Sprinkler Troubleshooting

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Outline/Objectives

- **Review problems**
  - Poor coverage
  - Runoff/overspray

- **Causes**
  - Pressure
  - Volume
  - Spacing
  - Broken and/or blocked
  - Wind

- **Solution**
  - Catch can test
  - Proper sprinkler/nozzle/spacing
  - General sprinkler repair
  - Correct runtimes
Improper operating pressure

- Pressure too low
  - Stream not sufficiently atomized
- Pressure too high
  - Misting, reduced radius
Inadequate water volume

- Demand exceeds available gpm
  - Too many sprinklers on a single zone
  - Nozzles too big
Sprinkler spacing

- Too far apart
  - Under watered areas
- Too close
  - Wet areas
Misaligned sprinklers

- Arc adjustment not set correctly
- Not level to surrounding grade
- Blocked spray
- Improper design/installation
Broken sprinklers

- Completely missing
- Clogged nozzles
- Slow or no rotation
Wind

- Too high during sprinkler operation
  - Reduces effective radius
  - Distorts spray pattern
Water Auditing

- A water audit measures the distribution uniformity of sprinklers installed in the field, where they are affected by wind, obstructions, etc...

- Catch cans are placed in a pattern between sprinklers operating on a single zone
Water Auditing

- The sprinklers are operated for a certain length of time (calculated to 1 hour)
- The amount of water in each catchment is measured and recorded
- This data is used to determine the performance of the zone
Sprinkler Performance Calculations & Testing

- Precipitation Rate (PR)
- Coefficient of Uniformity (CU)
- Distribution Uniformity (DU)
  - Low quarter
  - Low half
- Scheduling Coefficient (SC)
Precipitation Rate (PR)

- The PR is the average rate in inches per hour at which water is being applied to the area covered by a specific sprinkler layout.
- PR is a function of the total sprinkler discharge applied to the area between the sprinklers.
Calculating Precipitation Rates

Use this formula to calculate Precipitation Rates:

\[
\frac{96.3 \times GPM \times S \times L}{96.3} = IPH
\]

- 96.3 = a constant.
- GPM = gallons per minute applied to the target area by all sprinklers in pattern.
- S = distance in feet of the sprinklers on a row.
- L = distance in feet between sprinkler rows.
- IPH = average inches per hour.
Calculating Precipitation Rates

- **Precipitation Rate (PR):**
  - the calculated average amount of water that would be applied to a given area by all sprinklers in 1 hour (measured in inches per hour).

- **Matched Precipitation Rates (MPR):**
  - sprinklers which apply water at the same rate per hour no matter the arc of coverage (matching gpm flow rates to arc of coverage).
  - spray heads have fixed arcs and are matched for you.
  - rotors offer a choice of nozzles for you to match to the designed arc pattern.
Selecting Sprinklers & Spacing Ranges

Sprinkler performance charts contain the following:

- **PSI:**
  - sprinkler operating pressure.

- **Radius:**
  - distance from the sprinkler to the edge of throw (in feet).

- **GPM:**
  - flow rate of the sprinkler with different size nozzle orifices.

- **Precipitation Rate:**
  - delivery rate based on nozzle, arc and spacing.

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<thead>
<tr>
<th>Nozzle</th>
<th>Pressure psi</th>
<th>Radius ft.</th>
<th>Flow GPM</th>
<th>Precip. in/h</th>
<th>Precip. Δ in/h</th>
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Calculate the PR for the sprinkler layout using the following information: Operating pressure = 45 PSI.

- 90° - 1.4 GPM
- 180° - 2.9 GPM
- 360° - 5.5 GPM
Calculate the precip. rate for the sprinkler layout using the following information: Operating pressure = 45 PSI.

90° - 1.4 GPM
180° - 2.9 GPM
360° - 5.5 GPM

\[
\frac{96.3 \times 5.675 \text{ GPM}}{28' \times 29'} = \frac{546.5}{812} = 0.67 \text{ inches per hour (PR)}
\]
Performance Testing

- Precipitation rates (inches per hour)
- Coefficient of uniformity
- Distribution uniformity
- Scheduling coefficient (all in percent)
Good spacing
Coefficient of Uniformity (CU)

- The CU is a measurement of uniformity, expressed as a percentage, comparing the average deviation of values from the overall average to the average.

