

BIG GUN®



BIG GUN® SOLUTIONS

Portable / Solid Set Irrigation



PORTABLE / SOLID SET



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Big Gun® Sprinkler Models



| | 75 SERIES | | 100 SERIES | | | 150 SERIES | | | 200 SERIES | |
|----------------------------|--|---------------------|--|----------------------|-----------------------|---|----------------------|-----------------------|---|--------------------------------|
| FLOW | 25-160 GPM (6-36 M ³ /H) | | 40-300 GPM (9-70 M ³ /H) | | | 90-630 GPM (20-143 M ³ /H) | | | 230-1200 GPM (52-272 M ³ /H) | |
| PRESSURE | 25-80 PSI (1.75-5.5 BAR) | | 40-110 PSI (2.75-7.5 BAR) | | | 50-120 PSI (3.5-8.25 BAR) | | | 50-130 PSI (3.5-9 BAR) | |
| MODEL & TRAJECTORY | Full Circle F75 | Part Circle SR75 | Full Circle F100 | Part Circle SR100 | Part Circle SRA100 | Full Circle F150 | Part Circle SR150 | Part Circle SRA150 | Full Circle F200 | Part Circle SR200 |
| | 21°, 24° | 18°, 21°, 24°, 43° | 18°, 21°, 24°, 43° | | 15-45° Adjustable | 18°, 21°, 24° | 21°, 24°, 27°, 43° | 15-45° Adjustable | 21°, 24°, 27° | 21°, 24°, 27°, 33°, 36°, 39° |
| NOZZLE OPTIONS | - | | 100T (10 sizes) | | | 150T (8 sizes) | | | 200T (9 sizes) | |
| | 75TR (9 sizes) | | 100TR ¹ (11 sizes - Aluminum or Plastic) | | | 150TR (17 sizes - Aluminum or Plastic) | | | - | |
| RING | - | | 100R ¹ (8 sizes) | | | 150R (7 sizes) | | | 200R (7 sizes) | |
| THREADED CONNECTION | 1.5" FNPT / FBSP 2" FNPT / FBSP | | 2" FNPT / FBSP 2.5" FNPT ¹ | | | Adapter Required ² | | | Adapter Required ³ | |
| FLANGE CONNECTION | 2" ANSI/DIN / Nelson / Euro | | 2" ANSI/DIN ¹ / Nelson ¹ / Euro ¹ | | | 3" ANSI/DIN / Nelson / Euro | | | 4" Nelson / Euro, ANSI Adapter ⁴ | 4" ANSI/DIN / Nelson / Euro |
| SPECIAL COATING / MATERIAL | - | | Anodized, Anodized & Powder Coated | | | Anodized, Anodized & Powder Coated, Stainless Steel | | | Anodized, Anodized & Powder Coated | |
| SPECIAL OPTIONS | - | | Effluent Bearing Assembly, Vaneless Range Tube, Brakeless | | | Effluent Bearing Assembly, Vaneless Range Tube | | | Effluent Bearing Assembly | |
| ACCESSORIES | Dust shield ⁵ , Counterbalance kit, 12° wedge kit | | LP drive vane ⁶ , Dust shield, Counterbalance kit, 12° wedge kit | - | | Counterbalance kit, 12° wedge kit | - | | Counterbalance kit, 12° wedge kit, Manure/Large Nozzle kit ⁷ | |

Notes:

1. Not available on SRNV100
2. Use Nelson Flange x Threaded Adapter: 150FI, 3" or 3.5" FNPT/FBSP; or 150/200FI, 4" FNPT.
3. Use Nelson Flange x Threaded Adapter: 150/200FI, 4" FNPT.
4. For ANSI connection, use Nelson x 4" ANSI Flange kit (#12807)
5. Not available on SR75.
6. Works with SR100 and SRA100 only.
7. SR200 only

Portable / Solid Set Irrigation

OVERVIEW

Why Choose a Nelson Big Gun® Sprinkler

- The Big Gun® name is synonymous with the best quality available.
- Heavy-duty construction ensures long wear life & reliability.
- Greatest range of options. Full & part-circle sprinklers available in a variety of trajectory, nozzle & coating options.
- Integrated control valves with wireless automation available for maximum system efficiency.
- Easy to operate, maintain and repair with readily available parts and documentation.

Primary Applications

- Agricultural Irrigation
- Irregular Field Shapes
- Center Pivot Corners
- Sports Fields
- Horse and Livestock Pastures
- Mining and Industrial Dust Control

KEY PRODUCTS & ACCESSORIES



F75 / SR75 24°



F100 / SR100 24°



F150 / SR150 24°



Secondary Nozzles



800 / 1000 / QC Valves



TWIG® Wireless Controls

NELSON IRRIGATION - BIG GUN

Portable / Solid Set Irrigation: Overview

OVERVIEW

Nelson Big Gun® sprinklers are a great option for portable, solid set, and permanent set systems in agricultural irrigation, irregular field shapes, sports fields, and more. This application guide contains design guidelines, examples, and best practices for using Big Gun® sprinklers in these applications.

“Set” sprinkler irrigation systems operate with the sprinklers set in a fixed position (as opposed to mechanized or continuous-move systems such as center pivots and hose reel travelers). There are two main types of “set” systems:

- **Portable set** (also called “periodic-move”) systems where sprinklers must be moved through a series of positions over the course of irrigating a field;
- **Solid set** systems that do not require the sprinklers to be moved during the course of irrigation.

Portable systems may involve moving just the sprinkler or an entire lateral across the field. The system may be composed of buried pipe, with one or a few sprinklers that are moved from riser to riser, with only one sprinkler operating at a time in order to reduce the required pipe diameter. Alternatively, portable systems may use just one or a few lateral pipes that are moved across the field during the course of irrigation.

The mainline and laterals in **solid set** systems may be above ground, portable pipe that is left in place throughout the duration of the irrigation season, but removed only during cultivation/harvesting. This would be called a “portable solid set” system. Alternatively, “permanent solid set” systems use buried pipe.

ADVANTAGES OF PORTABLE SYSTEMS:

- *Pipe can be removed from the field for farming operations, which eliminates the necessity of farming around sprinkler risers.*
- *In its most basic form the portable sprinkler concept is one of the lowest cost systems available.*
- *Portable systems can be rotated to different fields to follow the crop rotation.*
- *Portable systems make land leasing programs practical.*

ADVANTAGES OF PERMANENT SOLID SET SYSTEMS:

- *Selection of the sprinkler spacing is not limited by standard portable pipe lengths.*
- *There is less irrigation labor involved, as the pipe does not have to be moved out of the field for farming operations.*
- *It is possible to loop the piping system, which affords some economies through pipe size reduction.*
- *Supporting the sprinkler riser is less complicated than with above-ground pipe.*

Portable / Solid Set: Design Guidelines

1. DESIGN GUIDELINES

In order to provide the best crop yield and health, agricultural irrigation systems should be designed for high uniformity and water efficiency. Other factors such as system cost, operating cost, durability, and labor deserve consideration. Use of an irrigation design software, such as IRRICAD, is strongly encouraged. A properly designed Big Gun® sprinkler system is capable of achieving high uniformity and will last for decades when the following factors are considered:

- ***Sprinkler Selection***
- ***Trajectory***
- ***Nozzle and Pressure***
- ***Spacing (application rate)***
- ***Water Quality***
- ***Operation***
- ***Riser Design***
- ***Rotation Speed***



Figure 1. The Big Gun® sprinkler family: (from left to right) 200 Series, 150 Series, 100 Series, 75 Series.

Portable / Solid Set: Design Guidelines

1.1 SPRINKLER SELECTION

KEY POINTS

- **75 and 100 Series are most commonly used models.**
- **Specify the correct connection to be compatible with the riser.**

The 75 Series and 100 Series Big Gun® sprinklers are the most commonly used models for portable and solid set systems. They offer the best balance of required pipe diameters, application rate, operating pressure and sprinkler spacing. The 150 Series Big Gun® sprinklers have larger nozzles that allow for a wider grid pattern, however the required flow per position increases to a greater degree than the increased spacing. Thus, higher pressures and larger diameter pipes are required, increasing the overall cost. The 200 Series is not commonly used in this application.

1.1.1 CONNECTIONS

The sprinkler connection type must be specified and should be compatible with the riser design. When Nelson control valves are used in conjunction with Big Gun® sprinklers, the ANSI flange is the ideal connection. Otherwise, threaded connections are available for 75 and 100 Series. The lower flange below the valve is available in 2" or 3", FNPT or FBSP. If a 3" or 4" threaded connection is needed for a 150 Series Big Gun® sprinkler, the sprinkler must be specified with a Nelson flange, and the Nelson Flange x Threaded adapter used.

