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

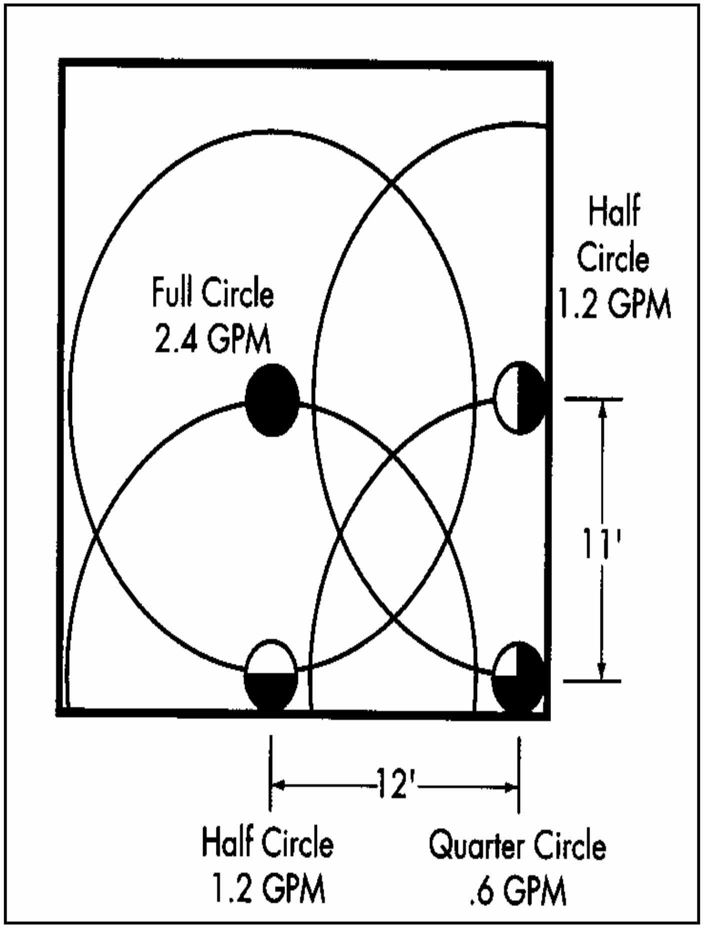
- Use this formula to calculate Precipitation Rates:

$$\frac{96.3 \times GPM}{S \times L} = IPH$$

  - 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:

15 Standard
SERIES 30° trajectory

Nozzle	Pressure psi	Radius ft.	Flow GPM	Precip. ■ in/h	Pricip. ▲ in/h
15F	15	11	2.60	2.07	2.39
	20	12	3.00	2.01	2.32
	25	14	3.30	1.62	1.87
	30	15	3.70	1.58	1.83
15TQ	15	11	1.95	2.07	2.39
	20	12	2.25	2.01	2.32
	25	14	2.48	1.62	1.87
	30	15	2.78	1.58	1.83
15TT	15	11	1.74	2.07	2.39
	20	12	2.01	2.01	2.32
	25	14	2.21	1.62	1.87
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15H	15	11	1.30	2.07	2.39
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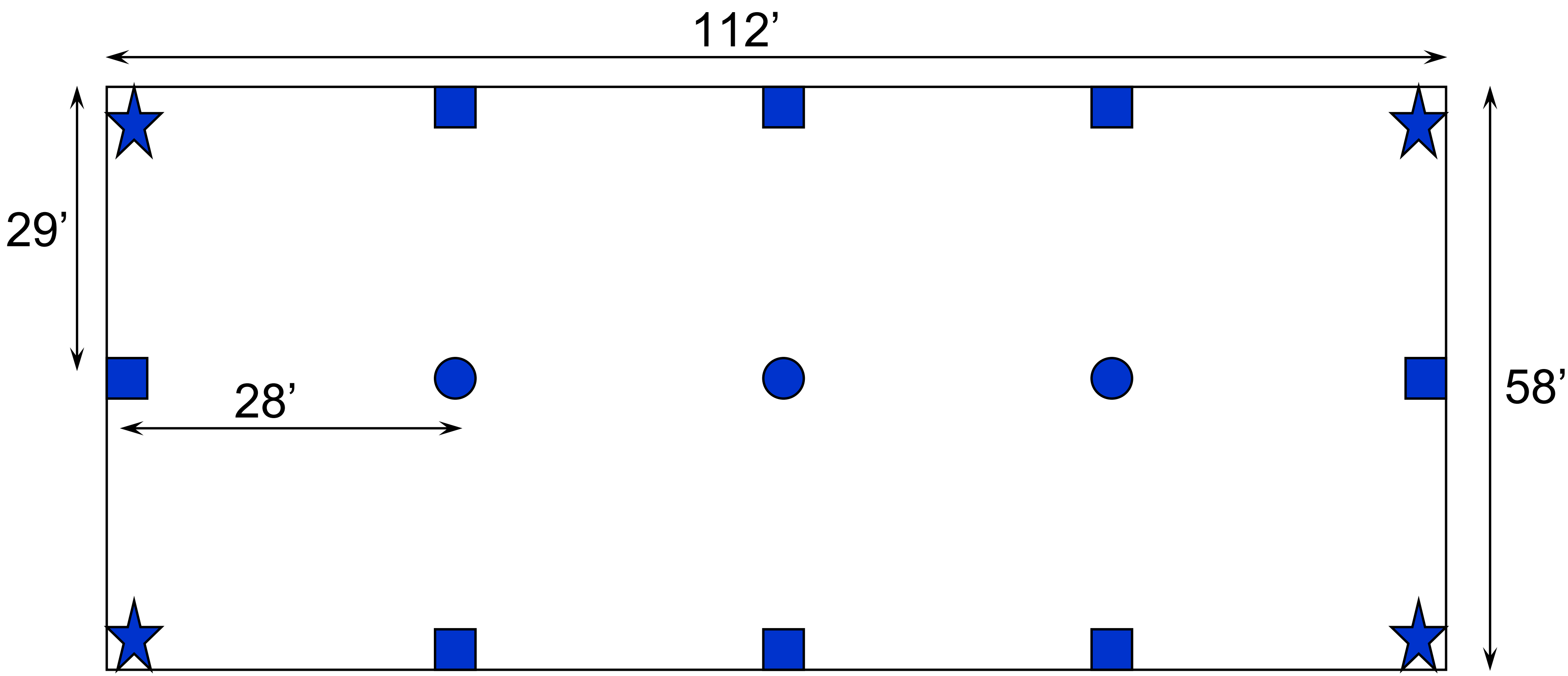
	25	14	1.10	1.62	1.87
	30	15	1.23	1.58	1.83
15Q	15	11	0.65	2.07	2.39
	20	12	0.75	2.01	2.32
	25	14	0.83	1.62	1.87
	30	15	0.93	1.58	1.83

