**NATURAL RESOURCES CONSERVATION SERVICE**
**CONSERVATION PRACTICE STANDARD**

# IRRIGATION SYSTEM, SPRINKLER

**(No. and Acre)**
**Code 442**

## DEFINITION

A planned irrigation system in which all necessary facilities are installed for efficiently applying water by means of perforated pipes or nozzles operated under pressure.

## PURPOSE

This practice may be applied as part of a conservation management system to support one or more of the following purposes.

- To efficiently and uniformly apply irrigation water
- To provide frost protection
- To apply chemicals
- For application of waste from agricultural waste management operations
- Crop cooling

## CONDITIONS WHERE PRACTICE APPLIES

This practice applies to the sprinkler irrigation system through which water is distributed by means of perforated pipe, sprinklers or spray nozzles. It applies to all components of the on farm irrigation system except for special structures such as permanently installed mains and laterals and pumping plants (NRCS FL conservation practice standards Irrigation Water Conveyance, Pipeline, Code 430, and Pumping Plant for Water Control, Code 533).

Sprinkler irrigation plans shall be based on an evaluation of the site, crops to be irrigated and the expected operating conditions. The soils and topography shall be suitable for irrigation for the planned purpose.

The water supply must be sufficient in quantity and quality for the crops to be grown.

The sprinkler method of irrigation is suited to most crops, to most irrigated lands, and to most climatic conditions where irrigated agriculture is feasible.

## CRITERIA

**General Criteria Applicable To All Purposes**.

All planned work shall comply with all Federal, State, and local laws and regulations. Plans to utilize water resources may need to be approved or permitted by the appropriate water management district in accordance with Chapter 40-2 Florida Administrative Code (F.A.C.).

All sprinkler irrigation systems shall be operated in accordance with the irrigation water management (IWM) plan. IWM plans shall be prepared in accordance with NRCS FL conservation practice standard, Irrigation Water Management, Code 449.

Sprinkler irrigation systems shall be operated without causing excessive water loss, erosion, or degrading water quality.

Distribution patterns and spacing. A combination of sprinkler spacing, nozzle sizes, and operating pressure that most nearly

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

provides the design application rate and distribution shall be selected. The velocity of prevailing winds and other conditions shall be considered in the design.

If available from the manufacturer, uniformity coefficient (CU) data shall be used in selecting sprinkler spacing, nozzle sizes, and operating pressure. The CU shall not be less than as shown below except as specified in "Additional Criteria for Wastewater Application":

70% for orchards and groves
75% for deep-rooted (4 feet or more) field and forage crops
85% for high-value or shallow rooted crops

In the absence of such data, sprinkler performance tables provided by the manufacturers shall be used in selecting nozzle sizes, operating pressure, and wetted diameter for the required sprinkler discharge. The maximum spacing shall comply with the following criteria:

1. Fixed and Hand Move Overhead Sprinkler Irrigation Systems.

   a. For low (2 - 35 psi), moderate (35 - 50 psi), and medium (50 - 75 psi) pressure sprinklers, the spacing along lateral lines ($S_l$) shall not exceed 50 percent of the effective wetted diameter, as given in the manufacturer's performance tables, when the sprinkler is operating under optimum pressure. The spacing of laterals along the main line ($S_m$) shall not exceed 65 percent of this wetted diameter. If winds that can affect the distribution pattern are likely, spacing ($S_m$)shall be reduced to 60 percent for average velocities of 5 mph, to 50 percent of the wetted diameter for average velocities of 10 mph, and to 30 percent for average velocities greater than 10 mph.

   b. For high pressure sprinklers (75 + psi), the maximum distance (diagonal) between two sprinklers on adjacent lateral lines shall not exceed 65 percent of the effective wetted diameter under favorable operating conditions. If winds that can affect the distribution pattern are likely, the diagonal spacing shall be reduced to 50 percent of the effective wetted diameter for average velocities of 5 mph and to 30 percent for average velocities greater than 10 mph.

   c. Sprinkler spacing requirements for citrus groves and orchard crops including subtropical fruits:

      (i) Triangular pattern. The spacing along lateral lines shall not exceed 65 percent of the effective wetted diameter, as given in the manufacturer's performance tables, when the sprinkler is operating under optimum pressure. The spacing of laterals along the main line shall not exceed 70 percent of the effective wetted diameter.

      (ii) Square or rectangular pattern. Both the spacing along the lateral and the lateral spacing along the main line shall not exceed 65 percent of the effective wetted diameter.

      (iii) Spacing shall be reduced by 2.5 percent for each mph over 3 mph average wind velocity normally occurring during planned hours of operation.

2. Perforated pipelines. The spacing recommendations of the manufacturer for the design application rate, number and size of perforations, and operating pressure shall be followed.