Table 1. Available connections on Big Gun® sprinklers.

| | 75 SERIES | 100 SERIES | 150 SERIES | 200 SERIES |
|---------------------|--|---|--|---|
| THREADED CONNECTION | 1.5" FNPT / FBSP 2" FNPT / FBSP | 2" FNPT / FBSP 2.5" FNPT ¹ | Use FI Adapter (Nelson Flange x Threaded) | Use FI Adapter (Nelson Flange x Threaded) |
| FLANGE CONNECTION | 2" ANSI/DIN Compatible Nelson ² Euro ³ | 2" ANSI/DIN Compatible ¹ Nelson ^{1,2} Euro ^{1,3} | 3" ANSI/DIN Compatible Nelson ² Euro ² | 4" ANSI/DIN Compatible ⁴ Nelson ² Euro ² |

Notes:

1. Not available on SRNV100
2. Includes gaskets and bolts
3. Includes gasket only
4. Available on SR200 and F200HD only; standard F200 use Nelson x ANSI adapter kit #12807

Table 2. Flange adapters for use with Big Gun® sprinklers.

| ADAPTER | 75 & 100 SERIES | 150 SERIES | 200 SERIES |
|--|--|---|--------------------|
| Big Gun/Valve Combo ANSI Flange, Threaded | 2" FNPT - #10356 2" FBSP - #12940 | 3" FNPT - #13233-001 3" FBSP - #13233-002 | - |
| FI Adapter Nelson x Threaded | 2" FNPT - #6860 2" FBSP - #7050 2.5" FNPT - #7040 2.5" FBSP - #7051 | 3" FNPT - #8403-001 3" FBSP - #8820 3.5" FNPT - #6621-000 3.5" FBSP - #6621-001 4" FNPT - #9127 | 4" FNPT - #9127 |
| Nelson x ANSI Flange Adapter | - | - | #12807 (F200 Only) |

Portable / Solid Set: Design Guidelines

1.1.2 PORTABLE SYSTEMS WITH THE QC VALVE/KEY

The Nelson Quick-Coupling (QC) Valve/Key system is an excellent solution for portable sprinkler systems. It allows the system to remain pressurized while the sprinklers are moved from position to position. Remember the following guidelines when using the Nelson QC Valve/Key system:

- **Only use the QC100 with 75 and 100 Series Big Gun® sprinklers**
- **Only use the QC150 with 150 Series Big Gun® sprinklers**
- **Maximum allowable extension between the QC Key and Big Gun® sprinkler is 12"**

The QC Valve and Key models and connections are summarized in Table 3. The QC100 Key connects directly to a 75 or 100 Series Big Gun® sprinkler (replaces the flange on the sprinkler); it is also available with a threaded outlet when an extension is needed between the QC Key and the sprinkler.

The QC150 Key is only available with 3" Nelson flange outlet, for connecting directly to the 150 Series Big Gun® sprinkler. The QC150 Valve is only available with a 3" threaded inlet.

Table 3. QC Valve and Key models and connections

| MODEL | INLET CONNECTION | OUTLET CONNECTION |
|-------------|------------------------------------|---|
| QC100 Valve | 2" FNPT, 3" FNPT, 2" FBSP, 3" FBSP | Connects to QC100 Key |
| QC100 Key | Connects to QC100 Valve | Direct to 75/100 Series, 2" FNPT, 2" FBSP |
| QC150 Valve | 3" FNPT, 3" FBSP | Connects to QC150 Key |
| QC150 Key | Connects to QC150 Valve | 3" Nelson Flange |



Figure 2. F100 Big Gun® sprinkler mounted to QC100 valve and key (left), and QC150 valve and key (right).

Portable / Solid Set: Design Guidelines

1.2 TRAJECTORY

KEY POINTS

- ***The 24 degree trajectory offers the best balance between wind resistance and throw distance.***
- ***Trajectory affects stream height, throw distance, droplet patterns, wind drift and evaporation, and uniformity.***

Selection of the correct trajectory angle for the Nelson Big Gun® sprinkler will result in optimization of pattern uniformity, minimized wind drift and evaporation, maximized radius of throw, and best droplet conditions possible. Generally, the 24° trajectory angle provides the best balance between wind resistance and throw distance.

Use the lower trajectory angle models or the variable trajectory models in windy conditions. While a 27° trajectory will give maximum radius in no wind conditions, the 24° trajectory or 21° trajectory will perform better in the wind. Note that higher trajectory angles give more desirable droplet patterns. When using lower trajectory angles use slightly higher operating pressures to enhance the droplet pattern. Riser height should also be considered when choosing the trajectory angle; tall risers may allow a lower trajectory.

The trajectory of the sprinkler affects the stream height. For example, the 0.7" taper bore nozzle at 80 psi on a 24° trajectory 100 Series Big Gun® sprinkler has a peak stream height of 24 feet above the nozzle. Under the same conditions, the 21° trajectory throws 19 feet above the nozzle. When choosing sprinkler trajectory and designing the sprinkler layout, beware of overhanging tree branches and power lines. Additional information about stream trajectory is found in the design guidelines for industrial and environmental applications, and stream heights are found in the performance tables in the Big Gun® Technical Manual.

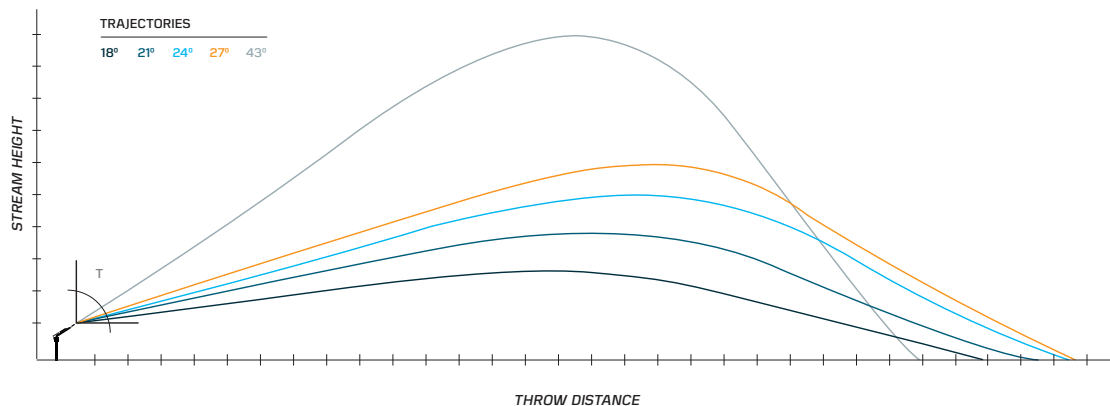


Figure 3. Relative effect of trajectory on stream height and throw distance.

Portable / Solid Set: Design Guidelines

1.3 NOZZLE AND PRESSURE

KEY POINTS

- **The taper bore nozzle is the best choice for most portable and solid set irrigation applications.**
- **Always use adequate pressure.**
- **Use secondary nozzles to improve uniformity.**

There are three types of Big Gun nozzles: taper bore, taper ring, and ring nozzles. Taper bore gives the greatest throw distance, while ring nozzles are interchangeable and provide more diffusion. The taper ring nozzle combines the changeability of the ring nozzle with some of the throw distance efficiency of the taper bore. Not all types of nozzles are available on each series of Big Gun® sprinkler; consult the comparison table on page 5. For most portable and solid set irrigation applications, the taper bore nozzle is the best choice. However, the ring nozzle will improve stream breakup when operating pressures are low.



Figure 4. From left to right: ring nozzle set, taper ring nozzle set, and taper bore nozzle.

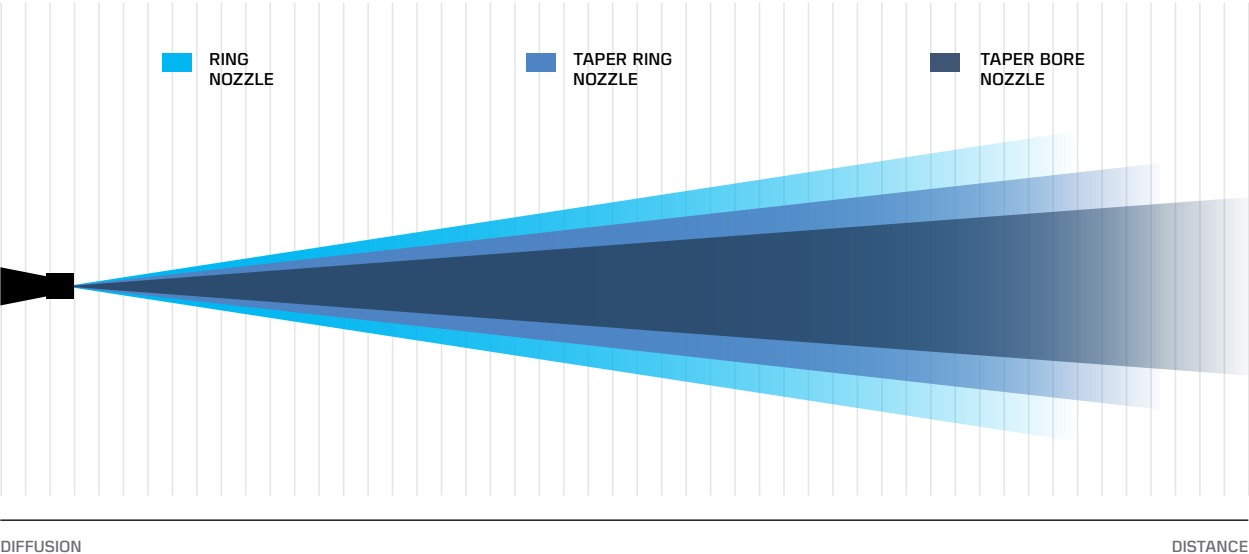


Figure 5. Stream diffusion and throw distance varies with nozzle type.

Portable / Solid Set: Design Guidelines

Always use adequate pressure. To produce good uniformity and desirable droplet characteristics, Big Gun® sprinklers require higher operating pressures than small sprinklers. Lower operating pressure does not necessarily reduce operating cost. Lower pressure results in reduced radius of throw and lower uniformity, which require closer sprinkler spacing, greater labor, and longer run times to apply the net water requirements. Furthermore, in many designs the actual pressure at the nozzle ends up being less than expected due to unaccounted pressure losses in the system. Avoid poor stream break-up and uniformity problems by designing for proper pressure.

