Idaho State Department of Agriculture

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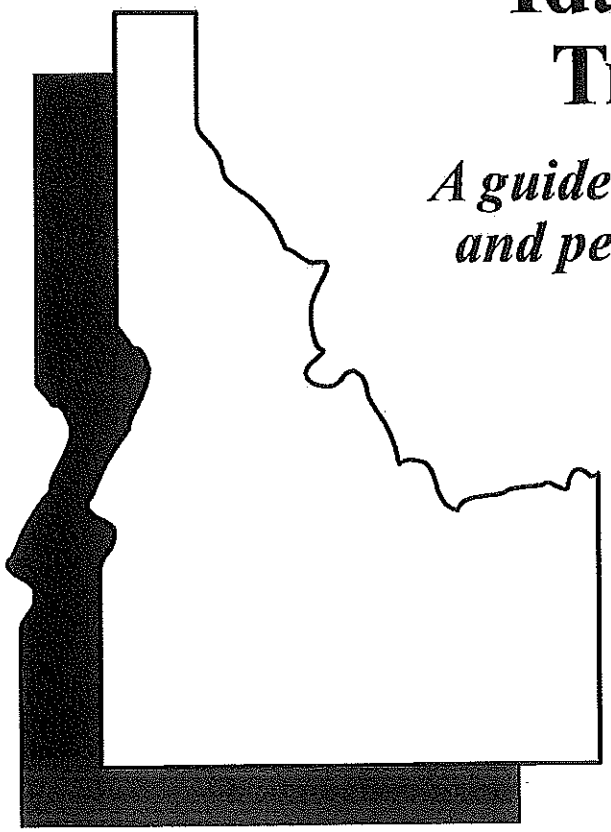
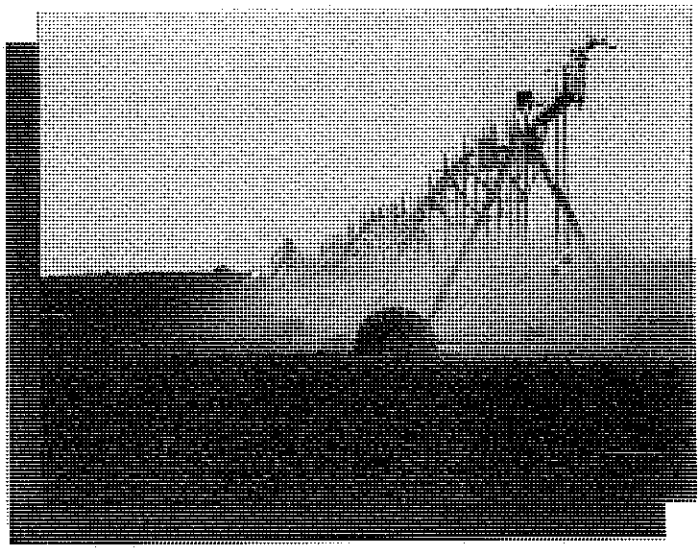
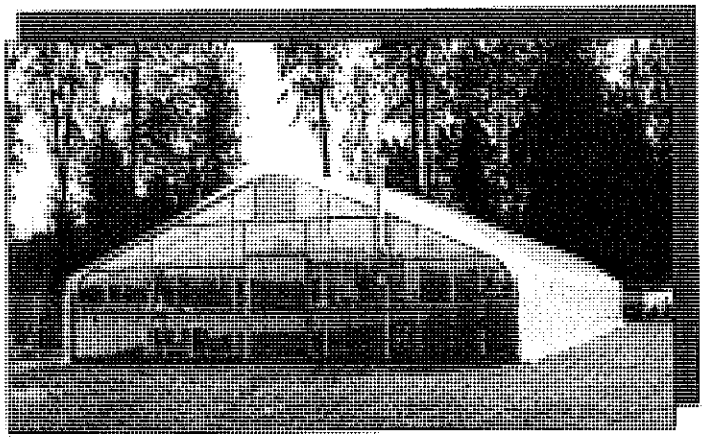
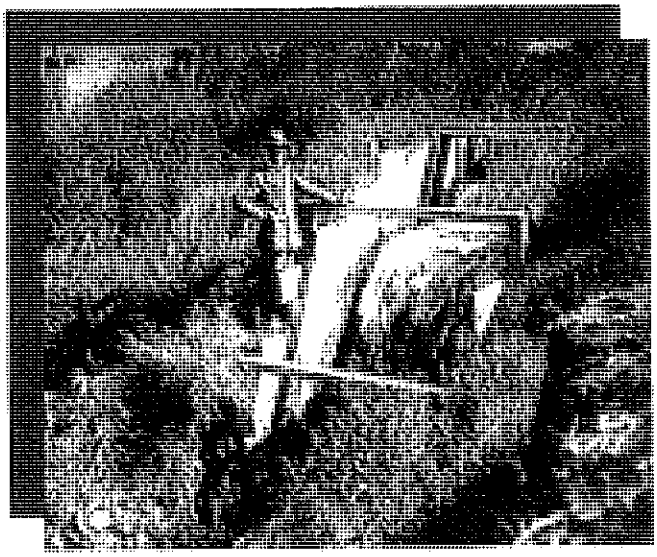
Idaho Chemigation Training Manual

A guide to safe injection of fertilizers and pesticides into irrigation water









Authored/Edited by Jim Childs

Idaho Chemigation Training Manual

A Guide to Safe Injection of Fertilizers and Pesticides Into Irrigation Water

By Jim Childs

Preface

This manual is intended to help you understand the federal regulations and state chemigation laws and rules. It will also help you understand the practices and equipment required for the safe and effective injection of chemicals into irrigation water.

Chemigation is the application of chemicals through an irrigation system where the irrigation water is applied to land, crops, or plants. Chemigation is a common practice on farms, nurseries, golf courses and in greenhouses. There has also been a recent interest in chemigation on residential, commercial, municipal, and school lawns and landscapes.

Because of human and environmental risks involved with chemigation, the chemigator must have good knowledge of the chemicals and equipment associated with chemigation. To minimize risks related to chemigation, an irrigation system must be properly equipped, maintained and operated by a certified chemigator or someone under his direct supervision.

Backflow prevention is one of the highest priorities of chemigation and therefore, much of this manual will be devoted to this topic. You will also find information concerning injection pumps, injection line check valves, chemical tanks, chemical movement through the soil profile, pesticide labels and other valuable information.

This manual, along with the **Idaho Pesticide Applicator Training Manual**, will provide the chemigator with the basic knowledge required to pass the Idaho Chemigation Exam, administered by the Idaho State Department of Agriculture (ISDA) and will provide the chemigator with an excellent chemigation reference manual.

Words printed in *italics* are defined in the "Glossary of Terms" in the back of this study manual.

About the author:
James R. Childs is the Chemigation Program Specialist for ISDA. His responsibilities include certification of chemigation equipment to be included on Idaho's List of Approved Chemigation Equipment, coordination of chemigation inspections and chemigation education. He is Idaho's primary contact for chemigation-related issues.

Any references to chemical products or trade names in this manual are not intended as an endorsement by ISDA. This manual is written to provide information on the chemigation application method of pesticides and fertilizers. It is not to promote chemigation nor imply that chemigation replace ground or aerial application of chemicals.

Acknowledgments

In addition to specific sources cited in the text the following publications were valuable sources of information and material: **"Chemigation, A Guide for Pesticide Chemigators in Virginia"** (Virginia Cooperative Extension); **"Fertigation"** (Irrigation Training and Research Center, California Polytechnic State University); **"Chemigation"** (The Irrigation Association); **"Backflow Prevention and Safety Devices for Chemigation"** (Center for Irrigation Technology); **"Grower Training Manual for Backflow Prevention in Chemigation of Pesticides"** (Center for Irrigation Technology); **"Using Chemigation Safely & Effectively"** (University of Idaho College of Agriculture); **"Chemigation Equipment and Calibration"** (University of Idaho College of Agriculture); **"1990 Chemigation Workbook"** (Texas AgriLife Extension Service); **"Chemigation in the Pacific Northwest"** (Pacific Northwest Extension).

We would like to thank Susan Nessler (Project Coordinator and Technical Writer, Virginia Pesticide Programs) for her timely assistance in providing material from their manual **"Chemigation, A Guide for Pesticide Chemigators in Virginia."** We would also like to thank Deborah Hamlin and Mike Hemsley in their efforts in providing copyright permission for use of material from The Irrigation Association publication **"Chemigation."**

We would also like to acknowledge the following people for providing source material or other helpful information: Joy Dias (EPA, California Department of Pesticide Regulation); Bill Green (Center for Irrigation Technology); Leon New and Dave Mayes (Texas AgriLife Extension Service); Brian Thomassen (Tessenderlo Kerley, Inc.); Dan Gilmore (EZ Flow); Raymond A. Smith III and Dan Salvatori (Yard Feeder, LLC); Brandon Greene and Dewey Miller (Skeet-R-Gone) and Charles M. Burt, Kris O'Conner and Thomas Ruehr (Irrigation Training and Research Center).

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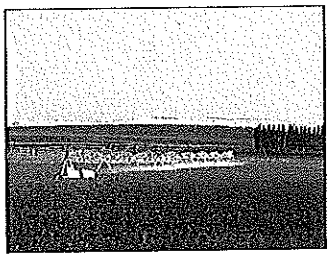
Table of Contents

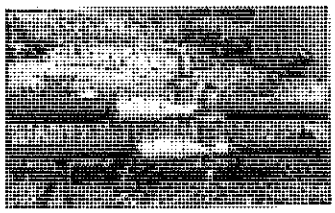
Appendices

Appendix A	"List of USEPA Authorized Alternative Chemigation Safety Equipment"
Appendix B	Chemigation System Calibration
Appendix C	Nalagate 54 (Fictitious Label)
Appendix D	Vexsion Supreme (Fictitious Label)
Appendix E	Bug Slug Product Label
Appendix F	"Chemical Injection Systems for Residential, School, Commercial and Municipal Landscapes"

Chapter 1 – Chemigation Overview



Chemigation is defined as any process whereby chemicals are added to irrigation water applied to land, crops or plants through an irrigation system. Chemigation may be used in many situations such as, but not limited to, agricultural fields, nurseries, turf fields, lawns, golf courses and greenhouses. Chemicals, as defined by Idaho State Department of Agriculture (ISDA) law, may be either fertilizers or pesticides. ISDA defines pesticides as any substance or mixture of substances intended to prevent, destroy, control, repel or mitigate pests, including, but not limited to herbicides, insecticides, fungicides, etc.



Federal and state laws require anti-pollution devices that prevent the reverse or backflow of water and chemicals be installed on irrigation systems prior to their use for chemigation. ISDA requires that these devices be approved through independent laboratory testing and other means to confirm chemical resistance, pressure ratings and other functional attributes. The ISDA publishes lists of equipment approved for use when chemigating. All equipment used for chemigation in Idaho must be listed on the latest version of the ISDA "The Idaho Chemigator – Idaho's List of Approved Chemigation Equipment" or "The Idaho Chemigator – Chemigation Approved Backflow Prevention Assemblies for Domestic and Municipal Water Supplies."

Licensing and Certification

The Idaho Pesticide and Chemigation Law (Chapter 34, Title 22, Idaho Code) requires persons who apply chemicals (pesticides and fertilizers) through an irrigation system obtain the chemigation (CH) category by passing the ISDA chemigation exam. The chemigator must also list all chemigation sites on his license application and certify that all irrigation equipment used for chemigation purposes meet ISDA requirements for chemigation. Applicator license recertification is accomplished during the valid licensing period by attending approved recertification training or by taking the recertification examination.

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)

All pesticide applications, including those made by means of chemigation, fall under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). Before buying a product for chemigation purposes, be sure the label allows chemigation of the product. If the label allows chemigation, it will list the required safety devices that must be installed on the irrigation/chemical injection system and the crops or sites where the product may be applied. If the pesticide is not labeled for chemigation it is required to state under Directions for Use: "Do Not Apply this Product through Any Type of Irrigation System." Pesticides considered 25b products are an exception to the rule and are addressed in Chapter 8. You may purchase a pesticide that does not reference application by chemigation on the label. If this situation occurs, ***you must not use the pesticide for chemigation.*** You may only chemigate with those pesticides that specifically state that chemigation is allowed.

Some pesticide labels do not allow the use of pivot system end guns while chemigating and others may not allow application through drip systems or when the irrigation system is hooked up to a public water system. Pollutant discharges incidental to chemigation of fertilizers or pesticides that might contaminate municipal, surface or groundwater may subject the chemigator to federal and/or state prosecution.

Pollution and Backflow Prevention

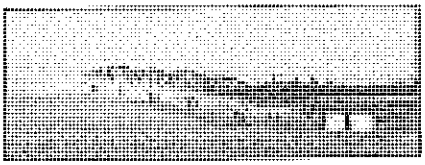
There are benefits and risks associated with chemigation, just as there are benefits and risks associated with ground and aerial pesticide/fertilizer applications. The most significant risk associated with chemigation is the potential contamination of the water supply. To minimize this risk, the chemigation system must be operated correctly and properly equipped with antipollution equipment. Proper installation, maintenance and operation of antipollution equipment ensures the safety of the chemigator, water source and the environment. All the components of a legal chemigation system help the operator make a safe, accurate application.

Types of Irrigation Systems used for Chemigation

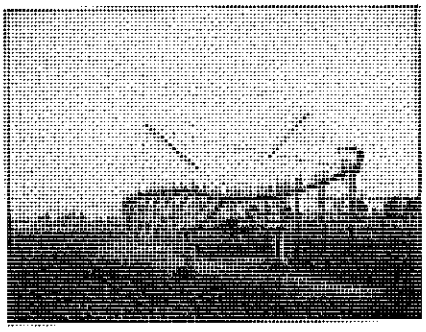
Chemigation can usually be conducted using *sprinkler, furrow, drip/trickle and flood irrigation.* Furrow, drip/trickle and flood irrigation systems can pose problems with chemical application uniformity and chemical movement from the field. In addition, these types of irrigation systems do not accommodate *foliar applications.* Sprinkler irrigation systems (center pivot, solid set, hand lines, lateral move, etc.) will accommodate foliar applications and typically provide a more uniform chemical application with little runoff.

Advantages of Chemigation

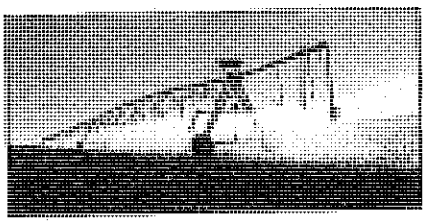
Some of the advantages of applying chemicals through an irrigation system may include:



- Many chemicals require moisture for activation or to incorporate the chemical to a desired depth. Chemigation provides a means of incorporation of the chemical to a prescribed depth and provides the moisture for chemical activation.
- Chemigation allows timely application of chemicals to meet crop needs even when the field is too wet for equipment or weather conditions prohibit other methods of application.



- In fields with soil types that are prone to compaction from farm equipment (including pesticide application equipment), applying chemicals through an irrigation system can reduce soil compaction.
- Irrigation systems cause less mechanical damage to the crop than sprayers and tractors.
- Chemigation may reduce applicator exposure to chemicals when done properly. The applicator (chemigator) is not required in the field during the entire application and the number of mixing/loading events during the application of pesticides is limited or non-existent.



- Drift of chemicals beyond the area intended for treatment may be reduced from that of conventional application methods (aerial, ground, etc.) during windy conditions.
- Chemigation allows the irrigation system (pivot, wheel line, etc.) to be a multifunctional machine that doubles as application equipment, thus a more viable investment. New technology in irrigation systems has made available chemigation capable systems that boost the potential for precision applications of chemicals.
- Chemigation may save 40% or more over the cost of conventional means of application. Savings increase when two or more chemical inputs are applied simultaneously.

Disadvantages of Chemigation

Although the advantages of chemigation appear to be many, there are also drawbacks with applying chemicals through irrigation water. The applicator must take these concerns into consideration before deciding that chemigation is suitable for their operation:

- The increased risk of water source contamination and *runoff* potential are always a disadvantage of chemigation as compared to other means of chemical application.
- Additional equipment may be required to modify the irrigation system to bring it into compliance with federal and state laws and to improve sprinkler system uniformity.
- Chemigation requires considerable management input and personnel training and increases the risk of surface and ground water contamination. Because of these factors, the State of Idaho requires applicator certification and licensure for any chemigation activity.
- Some chemicals and solutions may react with irrigation system components causing corrosion of the irrigation equipment.
- Chemigation typically increases application time compared to conventional methods of application (aerial, ground sprayer, etc.). As with conventional methods of application, climatic conditions may interfere or delay the application.
- Not all pesticides can be applied through chemigation. Pesticides the grower may need to use might not be labeled for chemigation.
- The possibility of chemigation equipment malfunction while the chemigator is not on site may cause chemical misapplication, human exposure, or environmental contamination.
- Application of chemicals through an irrigation system may apply moisture to your crop at a time when it is not required or when the field is already too wet.

Chapter 1 - Review Questions

Select the best answer for each question. See answers on page 42.

