NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

IRRIGATION SYSTEM, SPRINKLER

(No. and Ac.)

CODE 442

DEFINITION

An irrigation system in which all necessary equipment and facilities are installed for efficiently applying water by means of nozzles operated under pressure.

PURPOSE

This practice may be applied as part of a conservation management system to achieve one or more of the following:

- Efficiently and uniformly apply irrigation water to maintain adequate soil water for the desired level of plant growth and production without causing excessive water loss, erosion, or water quality impairment.
- Climate control and/or modification.
- Applying chemicals, nutrients, and/or waste water.
- Leaching for control or reclamation of saline or sodic soils.
- Reduction in particulate matter emissions to improve air quality.
- Reduce energy use.

CONDITIONS WHERE PRACTICE APPLIES

The sprinkler method of water application is suited to most crops, irrigable lands, and climatic conditions where irrigated agriculture is feasible. Areas must be suitable for irrigation or sprinkler water application and have an adequate supply of suitable quality water available for the intended purpose(s).

This standard applies to the planning and design of the overall water application through sprinkler discharge systems. This standard pertains to the planning and functional design of all sprinkler system components except for special structures, such as permanently installed main and lateral pipelines or pumping plants. Other components shall meet the requirements of applicable Oregon NRCS Conservation Practice Standards.

This standard does not include criteria for mini- or micro-sprinkler systems, which are covered by NRCS Conservation Practice Standard 441 – Irrigation System, Microirrigation.

CRITERIA

General Criteria Applicable to All Purposes

Each sprinkler discharge system shall be designed as an integral part of an overall plan of conservation land use and treatment for the intended purpose(s) based on the capabilities of the land, irrigation water supply, and the needs of the operator. The system selection shall be based on a site evaluation, expected operating conditions, and verification that soils and topography are suitable for the intended purpose(s).

All planned work shall comply with applicable Federal, state and local laws and regulations.

The criteria for the design of components not addressed in NRCS practice standards shall be consistent with sound engineering principles.

Depth of Application. Net depth of application shall meet criteria for the intended purpose, not exceeding the available soil water holding capacity and meeting the land user's management plan for the intended purpose.

Capacity. The sprinkler irrigation system shall be designed with adequate capacity to accomplish the primary purpose(s) of the system.

For the purpose of crop irrigation, sprinkler irrigation systems shall have either: (1) a design capacity adequate to meet peak water demands of all irrigated crops in the design area (based upon a water budget that accounts for available soil moisture; the system design capacity may be less than the flow needed to meet peak crop needs), or (2) adequate capacity to meet requirements of selected irrigations during critical crop growth periods when less than full irrigation is planned.

In computing capacity requirements, an allowance must be made for reasonable application water losses.

Design Application Rate. Rates shall be selected such that runoff, translocation, and unplanned deep percolation are minimized.

Additional conservation measures, such as furrow diking, dammer diking, in-furrow chiseling, conservation tillage and/or residue management shall be applied as needed and appropriate.

Distribution Patterns, Nozzle Spacing and Height. A combination of sprinkler spacing, nozzle size, and operating pressure that provides the design application rate and distribution shall be selected.

Coefficient of Uniformity (CU) data or distribution uniformity (DU) shall be used in selecting sprinkler spacing, nozzle size, and operating pressure. Definitions of each of these uniformity values can be found in the NRCS National Engineering Handbook, Part 652, Irrigation Guide.

Pipelines. The design of main lines, submains, and supply lines shall insure that required water quantities can be conveyed to all operating lateral lines at required pressures. For detailed criteria, see NRCS Conservation Practice Standard 430 – Irrigation Pipeline.

Pump and Power Unit. Where required, pump and power units shall be adequate to efficiently operate the sprinkler system at design capacity and total dynamic head. For detailed criteria, see NRCS Conservation Practice Standard 533 – Pumping Plant.