- 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.

Calculating Precipitation Rates

Calculate the PR for the sprinkler layout using the following information: Operating pressure = 45 PSI.

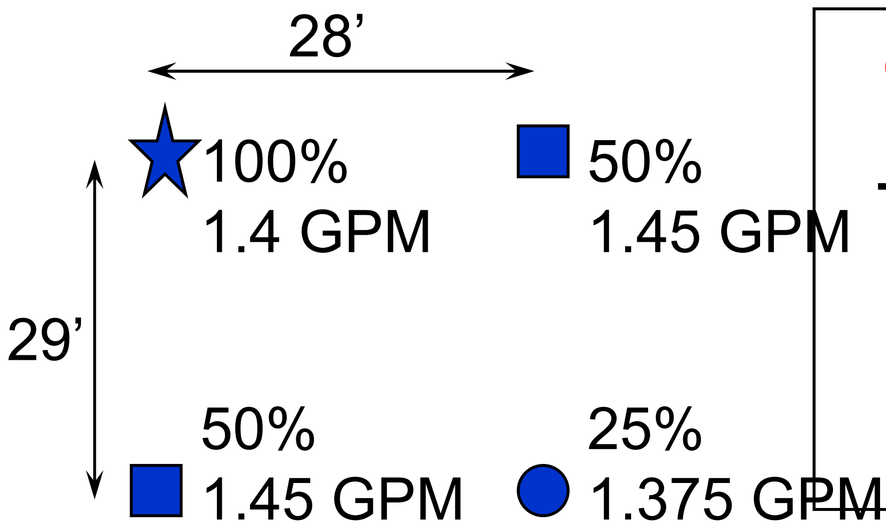
90^{o}- 1.4 GPM 180^{o}- 2.9 GPM 360^{o}- 5.5 GPM



Calculating Precipitation Rates Quiz

Calculate the precip. rate for the sprinkler layout using the following information: Operating pressure = 45 PSI.

90^{o}- 1.4 GPM 180^{o}- 2.9 GPM 360^{o}- 5.5 GPM



$$\frac{96.3 \times 5.675 \text{ GPM}}{28' \times 29'} = \frac{546.5}{812}$$

= 0.67 inches per hour (PR)

Performance Testing

- Precipitation rates
  (inches per hour)

- Coefficient of uniformity
- Distribution uniformity
- Scheduling coefficient
  (all in percent)


Good spacing

Not-so-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)

- $CU = 100\,(1 - D/M)$
- $D = (1/n) \sum \lvert X_i - M \rvert$
- $M = (1/n) \sum X_i$

- 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 = [average of low 25%/overall average] X 100

