Sprinkler Spacing and Winterization Specifications

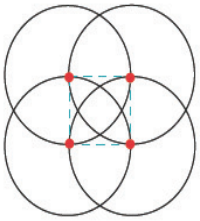
Sprinkler Spacing

- The Toro Company does not recommend designing for 0 mph wind conditions. Design in consideration of the worst wind conditions.

Precipitation Rate Formulas

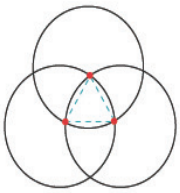
- Square-spaced sprinklers in pattern:

$$\frac{\text{GPM of full circle} \times 96.3}{(\text{Spacing})^2}$$



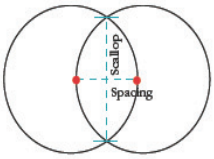
- Triangular-spaced sprinklers in pattern:

$$\frac{\text{GPM of full circle} \times 96.3}{(\text{Spacing})^2\ (0.866)}$$



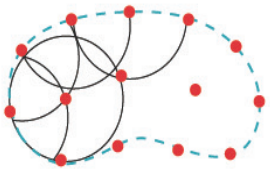
- Single row:

$$\frac{\text{GPM of full circle} \times 96.3}{(\text{Spacing})\ (\text{Scallop})}$$



- Area and flow:

$$\frac{\text{Total GPM of zone} \times 96.3}{\text{Total irrigated square feet of zone}}$$



FRICTION LOSS FORMULAS

Hazen-Williams Equation:

$$H_f = (0.2083)\ (100 / C)^{1.852}\ (Q^{1.852} / D^{4.866})$$

(The result is multiplied by .433 to give psi loss for 100 feet of pipe)

The velocity values were derived using the following:

$$V = (0.408 \times Q_{gpm}) / d^2$$

(The average inside diameter of OD controlled pipe was based upon subtracting two times the minimum wall thickness plus one-half of the wall thickness tolerance from the outside diameter.)

- Pressure ratings for plastic pipes are based on 23° C or 73.4° F
- Head loss decreases (increases) approximately 1% for every 3 degrees F above (below) the reference temperature (73.4° F)

Irrigation System
Pressurization and Winterization Procedures

Introduction

Any time that an irrigation system is filled and pressurized, or when the system is drained and water flushed from the system, there exists the potential for excessive pressures to be present leading to possible damage of the system components. For instance, each winter, in many parts of the world, irrigation systems must be completely drained and shut down to prevent damage due to freezing water in the system components. Then, in the spring, the irrigation system must be filled and started. This is also true for new installations and after repairs requiring system drainage. Serious damage can occur to system components and/or personal injury may result if improper start-up and winterization methods are used. This document contains the required procedures and specifications for start-up and winterization of irrigation systems utilizing components manufactured by The Toro Company, Irrigation Division. Failure to follow these procedures could result in damage to equipment, possible injury to personnel, and could affect your Toro product warranty

Please take the time to properly plan, prepare and perform these procedures. Always avoid shortcuts that could put personnel and system components at risk.

Please read the entire contents of this document before attempting any of these procedures. If you have any questions regarding the application of these procedures in your area, please contact a Toro distributor or call 1-800-367-8676 for assistance.

WARNING
THE WINTERIZATION AND PRESSURIZATION OF IRRIGATION SYSTEMS EXPOSES PERSONNEL AND EQUIPMENT TO COMPRESSED AIR THAT MAY REACH PRESSURES MUCH GREATER THAN NORMAL. GREAT CARE SHOULD BE TAKEN ANY TIME THE SYSTEM IS BEING SERVICED OR MANUALLY OPERATED DURING THESE PROCEDURES. NEVER STAND DIRECTLY OVER ANY COMMERCIAL OR LARGE TURF SPRINKLER WHEN FILLING THE SYSTEM OR WHEN ACTIVATING MANUALLY.

Pressurization and Start-Up Procedures

The following procedure is used any time water is filling an empty piping system. This applies to new system pressurization, start-up in the spring following a winterization in the fall, or after the piping system has been depressurized for any other reason such as break repairs. This procedure requires a maximum pressure of 50 psi and a fill rate velocity of less than two feet per second. The velocity is the speed at which the water is flowing in the piping system and is determined by the pipe size and the flow rate. (See Table 1 below.) It is also designed to eliminate pockets of trapped air that could be compressed to pressures much higher than normal, creating personnel safety concerns and damage to system components.