Management Plan. An Irrigation Water Management plan, meeting NRCS Conservation Practice Standard 449 – Irrigation Water Management, shall be developed for this practice, unless the purpose of the practice is waste water application. Where implemented for waste application, as a component of a Comprehensive Nutrient Management Plan (CNMP), a waste utilization plan and/or nutrient management plan shall be developed that meets the requirements of NRCS Conservation Practice Standard 633 – Waste Utilization and 590 - Nutrient Management, as appropriate.

Additional Criteria Applicable to Center Pivot or Linear-Move Sprinkler Systems

Descriptions and definitions of different types of center-pivot and linear-move systems are contained in the References Section.

Distribution Patterns, Nozzle Spacing and Height. Pivot system (Heermann-Hein) or Linear (Christensen) CU shall not be less than 85% (76% DU), except as noted in criteria for a Low Energy Precision Application (LEPA) system. In lieu of the manufacturer's CU information, simulation modeling shall use Agricultural Research Service model Center Pivot Evaluation and Design (CPED) or similar modeling software. Manufacturer's information on nozzle packaging, allowing exclusion of the end gun and the first 12 percent of pivot length, not to exceed 250 feet, shall be considered acceptable documentation of system CU.

In the absence of CU data, sprinkler performance tables provided by the manufacturer shall be used in selecting nozzle size, operating pressure, and wetted diameter for the required sprinkler discharge. To the extent possible, low pressure spray nozzles shall be at uniform heights along the length of the lateral, with the exception of height adjustment to increase wetted diameter for runoff control. From a point midway between the first and second tower to the distal end of a center pivot, spray nozzle spacing along lateral lines shall not exceed 25% of the effective wetted diameter and impact sprinkler spacing shall not exceed 50 percent of the effective wetted diameter. The effective wetted diameter shall be determined from manufacturer's information for the nozzle height.

Lower elevation nozzle application systems, typically less than 7 feet from ground surface, that discharge water in the crop canopy for a considerable length of time during the growing season shall also meet the criteria of a Low Pressure in Canopy (LPIC) system as defined in this standard.

Additional Criteria Applicable to LEPA and Low Elevation Spray Application (LESA) Center Pivot or Linear-Move Sprinkler Systems

Distribution Patterns. For center pivot systems, nozzle discharge CU using the Heermann-Hein weighted area method shall be used in selecting sprinkler spacing, nozzle size, and operating pressure. Nozzle discharge CU shall not be less than 94% of the calculated design flow rate needed at the discharge point. For linear systems, discharge shall be based on equivalent unit areas.

Nozzle Spacing. Nozzle spacing shall not be greater than two times the row spacing of the crop, not to exceed 80 inches.

Specific Additional Criteria for LEPA

Discharge Height. Water shall discharge through a drag sock or hose on the ground surface, or through a nozzle equipped with a bubble shield or pad at a uniform height not to exceed 18 inches.

Row Arrangement and Storage. LEPA systems are only applicable on crops planted with furrows or beds. LEPA systems shall have row patterns that match the lateral line movement (i.e., circular for center pivots). Water shall not be applied in the tower wheel track of a LEPA system. Runoff and translocation under LEPA systems shall be eliminated by providing surface basin storage such as furrow dikes, dammer dikes, or implanted reservoirs.

Slope. The slope for a LEPA system shall not exceed 1.0 percent on more than 50 percent of the field.

Systems that utilize bubble pads or shields, or drag hoses for a portion of the crop year and then spray nozzles at uniform height not exceeding 18 inches for a portion of the crop year shall meet LESA criteria.

Specific Additional Criteria for LESA

Discharge Height. LESA Systems shall discharge water through a spray nozzle at uniform heights not to exceed 18 inches.

Row Arrangement and Storage. LESA Systems are applicable on crops flat planted, drilled, or planted with furrows or beds. LESA Systems should employ some method of providing surface basin storage such as furrow dikes, dammer dikes, or implanted reservoirs, or farming practices such as conservation tillage, in-furrow chiseling, and/or residue management to prevent runoff.

Land Slope. The slope for LESA systems shall not exceed 3.0 percent on more than 50 percent of the field.