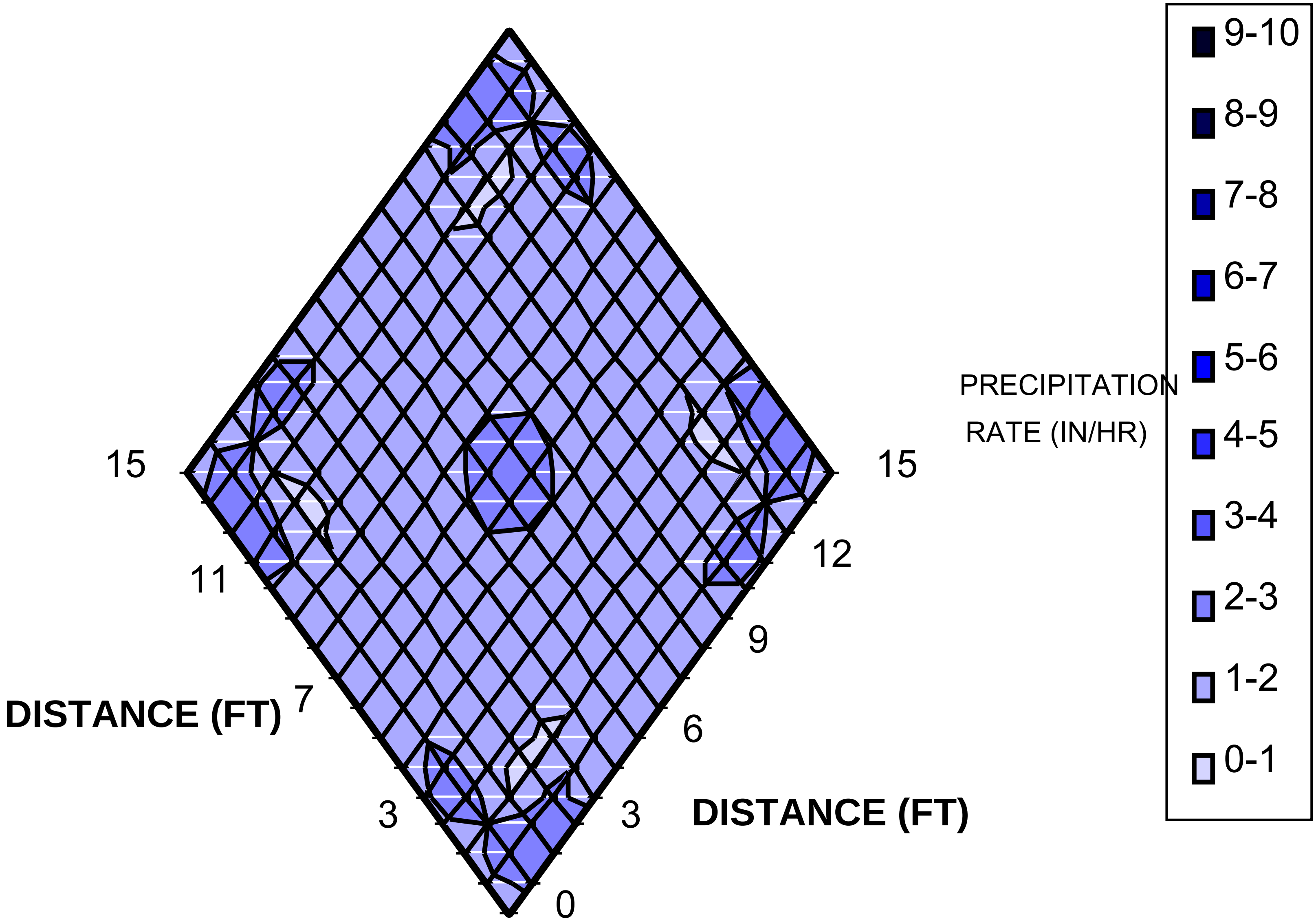
Scheduling Coefficient (SC)

- 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.