1. Chemicals, as defined by the Idaho State Department of Agriculture (Chapter 34, Title 22, Idaho Code), means:
   A. Fertilizers
   B. Pesticides
   C. Organic soil amendments
   D. A and B above

2. Which of the following is considered chemigation?
   A. Application of a chemical into a pond to kill mosquito larvae
   B. Application of fertilizer through a hose-end sprayer
   C. Application of a chemical into irrigation water applied to land, crops or plants
   D. Application of insecticides through use of a self-contained mosquito misting system

3. Which of the following is ***not*** required under Idaho Pesticide and Chemigation Law?
   A. Chemigation sites must be listed on the application for a chemigation license.
   B. The chemigator must certify that all chemigation equipment meets ISDA requirements.
   C. Licensed chemigators must recertify every 2 years.
   D. Chemigators must have the chemigation (CH) and the restricted use (RU) categories on their applicator license before they can chemigate.

4. All pesticide applications, including those made through injection into irrigation water, fall under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). (True or False)

5. Which of the following is a true statement?
   A. Even though a pesticide does not address chemigation on the label it is ok to inject the product into irrigation water.
   B. If an agricultural pesticide is approved for chemigation use, it will list the equipment required to be installed on the irrigation system.
   C. Herbicides are not pesticides so do not fall under chemigation laws and rules or FIFRA.
   D. All pesticide labels allow the use of any type of irrigation system for chemigation.

6. The most significant risk associated with chemigation is:
   A. Off-target drift of the chemical being applied
   B. Over application of the chemical being applied
   C. Potential contamination of the water supply
   D. Under application of the chemical being applied

7. Advantages of injection of chemicals into irrigation water as opposed to aerial or ground application are:
   A. Chemigation provides a means of incorporation of the chemical to a prescribed depth and provides moisture for chemical activation.
   B. Chemigation allows application of chemicals even when the field is too wet for ground equipment or weather conditions prohibit other methods of application.
   C. Chemigation may reduce applicator exposure to chemicals when done properly.
   D. All of the above

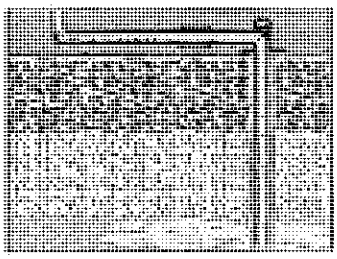
8. Disadvantages of chemigation include which of the following?
   A. Irrigation systems cause more mechanical damage to the crop than sprayers and tractors.
   B. In fields prone to soil compaction chemigation increases the total area of compaction.
   C. Chemigation typically increases application time compared to conventional methods of application.
   D. During windy conditions off-target drift is more likely to occur than through application by conventional means (ground or aerial applications).

9. Before making the decision to chemigate the chemigator should:
   A. Assess irrigation water runoff potential.
   B. Apply a soil adjuvant.
   C. Assure the pesticide to be applied is labeled for application through irrigation systems.
   D. A and C above

10. The chemigator must list all chemigation sites on his chemigation license application and certify the sites are in compliance with ISDA chemigation laws and rules. (True or False)

11. One of the disadvantages of chemigation using furrow, drip/trickle and flood irrigation systems as compared to sprinkler systems is:
   A. Too much water is applied during chemigation.
   B. They do not accommodate foliar applications.
   C. Most pesticide labels do not allow chemigation through these types of systems.
   D. Loss of chemical through evaporation.

Chapter 2 – Backflow



The introduction of chemicals into an irrigation system presents a potential hazard to the environment and to the public. *Backflow* is the movement of a liquid in reverse of the normal direction of flow in a piping system. In chemigation systems, backflow can occur in the irrigation water mainline causing source water contamination. Backflow in the chemical injection line can cause the chemical tank to overflow.

The irrigation system acts as a *cross connection* between the chemical supply tank and the water source. A cross connection is any connection or structural arrangement between the source water and the chemical injection line through which contamination of the source water can occur. Any temporary or permanent devices through which backflow can occur are considered cross connections. Cross connections can be to any water source such as irrigation district mainlines or *laterals*, *public*, *municipal* or *domestic* water lines, streams, lakes, rivers, ponds or *ground water*.

The water source can be contaminated by the chemical being injected into the irrigation system by two backflow processes: backsiphonage and backpressure.

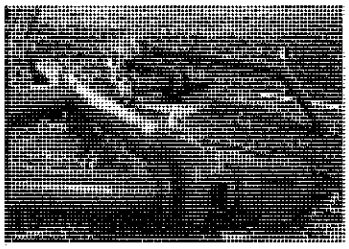
Backsiphonage

Backsiphonage is the reverse flow of a liquid in a piping system caused by a differential hydraulic pressure gradient between two points in the piping system. The resulting vacuum causes a siphoning action. Principal causes of backsiphonage are:

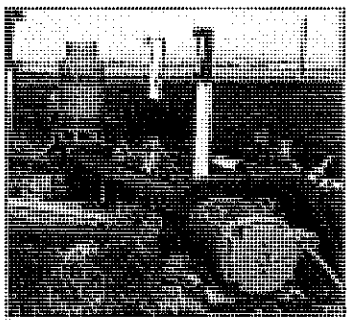
- Failure of the irrigation mainline check valve upon irrigation pump shutdown or power failure.
- Creation of a severe *hydraulic gradient* by undersized piping in the supply line.
- Pipeline breakages in the water supply mainline which is lower than the customer service point.
- Reduced irrigation mainline pressure due to a high water withdrawal rate such as during a fire fighting event or a mainline flushing.
- Reduced mainline supply pressure due to pump or power failure.
- Reduced supply pressure on the suction side of the booster pump.
- High liquid velocity in the pipeline.

Backpressure

Backpressure occurs when the irrigation system is operating at a higher pressure than the water supply system. Backpressure is most likely to occur when the irrigation distribution system (pivot, etc.) is subjected to a higher pressure than its normal operating pressure. An example would be an irrigation system operating at a lower pressure interconnected to a mainline of a system that is operating at a higher pressure. This condition could force contaminated water back to the water source of the low pressure system. Major sources of backpressure are:



Booster Pumps



Well pump with booster pump

- *Booster pumps* on the irrigation system used to increase flows and pressure requirements.
- Cross connections with other piping systems operating at higher pressures.
- Elevated piping; the weight of the irrigation water creates pressure on systems located at a lower elevation.
- Connections to pressurized systems such as boilers.
- Elevation differences in interconnected irrigation systems.
- An irrigation pump operating at a higher pressure than the chemical injection pump.

A typical example of backpressure caused by cross connections with other piping systems operating at higher pressures would be the flow of mainline irrigation water through the chemical injection line and into the chemical supply tank. This event might occur if the chemical injection pump shuts down and an injection line check valve is not in place.

Safety devices must be installed on irrigation systems to prevent the effects of backsiphonage and backpressure. The safety devices required will depend on existing laws, rules and the product label. Idaho chemigation law requires backflow prevention devices installed on all irrigation systems or, under certain circumstances, other alternative methods when injecting pesticides or fertilizers.

If the pesticide is labeled for chemigation, the label will list specific backflow equipment required for application of the product through irrigation systems, including systems cross connected to public water systems. ISDA Rules Governing Pesticide and Chemigation Use and Application (IDAPA 02.03.03) address chemigation equipment requirements when chemigating in Idaho.

Chapter 2 - Review Questions

Select the best answer or fill in the blank for each question. See answers on page 42.

1. Backflow of a liquid (water, chemical, or chemically treated water) can occur in the irrigation mainline or in the chemical injection line. (True or False)

2. In chemigation systems what is the primary concern of backflow?
   A. Over-application of the chemical being injected
   B. Water source contamination
   C. Loss of chemical through a ruptured chemical injection line
   D. Chemical release into the atmosphere

3. An example of a cross connection would be a potable water line connected to another potable water line used for chemical injection. (True or False)

4. Backflow of chemically treated water can occur through:
   A. Backsiphonage
   B. Backpressure
   C. Increased water supply pressure.
   D. A and B above

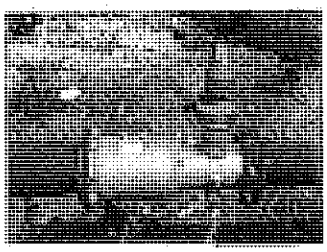
5. Backsiphonage can be caused by which of the following?
   A. Increased supply pressure on the suction side of the booster pump
   B. Low liquid velocity in the pipeline
   C. Reduced mainline supply pressure due to pump or power failure
   D. Oversized piping in the supply mainline

6. Backpressure occurs when the irrigation system is operating at a pressure that is _____ the water supply system.
   A. Lower than
   B. Higher than
   C. Equal to
   D. Five pounds per square inch (PSI) less than

7. Major sources of backpressure are:
   A. Booster pumps used to increase flows and pressure requirements.
   B. Cross connections with other piping systems operating at higher pressures.
   C. Elevation differences in interconnected irrigation systems.
   D. All of the above.

8. The backflow of irrigation water from a pressurized mainline though the chemical injection line and into the chemical tank would likely be the result of:
   A. Backsiphonage
   B. A vacuum in the injection line
   C. Backpressure
   D. Mainline/chemical tank elevation differences

Chapter 3 – Backflow Prevention Equipment and Methods



Chemigation Valve

Chemigation systems that use irrigation water from sources other than public, domestic or municipal water sources are typically designed to include a chemigation valve assembly (Diagram 1). The chemigation valve assembly meets pesticide label and ISDA requirements for irrigation water backflow prevention. Typical chemigation valve components include a spring-loaded *irrigation line check valve*, *vacuum relief valve*, *inspection port*, *automatic low pressure drain valve* with drain hose and a chemical injection port.

The chemigation valve is typically installed in the irrigation main line near the irrigation water pump. Installation near the irrigation water pump allows for water source backflow protection when chemigation takes place at multiple sites along the irrigation mainline. A chemigation valve may be installed at any point in the mainline or a lateral line but wherever the placement, the main priority is to protect the water source. The chemigation valve must be installed according to the manufacturer's specifications and in accordance with ISDA Laws and Rules.

Chemigation Valve

Illustration credits: Jim Childs
Idaho State Dept. of Agriculture

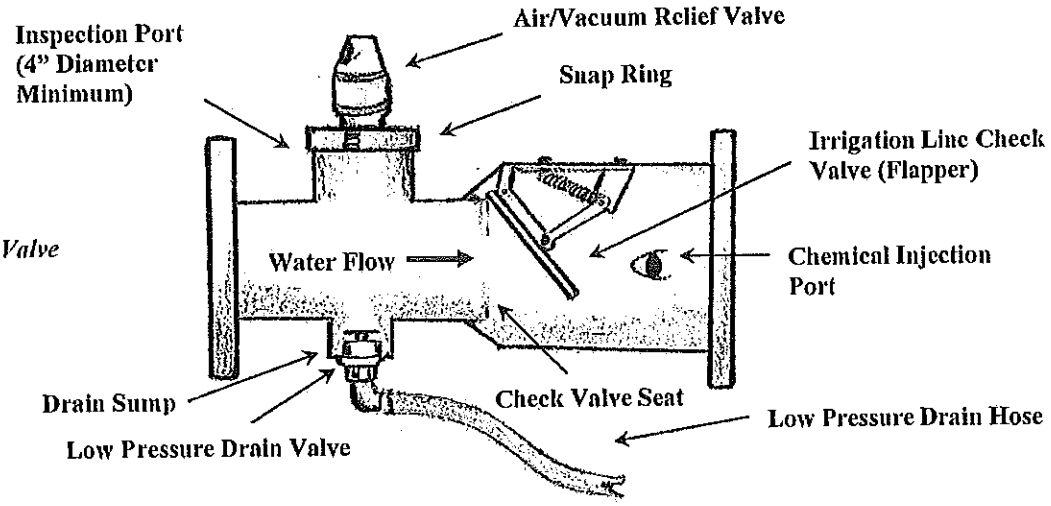
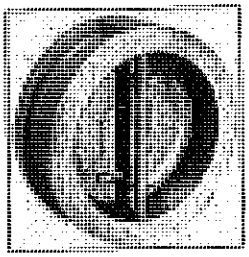


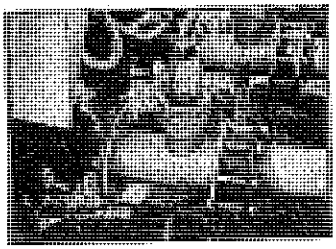
Diagram 1: Chemigation Valve Assembly

Before chemigation takes place the irrigation line check valve should be inspected for wear. Release the snap ring and remove the vacuum relief valve from the inspection port and inspect the irrigation line check valve seal. There should be no metal-to-metal surfaces where the check valve contacts its seat. Replace the chemical resistant seal if necessary. It is a good indication that the seal may need replaced if water constantly drains from the automatic low pressure drain valve when the irrigation pump is shut down.

If there is constant water pressure from the upstream side of the irrigation line check valve, as when the check valve is at an elevation below the water source, the low pressure drain will continually drain when the pump is shut down. To remedy this potentially hazardous condition, remove the drain hose and cap the automatic low pressure drain valve when not using the system for chemigation. The low pressure drain hose must be reinstalled before your next chemical application.

Wafer Check Valve



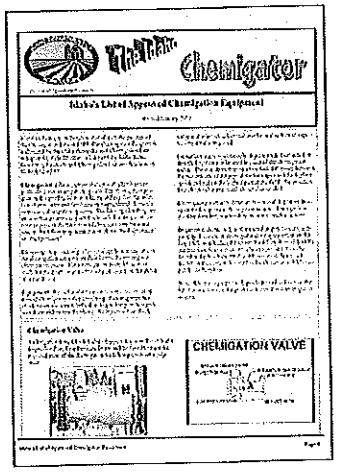


Wafer check valve with spool

The *Wafer Check Valve* is an irrigation line check valve that requires installation of a spool that consists of all the required chemigation valve components previously listed to make it the equivalent of a one-piece chemigation valve. The spool consists of an inspection port, vacuum relief valve and automatic low pressure drain with drain hose. Pesticide injection takes place anywhere down stream of the wafer check valve. This type of chemigation valve configuration may take the place of the one-piece chemigation valve.

The irrigation line check valve, or flapper located inside the one piece chemigation valve and the wafer check valve shown at left, prevents chemically treated irrigation water from flowing back into the water source if a back siphonage or backpressure event takes place. The spring loaded valves will quickly close preventing backflow.

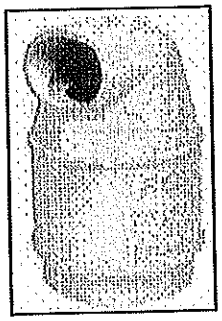
All chemigation valves and wafer check valves must be labeled with the manufacturer's name and model number, working pressure in pounds per square inch (psi), maximum flow rate in gallons per minute and direction of flow. This is the only way you can be assured the valve has been tested and is approved and listed on "Idaho's List of Approved Chemigation Equipment."



All state approved irrigation line check valves are tested by an independent laboratory before inclusion on "Idaho's List of Approved Chemigation Equipment." Manufacturers of these valves go through considerable expense to have these valves tested and approved by the ISDA. All check valves must provide a water tight seal, be installed according to manufacturer's specifications and be inspected and maintained on a regular basis. Valves not included on "Idaho's List of Approved Chemigation Equipment" are not acceptable for chemigation in Idaho and, if installed, will constitute an illegal chemigation system.

Chemigation from a well in Idaho requires installation of a state approved chemigation valve assembly or wafer check with spool plus all other required equipment.

Air/Vacuum Relief Valve

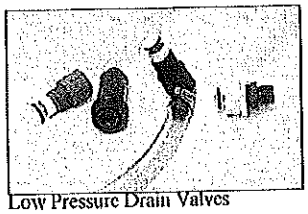


The *air/vacuum relief valve* located atop the inspection port or anywhere on the irrigation line upstream of the irrigation line check valve, will relieve the vacuum created upon pump shutdown, allowing untreated water located in the mainline upstream of the irrigation line check valve to drain to the water source.

The air/vacuum relief valve must have an orifice size that is appropriate to the size of the irrigation pipe. Refer to the below chart for proper diameter of the orifice for the irrigation pipe size.

If the irrigation pipe diameter is:	Then the air/vacuum relief valve orifice diameter must be at least:
4 inches	¾ inch
5 to 8 inches	1 inch
9 to 18 inches	2 inches
19 inches and above	3 inches

Automatic Low Pressure Drain


Low Pressure Drain Valves

The automatic low pressure drain sump and *automatic low pressure drain valve* are located directly below the inspection port on the chemigation valve or spool. Any chemically treated irrigation water that may drain past the irrigation line check valve (flapper) after it has closed will be expelled from the mainline instead of entering the water source. A hose installed on the low pressure drain valve directs discharged water at least 20 feet from the water source. Shut-off valves are not allowed on the outlet end of the drain tube.

The automatic low pressure drain valve cannot extend into the chemigation valve or spool beyond the valve or spool's inside surface and must be at least ¾" in diameter with a closing pressure of not less than 5 pounds per square inch (psi). Several models of the automatic low pressure drain valve are listed on "Idaho's List of Approved Chemigation Equipment." These valves should be removed in the fall before temperatures fall below freezing.