- A perfectly uniform application is represented by a CU of 100%. A less uniform application is represented by a lower percentage.
Coefficient of Uniformity (CU)

- CU = 100 \left(1 - \frac{D}{M}\right)
- D = \frac{1}{n} \sum Xi - M
- M = \frac{1}{n} \sum Xi

Where:
- CU = Christiansen's Coefficient of Uniformity (%)
- D = Average Absolute Deviation From the Mean
- M = Mean Application
- Xi = Individual Application Amounts
- n = Number of Individual Application Amounts
**Distribution Uniformity (DU)**

- The DU is a measurement of uniformity, expressed as a percentage, comparing the driest 25% or 50% of the area to the average PR.
  - Note: The low half or 50% DU will usually compare with the value calculated using CU.

- A perfectly uniform application is represented by a DU of 100%. A less uniform application is represented by a lower percentage.
Distribution Uniformity (DU)

DU = \left[ \text{average of low 25%}/\text{overall average} \right] \times 100
Scheduling Coefficient (SC)

- The SC is a measurement of uniformity, comparing the driest area to the average PR.
- A perfectly uniform application, a layout where all areas receive exactly the same amount of water, would have a SC of 1.00.
- The SC can also be used as a runtime multiplier.
Catch can data can also be represented graphically.

- Can tell you the location of the driest areas, unlike CU and DU.
15'x15' Square Spacing with an 1804-U15Q Nozzle at 30 PSI
30’ X 30’ Square Spacing
with an R-50 2.0 R/C at 45 PSI

DISTANCE (FT) DISTANCE (FT)

30' X 30' Square Spacing
with an R-50 2.0 R/C at 45 PSI

DISTANCE (FT)

DISTANCE (FT)

PRECIPI TATION RATE
(IN/HR)

- 2.25-2.5
- 2-2.25
- 1.75-2
- 1.5-1.75
- 1.25-1.5
- 1-1.25
- 0.75-1
- 0.5-0.75
- 0.25-0.5
- 0-0.25
Eagle 750s spaced at 60’ w/ #20 nozzles @ 60 psi
Eagle 750s spaced at 60’ w/ #20 nozzles @ 60 psi
Proper sprinkler/nozzle/spacing
Where a Rotor or Sprays Fit Into the System?
Selecting Sprinklers & Spacing Ranges

- Sprinklers are designed to provide uniform distribution of water only if overlapping coverage is provided.

  - A single sprinkler, when tested with catch cans, delivers most of its water close-in to the sprinkler and less and less as the distance away from the sprinkler increases.

- When overlapped, the weak area of coverage from one sprinkler is supplemented by the surrounding sprinklers.
Selecting Sprinklers & Spacing Ranges

- The most common sprinkler spacing range, and in most cases the most efficient, is Head-to-Head Spacing:
  - sprinklers spaced at their expected radii or 50% of the sprinklers diameter.

- The sprinkler radius shown in the manufacturers catalog is measured in a zero wind test building. For windy areas, closer spacing is required to maintain Head-to-Head Spacing (49% of diameter or closer).
- There are 3 main types of sprinkler spacing patterns and several variations.
Selecting Sprinklers & Spacing Ranges

- **Square spacing pattern:**
  - sprinklers placed in a square pattern, with the same distance between all 4 sprinklers in the pattern.
  - best pattern for areas with 90° corners and fixed boundaries.

- **Triangular spacing pattern:**
  - sprinklers placed in a triangular grid, with the same distance between all three sprinklers in the pattern.
  - good pattern for irregular shaped areas where over spray is not a problem.
Selecting Sprinklers & Spacing Ranges

- The most efficient triangular spacing pattern is the Equilateral Triangular pattern.
- To calculate the distance between rows of sprinklers maintaining equilateral spacing use the following formula:

\[ L = S \times 0.866 \]

- \( L \) = distance in feet between sprinkler rows.
- \( S \) = distance in feet between sprinklers on a row.
- 0.866 = a constant (sine of 60°).
Sprinkler Selection

- General recommendations
  - Popup spray or stream rotor, 2’-18’

- Large rotors & impacts, > 15’
Sprinkler selection guide

3. 4,6 / 10,7 m  
3500

4. 7,6 / 15,2 m  
5000 Plus

5. 10,0 / 16,8 m  
5500

6. 6,7 / 13,7 m  
MAXI-PAW™

7. 8,2 / 15,3 m  
R-50
Sprinkler selection guide

<table>
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<tr>
<th>Applications</th>
<th>R15</th>
<th>P500</th>
<th>P550</th>
<th>E-2001</th>
<th>E-2007 Plus</th>
<th>F-100</th>
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Rotor selection table for different applications.
Selecting Sprinklers & Spacing Ranges

This chart shows the maximum spacing ranges for different wind velocities.