For best results, choose nozzle sizes and operating pressure from near the center of the performance table. For example, the 0.7" taper bore nozzle at 70 psi offers ideal performance for the 100 Series Big Gun® sprinkler. The 150 Series likewise performs best in the 1.0-1.1" nozzle range, around 90 psi. Ideal operating pressures for a given flow rate are shown in the Table 4. If less than ideal pressure is used, consider using ring nozzles to create better stream breakup and improve uniformity.

Table 4. Ideal operating pressure for a given flow range.

| FLOW | IDEAL PRESSURE |
|---|-------------------------|
| 40-100 gpm (9-22 m ³ /hr) | 60-70 psi (4-5 bar) |
| 100-200 gpm (22-45 m ³ /hr) | 70-80 psi (5-5.5 bar) |
| 200-300 gpm (45-68 m ³ /hr) | 80-90 psi (5.5-6 bar) |
| 300-500 gpm (68-113 m ³ /hr) | 90-100 psi (6-7 bar) |
| >500 gpm (>113 m ³ /hr) | 100-110 psi (7-7.5 bar) |

1.3.1 SECONDARY NOZZLES

Secondary nozzles should be used to maximize uniformity, especially when sprinklers are spaced further apart than head-to-head (i.e. when spacing between sprinklers is greater than the sprinkler throw radius). The secondary nozzle provides additional water close to the sprinkler. However, beware of poor water quality that may plug small secondary nozzles. In general, the secondary nozzle should deliver approximately 10% of the primary nozzle flow rate. The typical nozzle to use for the 100 series Big Gun® sprinkler is the 7/32" 3RN nozzle. The typical nozzle to use for the 150 Series is the 5/16" (3RN for F150; 7RN for SR150).

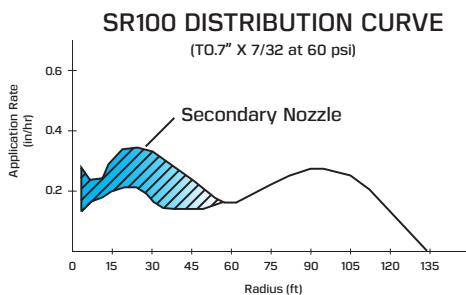


Figure 5. A secondary nozzle increases the amount of water applied close to the sprinkler.



Figure 6. Secondary nozzle kit (#9724) for SR100 and SR150 sprinklers.

Portable / Solid Set: Design Guidelines

1.4 SPACING AND UNIFORMITY

KEY POINTS

- **Spacing should generally be 50-65% of the sprinkler throw diameter**
- **Use closer spacing in windy areas**
- **Triangular layout generally results in better uniformity**
- **Irrigation application rate should not exceed the soil water intake rate**

For the best system performance and highest uniformity use conservative sprinkler spacing. Perhaps the most common and biggest mistake designers make is spacing sprinklers too far apart. Spacing should generally be from 50% to 65% of the sprinkler diameter (100 to 130% of the sprinkler radius), with the tighter spacing recommended in high wind conditions and for crops and soils requiring the best uniformity. Use secondary nozzles whenever sprinkler spacing is greater than head-to-head (more than 50% of throw diameter).

When using a rectangular or staggered spacing ensure the tighter dimension is perpendicular to the prevailing winds to improve coverage, as shown in Figure 7. Stagger the sprinkler for better distribution in windy conditions. Maximum spacing (65% of sprinkler diameter) should not be used in both directions (lateral and sprinkler spacing).

In general, a triangular spacing will result in better real-world uniformity and is the best choice unless farming operations require that the sprinklers be in-line across rows. Theoretical uniformity calculations from software programs may show rectangular spacing with higher uniformity, but field experience generally indicates that triangular spacing is better.

Note that uniformity is calculated in an area where there is complete overlap of sprinklers, as shown by the “overlap area” box in Figure 7. Uniformity for inconsistent spacing, or field edges without overlap from part-circle sprinklers should be estimated separately. For best uniformity across the entire field, use part-circle sprinklers at the field edges.

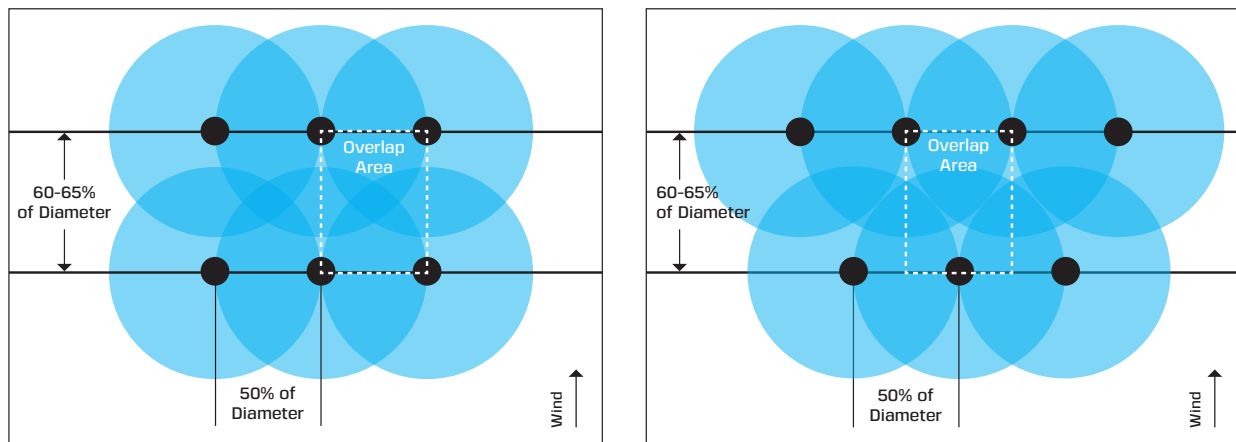


Figure 7. Rectangular (left) vs triangular (right) spacing.

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1.4.1 APPLICATION RATE

The irrigation application rate is how quickly water is applied. It must not be excessive or runoff may occur, which reduces irrigation efficiency, causes erosion, and deteriorates water quality. The soil must be able to intake the water at the rate it is applied. The **gross average application rate (AAR)** assumes that all sprinklers will be operated at the same time and is calculated as follows:

$$\text{AAR (in/hr)} = \frac{96.3 \times \text{Nozzle Flow (gpm)}}{\text{Sprinkler Spacing (ft)} \times \text{Pipe Spacing (ft)}}$$

$$\text{AAR (mm/hr)} = \frac{1000 \times \text{Nozzle Flow (m}^3\text{/hr)}}{\text{Sprinkler Spacing (m)} \times \text{Pipe Spacing (m)}}$$

If the soil has a low water intake (infiltration) rate, the application rate can be reduced by running only one sprinkler at a time. *This results in a reduced application rate of nearly 60% of that found with the Average Application Rate equation.*

Another way to improve irrigation infiltration is to use automation to create an irrigation program to “cycle and soak.” For example, if one hour of run time is required to deliver the gross application depth, set the system to run 4 cycles of 15 minutes. The application rate of well-designed, overlapped Big Gun systems can be in the range of 0.3 to 0.7 in/hr (7.5 to 18 mm/hr).

To estimate the **net depth** of water applied, multiply the gross average application rate by the run time, and then by the irrigation efficiency to account for losses due to evaporation, etc. These losses could be 10-25% depending on nozzle size, pressure, climate, soil type, and crop growth stage.¹

1.5 WATER QUALITY

This application guide assumes water quality typical of common agricultural water sources. The most common water quality concern in agricultural irrigation generally involves nozzle plugging. Big Gun® sprinklers, with their large nozzles, are particularly good for applications where nozzle plugging is a concern. However, be cognizant of secondary nozzles that may be more prone to plugging than the primary nozzle.

Industrial and/or wastewater applications will often have poor water quality that can cause corrosion of sprinkler parts or other problems. Contact the factory for more information on special sprinkler coatings and accessories for industrial applications.

1. For more information about sprinkler irrigation efficiency, see also:

Keller, J. and Bliesner, R.D. 2000. Sprinkle and trickle irrigation. The Blackburn Press, Caldwell, New Jersey.

Brouwer, C., Prins, K., and Heibloem, M. 1989. Irrigation water management: irrigation scheduling. Food and Agriculture Organization of the United Nations, Training Manual No. 4. Rome.

Howell, T. 2003. Irrigation efficiency. United States Department of Agriculture. Encyclopedia of Water Science.

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1.6 OPERATION

KEY POINTS

- *Use automation to improve uniformity*
- *Wireless control systems are less susceptible to damage*
- *Balance water application of full- and part-circle sprinklers*

Perhaps the biggest challenge with Big Gun® sprinkler systems is operation. Due to the relatively high application rates of Big Gun® sprinklers, long irrigation run times typical of other irrigation methods may result in runoff or over-irrigation with these systems. This can be avoided and managed by using an automated control system. Precision irrigation is possible when Big Gun® sprinklers are paired with Nelson control valves and TWIG® wireless controls. A wireless control system is preferred over traditional wired systems due to long wire runs required and the resulting damage from lightning and rodents.