Additional Criteria Applicable to LPIC and Mid Elevation Spray Application (MESA) Center Pivot or Linear-Move Sprinkler Systems

Systems that utilize bubble pads or shields or drag hoses for a portion of the crop year and spray nozzles for a portion of the crop year not meeting all of the LEPA or LESA criteria shall meet LPIC criteria.

Distribution Patterns, Nozzle Spacing and Height. For row crops, when nozzles operate in canopy for 50 percent or more of the growing season, nozzle spacing shall not exceed every other crop row. In-canopy heights shall be such that areas of high leaf concentration are avoided (i.e., corn near the ear height (approximately 4 feet)). Local research and Extension Service information with applicable crops may serve as a guide for establishing appropriate nozzle spacing, height, and row arrangement.

CU (Heermann–Hein CU for center pivots) shall not be less than 90% for all LPIC and MESA Systems with nozzle heights less than 7 feet.

CU shall not be less than 85% (76% DU) for MESA Systems with nozzle heights 7 feet or greater.

Land Slope. The slope for LPIC and MESA systems shall not exceed 3.0 percent on more than 50 percent of the field for fine textured soils and not exceed 5 percent on more than 50 percent of the field on coarse textured soils.

Coarse textured soils are normally Fine Sandy Loams or coarser and fine soils are Very Fine Sandy Loams or finer as described in NEH Part 652, Table 2-5. Descriptions are also included in the References Section.

Additional Criteria Applicable to Fixed-Solid-set, Big Gun and Periodic Move Sprinkler Systems

Design Application Rate. The design application rate shall be within a range established by the minimum practical application rate under local climatic conditions, and the maximum application rate consistent with soil intake rate, slope, and conservation practices used on the land. If two or more sets of conditions exist in the design area, the lowest maximum application rate for areas of significant size shall apply.

Lateral Lines. Unless pressure reducers or regulators are installed at each outlet, or other pressure compensating or flow control devices are used, lateral lines shall be designed so that the pressure variation or flow variation at any sprinkler, resulting from friction head and elevation differential, does not exceed 20 percent of the design operating pressure or 10 percent of the design flow of the sprinklers, respectively.

Distribution Patterns and Spacing. A combination of sprinkler spacing, nozzle size, and operating pressure that provides the design application rate and distribution shall be selected.

If available, CU (or DU) data shall be used in selecting sprinkler spacing, nozzle size, and operating pressure. CU shall not be less than the following:

75 % (60% DU) for deep-rooted (4 feet or more) field and forage crops where fertilizers and pesticides are not applied through the system.

85 % (76% DU) for high-value or shallow-rooted crops and for any crop where fertilizer or pesticides are applied through the system.

In the absence of CU data, maximum lateral and nozzle spacing shall comply with the following criteria:

1. For low (2-35 pounds/square inch (psi))-, moderate (36-50 psi)-, and medium (51-75 psi)-pressure sprinkler nozzles, the spacing along lateral lines shall not exceed 50 percent of the wetted diameter, as given in the manufacturer's performance tables, when the sprinkler is operating at design pressure. The spacing of laterals along the main line shall not exceed 65 percent of this wetted diameter.

If winds that can affect the distribution pattern are likely during critical crop growth periods, spacing should be reduced to 60 percent for average velocities of 1 to 5 miles per hour (mph), to 50 percent for average velocities of 6 to 10 mph, and to 45 percent for average velocities greater than 10 mph. In lieu of reducing the spacing on periodic move systems for increased wind speeds, swing lines may be used to adjust placement of the lateral for successive irrigations. When swing lines are included in the system design, their use will be specified in the O&M Plan for the system.

2. For high-pressure and big gun type sprinklers (>75 psi), 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 during critical crop growth periods, the diagonal spacing should be reduced to 50 percent of the wetted diameter for average velocities of

5 to 10 mph and to 30 percent for average velocities greater than 10 mph. Guidance for towpath spacing of travelers in Table 11-31 of NEH Part 623, Chapter 11, Sprinkle Irrigation.