3. Traveling Sprinkler Irrigation Systems. The tow path spacing shall follow the recommendations in Table 11-31, National Engineering Handbook (NEH) Part 623, Chapter 11, Sprinkle Irrigation.

Lateral Lines. Lines shall be so designed that in an irrigation unit operated simultaneously, the total pressure variation at the sprinkler heads resulting from friction and static head will not exceed 20 percent of the design operating pressure of the sprinklers. Where variation in pressure is not a good reflection of application uniformity, such as when flexible nozzles and pressure control devices are used, the lines shall be so designed that the total variation in discharge rate will not exceed 10 percent of the design discharge rate.

Except for undertree sprinklers, riser pipes used in lateral lines shall be high enough to prevent interference with the distribution pattern when

the tallest crop is irrigated. Riser heights shall not be less than shown in Table 1. Risers over 3 feet in height shall be anchored and stabilized.

Main lines. The design of main lines, submains, and supply lines shall ensure that the quantities of water required are conveyed to all lateral lines at sufficient pressure to ensure at least the minimum required pressure in the lateral lines.

If the pressure required for sprinkler system operation is provided by pumping, main line pipe sizes shall ensure that there is an economical balance between the capitalized cost of the pipe and annual pumping costs.

Table 1 - Riser Heights

| Sprinkler Discharge, gpm | Riser Height, in. |
|---|---|
| Less than 10 | 6 |
| 10-25 | 9 |
| 25-50 | 12 |
| 50-120 | 18 |
| More than 120 | 36 |

Pump and power unit. The pump capacity and the power unit shall be adequate to operate the sprinkler system efficiently when maximum capacity is being pumped against maximum total dynamic head. Pumps shall be in conformance with NRCS FL conservation practice standard Pumping Plant for Water Control, Code 533.

Pipe. The pipe shall meet the requirements of NRCS FL conservation practice standard, Irrigation Water Conveyance, Pipeline, Code 430, for permanently installed underground pipelines. The manufacturer shall provide performance data on all other pipe used in the system, including the maximum allowable operating pressure.

## Additional Criteria for Crop Irrigation

Sprinkler irrigation systems shall be capable of being operated to maintain adequate soil moisture for optimum plant growth.

Depth of application. The net depth of application shall be based on the available moisture capacity of the soil in the root zone of the crop irrigated or a lesser amount consistent with the land user's IWM plan. The gross depth shall be determined by using field application efficiencies consistent with the conservation of water resources. The gross depth of application shall be based on a field application efficiency ($E_a$) not to exceed the values in Table 2.

Design application rate. The design application rate shall be a minimum of 0.10 iph and a maximum application rate consistent with the intake rate of the soil and the conservation practices used on the land. If two or more sets of conditions are in the design area, the lowest maximum application rate for areas of significant size shall apply.

Capacity. In regularly irrigated areas, sprinkler irrigation systems shall have either (1) a design capacity adequate to meet the moisture demands of all crops to be irrigated in the design area or (2) adequate capacity to meet the requirements of several selected irrigations during critical crop growth periods when less than full irrigation is planned. NEH, Part 623, Chapter 2, Irrigation Water Requirements or the Florida Irrigation Guide may be used to determine crop irrigation requirements. In computing capacity requirements, allowance must be made for reasonable water losses during application periods.

Table 2 - Application Efficiencies for Various Sprinkler Irrigation Systems

| Type | $E_a$ (%) |
|---|---|
| Periodic move lateral | 75 |
| Periodic move (gun or boom) | 60 |
| Fixed laterals (solid-set) | 75 |
| Traveling sprinklers (gun or boom) | 65 |
| Center-pivot - standard | 85 |
| Linear (lateral) move | 87 |
| LEPA - center pivot and linear move | 95 |

Systems for special purpose irrigation shall have the capacity to apply a stated amount of water to the design area in a specified net operating period.

## Additional Criteria For Frost Protection

The irrigation system must be capable of applying the rate and uniformity of water application based on the minimum temperature, maximum anticipated wind speed and relative humidity. The irrigation system must be capable of being operated at one time for the entire protected crop.

Water application should begin by the time the wet bulb temperature reaches 4 degrees above the critical temperature of the crop being protected. Water application should stop when the wet bulb temperature is above the critical temperature of the crop being protected. Careful consideration needs to be given to the wind speed as this increases evaporative cooling.

Guidance on sprinkler rate of application and temperatures to start irrigating for frost protection is contained in NEH, Part 623, Chapter 2.

Criteria contained in the appropriate water management district Chapter 40-2 F.A.C. shall be followed in the use of water for cold protection.

**Additional Criteria for Chemigation**

The CU shall be not less than 85 percent for any crop where fertilizer or pesticides are applied through the system.