Full-circle or part-circle operation of the sprinkler has a great influence on the application rate. A sprinkler set to operate in a half-circle arc will double the application rate. Avoid over-irrigation by running part-circle sprinklers for less irrigation time.



Figure 8. TWIG® Wireless Automation with Nelson control valves helps achieve precision irrigation with Big Gun® sprinklers.

Portable / Solid Set: Design Guidelines

1.7 ROTATION SPEED

KEY POINTS

- **Adjust the rotation speed to optimize irrigation and sprinkler performance.**

All Big Gun® sprinklers are factory water-tested for steady rotation speed. The rotation speed of new sprinklers will slow down over time as they “break in” and the actual in-field rotation speed will vary based on the nozzle size, pressure, and riser design. Sprinklers that rotate too fast will result in poor uniformity and reduced radius. Sprinklers that rotate too slowly may damage bare soil or could more easily stall as debris builds up on the sprinkler brake, nozzle, or drive spoon/vane. Tilted or non-vertical risers can have uneven rotation speed resulting in poor uniformity or stalling; make sure risers are vertical, or use a counterbalance kit to even out the rotation speed (see Section 1.8.3)

For best results, follow the ideal rotation speed guidelines in Table 5. Rotation speed can be changed by adjusting the drive vane angle on full-circle models, or the arm weight position on part-circle models, as shown in Figures 9 and 10, respectively.

Table 5. Ideal rotation speed

| BIG GUN® SERIES | IDEAL ROTATION SPEED |
|-----------------|----------------------|
| 75 Series | 60-90 sec |
| 100 Series | 60-90 sec |
| 150 Series | 90-120 sec |
| 200 Series | 180-210 sec |



Figure 9. F100 drive vane adjustment bolt viewed from the bottom of the drive arm, shown with the vane in the fast position (left), and slow position (right).



Figure 10. Rotation speed on the SR100 is controlled by adjusting the arm weight position.

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1.8 RISER DESIGN

KEY POINTS

- ***Avoid excessive turbulence and pressure loss in pipe risers***
- ***Risers should be vertical and have adequate stabilization***
- ***Never use PVC***
- ***Install risers at the correct height for the application***
- ***Use air and pressure relief to protect the system from water hammer***
- ***Use isolation valves for maintenance***

The sprinkler riser must be properly designed and installed for optimum performance. Poor riser design can result in premature wear, pipe breakage, reduced throw distance, sprinkler stalling, and poor uniformity. Fixing these problems can be expensive; it is better to prevent them by following the recommendations in this guide. The following factors should be considered:

- ***Hydraulics***
- ***Stabilization and Thrust***
- ***Straightness***
- ***Material***
- ***Protection and Height***
- ***Air Relief, Pressure Relief, and Isolation***
- ***Drain-down***

1.8.1 HYDRAULICS

Proper riser design allows adequate pressure to be delivered to each sprinkler with minimal turbulence and therefore pressure loss. Consider using a design program like IRRICAD to layout looping pipe networks, and analyze system hydraulics to achieve the best possible design. While pipe purchase and other installation costs are a one-time, fixed capital cost, energy costs and low pressure problems are ongoing and will endure throughout the life of the system.

The riser pipe size should be at least equal to the size of the connection on the sprinkler, but in cases where large nozzles are used, the riser may need to be one pipe size larger than the sprinkler connection size. Big Gun® sprinkler connection sizes and types are shown in Table 1. Undersized risers will increase the pressure loss and turbulence, which will negatively impact the sprinkler performance.

One solution for correcting turbulence is to install stream straightener vanes (see Figure 11) in the riser immediately below the sprinkler. Vanes are available for 2" and 3" schedule 40 pipe and are listed in Table 6. These vanes can help reduce water swirling as it enters the sprinkler, resulting

Portable / Solid Set: Design Guidelines

in increased throw distance. However, they should not be used where there is poor water quality due to the increased potential of plugging.

Table 6. Riser stream straightener vanes.

| PIPE DIAMETER | LENGTH | PART NUMBER |
|---------------|--------|-------------|
| 2" | 6" | 6671 |
| 3" | 9" | 6843 |



Figure 11. Stream straightener vanes for pipe risers.

1.8.2 RISER STABILIZATION AND THRUST

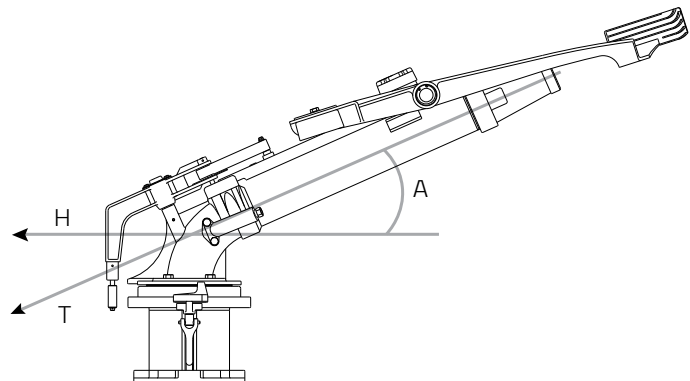
A stable riser is required for correct sprinkler operation. With a stable riser, the sprinkler's drive arm is able to consistently engage the stream resulting in uniform sprinkler rotation. A stable riser also dampens out vibration created by the drive arm. If vibration is not dampened, and is allowed to travel down to the lateral pipe, it could cause fatigue and possible failure of the tee joint. An unstable riser that does not provide a solid mount for the sprinkler can significantly reduce stream throw radius.

Wood support posts or concrete are the most common methods of riser stabilization (see Section 1.8 for examples). If support posts are used to stabilize the riser, beware of settling pipe or HDPE laterals/submains that can move with temperature, causing the riser to pull away from the support post. Always properly backfill and compact trenches, and design thrust blocks using proper engineering practices.

The thrust generated by a Nelson Big Gun® sprinkler can be substantial. Formulas for calculating thrust are found in Figure 12 and should be used by engineers to design thrust blocks and riser stabilization.

1.8.3 RISER STRAIGHTNESS

Risers should be installed vertically for optimum throw distance and even sprinkler rotation. Angled risers can result in uneven rotation speed or stalling. Swing assemblies, or swing joints, are a useful method for accomplishing this. In addition to allowing the riser to be plumbed vertical, they protect the buried pipe lateral from damage if the riser is disturbed by machinery or livestock.



Thrust Force (lbs)

$$T = 2P \frac{Q}{38\sqrt{P}} \quad \begin{array}{l} Q = \text{Flow Rate (gpm)} \\ P = \text{Pressure (psi)} \end{array}$$

Horizontal Force (lbs)

$$H = T \cos(A) \quad A = \text{Sprinkler Trajectory Angle}$$

Figure 12. Methods for estimating sprinkler thrust force.

Portable / Solid Set: Design Guidelines

The **2-elbow swing assembly** (see Figure 13) is the simplest method used to plumb riser assemblies, and results in the lowest turbulence and friction loss. It is used where height adjustment is not critical. This plumbing is not recommended for the QC valve in-box installation options.

The **3-elbow swing assembly** (see Figure 14) provides the most flexible installation. If the riser is hit by machinery, the 3-axis swing allows movement, helping to limit potential damage. This option is the best choice for the QC valve in-box installation options due to the flexibility it provides in fine-tuning the riser height. However, the turbulence and subsequent friction loss generated within the 3-elbow assembly is greater than that generated in the 2-elbow swing assembly.

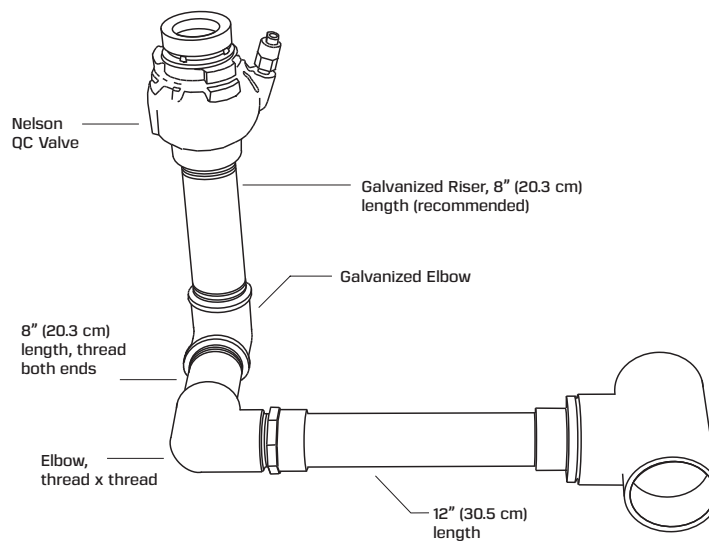


Figure 13. Example of a 2-elbow swing joint assembly used with a Nelson QC Valve.