3. Sprinkler spacing requirements for orchards, including subtropical fruits:

a) Triangular pattern. The spacing along lateral lines shall not exceed 65 percent of the effective wetted diameter. The spacing of laterals along the main line shall not exceed 70 percent of the effective wetted diameter.

b) Square or rectangular pattern. The nozzle spacing along the lateral and the lateral spacing along the main line shall not exceed 65 percent of the effective wetted diameter at the design operating pressure.

c) Spacing between sprinklers and lateral lines shall be reduced by 2.5 percent for each mph over 3 mph average wind velocity normally occurring during planned hours of operation.

Risers. Except for under-tree operation, riser pipes used on 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 below:

Sprinkler discharge *(gallons/minute)*	Riser length *(inches)*
Less than 10	6
10-25	9
25-50	12
50-120	18
More than 120	36

Risers over 3 feet in height shall be anchored and stabilized.

Additional Criteria Applicable to Traveling Sprinkler Irrigation Systems

The towpath spacing shall follow the recommendations in Table 11-31, NEH Part 623, Chapter 11, Sprinkle Irrigation.

Additional Criteria Applicable to Climate Control and/or Modification

Design Capacity. For temperature control, the sprinkler irrigation system shall have sufficient capacity to satisfy the evaporative demand on a minute-by-minute basis throughout the peak use period. NEH, Part 623, Chapter 2 contains guidance on using sprinkler irrigation systems for temperature control.

For frost protection, the system shall be capable of applying the necessary rate, based on the minimum temperature, maximum anticipated wind speed, and relative humidity, in a uniform manner. The capacity shall be sufficient to supply the demand for the entire crop being protected. NEH, Part 623, Chapter 2 contains guidance on using sprinkler irrigation systems for frost protection.

Additional Criteria Applicable to Chemical, Nutrient and/or Waste Water Application

The installation and operation of a sprinkler irrigation system for the purpose of chemical or nutrient application (chemigation and/or the application of manure or wastewater) shall comply with all federal, state and local laws, rules and regulations. This includes backflow and anti-siphon prevention measures. Additionally, surface waters shall also be protected from direct application of chemicals and nutrients.

Injectors (chemical, fertilizer or pesticides) and other automatic operating equipment shall be located adjacent to the pump and power unit and installed in accordance with state regulations, or lacking the same, in accordance with manufacturer's recommendation. The chemical injection device shall be accurate to within 1 percent of the maximum injection rate and easily calibrated and adjustable for all chemicals at required injection rates.

Sprinkler irrigation systems used to apply waste shall be designed with sprinkler nozzles of sufficient size to prevent clogging. Treatment of the wastewater using solid separators, two stage lagoons, two-stage waste holding ponds, etc., may be needed to reduce percent solids.

Design Application Rate and Timing. Application rates shall meet the levels specified in General Criteria. Timing of chemical applications shall be the minimum length of time it takes to deliver the chemicals and flush the pipelines at rates specified by the label.

Coefficient of Uniformity. If available, CU (or DU) data shall be used in selecting sprinkler spacing, nozzle size, and operating pressure. The CU shall not be less than 70% for wastewater and not less than 85% (76% DU) for chemigation or fertigation. If CU data are not available, distribution patterns and spacing requirements shall be in keeping with the appropriate specific criteria of this standard.

Nutrient and Pest Management. Chemicals, fertilizers and liquid manure shall be applied in accordance with appropriate NRCS Practice Standards: 590 – Nutrient Management, 595 – Pest Management, 633 – Waste Utilization and 634 – Manure Transfer. Chemical or nutrient application amounts shall not exceed these standards.

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

Additional Criteria Applicable to Leaching

Design Application Rate and Depth. Application rates shall meet the levels specified in General Criteria. Design depth shall be determined as defined in NRCS, National Engineering Handbook, Part 623, Chapter 2, Irrigation Water Requirements.

Management or Reclamation Plan. A plan shall be developed conforming to the requirements contained in NRCS Practice Standard 610 – Salinity and Sodic Soil Management.