Injectors (chemical, fertilizer or pesticides) and other automatic operating equipment shall be located adjacent to the pump and power unit and placed in accordance with manufacturer's recommendation. The chemical injection device shall be within 1 percent of maximum injection rates and easily calibrated and adjustable for all chemicals at the required injection rate. Irrigation systems, into which chemicals are injected, must incorporate backflow prevention equipment as required by Chapters 487.064 F.A.C. (pesticides) and 567.087 F.A.C. (fertilizers).

Application of chemicals will be the minimum length of time it takes to deliver the chemicals and flush the pipelines. Irrigation application amount shall be limited to the amount necessary to apply the chemicals as recommended by the chemical label. Chemigation shall be applied in conformance with NRCS FL conservation practice standards Nutrient Management, Code 590 and Pest Management, Code 595.

NEH, Part 623, Chapter 2 contains guidance on using sprinkler irrigation systems for chemigation.

**Additional Criteria for Wastewater Application**

Sprinkler irrigation systems used to apply waste shall be designed with sprinkler nozzles of sufficient size to prevent clogging. The irrigation system shall have a CU equal to or greater than 72 percent. Treatment of the waste water using solid separators, two stage lagoons, two stage waste holding ponds, etc., may be needed to reduce percent solids. Application of wastewater shall be in accordance with NRCS FL conservation practice standard Waste Utilization, Code 633.

**Additional Criteria for Crop Cooling**

Foliar cooling systems must have sufficient capacity to satisfy the evaporation demand on a minute-by-minute basis throughout the peak use days. Foliar cooling systems shall be designed and operated so that leaves are kept wet during the desired period. Water shall be applied until the leaf surfaces are saturated, shut off until they are nearly dry, then reapplied.

NEH, Part 623, Chapter 2 contains guidance on using sprinkler irrigation systems for crop cooling.

**CONSIDERATIONS**

Sprinkler irrigation will affect the water budget, especially volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation and ground water recharge because of an increased amount of water stored in the root zone for plant use.

Sprinkler irrigation can influence runoff and ground water percolation by raising the soil moisture level and decreasing the available soil water storage capacity thus increasing the probability of runoff or percolation below the root zone from storm events. This may affect surface water quality by the movement of sediment, soluble chemicals, and sediment attached substances carried by runoff or ground water quality through the movement of dissolved substances below the root zone.

Sprinkler irrigation may affect downstream flows or aquifers and the amount of water available for other uses.

Sprinkler irrigation may affect the salinity of soils, soil water and downstream water resources.

Crops may be more sensitive to salts applied to plant foliage during sprinkling than to similar water salinities applied by surface irrigation, subirrigation, and trickle irrigation. Information on foliar injury from saline water applied by sprinkler irrigation is contained in NEH, Part 623, Chapter 2. If the salt content of the irrigation water is high, other irrigation methods should be considered.

Weather conditions must be considered before applying chemicals. Chemigation should not be applied if rainfall is imminent. Chemigation may be required at the same time the crop receives an irrigation, while at other times chemical applications may be required when irrigation water is not needed by the crop. This will affect the economics of chemigation. Chemigation through irrigation systems that are capable of a minimum water application of 0.10 inch or less can greatly reduce the cost of chemigation and may improve the effectiveness of application.

On soils with excessive slope or where irrigation induced erosion is a concern, crop residue management practices should be considered to increase the soil infiltration rate.

Where wastewater is used for irrigation, timing of irrigation based on prevailing winds should be considered to reduce odor. In areas of high visibility, irrigating at night should be considered. The use of wastewater may reduce the life of the system due to corrosion or abrasion.

## PLANS AND SPECIFICATIONS

Plans and specifications for installation of sprinkler irrigation systems shall be in keeping with this standard and shall describe the requirements for properly installing the practice to achieve its intended purpose.

## OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be prepared for use by the owner or others responsible for operating the system. The O&M plan shall provide specific instructions for operating and maintaining the system to ensure that it functions properly for all planned purposes. The O&M plan shall provide for periodic inspections and prompt repair or replacement of damaged components.

Sprinkler nozzles should be inspected for wear and malfunctioning and replaced as necessary. Sprinkler irrigation systems used for applying waste water should be inspected periodically for clogging.

The irrigation system shall be operated in accordance with the IWM plan.

## REFERENCES

Chapters 487.064 and 567.087 F.A.C.
Chapter 40-2 F.A.C.
Florida Irrigation Guide
NEH, Part 623, Chapter 2
NEH, Part 623, Chapter 11
NRCS FL Conservation Practice Standards
- Irrigation Water Conveyance, Pipeline, Code 430
- Irrigation Water Management, Code 449
- Nutrient Management, Code 590
- Pest Management, Code 595
- Pumping Plant for Water Control, Code 533
- Waste Utilization, Code 633