procedure for Sprinkler Testing and Performance Reporting

   ASAE S435 FEB)$) — Polyethylene Pipe Used for Microirrigation Laterals

   ASAE EP400.2T FEB04) — Designing and Constructing Irrigation Wells

3. American Society for Testing Materials (ASTM) Partial listing of standards:

   ASTM A53/A53M-04a — Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

   ASTM A589-96 (2001) — Standard Specification for Seamless and Welded Carbon Steel Water-Well Pipe

   ASTM D1785-04a — Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120

   ASTM D2239-03 — Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter

   ASTM D2241-04b — Standard Specification for Polyvinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series)

   ASTM D2464-02 — Standard Specification for Threaded Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80

   ASTM D2466-02 — Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40

   ASTM D2564-04 — Standard Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Piping Systems

   ASTM D2855-96 (2002) — Standard Practice for Making Solvent-Cemented Joints with Poly

(Vinyl Chloride) (PVC) Pipe and Fittings

ASTM D3139-98 — Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

ASTM D412-98a (2002)e7— Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension

ASTM F477-02e7 — Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

ASTM F656-02 — Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

4. American Water Works Association (AWWA) Standards:

C510-97 — Double Check Valve Backflow Prevention Assembly

C511-97 — Reduced-Pressure Principle Backflow Prevention Assembly

C605-94 – Underground Installation of Polyvinyl Chloride (pvc) Pressure Pipe and Fittings for Water.

C900-97 — Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution

C901-96 — Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) Through 3 In. (76 mm), for Water Service

C905-97 — Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm), for Water Transmission and Distribution

5. American Society of Sanitary Engineering (ASSE) — Product Performance Standards

1001 – Pipe Applied Atmospheric Type Vacuum Breakers — ANSI 1990/ASSE 1988

1013-2005 – Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers — ANSI/ASSE 1999

1015-2005 – Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies — ASSE/ANSI 1999

1020-2004 – Pressure Vacuum Breaker Assembly — ASSE 1998

1024-2004 – Dual Check Valve Backflow Preventers — ANSI/ASSE 1994

6. Textbooks and Publications:

TURF IRRIGATION MANUAL by Richard B. Choate and James A. Watkins – A Telsco Publication – 5th Edition, May 1995

HANDBOOK OF TECHNICAL IRRIGATION INFORMATION by Hunter Industries Inc. – 1996

WATER AND THE LAND: A History of American Irrigation by Robert Morgan and The Irrigation Association – 1993

THE COMPLETE IRRIGATION WORKBOOK by Larry Keesen – 1995

PUBLICATIONS, NOTES, AND PAPERS by The Center of Irrigation Technology, California State University – Fresno, California

PUBLICATIONS and STANDARDS by The Florida Irrigation Society – Orlando, Florida

PUBLICATIONS, NOTES, AND PAPERS by The Institute of Food and Agricultural Sciences – University of Florida

PUBLICATIONS by The Irrigation Association – Falls Church, Virginia

INSTALLATION GUIDE FOR PVC PRESSURE PIPE by the Unibell PVC Pipe Association

ENTITIES WITH STANDARDS, SPECIFICATIONS AND PROCEDURES
FOR IRRIGATION PRACTICE — Partial listing

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ANSI: American National Standards Institute, 1819 L Street, NW., Washington, DC.
Phone: 202-293-8020 Fax: 202-293-9287 Web Site: www.ansi.org

ASAE: American Society of Agricultural Engineers, 2950 Niles Road St. Joseph, MI.
Phone: 616-429-0300 Fax: 516-420-3852 E-mail: www.asae.org
mailto:hq@asae.org

ASSE: American Society of Sanitary Engineering, 901 Canterbury, Suite A, Westlake, OH.
Phone: 440-835-3040 Fax: 440-835-3488 Web Site: www.asse-plumbing.org

ASTM: American Society of Testing Materials, 100 Barr Harbor Drive, West Conshohocken, PA.
Phone: 610-832-9500 Fax: 610-832-9266 Web Site: www.astm.org

AWWA: American Water Works Association, 6666 West Quincy Avenue, Denver, CO.
Phone: 303-794-7711 Web Site: www.awwa.org

CIT: Center for Irrigation Technology, 5370 N. Chestnut M/S Of 18, Fresno, CA.
Phone: 559-278-2066 Fax: 559-278-6033 Web Site: www.atinet.org/cati/cit

EPA: (U.S.) Environmental Protection Agency, 401 M Street, SW., Washington, DC.
Phone: 202-260-4355 Fax: 202-260-3522 E-mail: www.epa.gov

FIS: Florida Irrigation Society, 1025 S. Semoran Blvd., Suite 1093, Winter Park, FL.
Phone: 407-678-8119 Fax: 407-678-6494 E-mail: www.fis1234@aol.com
Web Site: www.fisstate.org

FS: Florida Statutes, State of Florida - Web Site: www.state.fl.us./statutes

IA: Irrigation Association, 6540 Arlington Blvd., Falls Church, VA.
Phone: 703-536-7080 Fax: 703-536-7019 Web Site: www.irrigation.org

IFAS: Institute for Food and Agricultural Sciences, University of Florida, Gainesville, FL.
Phone: (UF) 352-392-3261 or (IFAS) 352-392-1971 Web Site: www.ifas.ufl.edu

ISO: International Organization for Standardization, Geneva, Switzerland
Phone: 41-22-749-01-11 Fax: 41-22-733-34-30 Web Site: www.iso.ch

LCCC: Irrigation Management Program, Lake City Community College, Lake City, FL.
Phone: 904-752-1822 Fax: 904-755-1856 Web Site: www.irrigationschool.org

NRCS: Natural Resources Conservation Service, P.O. Box 2890, Washington, DC
(Formerly known as the Soil Conservation Service)
Phone: 202-720-4525 Fax: 202-720-7690 Web Site: www.fl.nrcs.usda.gov

SWCS: Soil & Water Conservation Society, 7515 NW Ankeny Road, Ankeny, IA.
Phone: 515-289-2331 Fax: 515-289-1227 Web Site: www.swcs.org
http://www.iso.org

FAC: Florida Administrative Code
http:fac.dos.state.fl.us

FBC: Florida Building Code
www.floridabuilding.org