Chemical Injection System with System Interlock

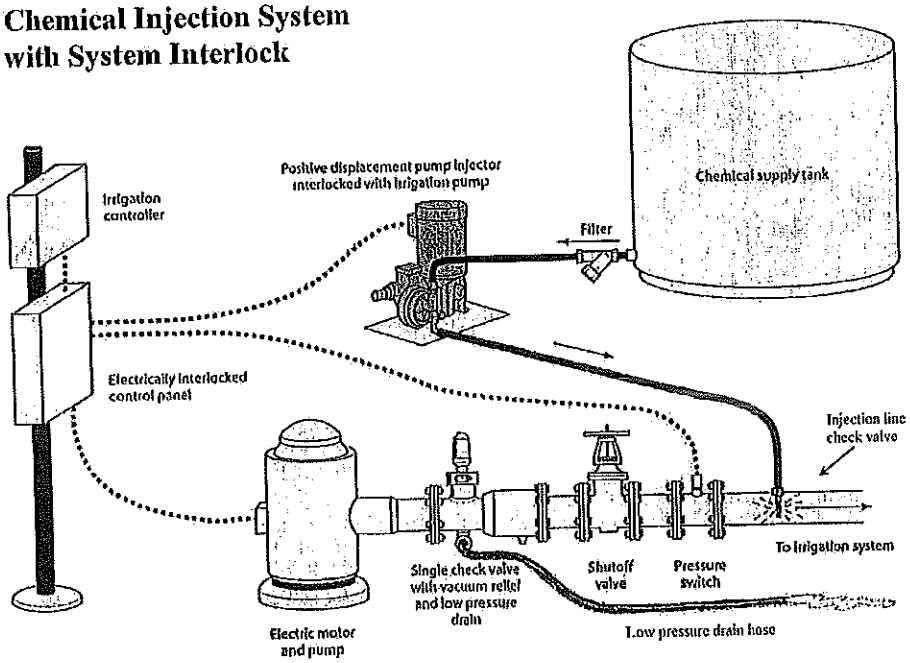
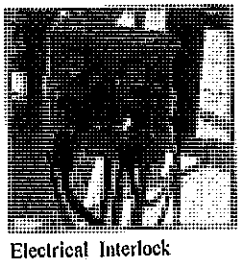


Diagram 2: System Interlock

Diagram credits: California Dept. of Pesticide Regulation
Edited by Jim Childs

System Interlock


Electrical Interlock

Every chemigation system must have a *system interlock* designed to shut down the chemical injection unit when chemical distribution is adversely affected. The *electrical interlock* functions when the electrical controls at the irrigation pump panel are interlocked with an electric powered chemical injection pump. If the water pump shuts off or the pressure switch shuts power off at the panel, the chemical injection pump shuts off.

The electrical interlock should also shut off the irrigation system if the chemical injection pump shuts down. This will stop the sprinkling system, such as a pivot, from continuing on its rotation if the chemical injection pump quits working.

Solenoid Operated Valves

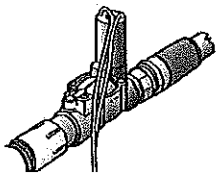


Illustration credits: Virginia Cooperative Extension

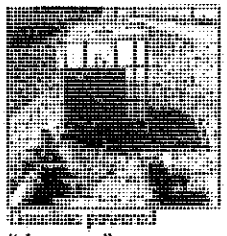
Alternative hydraulic interlock systems involve solenoid operated valves and automatic quick-closing check valves connected to the intake side of the chemical injection pump that are activated by pressure in the main water line. These check valves will allow chemical injection only when the irrigation system is adequately pressurized.

Another electrical interlock system involves the use of an automatic quick-closing check valve and vacuum relief valve located in the chemical injection line between a positive displacement chemical injection pump and the injection point. This installation involves elevating the chemical injection line at least 12" above the highest fluid level in the chemical supply tank. The quick-closing check and solenoid-operated valve configurations are addressed on pesticide labels that allow chemigation and are required by ISDA rule if an injection line check valve is not used.

Mechanical Interlock

Mechanical interlock systems include irrigation pumps driven by an internal combustion engine. The interlock consists of the operation of the chemical injection equipment from the engine electrical system or an electrical generator driven by the pumping plant power unit. Another mechanical interlock system would involve the use of a belt from the drive shaft or accessory pulley of an internal combustion engine powered irrigation pump. This interlock system also requires the use of an injection line check valve and other required chemigation equipment.

Human Interlock



"slug pump"

The *human interlock* consists of human supervision on-site during the injection of fertilizer into the irrigation system. Idaho chemigation rules allow this type of interlock for one hour or less to shut down the system in case of failure of the injection pump or irrigation system. The intention of the one hour rule is to allow fertilizers to be "slugged" into wheel lines, hand lines, set lines, etc. The rule is not intended to allow human supervision of applications of pesticides that require installation of specific system interlocks. An injection line check valve and all other required chemigation equipment must be installed and used even during human supervision of the injection.

Hydraulic Interlock

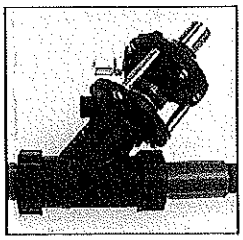


Photo credits: California Dept. of Pesticide Regulation

The *hydraulic interlock* includes the use of a hydraulically operated normally closed check valve that prevents leakage from the chemical supply tank on system shutdown. The valve is installed on the intake side of the chemical injection pump. A control line or tube connects the hydraulic check valve to the irrigation water line such that the hydraulic valve opens only when the main water line is adequately pressurized. The valve must be constructed of chemically resistant materials.

The United States Environmental Protection Agency (USEPA) has authorized the use of certain chemigation safety equipment as alternatives to the equipment listed on pesticide labels. The list of alternative devices that can be used in lieu of some of the equipment listed on pesticide labels can be found in Appendix A, "List of USEPA Authorized Alternative Chemigation Safety Equipment." Installation of alternative equipment must conform to Idaho State Department of Agriculture standards. It is advisable to contact ISDA before installing this equipment.

Pressure Switch

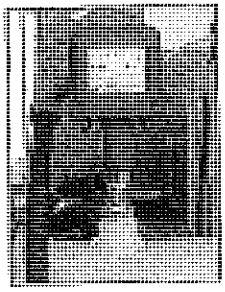
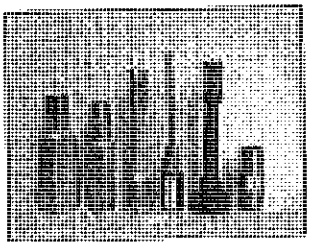


Photo credits: California Dept. of Pesticide Regulation

In pressurized irrigation systems, with the exception of injection with a gasoline powered slug pump, the irrigation line or water pump must include a functional *pressure switch* which will stop the water pump motor when the water pressure decreases to the point where chemical distribution is adversely affected.

Injection Line Check Valves



The *injection line check valve* is installed in the irrigation main line or a lateral line downstream from any backflow prevention equipment and fresh water supply valves. This check valve prevents irrigation water under pressure from entering the pesticide injection line and must prevent leakage from the pesticide supply tank on system shutdown. ISDA rules and the USEPA require the "*cracking pressure,*" or the amount of pressure required to crack the internal check ball open, be at least ten pounds per square inch (psi). ISDA also requires one psi per one foot of elevation between the chemical supply tank and the point of chemical injection (Appendix A). The check valve must be constructed of chemical-resistant materials and be of a brand and model listed on "Idaho's List of Approved Chemigation Equipment."

Alternatives to the Chemigation Valve

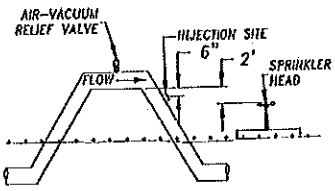
When possible, the point of chemical injection should be located as far as possible from the water source to protect the water source in the event of a chemical leak or spill. This is especially true when chemigating with ground water from a well.

A State approved injection line check valve can substitute for both the solenoid-operated valve and the functional, automatic, quick-closing check valve in the pesticide injection line as described in IDAPA 02.03.03 and listed on pesticide labels that allow chemigation of the product.

Under certain circumstances alternatives to the use of a chemigation valve in the irrigation water mainline may be used. When surface water is the sole water source for the irrigation system the following chemigation configurations, assuming all other chemigation requirements are met, may be allowed:

- Gooseneck pipe loop.
- Pumping down a hill.
- Pumping over a hill.
- Injection of chemical at the head of the field and downstream of a hydraulic discontinuity such as a weir.

Gooseneck Pipe Loop



AutoCAD drawing by Donell Fluckiger - ISDA

The *gooseneck pipe loop* configuration is listed as an alternative device in the "List of USEPA Authorized Alternative Chemigation Safety Equipment" (Appendix A). In Idaho it is allowed where surface water is the sole water source for the irrigation system and replaces the chemigation valve or the wafer check valve with inspection port, vacuum relief valve and low pressure drain with hose.

The gooseneck pipe loop configuration prevents backflow of chemically treated water only if certain criteria and equipment requirements are met. The gooseneck pipe loop must be located in the main water line immediately downstream of the irrigation water pump. A vacuum relief valve or combination air and vacuum relief valve with an orifice size matched to the mainline pipe size (Chapter 3, pg. 10, "Air/Vacuum Relief Valve") must be installed at the top of the loop apex of the gooseneck pipe loop.

The bottom side of the pipe at the loop apex must be at least 24" above the highest sprinkler or any other type of water emitting device on the highest part of the field. Also, chemical injection must take place at least 6" below the bottom side of the pipe at the loop apex (Diagram 3). An ISDA approved injection line check valve must be used.

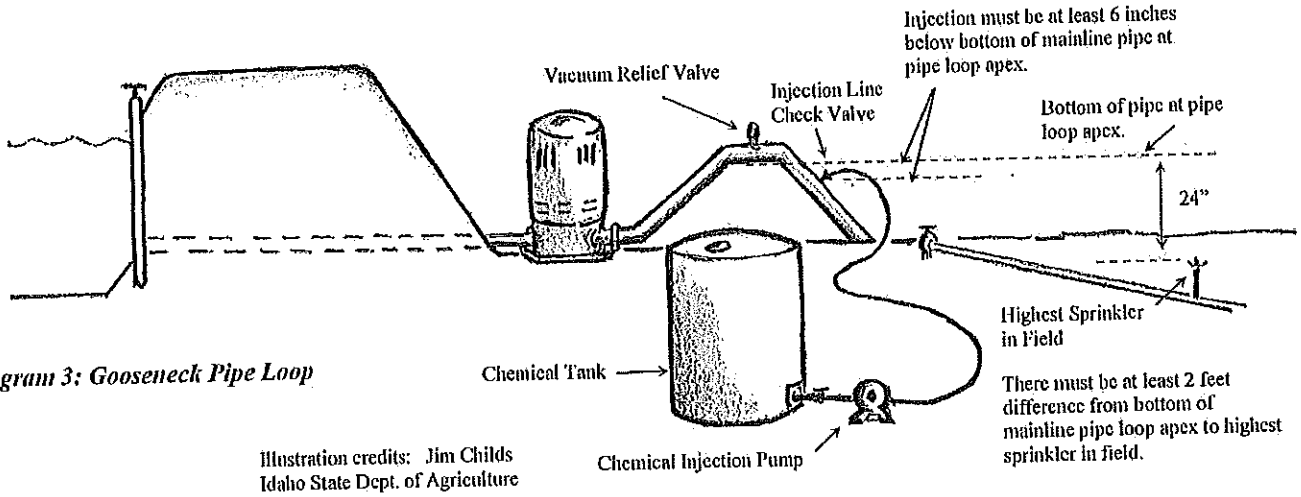


Diagram 3: Gooseneck Pipe Loop

Illustration credits: Jim Childs
Idaho State Dept. of Agriculture

Pumping Down or Over a Hill

The pumping down or over a hill configurations are similar to the gooseneck pipe loop configuration and has identical requirements. The apex is the level portion of the pipe immediately downstream of the irrigation pump when pumping down hill. When pumping over a hill the apex is where the pipe tops the peak of the hill. When pumping down a hill, injection of chemicals must take place at least 6" below the bottom side of the pipe and downstream from the vacuum relief valve. When pumping over a hill there must be a vacuum relief valve located at the top of the mainline pipe at the point it peaks the hill. Injection of chemicals may only take place on the downstream side of the hill.

When pumping down or over a hill the highest sprinkler at the highest point in the field must be at least 24" below the bottom of the pipe at its apex. An ISDA approved injection line check valve must be used.

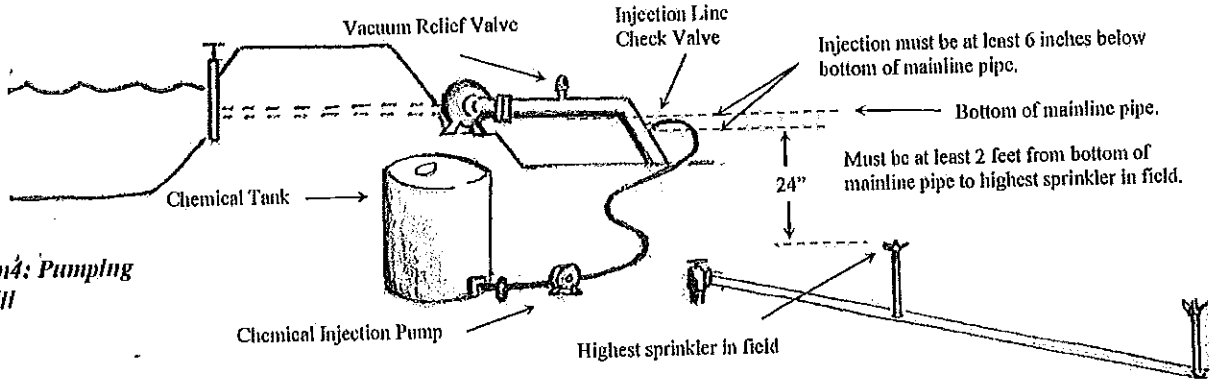


Diagram4: Pumping Downhill

Illustration credits: Jim Childs
Idaho State Dept. of Agriculture

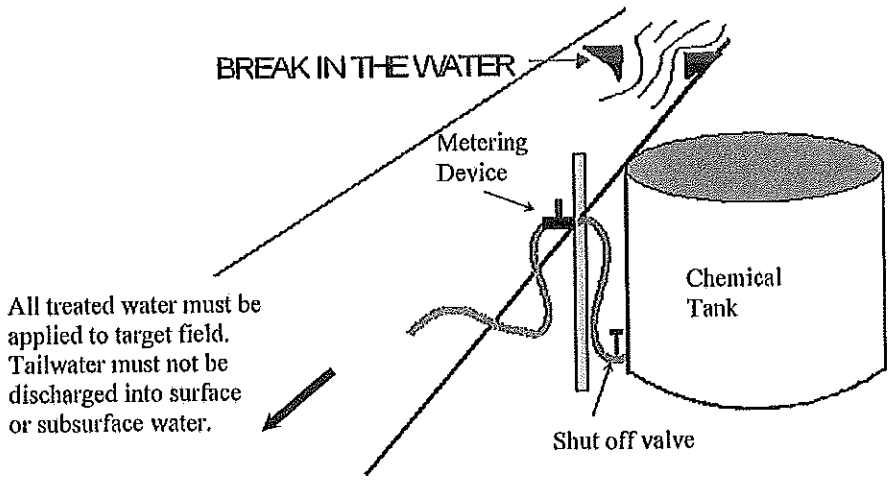
Injection below a Weir or Break in the Water

Injection of chemicals (fertilizers or pesticides) on the intake side of irrigation line pumps is not allowed in Idaho. Irrigation pump parts may corrode when exposed to pesticides and fertilizers and injection of chemicals on the intake side of the irrigation pump contributes to source water contamination.

It is illegal to inject chemicals into a lateral, canal, irrigation ditch, stream, etc. that flows off from land controlled by the chemigator. Treated water must be retained on the treatment site. Treated tailwater must not be discharged into any other body of water.

If a chemical, including anhydrous ammonia, is to be applied by flood, basin, furrow or border chemigation through a gravity flow dispensing system, the chemical must be metered into the water at the head of the field and downstream of a hydraulic discontinuity such as a drop structure or weir box. Injection must take place below a break in the water to prevent backflow of treated irrigation water. This type of chemical injection only requires a chemical tank, hose, shutoff valve and metering device that regulates the amount of chemical being applied.

Chemical is injected into the irrigation water on the downstream side of a weir or suitable water break and all treated water is used on the target field. Do not use this method unless all treated water is used on the target field and there is no chance of backflow of treated water to the water source.



Chapter 3 - Review Questions

Select the best answer or fill in the blank for each question. See answers on page 42.

1. The spring-loaded irrigation line check valve (flapper or butterfly valve) inside the chemigation or wafer check valve is to prevent:
   A. Backflow of chemicals into the chemical tank.
   B. Excessive pressure in the mainline.
   C. Backflow of chemically treated water into the water source.
   D. Loss of pressure in the mainline.