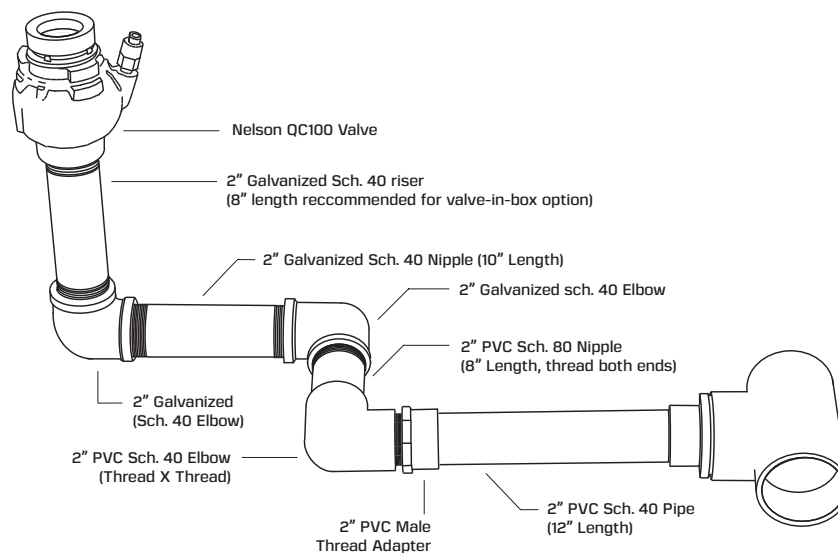


Figure 14. Example of a 3-elbow swing joint assembly used with a Nelson QC Valve.

Portable / Solid Set: Design Guidelines

In most cases, the riser should NOT be installed perpendicular to the field slope unless a vertical riser on an extreme slope will cause reduced radius and/or erosion on the uphill side of the sprinkler. If risers are installed perpendicular to field slope, a counterbalance kit should be installed on the sprinkler whenever slopes exceed 10 degrees (17%). Otherwise, uneven sprinkler rotation will occur and stalling is possible. The counterbalance kit (Figure 15) provides an even rotation for non-vertical risers, and available models are shown in Table 7.

Table 7. Available counterbalance kit models.

| MODEL NUMBER | BIG GUN® SERIES | PART NUMBER |
|--------------|-------------------|-------------|
| 100CBK | 75 and 100 Series | 8386 |
| 150CBK | 150 Series | 8399 |
| 200CBK | SR200 Only | 9346 |

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Figure 15. Counterbalance kit (left), installed on sprinkler (right) for even rotation on tilted risers.



Figure 16. Risers should not be installed perpendicular to field slope. The sprinkler in this photo will have uneven watering and may stall without the use of a counterbalance kit.

Portable / Solid Set: Design Guidelines

1.8.4 RISER MATERIAL

The riser material is critical to the durability of the system. Never use PVC as a riser material, even when adequately stabilized in concrete; it is not strong enough to endure the thrust and vibration found in Big Gun® sprinkler systems. Be aware of local soil conditions and water quality that may corrode pipes and choose a material that will offer the best corrosion resistance and durability to thrust and vibration.

1.8.5 RISER HEIGHT AND PROTECTION

Protect the sprinkler and the riser by designing it to the proper height and with adequate protection. To protect against wildlife and livestock a fence may be used to surround the sprinkler. Alternatively, make the riser tall enough that the sprinkler and any control valves are out of reach of livestock. Hydraulic control valves should also be configured with special tubing protection, especially if risers are short or not enclosed.

Risers that are too short may cause the sprinkler drive arm to interfere with the crop, vegetation, or the ground, which can cause the sprinkler to stall. Be especially aware of valve height when installing QC valves in valve boxes, as sunken valves will result in the sprinkler drive arm catching on the ground. An extension may be used between the QC100 Key and the sprinkler, but it may not exceed 12" in length.



Figure 17. Protect risers from livestock by using a fence (left) or tall risers (right).

Portable / Solid Set: Design Guidelines

1.8.6 AIR RELIEF, PRESSURE RELIEF, AND ISOLATION

When Big Gun® sprinkler systems are automated and include control valves on each riser, air relief is necessary upstream of the valve in key locations, such as high points and lateral ends. When the sprinkler does not include a control valve on the riser, the sprinkler itself will allow air to escape.

Pressure relief is a required for any automated system to protect system pipes in the event of control valve or automation equipment failure. Some designers may be tempted to specify spring-loaded, “pop-off” style pressure relief valves on the sprinkler riser, however they should be avoided in these locations due to the potential for erosion and riser destabilization when they are in the relief mode. This style of relief valve is better at the pump or other locations where routing of the discharge is less consequential.

A better solution for relief at the sprinkler riser is to use a Nelson 800 Series or 1000 Series hydraulic control valve, which can be configured to function as both a relief valve and a zone control valve. This is done using a solenoid in conjunction with a pressure sustaining pilot (Nelson plumbing logic code L06). In this configuration the valve is fully open when the solenoid is energized, but in sustaining/relief mode when the solenoid is de-energized. This allows the relief to discharge through the sprinkler, minimizing erosion and flooding caused by sudden pressure relief.

Isolation valves are another key component that will allow sprinklers and control systems to be repaired without having to drain the system or completely stop irrigation for maintenance and repairs. They can be installed on every riser, at the head of laterals, or other key locations.

1.8.7 DRAIN-DOWN

System drain-down may occur on solid set systems that operate multiple sprinklers on a single lateral at once. This is especially noticeable at the riser at the location of lowest elevation. Drain-down can destabilize risers and leads to ponding, runoff, and erosion. To prevent drain-down, a pressure sustaining valve can be installed on the riser, with the pilot set at a pressure greater than the static head. When the pump or main valve is turned on, the sustaining valve will automatically open when the pressure exceeds the set point; when the pump or main valve is closed, the sustaining valve will close automatically, preventing the remaining water in the lateral from draining out through the sprinkler.



Figure 18. F150 Big Gun® sprinkler with Nelson 800 Series Control Valve and TWIG® Wireless Controls, installed on a riser with butterfly valve for isolation, and Nelson ACV200 continuous acting air relief valve.

Portable / Solid Set: Design Guidelines

1.9 RISER EXAMPLES

This section shares some typical riser assemblies for permanent and portable systems. The options are shown as suggestions; contact Nelson Irrigation for additional standard riser detail drawings. It is possible that a loose soil will require more stabilization than shown. The methods shown have been successfully used in normal clay and clay loam soils. Design of riser assemblies should be customized to local conditions and done with proper engineering methods.

1.9.1 PORTABLE SYSTEMS (QC VALVE BOX)

The primary advantage of the QC valve in the box is the reduced exposure of the riser and sprinkler to damage and interference with cultural practices because the Big Gun® and QC key can be removed. The 3-elbow swing assembly is preferred. Concrete is the most permanent and solid method to stabilize the riser (see Figure 19). Portable aluminum tripod supports or carts (available from others) can be used in conjunction with the QC valve and key to avoid the need to stabilize the riser with a concrete block or post. These support systems are also often used in hose-fed or portable above-ground mainline/lateral systems.

1.9.2 PERMANENT SYSTEMS

An example of concrete stabilization for permanent systems is shown in Figure 20. The primary advantage of the riser with concrete stabilizing is the longer life expectancy of concrete compared to wood. With this option, the forming, placing and curing time of concrete must be allowed for during installation.

Figure 20 also shows an option with a control valve in a box in order to protect the valve from freezing and livestock. However, the box should be strong enough to withstand livestock if it is outside the area of protective fence around the riser. The control valve should have Victaulic connections (not threaded) to simplify servicing the valve.

Regardless of where the control valve is located, take care to protect the valve and the sprinkler from freezing by properly winterizing the system.

Examples of wood stabilizing posts are shown in Figure 21. The primary advantage of the riser with stabilizing post is the ease and cost of installation. Because no concrete is required, there is no need to allow for forming or curing time during the installation process. In place of a swing assembly, a tee-riser assembly may be used.

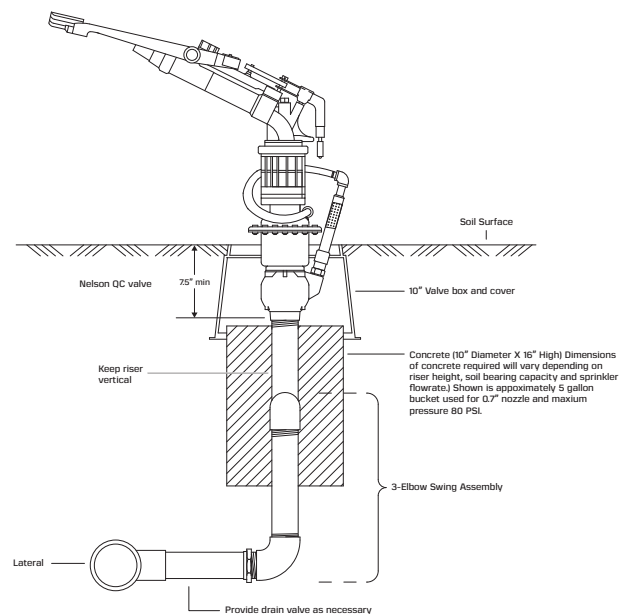


Figure 19. QC Valve in box with concrete stabilization.