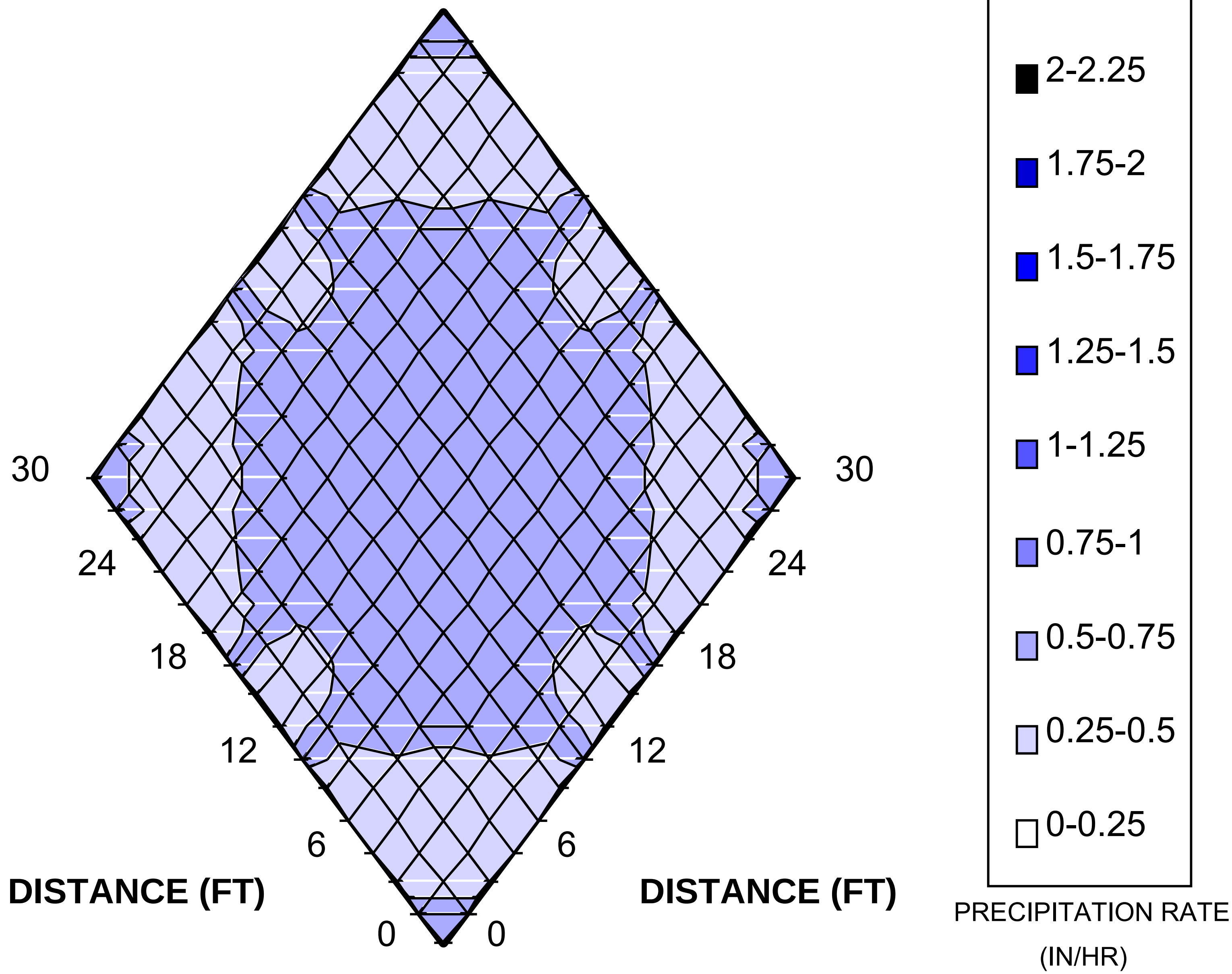
Catch can data can also be represented graphically

- Can tell you the location of the driest areas, unlike CU and DU.

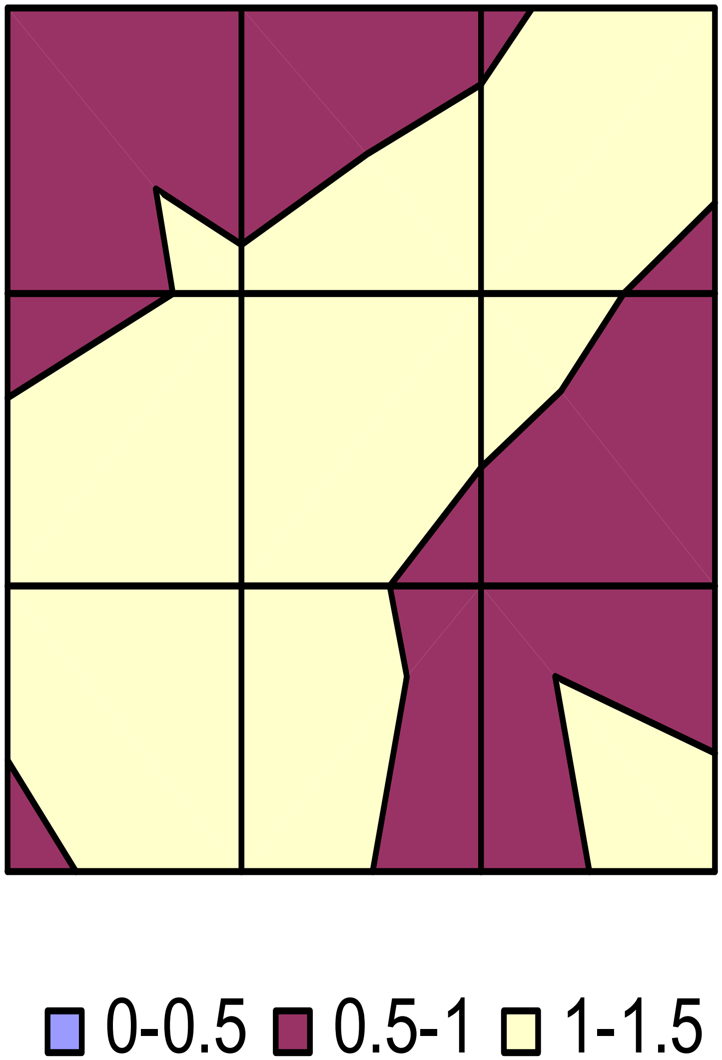
15'x15' Square Spacing with an 1804-U15Q Nozzle at 30 PSI