2. If the irrigation pump and chemigation valve are located below the high water mark on a pond or irrigation canal, the low pressure drain will usually remain open and seep water after the irrigation pump is shut down. How do you prevent this and still be in compliance with chemigation laws and rules?
   A. Remove the low pressure drain valve and replace with a permanent plug.
   B. Clamp the low pressure drain hose to prevent drainage.
   C. Replace the low pressure drain valve with a hose spigot.
   D. Remove the low pressure drain hose and cap the low pressure drain valve. Reinstall the drain hose before chemigating.

3. When using well water as the irrigation water source for chemigation, an ISDA approved chemigation valve or wafer check valve with inspection port, air/vacuum relief valve and low pressure drain with hose is always required. (True or False)

4. If a wafer check valve is installed for backflow prevention during chemigation what other equipment is also required?
   A. Inspection port
   B. Air/vacuum relief valve
   C. Low pressure drain with hose
   D. All of the above

5. The system interlock assures that:
   A. The injection of pesticides or fertilizers continues even if the irrigation water pump stops.
   B. The chemical injection pump shuts down if the irrigation pump stops.
   C. The irrigation pump shuts down if the chemical injection pump fails.
   D. B and C above

6. The ISDA maintains a list of approved injection line check valves. (True or False)

7. The injection line check valve's primary purpose is to:
   A. Prevent leakage of chemical into the mainline upon system shutdown.
   B. Prevent the backflow of irrigation water into the chemical tank.
   C. Regulate the amount of chemical being applied.
   D. A and B above

8. Alternatives to the chemigation valve requirement on (surface water only) include:
   A. Gooseneck pipe loop
   B. Pumping down a hill
   C. Pumping over a hill
   D. Injection of chemical below a weir
   E. All of the above

9. A _____ must be installed at the top of the gooseneck pipe loop to break the siphoning effect upon irrigation system shutdown.
   A. Combination air/vacuum relief or vacuum relief valve
   B. Solenoid Operated Valve
   C. Automatic Low pressure Drain
   D. Pressure switch

10. The highest sprinkler in the field must be at least _____ below the bottom side of the pipe loop apex to be a legal gooseneck pipe loop chemigation site.
   A. 10"
   B. 24"
   C. 12"
   D. 14"

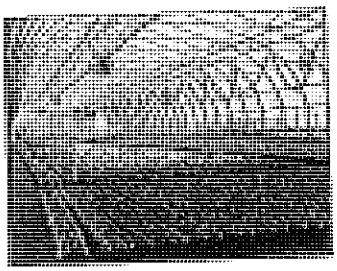
11. The point of injection of chemicals into a gooseneck pipe loop chemigation site must be at least _____ inches below the bottom of the pipe loop apex.
   A. 8
   B. 10
   C. 6
   D. 4

12. When pumping down a hill the highest sprinkler in the field being chemigated on must be at least _____ inches lower than the bottom side of the mainline pipe immediately downstream of the irrigation pump.
   A. 24
   B. 16
   C. 20
   D. 12

13. When pumping down or over a hill and the water source is an irrigation well a chemigation valve installed in the irrigation water mainline is not necessary. (True or False)

14. When applying fertilizers, such as anhydrous ammonia to ditch water, why is it important to inject only below a weir or break in the water flow?
   A. It helps mix the chemical with the water.
   B. The weir or water break will help prevent backflow of treated water into the water source if a canal break or other event causes the ditch water to momentarily flow in reverse.
   C. The ditch water flows at a higher rate below the weir.
   D. The fertilizer will be more evenly distributed across the field.

Chapter 4 – Backflow Prevention for Municipal and Domestic Water Supplies



Air Gap

Greenhouse, nursery and golf course operations often use municipal, public or domestic water for irrigation. Applying chemicals to irrigation water in this type of setting usually requires backflow prevention equipment that differs from the chemigation valve or the goose neck pipe loop as discussed in Chapter 3. ISDA chemigation rules and the pesticide label require the use of an "*Air Gap*" or a *Reduced Pressure Backflow Assembly (RPBA)* when there is a physical cross connection between a potable water line and the chemical supply tank.

The air gap configuration allows the irrigation water to be pumped into a reservoir, standpipe or holding tank before it is treated with chemicals and pumped through the irrigation system. It is generally regarded as the most fail proof method of backflow prevention. There is a physical break in the piping system that prevents backflow of chemically treated water from flowing back to the water source.

An air gap must be at least double the diameter of the supply pipe measured vertically above the overflow rim of the reservoir tank and in no case less than one inch. Chemical injection must take place downstream of the air gap. The disadvantage of the air gap configuration is that it typically requires two pumps, one to pump the irrigation water to the reservoir and one to pressurize the irrigation water required in a pressurized irrigation system.

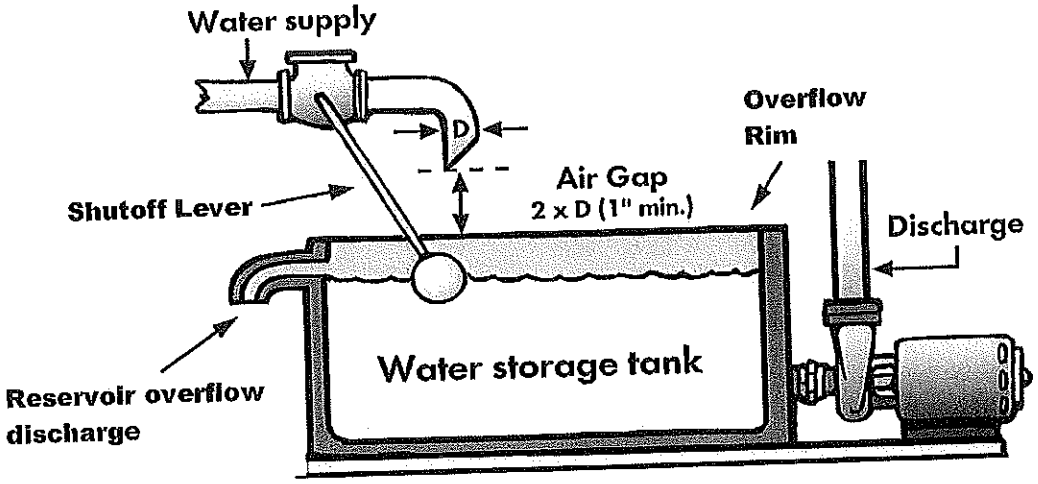
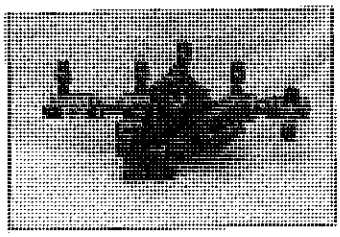


Diagram 5: Air Gap

Illustration Credits: Virginia Cooperative Extension

Reduced Pressure Backflow Assembly



Reduced Pressure Backflow Assembly

The Reduced Pressure Backflow Assembly (RPBA) is designed to prevent backflow caused by backpressure and backsiphonage. It consists of two independently acting spring loaded check valves separated by a spring loaded differential pressure relief valve, two resilient seated full ported shutoff valves and four resilient seated test cocks. This assembly is installed as a single unit upstream of the chemical injection site.

During normal operation, the pressure between the two check valves, referred to as the zone of reduced pressure, is maintained at a lower pressure than the supply pressure. If either check valve leaks, the differential pressure relief valve maintains a differential pressure of at least two psi between the supply pressure and the zone between the two check valves by discharging water into the atmosphere.

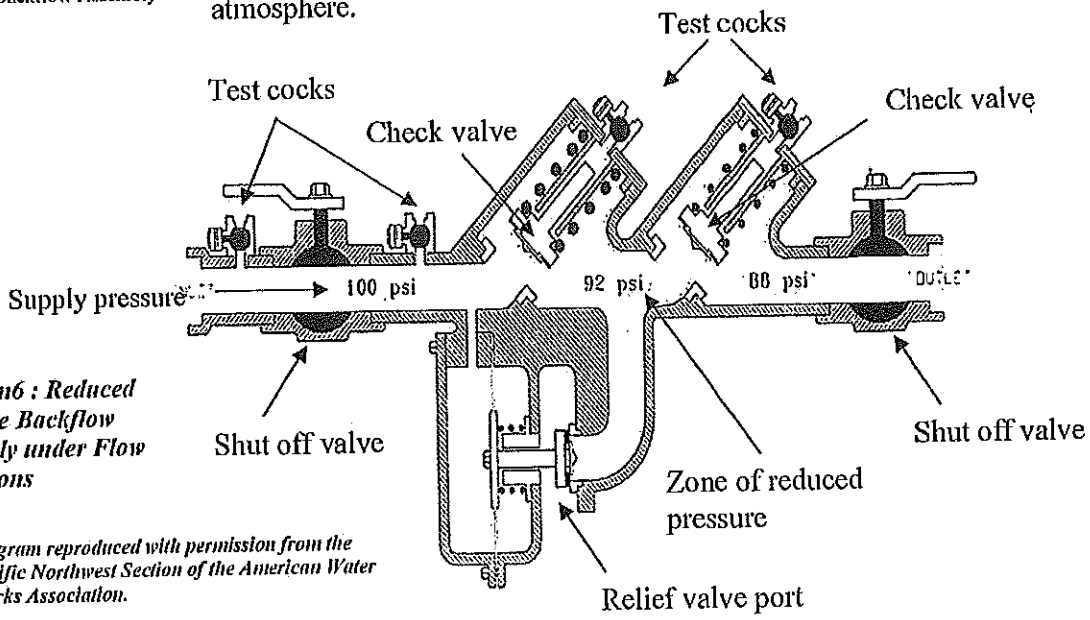
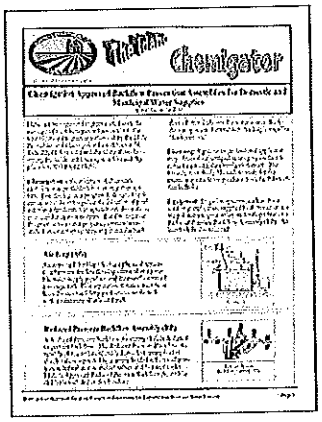


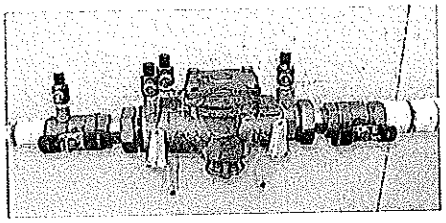
Diagram6 : Reduced Pressure Backflow Assembly under Flow Conditions

Diagram reproduced with permission from the Pacific Northwest Section of the American Water Works Association.

Approved Backflow Prevention Assemblies

The RPBA used for chemigation in Idaho must be one listed in the most recent edition of the University of Southern California (USC) Foundation for Cross-Connection Control and Hydraulic Research "List of Approved Backflow Prevention Assemblies."





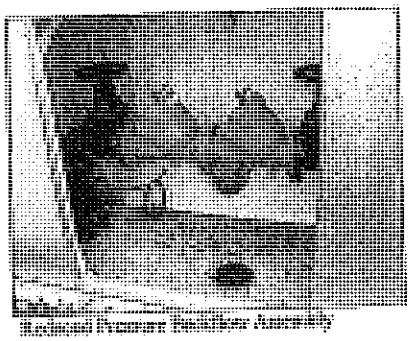
Reduced Pressure Backflow Assembly

Manufacturer, Model Number, Size

The Idaho State Department of Environmental Quality (DEQ) maintains the most current list of USC approved RP assemblies and regulates inter and cross connections to municipal water systems. It is recommended that the municipality or water purveyor and ISDA be contacted in planning a chemigation system connected to municipal or domestic water supplies.

RPBA Installation

All backflow prevention assemblies must be installed in a manner that will facilitate their proper operation, in-line testing and maintenance. They must also be installed in compliance with safety regulations and all applicable building and plumbing code regulations. An improper assembly installation jeopardizes the reliability of the assembly in preventing backflow because:



- An unsafe or inaccessible location reduces the likelihood of an assembly being tested and maintained.
- Improper orientation of an assembly may prevent its proper operation.
- Installation in a hazardous environment may allow contaminants to enter the assembly through test cocks, relief valve ports or air inlets.
- Freezing or excessively high temperatures may damage the assembly.

Each manufacturer provides recommendations for the proper installation of their assemblies. While it is important to consult the manufacturer's instructions prior to the installation of any assembly, other legislated authorities may have installation requirements that differ from the manufacturer's recommendations. In all cases the more stringent installation requirements must be followed.

The RPBA should not be installed below ground level because flooding could cause contamination of source water in the irrigation line through the RPBA relief valve, test cocks or air inlets.

RPBA's should be installed horizontally and RPBA's larger than 2 ½ in. should have support blocks to prevent water line or RPBA damage. Above ground level installation of the RPBA must provide adequate space for maintenance and testing.

Semi-buried pits (Diagram 7, pg. 21) may be acceptable (consult the water purveyor) if the air vent or relief valve is installed above the ground or maximum flood level with an approved air gap between the relief valve and a daylight drain. The daylight drain from above grade or semi-buried vault must:

- Be able to be bore sighted to a discharge point installed above the ground or maximum flood level, whichever is higher.
- Be able to handle the volume of water that potentially could be discharged from the relief valve port.

Water lines should be flushed before installation and the device tested after installation. Most "failure to test satisfactory" results in new installations are caused by debris fouling one of the check valves or the relief valve.

RPBA Installation in Semi-Buried Pit

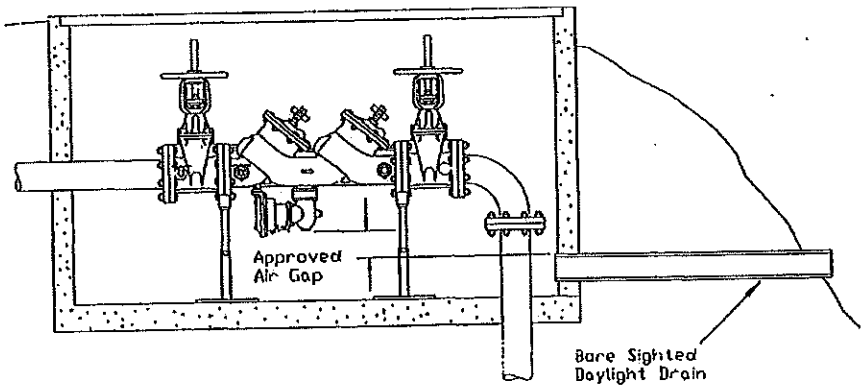


Diagram 7: RPBA Installation in Semi-Buried Pit

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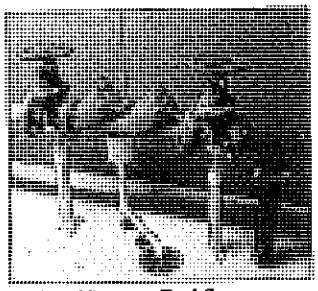


Reduced Pressure Backflow Assembly with shutoff valves

Waterline shutoff valves should be installed on the upstream and downstream sides of the RPBA valve as well as a strainer or filtering device on the upstream side. The RPBA must be protected from freezing temperatures and should be drained in the fall. Another option is to heat the RPBA valve enclosure.

RPBAs shall only be installed in the orientation for which they are approved (e.g. horizontal or vertical configuration). Any other orientation may hinder the RPBA from preventing backflow. RPBAs approved for vertical installation may have the check valve and isolating valve features installed vertically, but the relief valve feature installed horizontally. The RPBA must be installed a minimum of 12 inches above grade.

RPBA Dripping and Check Valve Fouling

Because of the inherent design of a reduced pressure backflow assembly, fluctuating supply pressure conditions may cause nuisance dripping and potential fouling of the assembly. Depending on the degree of fluctuating supply pressure, the assembly may discharge water from time to time. This nuisance discharge can potentially foul the first check valve. While not effective in all cases, the installation of a soft seated spring loaded check valve immediately ahead of the RPBA will often hold the pressure constant to the assembly in times of fluctuating supply pressure.

Water hammer, the result of a sudden change in liquid velocity in the piping system can cause excessive pressure. To avoid possible damage to the system and assembly from this situation, use water hammer arresters or surge protectors.

RPBA Testing

The RPBA should be tested by a certified tester each year. You may find a list of certified testers on the State of Idaho Bureau of Occupational Licenses website: https://www.ibol.idaho.gov.

Chapter 4 - Review Questions

Select the best answer or fill in the blank for each question. See answers on page 42.