Portable / Solid Set: Design Guidelines

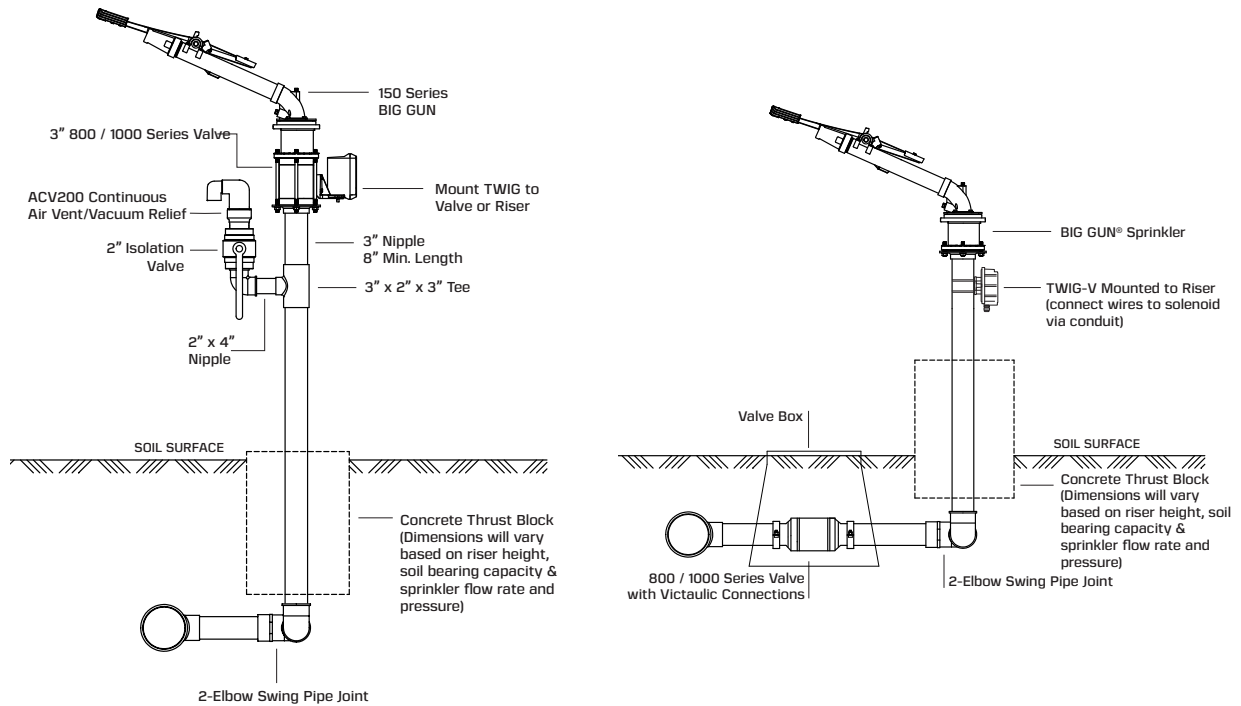


Figure 20. Concrete stabilization with 2-elbow swing joint, with air vent and isolation valve (left); and with control valve in a valve box (right).

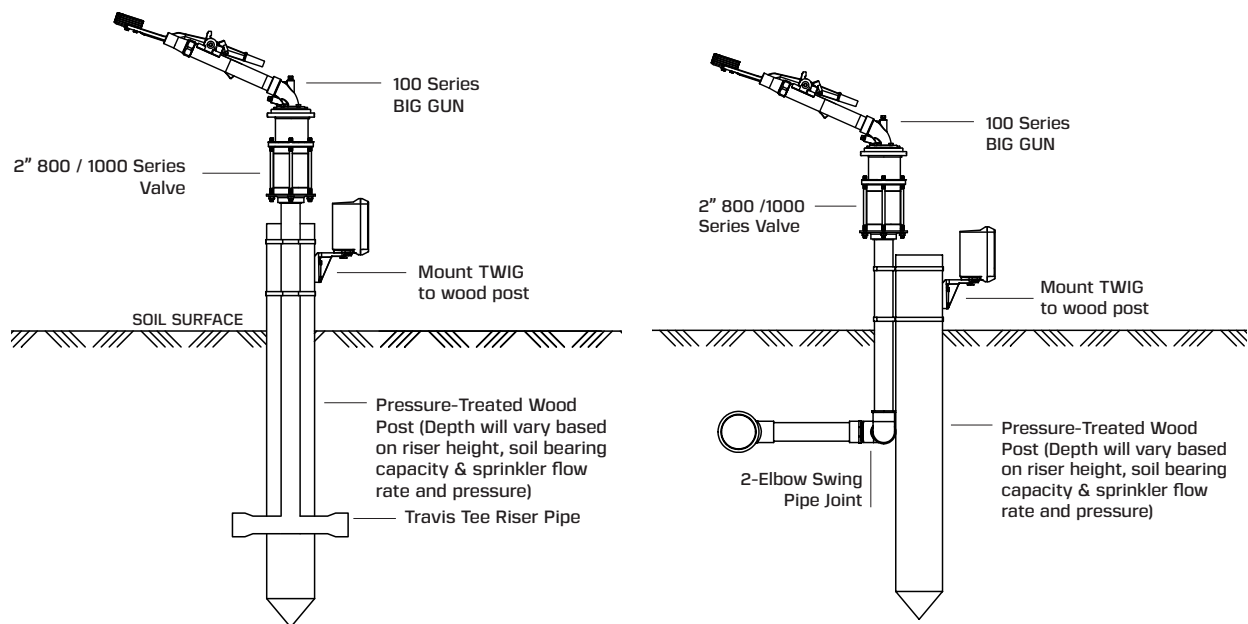


Figure 21. Wood stabilizing post used with a fabricated tee-riser made by Travis Pattern and Foundry (left), and with a 2-elbow swing joint (right).

Portable / Solid Set: Design Examples

2. DESIGN EXAMPLES

The flexibility of a Big Gun® sprinkler system makes it easy to customize to solve the diverse requirements and constraints of many applications. This section shares examples and challenges for some of the most common applications:

- **Manual vs Automatic Systems**
- **Center Pivot Corners**
- **Sports Fields**

2.1 MANUAL VS AUTOMATIC SYSTEMS

The following design examples illustrate the compromises present in three different types of Big Gun® sprinkler systems: portable manual, semi-automatic, and automated solid set. Portable systems require less investment, but require more labor to operate; whereas solid set systems significantly reduce labor, but at a higher capital investment. Semi-automatic systems offer a balance of labor savings and investment.

As noted earlier, portable systems may involve moving just the sprinkler as shown in these examples, moving an entire above-ground lateral with a Big Gun® sprinkler and wireless automated valve at each riser, or a combination of portable sprinklers and laterals.

For the purposes of this comparison, an example 20 acre (8 ha) field is to be irrigated using the 100 Series Big Gun® and buried laterals. Only full-circle sprinklers are used; for optimum uniformity, part circle sprinklers should be used at the field edges. Sprinkler specifications for all three of these examples are shown in Table 8.

Table 8. Nelson Big Gun® sprinkler specifications for the design examples in section 2.

| | |
|------------------------|--|
| Sprinkler Model | F100 24°, 0.7" Taper Bore Nozzle, 7/32" Secondary Nozzle |
| Performance | 132 gpm @ 70 psi (30 m ³ /hr @ 5 bar) (includes flow of secondary nozzle) |
| Spacing | 165' x 165' (50 x 50 m) |

Portable / Solid Set: Design Examples

2.1.1 PORTABLE, MANUAL OPERATION

In the example shown in Figure 22, two portable, alternating sprinklers are used to reduce the overall cost of the project. A manual control valve is located at the start of each lateral. One Big Gun® sprinkler is operated while the other sprinkler is moved into the next position. After the desired amount of water has been applied, the lateral to the working sprinkler is manually turned off and the lateral to the waiting sprinkler is turned on. Only one sprinkler is operated at any one time. This process is repeated until the entire field has been irrigated. Note that with only two total sprinklers and one operating at a time, frequent changing of the water is required to prevent over-watering. While portable, manual systems are the most affordable, they require the most labor to operate and tend to be the least efficient.

This design example requires a valve at the beginning of every lateral, as well as a quick-coupler device with cap/plug at each riser location. Alternatively, manual valves can be used on every riser in place of the lateral valves. The Nelson QC valve is an excellent option because it functions as both the valve and the quick-couple fitting, which allows the sprinkler to be moved while keeping the lateral pressurized.

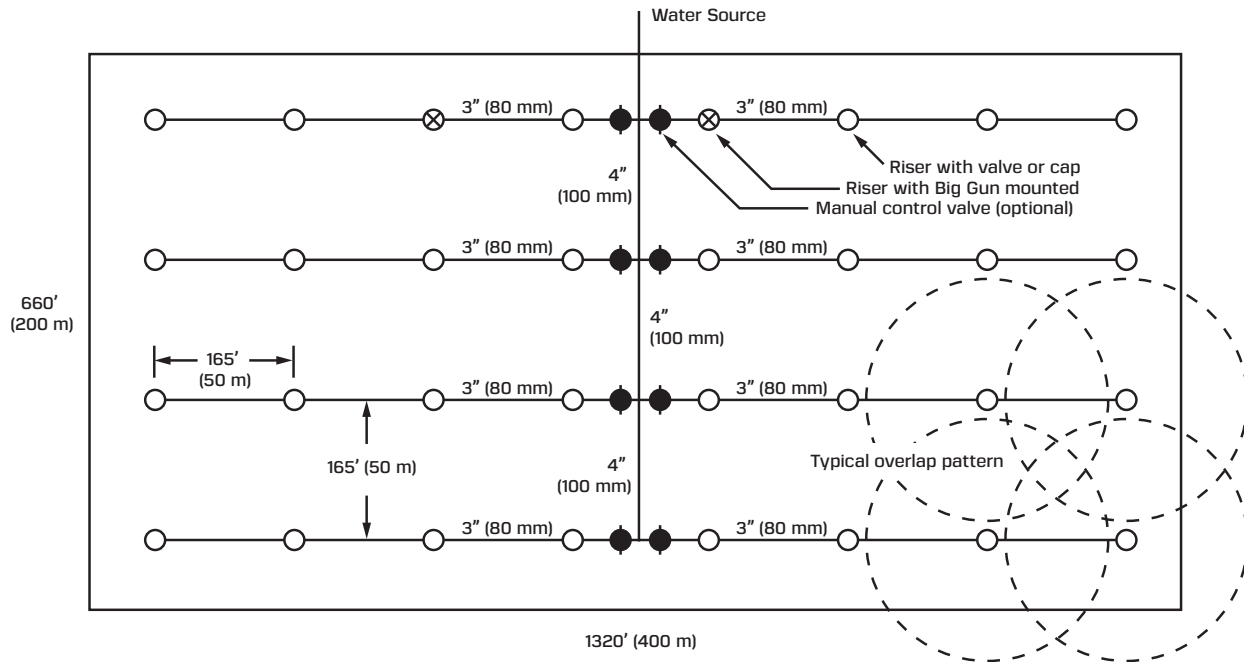


Figure 22. A manually operated, portable Big Gun® sprinkler system design using just two sprinklers.