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



Eagle 750s spaced at 60’ w/ #20 nozzles @ 60 psi



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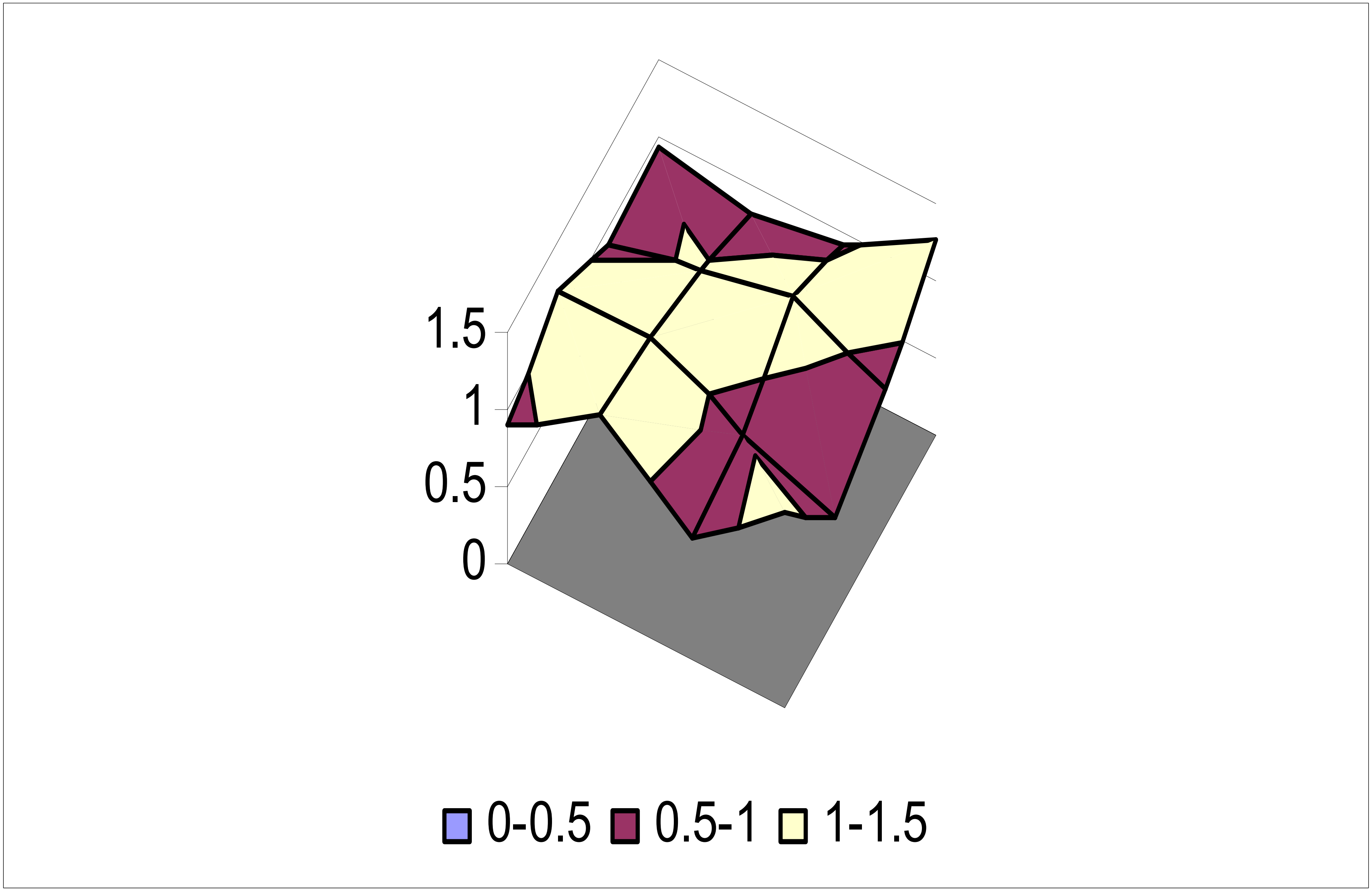
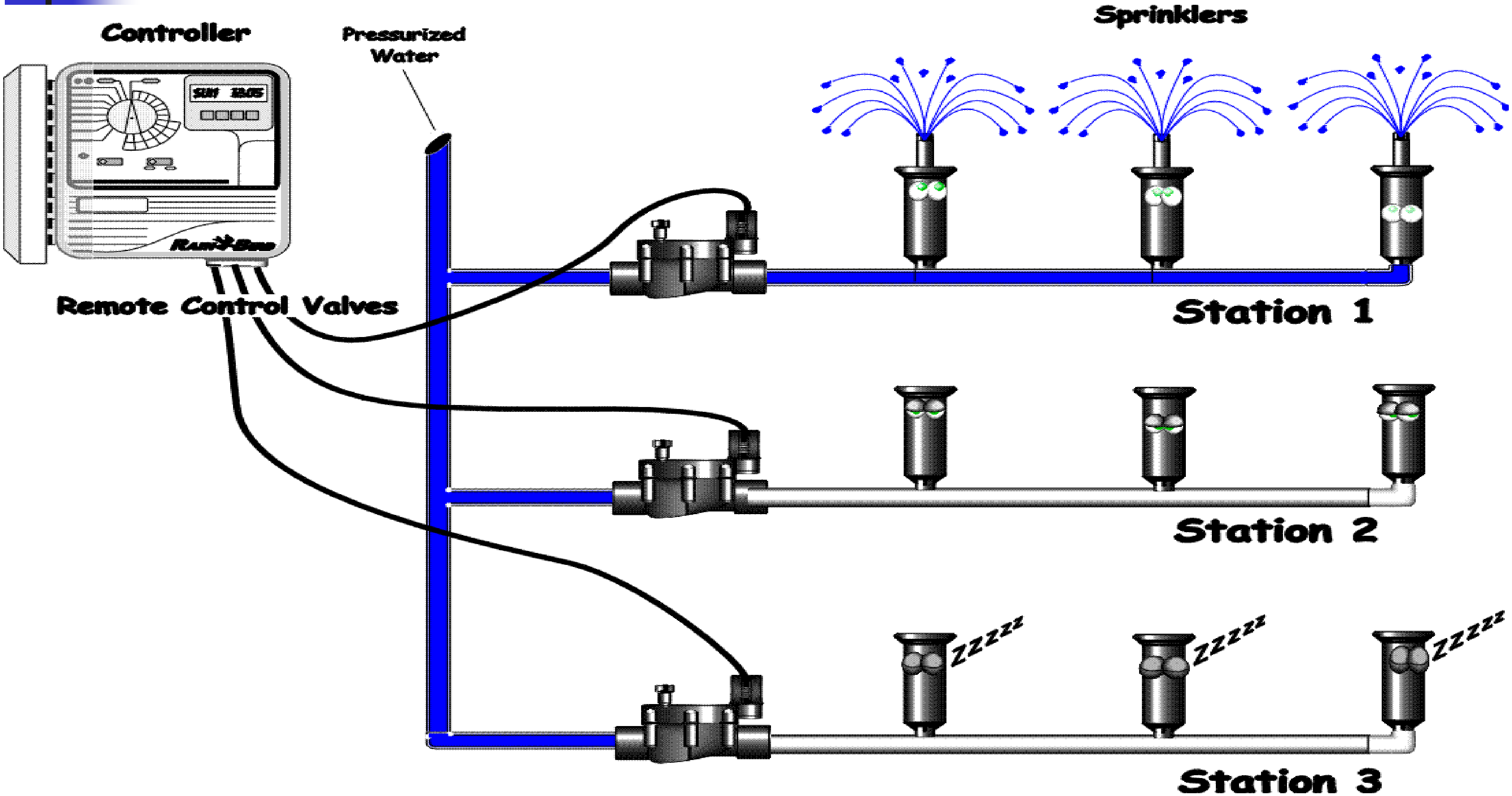