1. Pesticide labels that allow chemigation list two types of source water backflow prevention when the chemical supply tank is cross connected to a potable water source. What are the two types of backflow prevention methods allowed on the pesticide label?
   A. Reduced Pressure Backflow Assembly (RPBA)
   B. Chemigation valve
   C. Air gap configuration
   D. A and C above

2. The air gap between the water supply pipe outlet and the overflow rim of the reservoir tank must be at least _____?
   A. 2 times the water supply pipe diameter and in no case less than 1 inch
   B. 1 ½ times the water supply pipe diameter
   C. Equal to the water supply pipe diameter
   D. 3 times the water supply pipe diameter

3. What is the minimum distance allowed between the water supply pipe outlet and the rim of the reservoir tank when using the air gap backflow prevention method?
   A. 2"
   B. ½"
   C. 1"
   D. 3"

4. The Reduced Pressure Backflow Assembly (RPBA) is designed to prevent backflow of chemically treated water into _____ water supplies.
   A. Municipal
   B. Domestic
   C. Public
   D. All of the above

5. The RPBA is designed to prevent backflow caused by:
   A. Excessive water supply pressure
   B. Backpressure
   C. Backsiphonage
   D. B and C above

6. The ISDA publishes a list of approved Reduced Pressure Backflow Devices. (True or False)

7. RPBA's must be installed in a manner that will assure:
   A. Proper operation
   B. The valve can be properly tested
   C. The valve does not freeze
   D. All of the above

8. The RPBA should be installed:
   A. Below ground level
   B. In a small sprinkler valve control box
   C. Above ground level and protected from freezing temperatures and excessive heat
   D. In a vertical or horizontal position, your choice

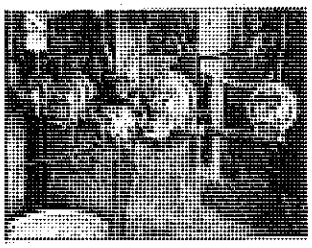
9. Installation of a RPBA in a semi-buried pit requires:
   A. An air gap between the relief valve and a daylight drain
   B. A daylight drain that can handle the amount of water that could be discharged from the relief port
   C. Ample room around the valve to allow testing
   D. All of the above

10. Most RPBA "failure to test satisfactory" results in new installations are caused by:
   A. Defective testing equipment
   B. Poor valve calibration
   C. Debris fouling
   D. A weak valve spring

11. The RPBA valve must be installed a minimum of _____ inches above grade.
   A. 6
   B. 12
   C. 10
   D. 9

12. The RPBA should be tested:
   A. Each year
   B. Twice a year
   C. Once every 2 years
   D. Only when it discharges water into the atmosphere

Chapter 5 – Chemical Injectors



Hydraulic Injectors

The chemical injector is the heart of the chemigation system. There are many types of chemical injectors available and several methods of injection to consider. The choice of method and equipment used for injection will depend on availability of electrical power, type of irrigation system, injection rate, type of chemical to be injected, irrigation system operating pressures and other variables.

Injectors can be categorized into two types of feeder systems, *constant rate feeders* and *constant ratio feeders*. Constant rate feeders inject at the same discharge rate even when the irrigation system flow rate changes. A constant ratio feeder will inject the chemical at a constant ratio in proportion to the irrigation system flow rate. The concentration of chemical in the irrigation water for a constant ratio feeder will therefore remain the same.

Passive Injectors

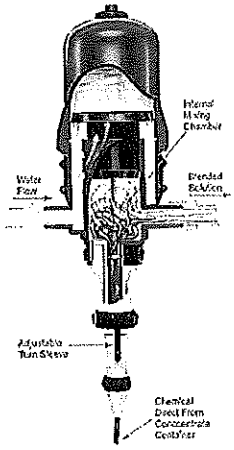
Injectors can also be categorized into two different types, *passive* and *active injectors* depending on their energy supply. Passive injectors use the energy supplied by the irrigation system to inject chemicals. Examples of passive injectors are venturi principle injection systems, pressure differential systems and water driven injection pumps.

Venturi Principle Injection Systems

The *venturi principle injection system*, a passive injection system, operates by creating a vacuum when water is forced through a constriction. The vacuum sucks the chemical into the irrigation water stream at the point of constriction. Venturi systems are most commonly installed on an irrigation mainline by-pass to a pressure reducing device such as a regulator or a gate valve.

Some advantages of the venturi injection system are:

- Simple operation with no moving parts.
- Longevity.
- No electrical connections or power costs.
- Operator and environmental safety as the injected material is under a vacuum as opposed to a pressurized system.
- Immediate shutdown when irrigation system flow stops.
- Accurate flow providing the irrigation system flow does not fluctuate.
- Easy adjustment of the injection rate with a metering valve installed on the suction line.



Water Driven Injection Pump (Proportioner)

Water Driven Injection Pumps

Water driven injection pumps are passive injectors as an external energy source is not used. The energy of the pressurized water in the irrigation system is used to drive the injector. Water powered injectors are available in turbine (impeller) or piston drives. Some water driven injection pumps, such as the piston operated units use a small amount of water pressure to drive the piston. Many greenhouses use this type of injection system.

Active Injectors

Active injectors use an external energy source or a mechanical moving part to create pressures exceeding the irrigation mainline pressure to inject the chemical. The main types of active injectors are *piston* and *diaphragm pumps*.

Chemical application rates vary widely as do pump application rates. Make sure the capacity rate of your pump matches the application rate of the chemical(s) you plan to use. You may need a pump injection rate as low as two gallons per hour or one as high as 300 to 400 gallons per hour. The injection pump should have a delivery accuracy of plus or minus one percent within the minimum to maximum operating range and should utilize stainless steel and other non-corrosive components when there is direct contact with chemicals.

It is not advisable to operate an injection pump at its maximum or minimum output. Pump damage and/or incorrect pumping rates may result. It is best to operate the pump in the midrange of its output.

Diaphragm Pumps

Diaphragm Pumps have a membrane, or diaphragm, separating the drive mechanism from the chemical injected. Single and multiple injection head models are available. Diaphragm pump materials must be selected with care to be compatible with the chemicals to be injected. They must also be carefully rinsed after use, and generally must be overhauled (gaskets, 0-rings, etc.) every season.

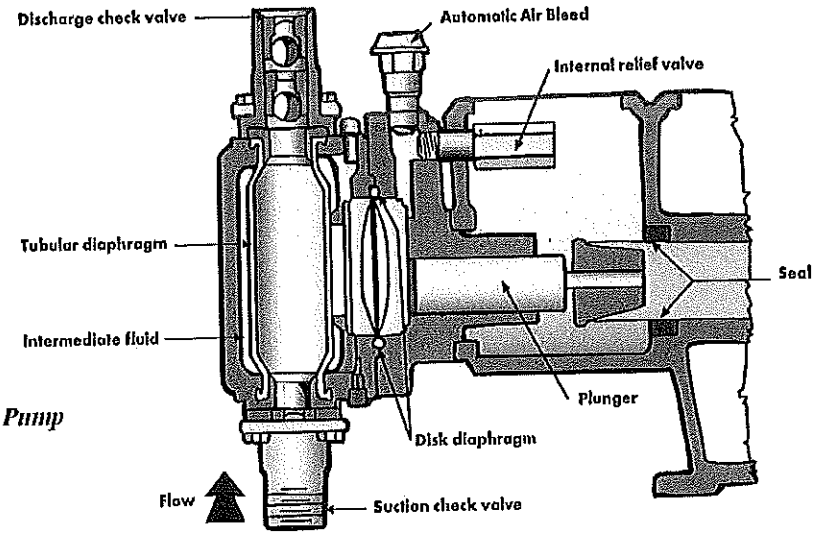
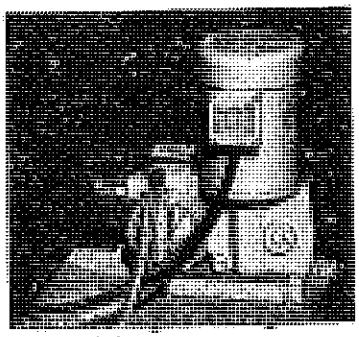


Diagram 8: Diaphragm Pump Cross Section

Illustration credits: Virginia Cooperative Extension

Diaphragm pumps are typically powered by electric motors, but may also be belt-driven or powered by small gasoline engines. Diaphragm pumps are used extensively for low rate chemical injection.

Diaphragm Pumps cont. . .



& Research Center

Although diaphragm pumps are typically more expensive than venturi systems, water powered injectors and other active injector pumps they have several advantages:

- They are dependable and have few moving parts.
- Changes in injection rates can be made while the pump is running so accurate injection can be conveniently established.
- A small part of the pump is exposed to the chemical injected reducing corrosion potential, wear and leakage.

Disadvantages of the diaphragm pump include:

- If the irrigation mainline pressure changes at the chemical injection point due to the pivot going up or down hills many diaphragm pumps will not maintain a constant flow rate. A diaphragm pump may not be the ideal selection if the field terrain causes major changes in mainline pressures.
- Diaphragm pumps do not typically have the output capacity of piston pumps.

Piston Pumps

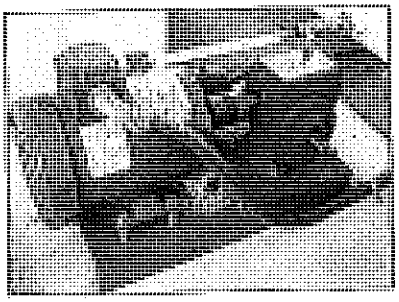


Photo. credit: California Dept. of Pesticide Regulation

Some pesticide labels require the use of a positive displacement pumps such as *piston pumps*. Piston pumps come as both single and dual piston units with a wide range of capacities. The big advantage of piston pumps is the discharge flow rate will not change as the irrigation pipeline pressure varies. Another advantage is that piston pumps have a wide range of injection capacities. Some disadvantages of the piston pump when used for chemigation include:

- Some piston pumps do not accommodate flow rate adjustment while the pump is in use, therefore, one must measure the flow rate, shut the unit off and adjust the piston stroke length, measure the flow rate and repeat the process until the desired discharge is obtained. Some newer positive displacement units have unique designs which change the piston stroke length automatically as adjustments are made while the unit is running. Also, some newer models are designed so the pump's output can be set proportional to water flow.
- Piston seals wear rapidly with abrasive type chemicals.
- Piston pumps lose suction capabilities proportionally as stroke length of the piston is reduced to pump smaller amounts.

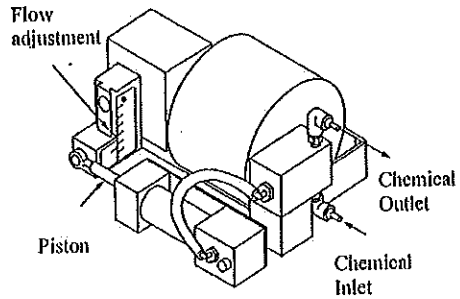


Illustration credits: Irrigation Training & Research Center

Chemical injection pumps, diaphragm and piston types, should be selected so chemicals can be applied at the appropriate rate. Injection pumps are often purchased with dual injection heads or piston units – one for injection of low applications of insecticide and herbicide and the other for injection of nitrogen fertilizer. A single pump with two heads is less expensive than two injection pumps. The dual head injection pump can be set to inject with both heads simultaneously. When operating the pump in this manner, install an injection hose and injection line check valve for each head.

All injection device components that come in contact with chemicals must resist corrosion or degradation from all formulations of agricultural chemicals applied – including the active ingredient and any emulsifiers, solvents or other carriers. Pump components, hoses, fittings, clamps, seals, gaskets, etc. in contact with chemicals should be made of stainless steel, polypropylene, polyethylene, EPDM, EVA, Teflon, Hypalon, Viton or other chemically resistant materials. In general, components that contain PVC, neoprene, butadiene or styrene butadiene rubber are not resistant to agricultural chemicals and should not be used when chemigating. All chemical injection components should also be designed to withstand pressures generated during chemigation.

As with all chemigation equipment, the injection pump must be flushed thoroughly after use. Chemicals that stay in the pumps may degrade seals, hoses and other mechanical parts and will ultimately shorten the useful life of the pump. Flushing the equipment after each use will keep precipitates (deposits) from forming and will help prevent product incompatibility and cross-contamination by removing all traces of pesticides and/or fertilizers. After injection is complete, the injection system should be flushed for a minimum of 15 minutes.

Chemical Tanks

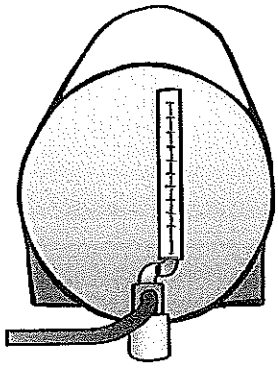


Illustration credits: Virginia Cooperative Extension

Many fertilizer solutions and pesticides are corrosive. Since chemical tanks are in constant direct contact with the chemical being applied, they must be chemically resistant. Tanks made of stainless steel, fiberglass, nylon or polyethylene are good choices. Tanks made of iron, steel, copper, aluminum or brass should be avoided as they are more likely to rust, corrode or produce toxic fumes through chemical reaction. If a pesticide label requires the pesticide to be constantly agitated, an agitator must be installed on the tank to assure a uniform suspension of the pesticide.

The chemical tank should be drainable and have a lid with a good seal to keep windborne foreign materials and rainwater from entering. I must be secured and should have secondary containment in the event of tank rupture or other spillage. It should also have a sump at the drain port for ease of rinsing and should be well marked with gallon marks on the outside of the tank.

The tank should have an on/off valve attached so the injection pump can be moved if the need arises or in case of an emergency. There should be a 40-80 mesh in-line filter or screen attached downstream of the on/off valve. A calibration tube of adequate size for the amount of chemical you plan to apply per hour should be attached in line between the filter/screen and the chemical injection pump.

Chapter 5 - Review Questions

Select the best answer or fill in the blank for each question. See answers on page 42.

1. Chemical injectors can be categorized into these two types of feeder systems depending on their energy supply:
   A. Active and passive feeder injectors
   B. Venturi and differential pressure injectors
   C. Negative pressure and positive pressure injectors
   D. Constant rate and constant ratio feeders

2. The constant rate feeder adjusts the chemical injection rate according to the irrigation system flow rate. (True or False)

3. An example of a passive injector would be:
   A. Piston pump
   B. Diaphragm pump
   C. Venturi principle injection system
   D. None of the above

4. An example of an active injector would be a:
   A. Venturi system
   B. Piston pump
   C. Diaphragm pump
   D. B and C above

5. Typically, the best type of active injector to use for a low rate chemical application is the diaphragm pump. (True or False)

6. Diaphragm pumps typically have a higher output than a piston pump. (True or False)

7. Some pesticide labels that allow chemigation require the use of a positive displacement pump for chemical injection. (True or False)

8. The major advantages of using a piston pump over a diaphragm pump for chemical injection is:
   A. They maintain the discharge flow rate even when the irrigation mainline water pressure varies
   B. The discharge flow rate changes according to the irrigation mainline water pressure
   C. They have a wide range of injection capacities
   D. A and C above

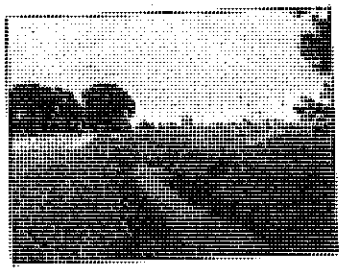
9. Disadvantages of piston pumps include:
   A. Some piston pumps do not allow flow rates to be adjusted while the pump is running
   B. Piston seals wear rapidly with abrasive type chemicals
   C. Piston pumps lose suction capabilities proportionally as stroke length of the piston is reduced
   D. All of the above

10. Piston pumps are positive displacement pumps. (True or False)

11. Which of the following materials may not be resistant to certain agricultural chemicals?
    A. Polypropylene
    B. Neoprene
    C. EPDM
    D. Viton

12. Chemical tanks should never be made of:
    A. Iron
    B. Copper
    C. Aluminum
    D. All of the above

Chapter 6 – Chemigation Management

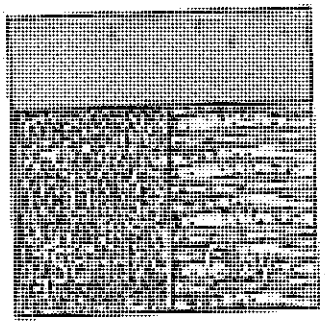


Do not chemigate over streams, rivers, irrigation ditches, canals, ponds, lakes or the road.

When making the decision to chemigate there are several things that should be taken into consideration. When planning an application of fertilizer or pesticide through any irrigation system, the chemigator should assess the location of the treatment site, soil type, surface topography, distribution uniformity of the irrigation system, drift, *overspray* and runoff potential.

Assessment of the location of the treatment site should include consideration of how close the irrigation system is to *sensitive areas* such as residential areas, labor camps, occupied buildings, hospitals, schools, parks, greenhouses, neighboring crops, rivers, lakes, ponds, roadways and public water systems. Chemigation over irrigation canals and other bodies of water is illegal. Off target applications of pesticides through chemigation is also illegal.

Some pesticides give off a strong odor and emit fumes that irritate the eyes and respiratory system when applied through irrigation systems. Nearby greenhouse cooling fans could pull pesticide fumes into the greenhouse and injure sensitive plants. High wind conditions at the time of the application could cause damage to sensitive crops in the area through off-target drift of the chemical solution. High temperature conditions could lead to pesticide *volatilization*: the rapid transformation of the chemical solution into a gas that can easily move offsite.



Soil Type

The soil type of any field should be considered prior to chemigation. Course-textured sandy soils can have a high *infiltration rate*, the rate at which water and chemicals enter the soil. *Leaching* of the chemical below the crop root zone is also more of a problem in course-textured sandy soils while water and chemical runoff is typically not a problem. Heavy clay-type soils have a low infiltration rate that lowers the risk of leaching, but increases the risk of runoff. Off target pollution is a major concern when chemigating on this type of soil.