Portable / Solid Set: Design Examples

2.1.2 SEMI-AUTOMATIC (AUTOMATED, PORTABLE)

The labor component of the portable system can be reduced by using additional Big Gun® sprinklers along with automatic valves at the start of each lateral, as shown in Figure 23. Four sprinklers (one on each lateral) are placed in position and an irrigation controller operates the valves in order to turn the sprinklers on and off in sequence, with one sprinkler operating at a time. At the end of an irrigation set, all sprinklers are moved to the next riser on the lateral pipes.

In this example, if one hour of run time is required per position, the sprinklers would need to be moved every 4 hours. It will take seven moves (8 positions, A-H) to complete the irrigation of this field. The controller can also be used to spread out the application time by using cycles (for example, instead of a 1 hour set, use 4 x 15 minute cycles). The number and length of the cycles will vary based on climate and soil types, and can help improve uniformity and infiltration.

The number of sprinklers used can be customized to fit the operator's budget and labor availability. Additional sprinklers will allow a longer period of automated operation, thus requiring less frequent moves. Likewise, if more water is available to run more than one sprinkler at a time then the amount of time required to irrigate the entire field can be reduced. The advantage of the automated system over the manual system is that it can operate unattended for a much greater period of time. Like the manual system, the semi-automatic design requires either a valve or quick-coupler device with cap/plug at each riser location. TWIG® wireless automation with QC valves are ideally suited to this operation because it eliminates the need for control valves at each lateral and long lengths of wire that are susceptible to lightning damage.

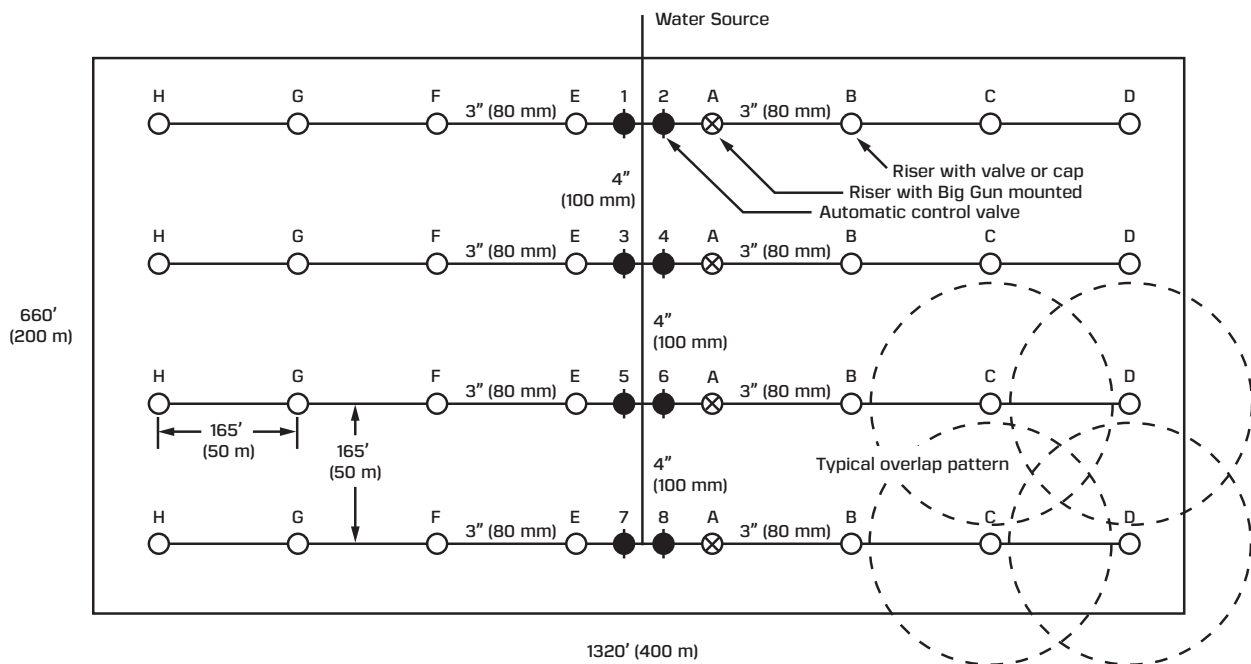


Figure 23. An automated Big Gun® sprinkler system design using four portable sprinklers.

Portable / Solid Set: Design Examples

2.1.3 AUTOMATED SOLID SET

The fully automatic system eliminates the need for an automatic valve on each lateral, and instead has an automatic control valve, such as a Nelson 800 or 1000 Series valve, and a Big Gun® sprinkler installed at each riser, as shown in Figure 24. The controller cycles through all the valves and repeats the program as necessary. The number of sprinklers operating at one time depends on pipe size, and availability of water and pressure. Solid set automated Big Gun® sprinkler systems work best with a wireless control system, such as TWIG® Wireless Automation, as opposed to wired systems that are susceptible to lightning and rodent damage and are difficult to maintain.

Except for adjustments to meet variations in plant water requirements, weather, or other farming operations, there is no labor required to operate this system and it is the most flexible to operate. Therefore, it can also irrigate with greater efficiency by reducing over-watering. While it comes at the expense of purchasing the greatest amount of equipment up-front, some of this cost may be offset by using looped mainlines, which may allow a smaller pipe size. Use an irrigation design software program like IRRICAD to assist with designing looped mainlines.

As noted in Section 1.8.6, air and pressure relief are critical in automated systems. Always specify adequate air and pressure relief for Big Gun® sprinkler systems.

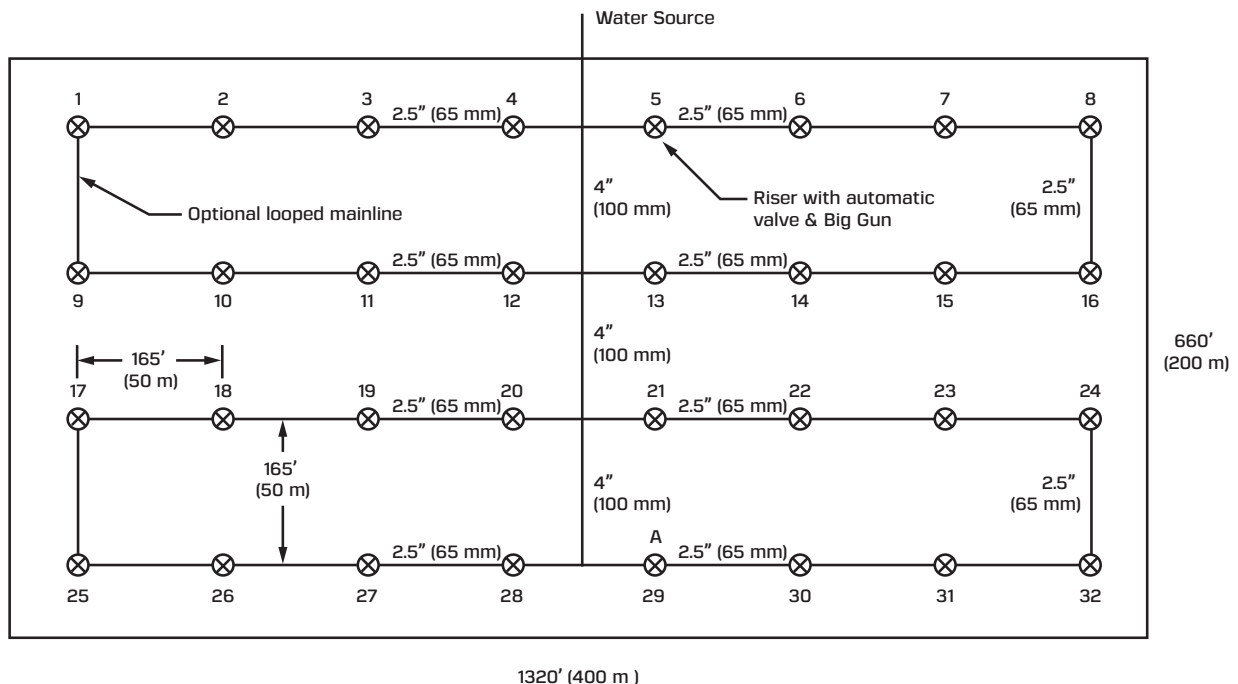


Figure 24. An automated, solid set Big Gun® sprinkler design layout using a sprinkler and automatic control valve at each riser location.