Additional Criteria Applicable to Reduction in Particulate Matter Emissions to Improve Air Quality

These criteria pertains to sprinkler systems used to improve air quality by controlling dust emissions from confined animal pen areas and other critical areas such as unpaved roads, staging areas, and equipment storage yards.

Installation of fixed solid set sprinklers or periodic move sprinkler systems for dust control shall conform to the criteria stated above, unless described by criteria in this section. The installation and operation of Sprinkler Systems for dust control on confined animal pen areas shall provide application coverage on the majority of pen areas occupied by livestock, except for feed bunk aprons. The quality of discharge water shall be pathogen free and fit for animal consumption.

Capacity and Application Rate. For dust control, the sprinkler irrigation system shall have sufficient capacity and operational flexibility to apply the design application depth every three days or more frequently. When determining capacity requirements, allowance shall be made for reasonable water losses during application.

The minimum design application rate shall meet the maximum total daily wet soil evaporation rate, with allowances for moisture input to pen areas from animal manure and urine.

Open-lot management practices shall be applied that include scraping and removal of manure in pens between occupations, and shaping of the holding areas to prevent water ponding and chronic wet areas.

Over-application and excessive sprinkler overlap shall be avoided to minimize runoff and reduce odor and fly problems.

Water Amendments. Appropriately labeled chemicals for pest control or dust suppression may be applied through the sprinkler system when designed, installed and operated with appropriate backflow prevention and anti-siphon devices. When chemicals are applied through the sprinkler system, surface waters and livestock watering facilities shall be protected from direct application unless chemical labels indicate that direct application will not negatively impact animal health or water quality.

Distribution Patterns and Spacing. A combination of sprinkler spacing, nozzle size, and operating pressure that provides the design application rate and distribution pattern shall be selected.

Maximum spacing of sprinklers along laterals shall not be greater than 75 percent, and no closer than 50 percent of wetted diameter listed in manufacturer's performance tables. Spacing between laterals shall comply with the following criteria:

1. For medium (51-75 psi)-pressure sprinkler nozzles, the spacing of laterals along the main line shall be no more than 90 percent, and no closer than 70 percent of wetted diameter.

2. For high-pressure sprinklers (>75 psi), the maximum distance between two sprinklers on adjacent lateral lines shall not exceed 100% of wetted diameter.

If winds impact distribution patterns during critical dust emission periods, the system shall be equipped with timer overrides and have the flexibility to be operated manually during periods of lesser wind, such as late evening and early morning.

Risers. Riser pipes used in lateral lines shall be high enough to minimize interference with the distribution pattern. The risers shall be constructed in a manner that provides protection from corrosive soils, equipment damage, and livestock damage. Riser heights shall place the discharge sprinkler not less than 6 feet above ground surface. Risers shall be anchored and stabilized.

System Valves and Controllers. Due to high application rates inherent with large sprinkler nozzle diameters, an automatic irrigation control system shall be utilized for all nozzles greater than 0.5 inch diameter. The automated control system shall utilize electro-hydraulic valves facilitating automatic operation. The valves shall be of a size and quality consistent with standard engineering practice. The operating system shall provide the flexibility to change sprinkling duration in one-minute increments and have a minimum of six start times per-day to provide for adjustment for climate conditions.

Systems shall be equipped with a rain sensor connected to the control valve network set to prohibit system operation during rainfall events.

Manual zone isolation valves shall be incorporated to isolate laterals allowing partial system operation during periods of maintenance and repair.

In areas of uneven or sloping terrain a control valve or low-head drainage device shall be incorporated at each sprinkler to ensure that line drainage to the lowest sprinkler is minimized.

Additional Criteria Applicable to Reduce Energy Use

Provide analysis to demonstrate reduction of energy use from practice implementation.

Reduction of energy use is calculated as average annual or seasonal energy reduction compared to previous operating conditions.