Field Topography

The topography of the field affects the dispersal of chemicals through the irrigation system. Hills, slopes and valleys in rolling terrain may cause an uneven distribution of chemicals. If the terrain varies along the length of the system, the pressure will vary. Pressure or flow regulators may be required on each individual sprinkler head to adjust for this pressure variation. Low pressure center pivot and drip systems are most susceptible to pressure differences caused by elevation or friction loss.

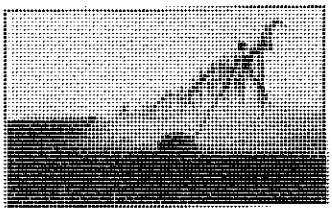
System Uniformity

The irrigation system should have the ability to apply water in a controlled and uniform manner. This is essential to achieve a uniform pesticide or fertilizer application.

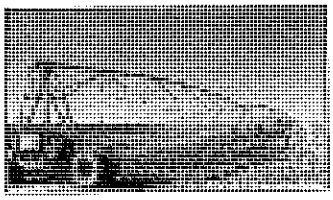
Sprinkler irrigation systems used to apply chemicals must be designed and operated to achieve a minimum *uniformity coefficient* of 80%. The maximum pressure variation along the lateral must not exceed 20% of the sprinkler operating pressure.

System Uniformity cont. . .

If pressure fluctuations exceed 20%, pressure or flow regulators should be installed to eliminate pressure variation. The sprinkler spacing along the pivot lateral should not exceed 50% of the sprinkler head's wetted diameter. For wheel lines, hand lines and set lines, the spacing between lines (laterals) should not exceed 50% of the sprinkler wetted diameter.



You can check sprinkler system uniformity by placing straight walled catch cans of equal size at equal intervals along the lateral of the system and operating the system at the same speed and pressure as you would when applying the fertilizer or pesticide. By comparing the average amount of water collected in all cans to the amount actually collected in each can, you can determine if there are any substantial deviations in uniformity. Deviation of volumes in any of the cans indicates the probability of an over or under application of the chemical you plan to apply in the field.



The chemical application will only be as uniform as the irrigation system. Over or under irrigation to any portion of a field means that pesticide or fertilizer applications are equally in error. The lack of irrigation uniformity could result in lower yields and/or lack of pest control throughout the field. Crop injury, lack of effectiveness or illegal pesticide residues in the crop can result from non-uniform distribution of chemically treated irrigation water.

The sprinkler system must be operated within the manufacturer's recommended pressure range to provide adequate stream breakup for proper chemical mix dispersal.

Shut off or plug first few nozzles to prevent chemical contamination of injection site.

If the first few nozzles on the sprinkling system are near the chemical injection equipment and tank, electrical control panel or well head, shut off or plug all nozzles necessary to keep chemically treated water from contaminating these areas. It will help reduce well head pollution and chemical exposure risks while monitoring the application.

All chemically treated water must stay on the field or application site. In the event of runoff of chemically treated irrigation water, the chemigator must contain the runoff so that it does not enter lakes, streams, canals, or any other water body.

Irrigation System Calibration

The goal in managing a chemigation system is to apply the correct amount of chemical at the correct location. This involves proper chemigation equipment calibration to ensure the correct amount of material is applied and proper irrigation system management to avoid moving the material too deep into the soil profile or not deep enough. Included in this manual is valuable calibration information for pivot, wheel line, solid sets, hand move and wheel lines (Appendix B).

Flushing the Chemigation System

After each chemigation activity the irrigation and chemical injection systems must be flushed with clean water to prevent precipitates (chemical deposits) from forming and to clear all chemical from the lines. Flushing the tank, chemical injection system and irrigation system eliminates chemicals that could be incompatible with the next chemical(s) you use. It will also assure that all chemicals are applied to the field, eliminating the possibility of chemical backflow into the water source. Flushing time should be at least 15 minutes.

Chapter 6 - Review Questions

Select the best answer or fill in the blank for each question. See answers on page 42.

1. When making the decision to chemigate the chemigator should take into consideration the following:
   A. Topography of the field
   B. Soil type
   C. System uniformity
   D. All of the above

2. Sensitive areas to be considered before chemigating might include which of the following?
   A. A nearby greenhouse
   B. A grade school
   C. A labor camp
   D. All of the above

3. Leaching of chemical below the crop root zone is more likely to occur in _____ soils.
   A. Heavy clay-type soil
   B. Clay/loam soils
   C. Course-textured soils
   D. Fine-textured soils

4. Field topography may affect system uniformity by causing uneven pressures in the sprinkling system lateral piping system. (True or False)

5. For even distribution of chemicals the sprinkler irrigation system should be designed to achieve a minimum coefficient of uniformity of _____.
   A. 90%
   B. 80%
   C. 75%
   D. 50%

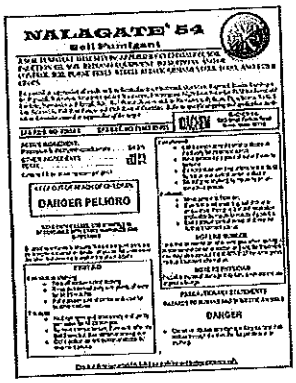
6. If pressure fluctuations in the lateral line exceed _____, pressure or flow regulators should be installed.
   A. 20%
   B. 10%
   C. 50%
   D. 25%

7. Which of the following could be a consequence of a sprinkling system that does not achieve a minimum coefficient of uniformity of at least 80%?
   A. Lack of expected pest control
   B. Crop injury
   C. Illegal pesticide residues in the crop
   D. All of the above

8. To prevent chemical-treated water from contaminating injection equipment, electrical control panel or the wellhead you should:
   A. Replace the first few nozzles with low pressure nozzles
   B. Shut off or plug the first few nozzles on the pivot
   C. Install a secondary containment structure
   D. Cover the electrical control panel

Chapter 7 – Chemigation and the Pesticide Label

The NALAGATE 54 Label


NALAGATE 54
Soil Fumigant
DANGER PELIGRO
DANGER

The NALAGATE 54 Soil Fumigant label (Appendix C), a fictitious label, is included with this chemigation manual as an example of a pesticide label that allows injection of the pesticide into irrigation water (chemigation). The NALAGATE 54 label contains information that is typically found in an agricultural use pesticide label. Besides the usual information (i.e. EPA Reg. No., Active Ingredient, Signal Word, Personal Protective Equipment, User Safety Requirements, Directions for Use, Agricultural Use Requirements, etc.) the NALAGATE 54 label includes specific instructions and recommendations for chemigation so please use this sample label as a reference.

Page 1 of the NALAGATE 54 label states that the soil fumigant may be applied by chemigation as well as by other methods: "NALAGATE 54 Soil Fumigant" "A SOIL FUMIGANT THAT MAY BE APPLIED BY CHEMIGATION, SOIL INJECTION OR SOIL BEDDING EQUIPMENT TO SUPPRESS AND/OR CONTROL SOIL-BORNE PESTS WHICH ATTACK ORNAMENTALS, FOOD, AND FIBER CROPS." Not all pesticide labels will address the chemigation method of application on the first page.

Is the Product Labeled for Chemigation Use?

The pesticide label will tell you if the product is labeled for use through irrigation systems. You can apply a pesticide through an irrigation system only if the label states that you may do so. Most agricultural use labels will address chemigation several pages into the label where you will find specific information regarding chemigation of the product or language expressly forbidding injection of the product into irrigation water. Some samples of what to look for: "Do not apply (product name) through chemigation." Or "Do not apply through any type of irrigation equipment. Do not treat irrigation ditches or water used for crop irrigation or domestic purposes."

Irrigation System Type Restrictions

The label may also restrict the types of irrigation systems that can be used for chemigation of the product. The NALAGATE 54 label, page 6 under "**CHEMIGATION OF *NALAGATE 54,***" reads: "Apply this product only through sprinkler, including center pivot, lateral move, end tow, side (wheel) roll, traveler, big gun, solid set, or hand move; flood (basin); furrow, border, or drip (trickle) irrigation systems". "DO NOT APPLY this product through any other type of irrigation system." The pesticide label may also prohibit the use of an end gun on a pivot system or list other irrigation equipment requirements or limitations.

Water Source Restrictions

The pesticide label may restrict or prohibit the use of the product through an irrigation system that is connected to a public water system. An example of this restriction might read: "Do Not Apply this Product through Any Irrigation System Physically Connected to a Public Water System." In this case the product may be used for chemigation, but only if the irrigation system is ***not*** "Physically Connected" to a public water system.

Public and Domestic Water Systems

The irrigation system is not physically connected to a public water source if the water is first discharged into a reservoir tank prior to pesticide injection. This configuration requires a complete physical break (*air gap*) between the outlet end of the fill pipe and the top or overflow rim of the reservoir tank of at least twice the inside diameter of the fill pipe (Chapter 4, p. 18, "Backflow Prevention for Municipal and Domestic Water Supplies").

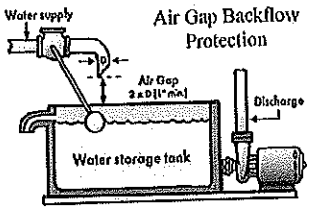
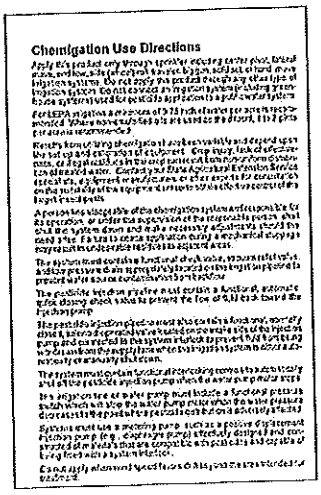


Diagram credits: Virginia Cooperative Extension

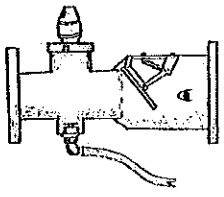
A public water system is a system that provides the public piped water for human consumption and services at least 15 connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. Idaho chemigation rules (IDAPA 02. 03.03) extend the restrictions of chemigation when using a public water supply system as source water to include domestic water supply systems. A domestic water supply system is any system that supplies potable water for everyday uses and includes private wells.


Chemigation Use Directions

A pesticide label such as the fictitious NALAGATE 54 label (Appendix C, p. 6) may allow injection of the product when the irrigation system is cross-connected to a public water system and a *Reduced Pressure Backflow Assembly (RPBA)*, otherwise known as a Reduced Pressure Principle Backflow Prevention Assembly (RP) or a Reduced Pressure Zone Backflow Preventer (RPZ) is installed (Chapter 4, p. 19, "Reduced Pressure Backflow Assembly"). Idaho chemigation rules require installation of an RPBA or the use of an air gap if the chemigation system is cross-connected to any domestic or municipal water supply system.


Reduced Pressure Backflow Assembly

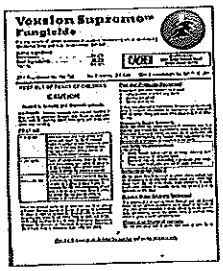
If the pesticide label allows chemigation it will list the specific backflow prevention devices, injection equipment and interlock devices required for each type of water source. This information is found under the section "Chemigation Use Directions" or under similar headings of the label. You may also find statements concerning prohibited injection methods: "Always inject this product into irrigation water after it discharges from the irrigation pump and after it passes through the check valve. Never inject pesticides into the intake line on the suction side of the pump."


Chemigation Valve

The pesticide label will address equipment requirements when the pesticide is labeled for injection through sprinkler or drip irrigation systems. An example of this can be found on page 6 of the NALAGATE 54 label under the heading "**Sprinkler and Drip Chemigation Systems.**" A functional check valve, vacuum relief valve, and low-pressure drain are required to prevent water source contamination from backflow (Chapter 3, p. 9, "Chemigation Valve"). Other requirements include a functional, normally-closed, solenoid-operated valve on the intake side of the injection pump (Chapter 3, p. 12, "Solenoid Operated Valves") a system interlock (Chapter 3, p. 11, "System Interlock") and, in this case, a metering pump (Chapter 5, p. 24, "Chemical Injectors").

USEPA-approved alternatives to some of the equipment requirements listed on the pesticide label may be used under certain circumstances in Idaho. As discussed in Chapter 3, p. 13, an injection line check valve may be substituted for the solenoid-operated valve. If the water source is other than from a well, the gooseneck pipe loop, pumping over a hlll, pumping down a hill or chemical injection into an irrigation ditch on the downstream side of a hydraulic discontinuity such as a weir (Chapter 3, pp. 13 – 15) may be acceptable.

The Vexsion Supreme Label



Another example of a pesticide approved for chemigation is "Vexsion Supreme Fungicide" (Appendix D). The Vexsion Supreme label, a fictitious label, has been included to demonstrate the differences and similarities of pesticides commonly used for chemigation on the farm (Nalagate 54) and those that are commonly used in greenhouses and nurseries (Vexsion Supreme Fungicide).

As noted on the first page of the label this fungicide is used "For the control of certain diseases in conifers, nonbearing citrus, nonbearing deciduous fruits and nuts, ornamentals, and turf." Under **General Information** (Appendix D, p. 2) the label again lists these application sites and makes reference to nurseries, landscapes and plantations. You may find other information on the label that is specific to certain crops that limits the use of the pesticide: "**Attention:** Do not use in greenhouse citrus nursery stock intended for commercial fruit production" (Appendix D, p. 6).

Irrigation System Type Restrictions

The Vexsion Supreme label (Appendix D, p. 3) under **Application Through Irrigation Systems** limits the use of the product to certain types of irrigation systems: "This product may be applied through micro sprinkler or drip irrigation systems. Do not apply this product through any other type of irrigation system." The label also reads: "Do not connect an irrigation system (including greenhouse systems) used for pesticide application to a public water system, unless the label-prescribed safety devices for public water supplies are in place." Be sure to read this part of the label **before** purchasing the pesticide. You may not have the required type of irrigation system and the system may lack certain required chemigation equipment.

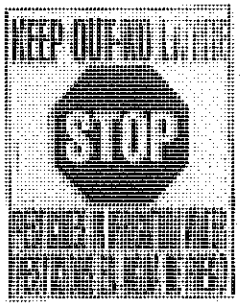
Dilution and Calibration

Under the **Application Through Irrigation Systems** heading, the label directs the chemigator to dilute Vexsion Supreme with water at a ratio of at least 1 part of Vexsion Supreme to 15 parts water (15:1) and to inject the solution at a ratio of 50:1 or greater. The label also directs the chemigator to meter the fungicide solution into the irrigation water during the first part of the irrigation cycle. This is the only place on this label you will find Vexsion Supreme dilution instructions. The *dilution ratio* is applicable to all application sites listed on the label. The label includes a step-by-step process for calibration of the irrigation system before chemigation (Appendix D, pp. 4 - 5). Calibration must be made prior to the application to assure a uniform labeled rate application.

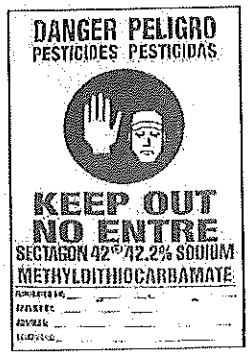
The Vexsion Supreme label contains a section called "**Safety Devices for Irrigation Systems Connected to Public Water Supplies**" and a section with the heading "**Safety Devices for Irrigation Systems *NOT* Connected to a Public Water Supply**" (Appendix D, pp. 3 - 4). The backflow prevention and other equipment requirements listed in these sections are almost identical to the requirements listed in the Nalagate 54 label requiring a RPBA for irrigation systems connected to publie water supplies and a chemigation valve when the irrigation system is not connected to a public water supply.

Remember to check the **Personal Protective Equipment** section on the label for required Personal Protective Equipment (PPE) and the **Agricultural Use Requirements** box for the *restricted-entry interval* (REI) into treated areas when using any pesticide. The Vexsion Supreme label (Appendix D, p. 2) reads, "The REI for chemigation via miero sprinklers, flood floor, and drip line irrigation application is zero hours." REI's vary depending on the pesticide used and method of application.

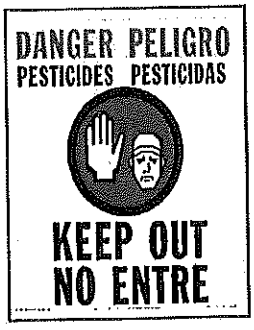
Field Posting



Sign used when posting treated field near "sensitive areas."



Example of sign used when posting a fumigant-treated field (fumigant warning sign).



WPS sign normally used for posting pesticide treated fields.

In some cases the pesticide label will require field posting when application is through chemigation (NALAGATE 54 label, Appendix C, p. 5 "General Precautions for Irrigation Systems"). The sign used is in addition to any sign posted to comply with the Worker Protection Standard (WPS). Posting of areas to be chemigated is required when any part of a treated area is within 300 feet of a sensitive area, such as residential areas, labor camps, businesses, day care centers, hospitals, in-patient clinics, nursing homes or any public areas such as schools, parks, playgrounds or other public facilities not including public roads, or when the chemigated area is open to the public such as golf courses or retail greenhouses.