Note: When filling with a pump station, please contact the pump manufacturer's service representative for best practices with your specific station. Pump stations vary widely and one particular process may not be suitable for all pump stations.

Important!

Having knowledge of the piping system is very useful. Please take the time to review the system's as-built drawing to identify the locations of all drains, quick couplers, the highest and lowest elevation points, and all

piping dead-ends. Water will always flow to the lowest points first. Develop a plan for how you will sequentially close the lowest venting points first, allowing the air to continue venting at the higher locations, then working your way from the lowest points to the highest points until all venting locations are closed.

1. Per your plan, open drain valve(s) which will be in the low areas of the system. Also, insert quick coupler keys and/or turn sprinklers to the manual "ON" position at all tees and greens (if a golf system) and/or at high points in the system and at all dead-ends. This will allow air to bleed from system lines during the filling process. Do not compress air and then relieve; bleed air while filling the system.
2. Adjust pressure regulation at the water source to 50 psi maximum. Supply water to the system at a velocity fill rate of less than two feet per second. Reference Table 1 below to determine the maximum gallons per minute for your particular pipe size to maintain less than two feet per second.
3. Starting at the locations closest to where the piping system is being filled and at the lowest elevation points, monitor the open drains, quick couplers and sprinklers that have been selected "ON" for air and water flow. When steady water flow is detected at that location, close the drain, remove the quick coupler key or turn the sprinkler "OFF", and proceed to the next higher location. Repeat this process until air is evacuated, water is present, and all venting locations have been closed.
4. While maintaining a maximum pressure of 50 psi, electrically activate each sprinkler to allow any remaining air to escape. Take this opportunity to identify correct operation and flag any system components that require additional service.
5. Once all air has been removed from the system and system repairs have been completed, adjust system pressure to normal operating pressure.
6. Identify locations where trapped air is a persistent problem and install an air relief valve(s). These areas can be identified by sprinklers running air or air/water mix for a significant amount of time after the system was thought to be completely filled with water.

Table 1: System Fill Rate Specification

CAUTION!
The following table assumes the piping system has been designed to minimize pipe friction loss and maintain a safe operating water velocity in the pipes to five feet per second or less. Select the system pipe size where the fill water is being introduced.

Pipe Size	GPM	Velocity - Feet per second
1"	5	1.50
1½"	10	1.41
2"	20	1.80
2½"	30	1.84
3"	45	1.86
4"	75	1.87
6"	150	1.73
8" and above	200	<1.50

Winterizing with Compressed Air

WARNING!
TO PREVENT PERSONAL INJURY, NEVER ATTEMPT TO DISASSEMBLE SYSTEM WHILE UNDER PRESSURE.

TO PREVENT PERSONAL INJURY, DO NOT STAND DIRECTLY OVER ANY LARGE TURF SPRINKLER WHEN ACTIVATING MANUALLY AT THE SPRINKLER.

CAUTION!
Do not exceed 50 PSI of air pressure in any system. Exceeding 50 PSI could result in severe equipment damage and personal injury.

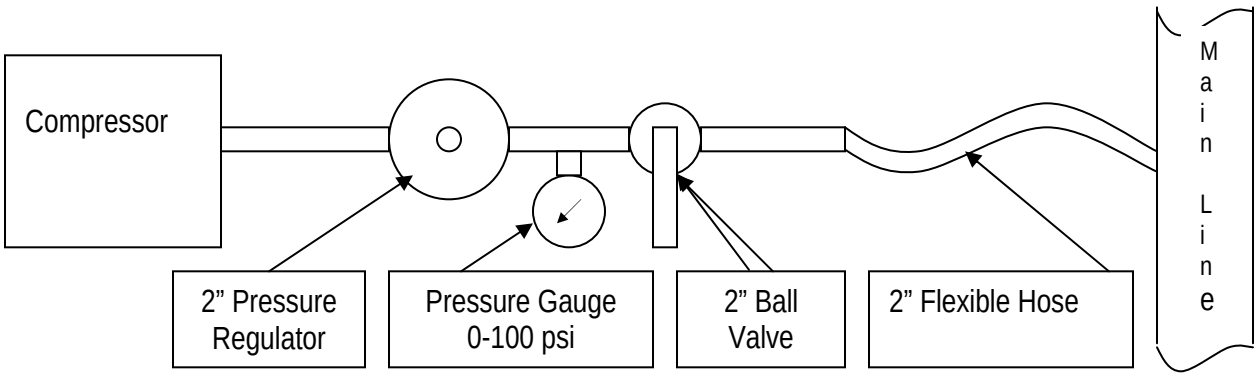
Compressed Air Push Method

The compressed air push method utilizes compressed air to force water out of the main line through drains, quick couplers and sprinklers at the lowest elevation points and in low-lying areas. Once the main line is clear and drains are closed, the compressed air is then used to force the remaining water out of each individual sprinkler head.