Portable / Solid Set: Design Examples

2.2 CENTER PIVOT CORNERS

Center pivot corners present unique challenges that automated solid set systems are uniquely qualified to solve. The key challenge is “blending” the solid set sprinkler system with the water application under the center pivot (and end gun) by locating the sprinklers accordingly. The example in Figure 25 assumes:

- The center pivot uses an end gun such as the SR100 – an end gun is a cost effective way of bringing additional land into production and thus requires less solid set sprinklers.
- The water source comes from the center pivot point, which might not be the best location in all instances.
- A standard quarter-mile (1320') pivot, with solid set 100 Series Big Gun® sprinklers operating at 70 psi with a 0.7” taper bore nozzle, with a 7/32” secondary nozzle.

To design the sprinkler layout, start with the field boundary and center pivot area (under pipe):

1. Draw a line from the pivot point to the corner.
2. Draw 3 arcs past the end of iron at 120', 240', and 360'
3. Place the first sprinkler where the 120' arc intersects the line from the pivot point.
4. From this sprinkler, place one sprinkler on each side along the 120' arc at equal distances (approximately 95% of the sprinkler diameter, 260' in this example).
5. On the 240' arc, place two sprinklers at a distance of R (radius of throw) from the field edge. This should place these two sprinklers at a distance of approximately R from the first sprinkler placed in step 3.
6. Place a sprinkler where the 360' arc intersects the line from the pivot point.
7. For maximum coverage, place part circle sprinklers along the two field edges and in the corner. This adds nine sprinklers to the design, for a total of 15 sprinklers.

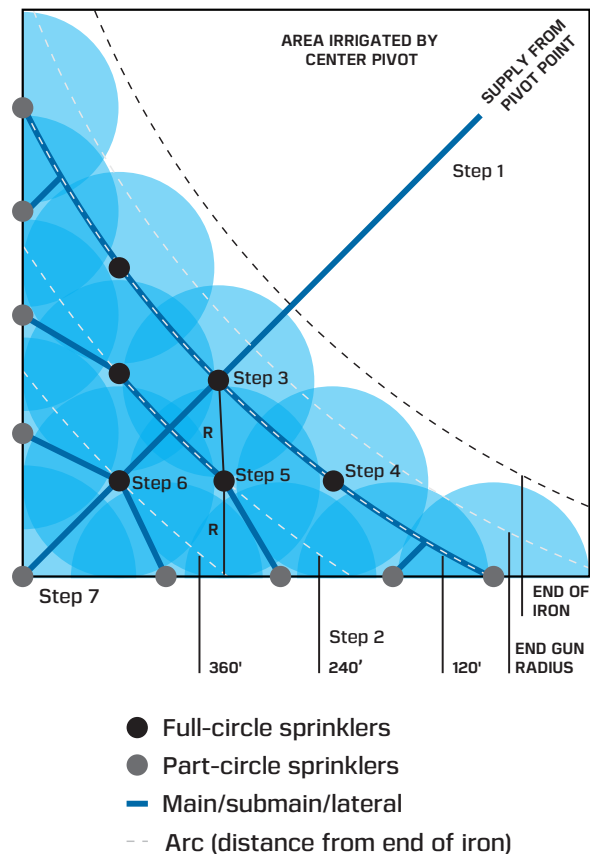


Figure 25. An automated, solid set Big Gun® sprinkler design layout in a center pivot corner.

Portable / Solid Set: Design Examples

2.3 SPORTS FIELDS

Nelson Big Gun® sprinklers are ideal for sports field irrigation and sports turf cooling and cleaning. There are several ways to install Big Gun® sprinklers in sports field applications.

- The sprinklers can be mounted on risers away from the field and people
- Inside large boxes with covers, outside the field perimeter, utilizing the portable, QC Valve system

The QC Valve system is beneficial because it keeps sprinklers off the field where they may cause injuries. The quick-coupling key makes attaching the sprinkler to the valve effortless and it can be done on a pressurized system. Connecting the hydraulic assist smoothly opens the valve and starts the flow of water. Disconnecting and moving the gun to the next valve location is just as quick and easy. Note that the throw radius is typically reduced by 1-2% due to the sprinkler being installed at ground level.

Sample layouts for a US football field and soccer field are shown in Figures 27 and 28. The same design recommendations outlined in Section 1 for model, trajectory, nozzle, pressure, spacing, and riser design apply in sports field applications. The examples shown in section 2.1 are also worth reviewing.

The system can also be equipped for automated or semi-automated operation to reduce time and labor. Wireless, battery operated controls like the Nelson TWIG wireless control system can be configured



Figure 26. Big Gun® sprinklers with the portable QC valve/key system in box are ideal of sports fields.

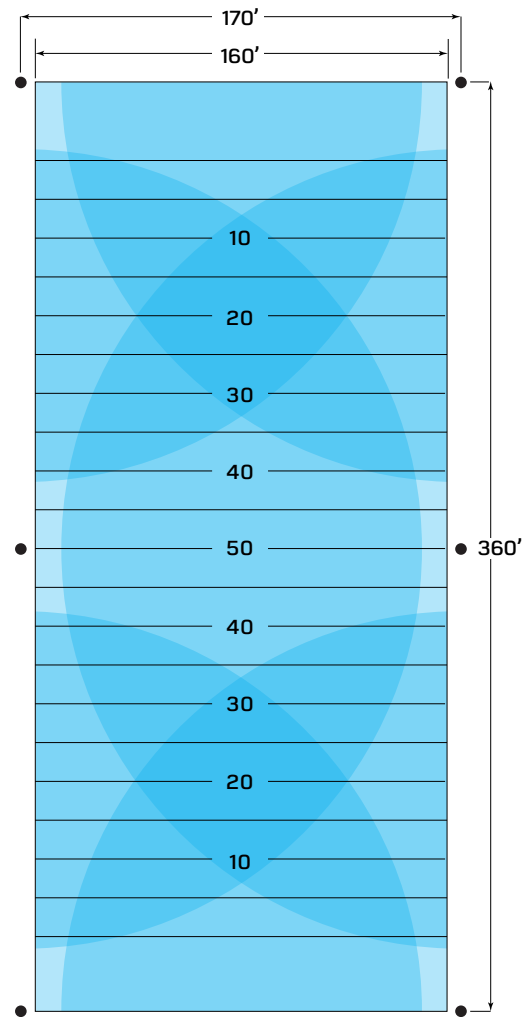


Figure 27. Big Gun® sprinkler design layout for a US football field, using SR100 sprinklers with 0.9" taper bore nozzle at 80 psi.

Portable / Solid Set: Design Examples

on the Big Gun® Quick Coupling arrangement to automate watering times or remotely actuate individual sprinklers. Ideal applications include hard-to-reach areas such as parks, cemeteries, athletic fields and other spots where it is not practical or economical to install a hard-wired controller.

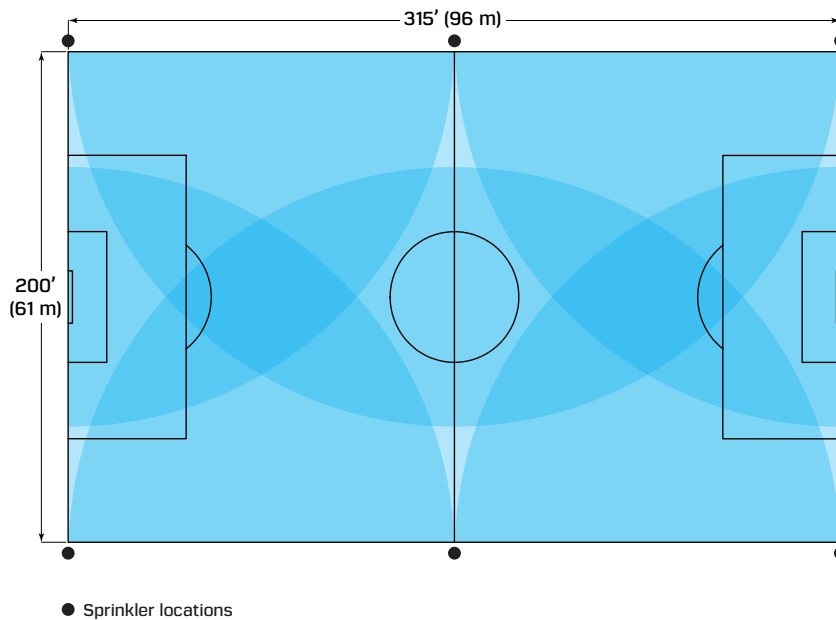


Figure 28. Big Gun® sprinkler design layout for a soccer field, using SR100 sprinklers with a 0.85” taper bore nozzle at 80 psi, and 7/32” secondary nozzle.



Figure 29. Permanent solid set Big Gun® sprinklers irrigate synthetic turf at the Olympic field hockey stadium in Athens, Greece.

BIG GUN®



NELSON IRRIGATION CORPORATION

848 Airport Rd.
Walla Walla, WA 99362, USA
P: +1 509-525-7660
F: +1 509-525-7907
nelsonirrigation.com
info@nelsonirrigation.com

NELSON AUSTRALIA

20 Macadam Street
Seventeen Mile Rocks, QLD 4073
Tel: +61 7 3715 8555
nelsonirrigation.com.au
info@nelsonirrigation.com.au

NELSON IRRIGAÇÃO BRASIL

Rua Benedita Mano Schincariol
110. Mogi Mirim, SP. Brasil
Tel: +55 19 3806 5987
nelsonirrigation.com.br
info@nelsonirrigation.com.br

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