The chemigation posting sign must be placed at usual points of entry into the field and along likely routes of approach from the above listed sensitive areas. When there are no usual points of entry, signs must be posted in the corners of the treated areas. Signs must be posted prior to application and must remain in place until foliage has dried and the soil surface water is gone. The signs must read "Keep Out," "Stop," "Pesticides in Irrigation Water" and contain an octagonal stop sign symbol at least 8 inches in diameter.

When chemigating with a soil fumigant such as NALAGATE 54 (Appendix C), workers must be notified of the application by warning them orally and by posting fumigant warning signs. The signs must include the statements: "Danger/Peligro," "Keep Out/No Entre," the date and time of the fumigation, the full name and active ingredient of the product applied and the name, address and telephone number of the applicator. This WPS requirement is found in the "Agricultural Use Requirements" box of the pesticide label.

When treating a field with a fumigant the fumigant warning sign should be used for posting the field instead of the WPS sign but all WPS requirements should be followed pertaining to location, legibility, size, posting timing (before application) and removal of the posting signs (after the end of the REI).

The pesticide label contains valuable information the chemigator can use to make a safe, accurate application. This information usually includes chemigation equipment requirements, preparation and calibration, pesticide premixing, application rates, injection system cleaning, irrigation line flushing and specific instructions for various types of irrigation systems and various crops. It will usually discuss wind speed and off-target drift, irrigation water runoff and product leaching below the crop root zone and will always list Personal Protective Equipment (PPE) required during use of the product and for re-entry into treated areas. Read the label before making the application so you will be aware of all the requirements, recommendations and precautions.

Chapter 7 - Review Questions

Select the best answer or fill in the blank for each question. See answers on page 42.

Use the Nalagate 54 Soil Fumigant label (Appendix C) to answer questions 1 through 6.

1. The Nalagate 54 Soil Fumigant label lists a RPZ (a.k.a. Reduced Pressure Backflow Assembly or RPBA) as required equipment for injection of the product into an irrigation system cross-connected to a public water system. The label also lists an option to the use of a RPZ. What is the option?
   A. An injection line check valve
   B. Solenoid-operated valve
   C. Air gap
   D. Goose neck pipe loop

2. The Nalagate 54 application rate range is:
   A. 10 to 20 gallons per acre
   B. 30 to 40 gallons per acre
   C. 30 to 60 gallons per acre
   D. 40 to 60 gallons per acre

3. When using a drip irrigation system to apply Nalagate 54 field soil moisture must be at:
   A. 50% to 80% of field capacity in the top 2 to 3 inches
   B. 20% to 30% of field capacity
   C. 30% to 40% of field capacity in the top 2 to 3 inches
   D. None of the above

4. The Nalagate 54 label allows application on cover crops (i.e. alfalfa, clover, stubble, etc.) without cultivation of the field before application. (True or False)

5. In Idaho the minimum number of days required between application of Nalagate 54 and planting of the crop, assuming the soil temperature has not reached at least 60° F, is:
   A. 21 days
   B. 14-21 days
   C. 12 days
   D. 14 days

6. The Nalagate 54 label lists as required Personal Protective Equipment (PPE) coveralls over long-sleeved shirt and long pants, chemical-resistant gloves, footwear, headgear, apron and face-sealing goggles unless a full-face respirator is worn. What other PPE is required?
   A. Dust filtering mask
   B. Respirator with organic-vapor-removing cartridge with an approved prefilter
   C. Respirator with organic-vapor-removing cartridge
   D. Respirator

Use the Vexsion Supreme label (Appendix C) to answer questions 7 through 12.

7. Through what types of irrigation systems can Vexsion Supreme be applied?
   A. Micro sprinkler and drip irrigation systems
   B. Flood and corrugated irrigation systems
   C. Pivots and wheel lines
   D. All of the above

8. The Vexsion Supreme label allows the use of a RPZ (RPBA) or, as an option, an Air Gap configuration to protect the source water when chemigating with an irrigation system connected to a public water supply. (True or False)

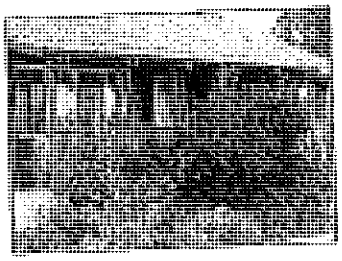
9. Vexsion Supreme may be applied over surface water and does not typically leach through soil to contaminate groundwater. (True or False)

10. The REI for applications of Vexsion Supreme made through micro sprinklers, flood floor, and drip line irrigation is:
    A. 12 hrs.
    B. Zero hrs.
    C. 24 hrs.
    D. 4 hrs.

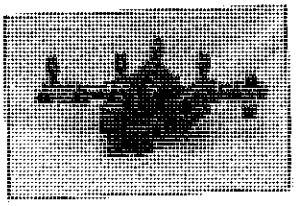
11. When chemigating the Vexsion Supreme label recommends:
    A. Injection of the product near the end of the set in ½ -1 inch of irrigation water
    B. Injection of the product near the end of the set in 2-3 inches of irrigation water
    C. Injection of the product at the beginning of the set in ½ - 3 inches of irrigation water
    D. Injection of the product at the beginning of the set in ½ - 1 inches of irrigation water

12. Some pesticide labels require posting when chemigating near "sensitive areas." Which of the following is ***not*** considered a sensitive area?
    A. Residential area
    B. Public road
    C. Day care center
    D. Labor Camp

Chapter 8 – Chemical Injection Systems for Residential, School, Commercial and Municipal Landscapes

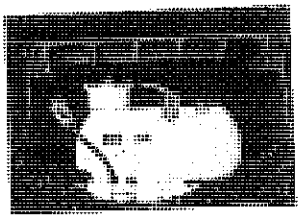


Chemical injection systems designed for residential, school, commercial and municipal landscapes are typically water driven injection pumps (p. 24), *pressure differential injectors* or electrical motor driven pumps. These systems and operators of these systems are subject to requirements as stated in Idaho Pesticides and Chemigation Laws and IDAPA 02.03.03: Rules Governing Pesticide and Chemigation Use and Application. This means the injection systems must be installed in a manner that prevents backflow of chemicals into the water source and operators of the system must be licensed with a chemigation category.



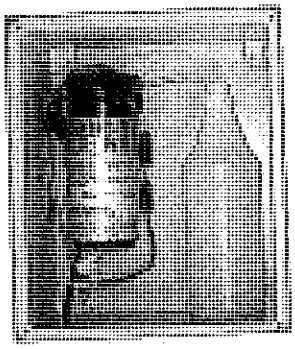
Reduced Pressure Backflow Assembly

All irrigation system installations used for chemical application cross-connected to a domestic or municipal water supply must incorporate a Reduced Pressure Backflow Assembly (RPBA) (pp. 19 – 21) in the source water pipeline or provide a suitable Air Gap (p. 18). Most if not all Idaho cities require installation of a RPBA in the residential service line. In order to meet ISDA chemigation requirements this RPBA must be of a brand and model listed in the University of Southern California (USC) Foundation for Cross-Connection Control and Hydraulic Research "List of Approved Backflow Prevention Assemblies."



Pressure Differential Injector

Any device designed for injection of chemicals into irrigation water in the State of Idaho must first be approved by ISDA for chemigation and included on a list of approved injectors. The list of approved injectors can be found on page 5 of "The Idaho Chemigator" "Chemigation Approved Backflow Assemblies for Domestic and Municipal Water Supplies," "Lawn and Landscape Chemical Injection Devices," available on line at www.agri.idaho.gov, the ISDA Boise Main Office or field offices located in Coeur D'Alene, Nampa, Idaho Falls, Pocatello and Twin Falls.



Electrical motor powered injection pump

Installation of solenoid-operated valves on the intake and chemical distribution sides of the injector are required in the event that water pressure decreases to the point that chemical distribution is adversely affected (p. 12).

Only pesticides and/or fertilizer products recommended by the manufacturers of lawn and landscape injection equipment should be used when chemigating. These products are typically plant nutrients, soil amendments, etc. designed for injection through residential chemical injectors or insect control products that the USEPA designates as 25b products. 25b products offered for chemigation purposes do not normally address chemigation equipment requirements on their labels other than the need of a RPBA when using municipal or domestic water supplies for chemigation.

An example of a 25b product labeled for chemigation is "Bug Slug" (Appendix E), a product used in landscape applications. This label does not include a list of chemigation equipment required for injection into the landscape irrigation system as do labels like the Nalagate 54 and Vexsion labels. The "Bug Slug" label does require that a Reduced Pressure Backflow Device be installed on the irrigation water line.

It is important to be familiar with additional backflow prevention and other equipment required by the Idaho State Department of Agriculture when installing equipment used for chemigation on residential, school, commercial and municipal properties. Information specific to chemigation at these sites can be found in the publication "Chemical Injection Systems for Residential, School, Commercial and Municipal Landscapes" (Appendix F).

Chapter 8 - Review Questions

Select the best answer or fill in the blank for each question. See answers on page 42.

1. Idaho Pesticides and Chemigation Laws and IDAPA 02.03.03: Rules Governing Pesticide and Chemigation Use and Application requires operators of residential, school, commercial and municipal chemigation equipment be licensed applicators with the chemigation category. (True or False)

2. All irrigation systems cross-connected to a domestic or municipal water supply and used for chemical application must install a RPBA or an Air Gap configuration to protect the supply water source. (True or False)

3. Any product label authorizing chemigation may be used for chemigation on residential, school, commercial or municipal lawns and landscapes. (True or False)

4. A 25b product labeled for injection into residential lawn irrigation water usually lists the following equipment as required installations:
   A. Chemigation valve
   B. RPBA valve
   C. Injection line check valve
   D. Venturi

Use Appendix F – Chemigation Advisory to answer the following questions.

5. Which of the following is ***not*** considered a plant nutrient when injected into irrigation systems?
   A. Micronutrients
   B. Nitrogen
   C. Potassium
   D. Humic acid

6. "Chemigation" means any process whereby chemicals are added to irrigation water applied to land, crops or plants through an irrigation system including the following:
   A. Agricultural
   B. Nursery
   C. Lawn
   D. Not limited to the above listed sites

7. The ISDA maintains a list of approved RPBA valves for installation in domestic or municipal water supply lines when chemigating through residential, school, commercial and municipal irrigation systems. (True or False)

8. An Air Gap configuration used for backflow prevention into the supply water line is acceptable for use in chemigation when the supply water source is municipal or domestic. (True or False)

9. Approved methods of chemical injection into residential chemigation systems include:
   A. Pressure differential injection systems.
   B. Venturi systems.
   C. Water-powered injection pumps.
   D. All the above plus electrical pumps and others

10. Pressure differential type injectors are considered Venturi systems when considered under IDAPA 02.03.03 and must meet Venturi system interlock requirements. (True or False)

11. System interlock options include: Mechanical, Electrical, Hydraulic and _____.
   A. Pressure switch
   B. Human
   C. Pneumatic
   D. Wafer check

12. The Injection Line Check valve must have a cracking pressure of 10 psi plus _____.
   A. 2 psi per foot of chemical tank elevation above the point of chemical injection
   B. ½ psi per foot of chemical tank elevation above the point of chemical injection
   C. 1 psi per inch of chemical tank elevation above the point of chemical injection
   D. 1 psi per foot of chemical tank elevation above the point of chemical injection

Answers - Chapter Review Questions

The following are the answers to chapter review questions for this manual. If you missed answers to the chapter review questions, go back through the manual and revisit the information for those questions.

Chapter 1	Chapter 2	Chapter 3	Chapter 4
1. D 2. C 3. D 4. True 5. B 6. C 7. D 8. C 9. D 10. True 11. B	1. True 2. B 3. True 4. D 5. C 6. B 7. D 8. C	1. C 2. D 3. True 4. D 5. D 6. True 7. D 8. E 9. A 10. B 11. C 12. A 13. False 14. B	1. D 2. A 3. C 4. D 5. D 6. True 7. D 8. C 9. D 10. C 11. B 12. A

Chapter 5	Chapter 6	Chapter 7	Chapter 8
1. A 2. False 3. C 4. D 5. True 6. False 7. True 8. D 9. D 10. True 11. B 12. D	1. D 2. D 3. C 4. True 5. B 6. A 7. D 8. B	1. C 2. C 3. A 4. True 5. A 6. B 7. A 8. True 9. False 10. B 11. D 12. B	1. True 2. True 3. False 4. B 5. D 6. D 7. True 8. True 9. D 10. True 11. B 12. D

Glossary of Terms

Active Injector – A chemical injector that uses an external energy source such as electricity to inject chemicals into irrigation water.

Air Gap – A physical break (gap) in the piping system that provides backflow prevention. Supply water is pumped into a reservoir before being treated for chemigation.

Air/Vacuum Relief Valve – A valve located on top of the inspection port cap or the irrigation water mainline that allows air to escape from the mainline when the pipeline is initially pressurized. It also allows air to enter the mainline when the irrigation mainline is depressurized to prevent a potentially destructive vacuum in the mainline.

Automatic Low Pressure Drain Valve – A check valve located in the main irrigation water line on the upstream side of the irrigation line check valve. Its purpose is to drain contaminated water from the line in the event of chemigation system shut down.

Backflow – The movement of a liquid in reverse of the normal direction of flow in a piping system.

Backpressure – A condition that occurs when an irrigation system is operating at a pressure lower than that of an interconnected irrigation system causing backflow into the low pressure system.

Backsiphonage – The reverse flow of a liquid in a piping system caused by a differential hydraulic pressure gradient between two points in the piping system.

Booster Pump – A pump installed on the irrigation water line to increase flow and pressure requirements.

Calibration – The process of determining the desired amount of chemical to be applied to a given area by measuring and adjusting the delivery rate of the irrigation/injection system.

Check Valve – A valve that automatically closes upon reduced or discontinued pipeline pressure.

Chemigation – The application of chemicals (pesticides or fertilizers) through an irrigation system.

Constant Rate Feeder – A chemical injector that injects chemicals at the same discharge rate even when the irrigation system flow rate changes.

Constant Ratio Feeder – A chemical injector that injects chemicals at a constant ratio in proportion to the irrigation system flow rate.

Cracking Pressure – The pressure required of a chemical injection pump or gravity pressure to open a spring-loaded injection line check valve.

Cross Connection – Any connection or structural arrangement between the source water and the chemical injection line through which contamination of the source water can occur.

Diaphragm Pump – A chemical injection pump that has a membrane, or diaphragm, separating the drive mechanism from the chemical injected.

Dilution Ratio – A proportion of water to chemical mix (example: 15:1).

Domestic Water – Water used for household purposes, including consumption, bathing and cooking.

Drip/Trickle Irrigation – Irrigation through use of emitters using low flow rates and low pressure.

Electrical Interlock – An interconnection of the water pump electrical panel and the chemical injection pump that shuts down the system if either pump fails to operate.

End Gun – A large, high pressure sprinkler located at or near the terminal end of a pivot sprinkling system used to extend the irrigated area of the pivot.

Flood Irrigation – An irrigation method in which water is applied to land without the use of furrows to control the direction of flow.

Foliar Application – Application of chemicals directly to the plant foliage.

Fungicide – A pesticide used to control fungi.

Furrow Irrigation – Irrigation by means of corrugates or furrows to control the direction of water flow.

Gooseneck Pipe Loop – A backflow prevention configuration where the main irrigation water line is constructed in such a manner to allow a break in reverse water flow through the use of a vacuum relief valve located at the top of the pipe loop apex.

Ground Water – Water pumped from below the earth's surface.

Herbicide – A pesticide used to kill or inhibit plant growth.

Human Interlock – Continual on-site presence of the chemigator during the entire application of chemicals into irrigation water. This interlock takes the place of other types of interlocks (i.e. electrical, hydraulic, etc.) and is commonly used when "slugging in" fertilizers with a gasoline-powered injection pump.

Hydraulic Gradient – The friction loss that corresponds to water flowing through a section of pipeline, fitting, valve or fixture.

Idaho State Dept. of Agriculture (ISDA) – The state agency that regulates pesticide and fertilizer use and application.

Infiltration Rate – The rate at which soil is able to absorb rainfall or irrigation water.

Injection Line Check Valve – A check valve installed in the irrigation water line down stream of the irrigation line check valve. The check valve prevents irrigation water under pressure from entering the pesticide injection line and leakage from the pesticide supply tank on system shutdown.

Insecticide – A pesticide used to control insect pests.

Inspection Port – A fixture attached to the top side of a chemigation valve that allows access for inspection of irrigation line check valve and automatic low pressure drain valve.

Irrigation Line Check Valve – A spring-loaded circular plate located inside the chemigation valve that closes upon irrigation system shut down and prevents backflow of chemical-treated water to the water source. Wafer type check valves are also considered irrigation line check valves.

Irrigation set – The time allowed and the particular area to be irrigated at a given time.

Irrigation System – Any device or combination of devices having a hose, pipe or other conduit which connects directly to any source of ground or surface water, through which water or a mixture of water and chemicals is drawn and applied to land, crops or plants.