Important!

Having knowledge of the piping system is very useful. Please take the time to review the system's as-built drawing to identify the locations of all drains, quick couplers, the highest and lowest elevation points, and all piping dead-ends. Water will always flow to the lowest points first. Develop a plan for how you will sequentially close the highest draining points first, allowing the water to continue draining at the lower locations, then working your way from the highest points to the lowest points until all draining locations are closed.

1. Close the main supply water valve.
2. Connect the air compressor, sized appropriately for your system (typically 375-900 cfm – see diagram below), through an external pressure regulator adjusted to the lowest possible pressure to adequately remove water from the system and attached to the main line through a 2" diameter hose with the shortest length possible.



Note: *Large irrigation systems (Golf course sized) require a higher-volume air compressor. Excessive heat will be generated at the point of air connections to the system. To avoid damage to PVC piping systems, use a length of 2" galvanized pipe to dissipate the heat prior to entering the irrigation piping system.*

3. Open drain valves, quick coupler valves, and/or select sprinklers to the manual "ON" position at the lowest elevation points and any known low spots in the system.
4. Open ball valve at compressor to allow air to pressurize the piping system and assist in the evacuation of water from the piping system.

Note: *The key to successful water removal is volume (cfm), not pressure.*

Note: *The Toro Company recommends installing pressure gauges in the areas where sprinklers are being electrically activated. Monitoring this pressure allows you to maintain the appropriate number of activated sprinklers at any one time. Too many heads activated will result in low pressure and possibly heads that will not operate, and too few heads activated may result in higher pressures than desired. Each crew should have a gauge that will move with them from location to location to monitor pressure.*

5. Starting at the highest elevation locations, monitor the drain-points for the presence of air. When there is no water present and that drain location is only air, close the drain, remove the quick coupler key, and/or select the sprinkler to the manual "AUTO" position. Continue working your way from the highest to the lowest elevation points, closing each drain location until all drain locations are closed.
6. Adjust pressure regulator at the compressor to 40 psi.
7. Determine the maximum number of sprinklers that can be operated at one time with the compressor in use. (See Table 2 below.)

Table 2

			Compressor CFM							
	Sprinkler CFM Use		250		500		750		1000	
Nozzle	35 psi	50 psi	35 psi	50 psi	35 psi	50 psi	35 psi	50 psi	35 psi	50 psi
0	10	13	25	20	50	40	75	60	100	80
1	23	28	11	9	22	18	33	27	44	36
2	30	33	8	8	17	15	25	23	33	31
3	35	38	7	7	14	13	21	20	29	27
4	43	48	6	5	12	11	18	16	24	21
5	48	53	5	5	11	10	16	14	21	19
6	50	55	5	5	10	9	15	14	20	18
7	53	58	5	4	10	9	14	13	19	17
8	59	64	4	4	8	8	13	12	17	16
9	65	70	4	4	8	7	12	11	15	14

Note: Electric valve-in-head sprinklers require a minimum air pressure of 35 psi and may require additional time to operate.

CAUTION!
Operating the sprinklers on air alone will generate heat that could potentially cause damage. When the air/water coming from the sprinkler becomes a light mist, that sprinkler should be turned off. Never allow the sprinkler to operate on air alone for more than two minutes.

8. Starting at the highest elevation points, electrically activate the maximum number of sprinklers (as determined in Table 2 above) simultaneously. The sprinklers will pop up and the remaining water in the swing joint and body will be discharging out of the nozzles. Operating the sprinklers in a logical sequence that moves any remaining water though the system will provide the best results. Moving from tee to green or green to tee (in a golf system) forcing the water towards low end-points will minimize water pockets in low-lying areas. When this discharge changes from a stream to a mist, electrically activate the next sprinkler(s) and then turn off the sprinkler(s) that are misting. Always turn "ON" the next head(s) before turning the misting head(s) "OFF". Continue this process until every sprinkler has been electrically activated **once**.
9. Turn "OFF" compressor and open low elevation drains to allow residual water to drain and to relieve air pressure.
10. Close all drains.