CONSIDERATIONS

When planning this practice the following items should be considered, where applicable:

Application rates near the end of a center pivot may exceed soil intake rate. Light, frequent applications can reduce runoff problems, but may increase soil surface evaporation. Nozzle offsets or booms can be used to reduce peak application rates.

For low suspended nozzle application systems, row arrangement, nozzle spacing, discharge nozzle type and configuration, along with height all impact CU. System design and field management should complement each other to result in the highest possible CU. In general, circular rows for center pivot systems and straight rows for linear move systems provide higher CU's.

Some aspects of non-uniformity tend to average out throughout the irrigation season while others tend to accumulate. Factors that tend to average out during the irrigation season are climatic conditions and uneven travel speed for systems that start and stop. Factors that tend to accumulate during the irrigation season are nozzle discharge variances due to pressure or elevation differences, surface movement of water, and poor water distribution around field boundaries. It is recommended that the operations of continuously moving systems such as center-pivot, linear-move, and traveling gun be scheduled so that water is not applied to the same area of the field at the same time of the day during successive irrigations.

Consider the effects of a center pivot end gun operation on CU. A large end gun may reduce the average CU by 1 percent for each 1 percent of the area covered past the main system hardware.

Consider the potential effect to the sprinkler system performance from the variation in the system flow rate as the center pivot corner arm unit and end gun(s) turn on or off. Design pumping plants and/or use pressure regulators/flow control valves to maintain the specified system CU.

Beneficial effects of conservation practices applied to limit surface redistribution of water and runoff may diminish over the irrigation season.

The velocity of prevailing winds and the timing of occurrence should be considered when planning a sprinkler system. Systems designed to operate in varied time increments aid in balancing the effects of day and night wind patterns.

Consider filtering or screening the irrigation water before it enters the system if it contains particulate matter, algae, or other material that could plug the sprinkler nozzles.

Drop tubes on center-pivot and linear-move systems should be installed alternately on both sides of the mainline, and when used in-crop, they should have a flexible joint between the gooseneck pipes and the application device. Drops should be weighted or secured in windy areas.

Consider different sprinkler application depths and application rates with hand-move and center-pivot systems. With hand-move systems, the application rates more nearly match the soil infiltration rate so that large irrigation depths can be applied and the number of hand moves reduced. With an automated system, such as a center-pivot, hand labor is not a major consideration and small applications at high rates are achievable.

Fertilizer and chemical application amounts may vary from prior application methods and rates, due to precise applications possible with some sprinkler irrigation systems.

Management of sprinkler irrigation systems normally include utilizing soil water stored in the root zone, especially during critical crop growth stages when daily crop water use may exceed system capacity for short periods of time.

Deflection of spans on center pivots and linear-move systems is common when the lateral is loaded (filled with water). This factor should be considered when determining nozzle heights. Wheel track depth will also affect nozzle height.

Water distribution is greatly affected by nozzle spacing and height for LPIC and MESA systems. In general, smaller, more closely spaced nozzles will yield a higher uniformity than larger, more widely spaced nozzles.

On center pivot or linear move systems, nozzles should be diverted away from wheel tracks to avoid rutting.

Low pressure systems (35 psi or less) are sensitive to small changes in nozzle pressure. Consider using pressure regulators on all low pressure systems where elevation differences, pumping depth variations, and end gun or corner arm operation can significantly change nozzle discharge and sprinkler uniformity. Also consider installing a pressure gauge at both ends of the sprinkler system to monitor system pressures.

Consider system effects on the water budget, especially the volume and rate of infiltration, evaporation, transpiration, deep percolation, ground water recharge, and potential runoff.

Consider system effects on erosion and movement of sediment, and soluble and sediment-attached substances carried by runoff.

Consider system effects on soil salinity, soil water or downstream water quality including subsurface drains. Crops may be more sensitive to salts applied to plant foliage during sprinkling than to similar water salinities applied by surface irrigation, subirrigation, and microirrigation. 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.

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.

When utilized for particulate matter reduction, check to assure adequate animal feeding operation water supplies are available to meet other operating needs, during sprinkler system operation.

