Natural Resources Conservation Service
Conservation Practice Standard

IRRIGATION SYSTEM, SPRINKLER
(No. and Ac.)
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

To efficiently and uniformly apply irrigation water, by means of sprinklers or spray nozzles, to maintain adequate soil moisture for optimum plant growth without causing excessive water loss, erosion, or reduced water quality.

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 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 and the expected operating conditions. The soils and topography shall be suitable for irrigation for the proposed crops.

Enough good-quality water must be available for practical irrigation of the crops to be grown.

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

CRITERIA

General

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.

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 conservation practice standard, Irrigation Water Management, Code 449.

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

Design

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 field application efficiency (E_a) not to exceed the values in Table 1.

Table 1 - 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

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 may be used to determine crop irrigation requirements. In computing capacity requirements, allowance must be made for reasonable water losses during application periods.

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.

Distribution patterns and spacing. A combination of sprinkler spacing, nozzle sizes, and operating pressure that most nearly provides the design application rate and distribution shall be selected. The velocity of prevailing winds and other conditions must be considered.

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

- 70% for orchards
- 75% for deep-rooted (4 ft or more) field and forage crops
- 85% for high-value or shallow-rooted crops and for any crop where fertilizer or pesticides are applied through the system.

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:

- For low, intermediate, and moderate pressure sprinklers, the spacing along lateral lines (S_l) shall not exceed 50 percent of the 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 mi/h, to 50 percent for average velocities of 10 mi/h, and to 30 percent for average velocities greater than 10 mi/h.
- For high-pressure sprinklers and for the giant hydraulic type, the maximum distance (diagonal) between two sprinklers on adjacent lateral lines shall not exceed two-thirds of the 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 wetted diameter for average velocities of 5 mi/h and to 30 percent for average velocities greater than 10 mi/h.
- For perforated pipelines, the spacing recommendations of the manufacture for the design application rate, number and size of perforations, and operating pressure shall be followed.
- For 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.

Main lines. The design of main lines, submains, and supply lines shall insure that the quantities of water required are conveyed to all lateral lines at the maximum required pressure.

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

Lateral lines. Lateral lines shall be so designed that the total pressure variation at the sprinkler heads, resulting from friction head and static head, does not exceed 20 percent of the design operating pressure of the sprinklers.

Except for undertree operation, riser pipes used in lateral lines shall be long enough to prevent interference with the distribution pattern when the tallest crop is irrigated. Riser lengths shall not be less than shown below:

Sprinkler discharge *(gal/min)*	Riser length *(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 conservation practice standard Pumping Plant for Water Control, Code 533.

Pipe. The pipe shall meet the requirements of NRCS 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.

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.

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.

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.

Applications of chemicals will be the minimum lengths 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 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 wastewater 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 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

Water quantity

- Effects on the water budget, especially the volume and rate of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
- Potential for changes in plant growth and transpiration because of changes in the volume of soil water.
- Effects on downstream flows or aquifers that would affect other water uses or users.
- The effect on the water table of the field in providing suitable rooting depth for anticipated land uses.
- Potential ability to manage irrigation water through control of water in the root zone.

Water quality

- Effects on erosion and the movement of sediment, and soluble and sediment-attached substances carried by runoff.
- Effects of nutrients and pesticides on surface and ground water quality.
- Potential effects on the movement of dissolved substances below the root zone or to ground water.
- Effects of soil water levels on such nutrient processes as nitrification and denitrification.
- Effects of soil water levels in controlling the salinity of soils, soil water, or downstream water quality.
- Effects on the visual quality of downstream water resources.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing irrigation sprinkler 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 wastewater should be inspected periodically for clogging.

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

REFERENCE

NEH, Part 623, Chapter 2
NEH, Part 623, Chapter 11
NRCS 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
Mississippi Department of Transportation, Specifications for Road and Bridge Design
National Engineering Field Handbook, Part 650
Chapter 6, Structures

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CONSTRUCTION SPECIFICATION
IRRIGATION SYSTEM, SPRINKLER

1. SCOPE

The designer of the sprinkler irrigation system (consulting engineer, equipment vendor, or others) shall furnish the owner with a complete set of engineering plans and specifications covering all components of the system and performance requirements. The engineering plans and specifications shall contain sufficient details to allow the irrigation system to be installed by someone unfamiliar with the job. The installation shall be checked for conformance to this standard. The plan shall specify type, grades, quality, size, and construction materials of all equipment and appurtenances included in the system design.

2. MATERIALS AND INSTALLATION

The irrigation system and components shall be installed as designed and shown on the engineering plans or as staked in the field. Materials and components shall be of type, size, and quantities specified in the plans and specifications.

Pumps, power units, and filters shall be set on a firm base and be placed in proper alignment. All pertinent safety codes and manufacturer's recommendations shall be met for the type of equipment installed. They shall meet the power, capacity, and pressure requirements specified.

Sprinklers shall be installed as recommended by the manufacturer. Sprinkler performance tables provided by the manufacturer shall be used to determine that the sprinklers meet the requirements specified in the plan and design.

Risers may be constructed of standard galvanized steel, aluminum, or plastic. On permanent sprinkler systems, they shall be installed in a vertical position and adequately supported by anchor blocks or other suitable means. Plastic materials that will be exposed to sunlight shall be made of ultraviolet-resistant materials or protected by coating or shielding as recommended by the manufacturer. Plastic risers shall meet or exceed the pipe material requirements specified for the mains and laterals.

All joints and connections shall be made in accordance with the manufacturer's recommendations. All valves shall be equal to the size of pipe in which they are installed and of the material and type specified. All joints, connections, and valves shall be constructed to withstand the maximum design working pressure for the pipelines without damage or leakage. They shall meet the performance requirements of the system without damage or leakage.

3. TESTING

The system shall be thoroughly and completely pressure tested at the design pressure for proper functioning and leakage. Any leaks shall be repaired and the system retested.

The system shall be checked to ensure that it functions properly at design capacity, that the distribution pattern and spacing requirements are met, and that the variation in pressure or discharge rate is within the allowable specified. At or below design capacity, there shall be no objectionable flow conditions and all appurtenances shall perform properly.