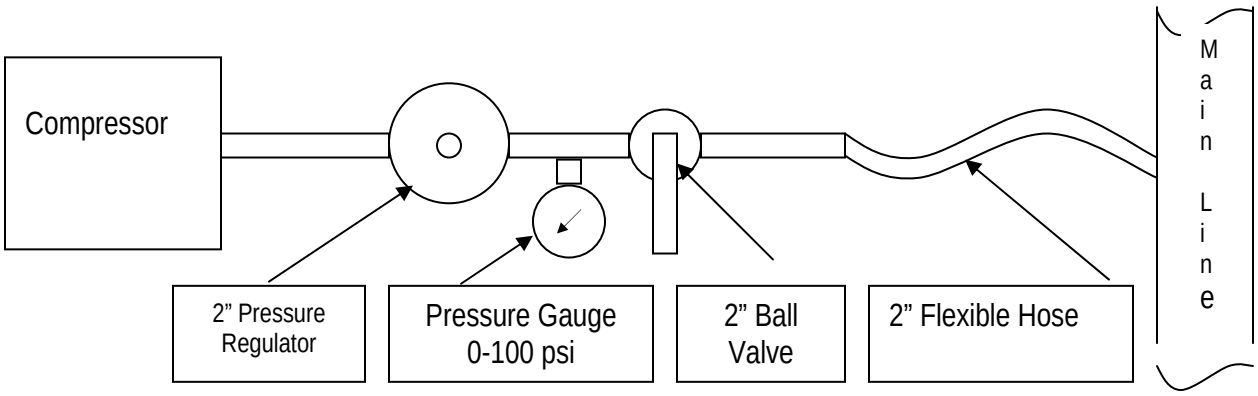
Gravity Drain/Compressed Air Method

The gravity drain/compressed air method utilizes gravity flow to remove water from the main line through drains, quick couplers, and sprinklers at the lowest elevation points and in low-lying areas. Once the main line is clear and drains are closed, compressed air is then used to force the remaining water out of each individual sprinkler head.

Important!

Having knowledge of the piping system is very useful. Please take the time to review the system's as-built drawing to identify the locations of all drains, quick couplers, the highest and lowest elevation points, and all piping dead-ends. Water will always flow to the lowest points first.

1. Open drain valves, quick coupler valves, and/or remove the sprinkler riser assembly and valve at the lowest elevation points and any known low spots in the system.
2. Install quick coupler keys into quick coupler valves or remove the sprinkler riser assembly and valve at the highest elevation points to provide the venting required that promotes draining.
3. Allow system to gravity drain until all water is removed.
4. Once all water has been drained, close all drain valves, replace all sprinkler internals, and remove all quick coupler keys.
5. Connect the air compressor, sized appropriately for your piping system (typically 375-900 cfm. – see diagram below), through an external pressure regulator adjusted to 40 psi and attached to the main line through a 2" diameter hose with the shortest length possible.



6. Connect air compressor to piping system and regulate outlet pressure to 40 psi maximum pressure.

Note: When pressuring the drained piping system with a compressor, the time required to reach the desired pressure will vary based upon the amount and size of pipe in the system, and the cfm rating of the compressor.

7. Determine the maximum number of sprinklers that can be operated at one time with the compressor in use (see chart below).

Note: Electric valve-in-head sprinklers require a minimum air pressure of 35 psi and may require additional time to operate.

CAUTION!
Operating the sprinklers on air alone will generate heat that could potentially cause damage. When the air/water coming from the sprinkler becomes a light mist, that sprinkler should be turned off. Never allow the sprinkler to operate on air alone for more than two minutes.

Note: *The Toro Company recommends installing pressure gauges in the areas where sprinklers are being electrically activated. Monitoring this pressure allows you to maintain the appropriate number of activated sprinklers at any one time. Too many heads activated will result in low pressure and possibly heads that will not operate, and too few heads activated may result in higher pressures than desired. Each crew should have a gauge that will move with them from location to location to monitor pressure.*

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9. Turn "OFF" compressor and open low elevation drains to allow residual water to drain and to relieve air pressure.
10. Close all drains.