Proper sprinkler/nozzle/spacing

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.

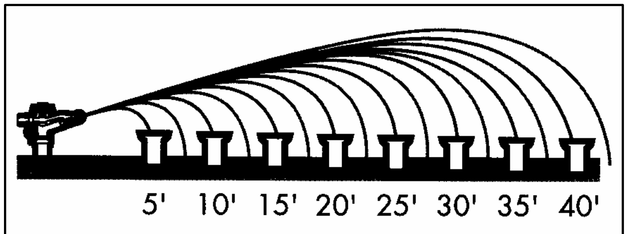
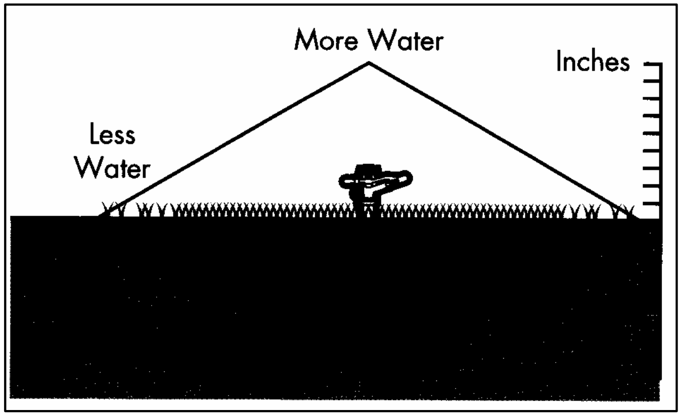


Figure 32: Measuring sprinkler distribution with containers

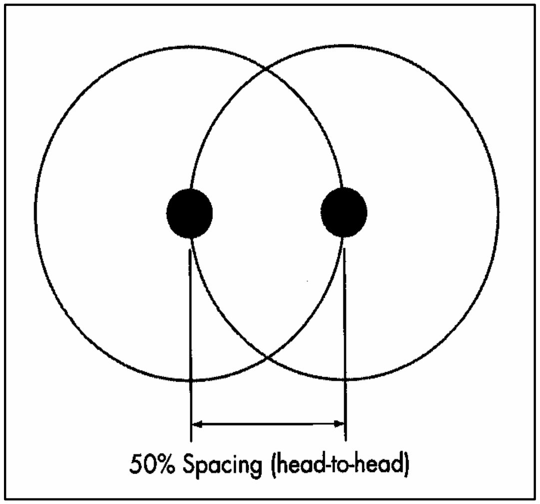


- A single sprinkler, when tested with catch cans, delivers most of it's water close-in to the sprinkler and less and less as the distance away from the sprinkler increases.