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<tr>
<th>Wind Velocity</th>
<th>Square Pattern</th>
<th>Triangular Pattern</th>
<th>Rectangular Pattern</th>
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<tr>
<td>0 to 3 mph</td>
<td>55% of Diameter</td>
<td>60% of Diameter</td>
<td>60% x 50% of Diameter</td>
</tr>
<tr>
<td>4 to 7 mph</td>
<td>50% of Diameter</td>
<td>55% of Diameter</td>
<td>60% x 45% of Diameter</td>
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<tr>
<td>8 to 12 mph</td>
<td>45% of Diameter</td>
<td>50% of Diameter</td>
<td>60% x 40% of Diameter</td>
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Selecting Sprinklers & Spacing Ranges

Sprinkler performance charts contain the following:

- **PSI:**
  - sprinkler operating pressure.

- **Radius:**
  - distance from the sprinkler to the edge of throw (in feet).

- **GPM:**
  - flow rate of the sprinkler with different size nozzle orifices.

- **Precipitation Rate:**
  - delivery rate based on nozzle, arc and spacing.
Selecting Sprinklers & Spacing Ranges

- Select spacing patterns, ranges and sprinklers for all areas of the site. Check your sprinkler layout:
  - Are sprinklers stretched too far apart (farther than head-to-head spacing)?
  - Are all sprinklers in the pattern spaced the same distance apart?
  - Are there any sprinklers missing in the pattern (areas of little or no coverage)?
  - Will there be much over spray onto hardscapes or buildings?
General Sprinkler Repair
Troubleshooting Sprays
Symptoms of a Pressure Problem

SYMPTOM:
- Water not reaching specified distance
- Stem is not popping up all the way

POSSIBLE CAUSE:
- Number of sprinklers on a zone exceed the available GPM

POSSIBLE SOLUTION:
- Reduce number of heads in the zone
Troubleshooting Closed Case
Symptoms of a Pressure Problem

**SYMPTOMS:**
- Rotor will not rotate
- Water not reaching specified distance
- Rotor is not popping up all the way

**POSSIBLE CAUSE:**
- Number of rotors on a zone exceed the available GPM

**POSSIBLE SOLUTION:**
- Nozzle down
- Reduce number of heads in the zone
Troubleshooting Impacts
Symptoms of a Pressure Problem

SYMPTOM:
- Impact will not rotate
- Water not reaching specified distance
- Impact is not popping up all the way
- Canister fills with water

POSSIBLE CAUSE:
- Number of impacts on a zone exceed the available GPM

POSSIBLE SOLUTION:
- Nozzle down
- Reduce number of heads in the zone
Troubleshooting

Symptoms Indicating Debris

SYMPTOM:
- Water spray seems to come out in an irregular pattern
- Stem pops up but water only dribbles

POSSIBLE CAUSE:
- Water source is other than drinking water supply
- New installation system was not flushed prior to rotor install
- A break in the plumbing was recently repaired

POSSIBLE SOLUTION:
- Filtration
- Flush system
- Unscrew nozzle and clean screen
Troubleshooting Closed Case
Symptoms Indicating Debris

**SYMPTOMS:**
- Rotor does not rotate easily by hand
- Water spray seems to come out in an irregular pattern

**POSSIBLE CAUSE:**
- Water source is other than drinking water supply
- New installation system was not flushed prior to rotor install
- A break in the plumbing was recently repaired

**POSSIBLE SOLUTION:**
- Filtration
- Clean heads
- Flush system
Troubleshooting Impacts

Symptoms Indicating Debris

**SYMPTOM:**
- Impact does not rotate easily by hand
- Water spray seems to come out in an irregular pattern

**POSSIBLE CAUSE:**
- Water source is other than drinking water supply
- New installation system was not flushed prior to impact install
- A break in the plumbing was recently repaired

**POSSIBLE SOLUTION:**
- Filtration
- Clean head
- Flush system
Calculating System Operating Time
Calculating System Operating Time

- This is a good time to stop and calculate the total system operating time. Use this formula to calculate the circuit operating time for each valve:

\[
\text{ET} \times 60 \\
(\text{PR} \times \text{EFF}) \times \text{DA} = \text{OT}
\]

- **ET** = evapotranspiration (inches per week). Use the PET.
- **PR** = a formula constant.
- **PR** = precipitation rate.
- **DA** = days of the week available for irrigation.
- **EFF** = system efficiency % (as a decimal).
- **OT** = station operating time per active day.
RUN TIME MINUTES

target irrigation (inches) \times 60
\hline
precipitation rate (inches/hr)

= run time minutes!
RUN TIME MINUTES

\[
\frac{\text{target } 0.25 \text{ (inches)}}{\times 60} = \frac{\text{precipitation rate } 0.45 \text{ (inches/hr)}}{= 33 \text{ run time minutes!}}
\]