Irregularly shaped pen areas that are impractical to treat with a sprinkler system and where potential dust sources may occur should be treated for dust control with tanker water trucks equipped with hoses, or nozzles designed to apply water at rates similar to an equivalent sprinkler system.

Open-feedlot management practices that minimize thickness of loose manure will reduce water demands for dust control, as well as, reduce wet areas and ponding that could increase ammonia emissions.

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 plan must provide specific instructions for operating and maintaining the system to insure that it functions properly. It should also provide information regarding periodic inspections and prompt repair or replacement of damaged components. The plan, at minimum, shall include provisions to address the following:

- Periodic checks and removal of debris and sediment as necessary from nozzles to assure proper operation.
- Inspection or testing of all pipeline and pumping plant components and appurtenances, as applicable.
- Regular testing of pressures and flow rates to assure proper operation.
- Periodic checks of all nozzles and spray heads for proper operation and wear.
- Routine maintenance of all mechanical components in accordance with the manufacturer's recommendations.
- Prior to retrofitting any electrically powered irrigation equipment, electrical service must be disconnected and the absence of stray electrical current verified.

REFERENCES

NEH 652**,** NRCS, Irrigation Guide.

NEH Part 623 (formerly NEH Section 15), Irrigation, Chapters 3, 8 and 11.

NRCS Conservation Practice Standards:

Irrigation Water Conveyance (430).
Irrigation Water Management (449).
Pumping Plant (533).

Descriptions and Definitions

Definitions of terms related to Center-Pivot Sprinklers

LEPA - Low Energy Precision Application

a) Farmed in Circular Rows (except Linear Move Systems)
b) Nozzle Height is 18 inches or lower
c) Nozzle Spacing is alternate row, up to a maximum of 80 inches
d) Discharge is through a drag sock or hose on the ground, or through a bubble shield or pad
e) Only applicable to crops planted with furrows or beds
f) Maximum of 1% slope in most of field

g) Furrow Diked or other means of preventing irrigation water movement away from point of application

LESA - Low Elevation Spray Application

a) Farmed in any row direction
b) Nozzle Height is 18 inches or lower
c) Nozzle Spacing is alternate row, up to a maximum of 80 inches
d) Discharge is through spray nozzles
e) Applicable on crops flat planted, drilled, or planted with furrows or beds
f) Maximum of 3% slope in most of field
g) Furrow Diked or other means of preventing irrigation water movement away from point of application

LPIC - Low Pressure In Canopy

a) Farmed in any row direction
b) Nozzle Height is 18 inches to 36 inches
c) Nozzle Spacing up to 120 inches (10 feet)
) Discharge is in the crop canopy
e) Maximum of 3% slope in most of field
f) Systems that utilize bubble nozzles or drag hoses for a portion of the crop year and spray nozzles for a portion of the crop year but do not meet all LEPA criteria should be considered LPIC systems

MESA - Mid Elevation Spray Application

a) Farmed in any row direction
b) Nozzle Height is more than 36 inches (3 feet) and less than 84 inches (7 feet)
c) Nozzle Spacing up to 120 inches (10 feet)
d) Discharge is above the crop canopy
e) Maximum of 3% slope in most of field

Groupings of soil texture classes from Soil Survey Manual, Agriculture Handbook 18

***General Terms*[a]**	***Texture Classes***
Sandy soil materials:	
Coarse-textured	Sands (coarse sand, sand, fine sand, very fine sand) Loamy sands (loamy coarse sand, loamy sand, loamy fine sand, loamy very fine sand)
Loam soil materials:	
Moderately coarse-textured	Coarse sandy loam, sandy loam, fine sandy loam
Medium-textured	Very fine sandy loam, loam, silt loam, silt
Moderately fine-textured	Clay loam, sandy clay loam, silty clay loam
Clayey soils:	
Fine-textured	Sandy clay, silty clay, clay
a. These are loamy, and clayey texture groups, not the sandy, loamy, and clayey particle-size classes defined in Soil Taxonomy.	