- When overlapped, the weak area of coverage from one sprinkler is supplemented by the surrounding sprinklers.

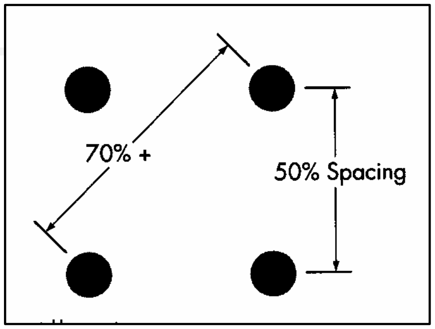
Selecting Sprinklers & Spacing Ranges

- **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.

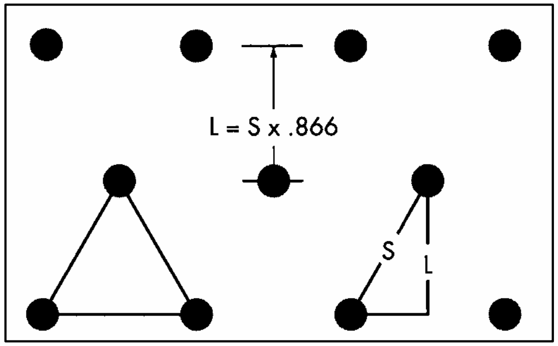


- **The sprinkler radius shown in the manufacturers catalog is measured in a zero wind test building. For windy areas, closer spacing is required to maintain Head-to-Head Spacing (49% of diameter or closer).**
- **There are 3 main types of sprinkler spacing patterns and several variations.**

Selecting Sprinklers & Spacing Ranges



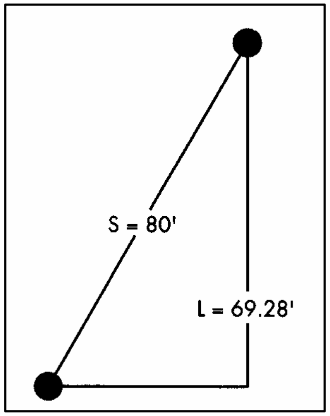
- Square spacing pattern:
  - sprinklers placed in a square pattern, with the same distance between all 4 sprinklers in the pattern.
  - best pattern for areas with 90^{o} corners and fixed boundaries.



- 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:



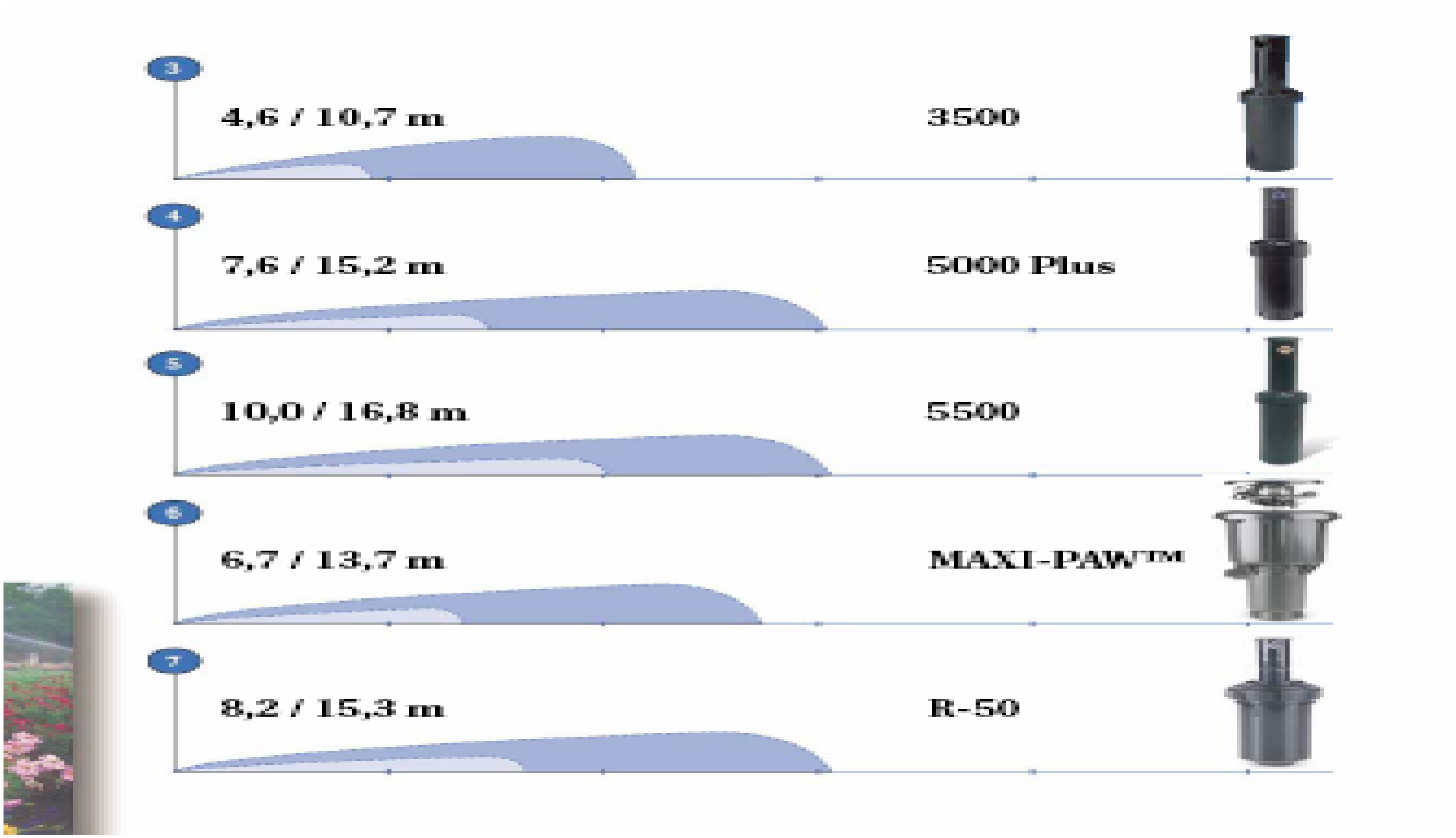
L = S x .866

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

Sprinkler Selection

- General recommendations
  - Popup spray or stream rotor, 2’-18’
  - Large rotors & impacts, > 15’

Sprinkler selection guide



Sprinkler selection guide

Selecting Sprinklers & Spacing Ranges

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

Wind Velocity	Square Pattern	Triangular Pattern	Rectangular Pattern
0 to 3 mph	55% of Diameter	60% of Diameter	60% x 50% of Diameter
4 to 7 mph	50% of Diameter	55% of Diameter	60% x 45% of Diameter
8 to 12 mph	45% of Diameter	50% of Diameter	60% x 40% of Diameter

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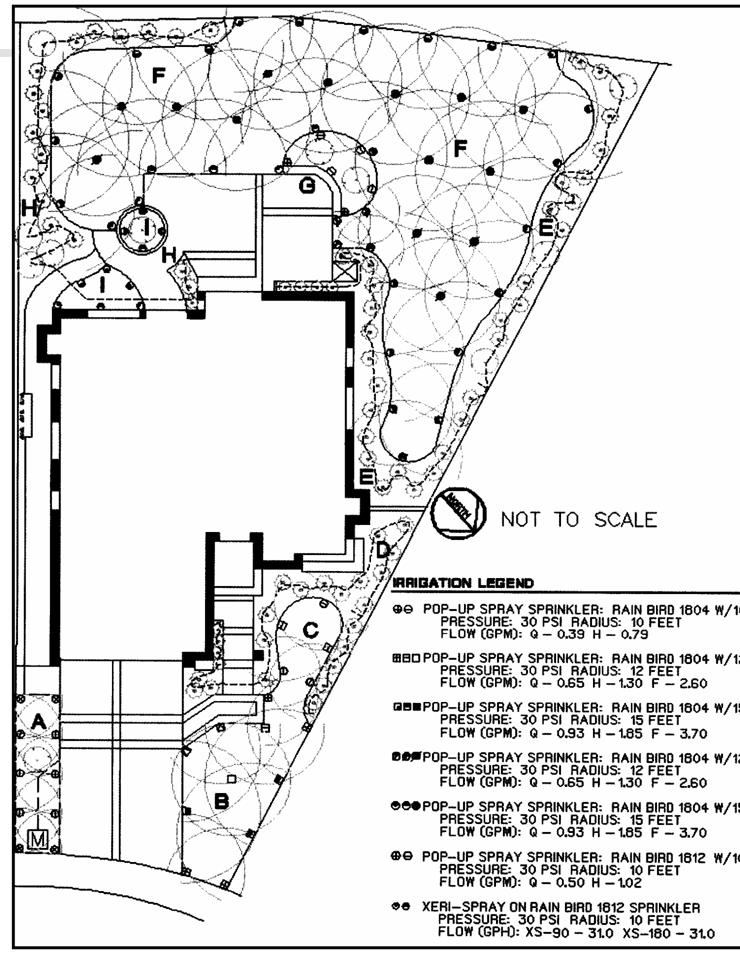
- Precipitation Rate:
  - delivery rate based on nozzle, arc and spacing.

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

<u>SYMPTOMS</u>:

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

<u>POSSIBLE CAUSE</u>:

- Number of rotors on a zone exceed the available GPM

<u>POSSIBLE SOLUTION</u>:

- 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:

$$\frac{\textbf{ET x 60}}{\textbf{(PR x EFF) x DA}} = \textbf{OT}$$

  - ET = evapotranspiration (inches per week). Use the PET.
  - 60 = 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

$$\frac{\text{target irrigation (inches)} \quad \times \ 60}{\text{precipitation rate (inches / hr)}}$$

= run time minutes !

RUN TIME MINUTES

$$\frac{\text{target } 0.25 \text{ (inches)} \qquad \times\ 60}{\text{precipitation rate } 0.45 \text{ (inches /hr)}}$$

= 33 run time minutes !