Lateral(s) – Irrigation lines that supply water to sprinklers or emitters. Laterals are typically parallel to each other and are connected to the main irrigation line.

Leaching – The movement of a substance such as fertilizers or pesticides through soil with water.

Mechanical Interlock – A system that shuts down the chemical injection pump when using an internal combustion engine as power for the irrigation water pump. The chemical injection pump is powered by the pumping plant power unit through electricity generated by the unit or by means of an accessory pulley.

Municipal Water – Water controlled by a city for use of its inhabitants.

Nematicide – A pesticide used to control nematodes.

Non-Potable Water – Water that is not suitable for human consumption.

Over Spray – An application of a chemical that overshoots the intended target area.

Passive Injector – A chemical injector that uses energy supplied by the irrigation system to inject chemicals into irrigation water.

Pesticide – Any substance or mixture of substances intended to prevent, destroy, control, repel or mitigate any insect, rodent, nematode, snail, slug, fungus, weed and any other form of plant or animal life or virus, except virus or fungus on or in living man or other animals. Pesticides includes plant regulators, defoliants, dessicants and adjuvants.

Piston Pump – A chemical injection pump that operates by means of a cylinder and piston.

Potable Water – Water that is suitable for human use and consumption.

PR Notice 87-1 – Part of the EPA Label Improvement Program that requires pesticide registrants to state on the product label whether (and how) a pesticide may be used for chemigation.

Precipitate – A solid substance that forms in a liquid and settles to the bottom of a container; a material that no longer stays in suspension.

Pressure Differential Injector – A chemical injector that operates on the vacuum created by the differential pressure between the inlet and outlet ends of the injector (ex. Venturi).

Pressure Switch – A switch mounted on the irrigation mainline that senses a drop in irrigation water line pressure. If water line pressure decreases to a point that causes adverse chemical distribution during chemigation, the switch will shut the water pump down.

Proportional Rate Injector – A chemical injector that delivers chemicals into the irrigation line maintaining a constant proportion of chemical per water flow rate.

Public Water – Water controlled by a government entity such as a city, state or county and is available for public use.

Reduced Pressure Backflow Assembly (RPBA or RPZ) – A device that consists of two independently acting spring loaded check valves separated by a spring loaded differential pressure relief valve. The RPBA is installed upstream of chemical injection sites when chemigating with domestic and municipal supply water.

Restricted Entry Interval (REI) – The length of time specified on a pesticide label that is between the completion of the pesticide application and the time it is safe for a person to enter the treated area without wearing personal protective equipment required by the pesticide label or have had required training.

Runoff – Movement of irrigation water away from the intended irrigated area. Runoff water could contain chemicals applied to the irrigation water.

Sensitive Area – Term used to describe areas around chemigation sites that are occupied by people (i.e. residential areas, labor camps, businesses, day care centers, hospitals, schools, etc.)

Soil Amendment – Material added to the soil to improve its overall ability to maintain plant growth. Soil amendments may reduce compaction, promote water infiltration and/or drainage.

Sprinkler Irrigation – A method of irrigation in which water is applied through the air to the crop or landscape.

Surface/Gravity-Flow Irrigation – A method of irrigation in which water is applied to land through flood or furrow methods.

System Interlock – An electrical, hydraulic, mechanical or human interconnection of the irrigation pump and a chemical injection system. If the irrigation system pressure or flow rate drops the interlock will shut down the chemical injection pump. It is recommended the system interlock also shut down the irrigation water pump should the chemical injection pump fail.

Uniformity Coefficient (UI) – A calculation of an irrigation system's ability to apply irrigation water evenly across the wetted area with 80% being the minimum UI and 100% being perfect uniformity.

Vacuum Relief Valve – A valve that automatically breaks the vacuum in an irrigation pipeline to help prevent backflow of chemically treated water.

Venturi Principle Injection System – An injection device that operates on the reduced pressure created by the differential pressure between the inlet and outlet ends of the injector.

Volatility – The degree to which a substance changes from a liquid state to a gas at ordinary temperatures when exposed to air.

Wafer Check Valve – A type of irrigation line check valve that incorporates two spring-loaded "flappers" that immediately close upon irrigation system shut down preventing backflow of chemically treated water from entering the water source.

Water Driven Injection Pump – A passive chemical injector that uses pressurized water in the irrigation system to drive a piston or impeller.

Water Hammer – The result of a sudden change in liquid velocity in the piping system. To eliminate potential damage to the piping system, water hammer arrestors or surge protectors should be installed.

NOTES

Appendix A

List of USEPA Authorized Alternative Chemigation Safety Equipment

PR Notice 87-1, the Label Improvement Program for Chemigation, issued March 11, 1987 requires that the labeling of agricultural pesticides intended for application through irrigation systems must include the use of certain types of safety devices to protect ground water from pesticide contamination. As a result of comments and new information received subsequent to issuance, a list of alternative devices to those included in PR Notice 87-1 has been considered and approved for use. In some cases these alternative devices may be less expensive, more reliable, or more available than some of those devices originally required. Be advised that all of the devices originally included in PR Notice 87-1 are still acceptable and that the PR Notice 87-1 is, in its entirety, still in effect. Devices required in PR Notice 87-1 which have no listed alternatives are still required components of all chemigation systems. The original devices as required in PR Notice 87-1 and their corresponding alternatives are listed below:

Original Device

Functional normally closed, solenoid-operated valve located on the intake side of the injection pump.

Alternative Device 1

Functional spring-loaded check valve with a minimum of 10 pounds per square inch (psi) cracking pressure. The valve must prevent irrigation water under operating pressure from entering the pesticide injection line and must prevent leakage from the pesticide supply tank on system shutdown. This valve must be constructed of pesticidally resistant materials. [Note: this single device can substitute for both the solenoid-operated valve and the functional, automatic, quick closing check valve in the pesticide injection line.]

Alternative Device 2

Functional normally closed hydraulically operated check valve. The control line must be connected to the main water line such that the valve opens only when the main water line is adequately pressurized. This valve must prevent leakage from the pesticide supply tank on system shutdown. The valve must be constructed of pesticidally resistant materials.

Alternative Device 3

Functional vacuum relief valve located in the pesticide injection line between the positive displacement pesticide injection pump and the check valve. This alternative is appropriate for only those chemigation systems using a positive displacement pesticide injection pump and is not for use with venturi injection systems. This valve must be elevated at least 12 inches above the highest fluid level in the pesticide supply tank and must be the highest point in the injection line. The valve must open at 6 inches water vacuum or less and must be spring loaded or otherwise

constructed such that it does not leak on closing. It must prevent leakage from the pesticide supply tank on system shutdown. The valve must be constructed of pesticidally resistant materials.

Original Device

Functional main water line check valve and main water line low pressure drain.

Alternative Device 1

Gooseneck pipe loop located in the main water line immediately downstream of the irrigation water pump. The bottom side of the pipe at the loop apex must be at least 24 inches above the highest sprinkler or other type of water emitting device. The loop must contain either a vacuum relief or combination air and vacuum relief valve at the apex of the pipe loop. The pesticide injection port must be located downstream of the apex of the pipe loop and at least 6 inches below the bottom side of the pipe at the loop apex.

Original Device

Positive displacement pesticide injection pump.

Alternative Device 1

Venturi systems including those inserted directly into the main water line, those installed in a bypass system, and those bypass systems boosted with an auxiliary water pump. Booster or auxiliary water pumps must be connected with the system interlock such that they are automatically shut off when the main line irrigation pump stops, or in cases where there is no main line irrigation pump, when the water pressure decreases to the point where pesticide distribution is adversely affected. Venturies must be constructed of pesticidally resistant materials. The line from the pesticide supply tank to the venturi must contain a functional, automatic quick closing check valve to prevent the flow of liquid back toward the pesticide supply tank. This valve must be located immediately adjacent to the venturi pesticide inlet. This same supply line must also contain either a functional normally closed solenoid-operated valve connected to the system interlock or a functional normally closed hydraulically operated valve which opens only when the main water line is adequately pressurized. IN bypass systems as an option to placing both valves in the line from the pesticide supply tank, the check valve may be installed in the bypass immediately upstream of the venturi water inlet and either the normally closed solenoid or hydraulically operated valve may be installed immediately downstream of the venturi water outlet.

Original Device

Vacuum relief valve.

Alternative Device 1

Combination air and vacuum relief valve.

Appendix B - Chemigation System Calibration

Chemigation Calibration - Center Pivots

Because a center pivot lateral is moving almost continuously, the chemical is injected continuously for the course of one irrigation pass. Chemicals that move readily with water through the soil profile should be nearly uniformly distributed throughout the wetting zone.

Chemigation equipment calibration for center pivots involves determining the number of acres covered per minute and then determining how much chemical to add per minute for the desired application rate. This procedure is broken down into six basic steps:

1. Calculate the circumference of the last wheel track (ft).
2. Calculate the irrigated area (acres).
3. Calculate the system rate of travel (ft/min)
4. Calculate the time for one revolution (min).
5. Calculate the acres treated per minute (acres/min).
6. Calculate the chemical injection rate (gal/min or oz/min.).

Example 1:

A center pivot with endgun not operating is to apply 30 units of N per acre (30 lb/acre) as 32% urea ammonium nitrate (Uran), which contains 3.54 lb N/gal. Distance from the pivot point to the outer tower is 1,265 feet, and the overhang is 35 feet. The outer tower was found to travel 150 feet during a 1-hour period when running at the chemigation speed. Determine the required injection rate in gpm and liters/min.

Step 1: Calculate the circumference of the last wheel track (ft).

Circumference = (2)(3.1416)(r),
where r = distance to outer tower or 1,265 ft

Circumference = (2)(3.1416)(1,265)

Circumference = 7,948 ft

Step 2: Calculate the irrigated area (acres).

area = 3.1416 x r^2, where r = r + overhang in feet.
= 3.1416(1,265 + 35)^2
= 3.1416(1,300)^2
= 3.1416(1,690,000)
area = 5,309,304 ft^2

Since 1 acre = 43,560 ft^2

$$\text{acres} = \frac{5{,}390{,}304 \text{ ft}^2}{43{,}560 \text{ ft}^2}$$

acres = 122

Step 3: Calculate the rate of travel of the outer tower (ft/min).

Outer tower travel rate = 150 ft / hour
= **2.5 ft/min**

Step 4: Calculate time required for one pivot rotation (min).

$$\text{Time/revolution} = \frac{\text{circumference (from step 1)}}{\text{outer tower travel rate (step 3)}}$$

$$= \frac{7{,}948 \text{ ft}}{2.5 \text{ ft/min}}$$

$$= 3{,}179 \text{ min or } \mathbf{53 \text{ hours}}$$

Step 5: Calculate acres treated per minute

$$\text{Acres treated/min} = \frac{\text{acres treated}}{\text{min/revolution}}$$

$$= \frac{122 \text{ acres}}{3{,}179 \text{ min}}$$

$$= \mathbf{0.03838 \text{ acre/min}}$$

Step 6: Calculate Uran injection rate (gal/min)

$$\text{Injection rate (gal/acre)} = \frac{\text{application rate}}{\text{lb N/gal uran solution}}$$

$$= \frac{30 \text{ lb N/acre}}{3.54 \text{ lb N/gal}}$$

$$= 8.47 \text{ gal/acre}$$

Injection rate (gal/min) = (8.47 gal/acre)(0.03838 acre/min)
= **0.32 gal/min**

Since 1 gal = 4 quarts or 128 fl ounces

Injection rate (quarts/min)

= (0.32 gal/min)(4quarts/gal)
= **1.3 quarts/min**

Injection rate (fluid ounces/min)

= (0.32 gal/min)(128 ounces/gal)
= **41 fluid ounces/min**

Injection rate (liters/min)

= (0.32 gal/min)(3.785 liters/gal)
= **1.21 liters/min**

Therefore, set injection equipment to deliver 0.32 gal/min, 1.3 quarts/min, 41 fluid ounces/min, or 1.21 liters/min. If an endgun is to be operating during part of the rotation, the injection rate must be increased to account for the additional area watered. Recalculate the injection rate, adding the effective endgun radius to the radius previously used in steps 1 and 2.

Chemigation Calibration – Wheel line, Hand Line and Solid Set

In set-move systems, chemicals may be injected either continuously or in batch mode during some period of the irrigation. If injected continuously, all water applied during the irrigation contains the chemical. Therefore, any added chemicals that move readily with water in the soil should be nearly uniformly distributed throughout the depth of wetting.

Because of convenience and the types of pumps generally available, chemigation in set-move systems is generally done in batch mode. All chemicals are added over a short period, usually about 30 minutes. If added near the beginning of the set, the chemical will be followed with regular irrigation water, which will tend to push it deeper into the soil. If added near the end, it will remain closer to the surface.

Chemigation equipment calibration for set-move systems involves determining the number of acres covered during each set and the amount of chemical to add per set. From this, the rate of chemical injection into the irrigation system can be determined so the chemical is injected in a certain amount of time.

This procedure is broken down into six procedural steps:

1. Determine the area to be treated (acres).
2. Determine the desired amount of chemical to be applied based on label directions (lb/acre).
3. Determine the total amount of chemical required (lb or gal) by multiplying the treated area by the chemical application rate.
4. Determine the length of time, in minutes, during which injection will take place. Consider irrigation set length, water application rate, water applied with chemical, and chemical transit time in the system.
5. Determine the proper chemical mixture or proper volume of chemical solution.
6. Determine the injection rate and set the injection device to the proper flow rate.

Example 2: Four 1,200-foot-long wheel lines are operated at the same time. Sprinkler spacing along each lateral is 40 feet, and laterals are moved 50 feet between sets. The system is to apply 30 units of N per acre (30 lb/acre) as 32% urea ammonium nitrate (Uran). Uran solution contains 3.54 lb N/gal. Determine the required injection rate in lb/min and liters/min.

Step 1: Determine the treated area (acres).

$$\text{Area per wheel line} = \frac{(\text{length})(\text{lateral spacing})}{43{,}560\ \text{ft}^2/\text{acre}}$$

$$= \frac{(1{,}200\ \text{ft})(50\text{ft})}{43{,}560\ \text{ft}^2/\text{acre}}$$

$$= 1.38\ \text{acres/wheel line}$$

Since we have 4 lines:

total area = 4(1.38)

= **5.52 acres**

Step 2: Determine the desired amount of chemical to apply (units/acre).

Given: We want to apply **30 units/acre N as uran**.

Step 3: Determine the total amount of chemical required (lb).

Total chemical = (total set area from step 1)(application rate from step 2)

= (5.52 acres)(30 lb/acre)

= **165.6 lb N**

Step 4: Determine the total chemical solution volume required (gal).

$$\text{Total volume} = \frac{\text{total applied chemical (from step 3)}}{\text{lb N/gal uran solution}}$$

$$= \frac{165.6 \text{ lb N}}{3.54 \text{ lb N/gal}}$$

$$= \mathbf{46.8 \text{ gal uran}}$$

Step 5: Determine injection time (hours).

For impact sprinklers in a wheel line setting, 15 minutes is the minimum injection time to give "uniform" application; 30 minutes is better. Therefore, select **30 minutes.**

Step 6: Determine the injection rate (gal/minute).

$$\text{Injection rate} = \frac{\text{total volume to be injected (from step 4)}}{\text{Injection time (from step 5)}}$$

$$= \frac{46.8 \text{ gal}}{30 \text{ min}}$$

$$= \mathbf{1.56 \text{ gal/min}}$$

$$= \mathbf{5.9 \text{ liters/min}}$$

Therefore, set the injection equipment to deliver 1.56 gal/min or 5.9 liters/min

Formulas :

r = radius	2 x r = diameter	$r^2 = r \times r$	d = diameter	W = width
L = length	12" = 1 foot	1 mile = 5280 ft	1 acre = 43,560 ft^2	
$\pi = 3.1416$	1 ft^3 = 7.48 gallons			

Volume of a pipe = $\pi \times r^2 \times l$

Example: radius of pipe = .5 ft
length of pipe = 200 ft

$3.1416 \times (.5)^2 \times 200$

= 157 $ft^3 \times 7.48$

= 1175 gallons

Chemigation Calibration Worksheet – Center Pivots

	Example	Your Case
Input:		
Distance to outer tower (r), ft	1265 ft	
Overhang, ft	35 ft	
Outer tower rate of travel, ft/hour	150 ft in 1 hour	
Material to be applied	32% N solution	
Application rate, lb/acre	30 lb/acre	
Active ingredient, lb/gal	3.54	
Calculations:		
1. Last wheel track circumference (C)		
$C = (d)(3.1416)$	7,948 ft	
2. Irrigated area (A)		
$A = \frac{3.1416(r + \text{overhang})^2}{43{,}560}$	122 A	
3. Outer tower travel rate (V_o)		
V_o = ft traveled/time in min	2.5 ft/min	
4. Pivot rotation time (T), min		
$T = \frac{C(\text{from step 1})}{V_o \text{ (from step 3)}}$	3,179 min (53 hr)	
5. Acres treated/min		
$\frac{A \text{ (from step 2)}}{T \text{ (from step 4)}}$	0.03838 acres/min	
6. Injection rate (I_a), gal/acre		
$I_a = \frac{\text{material application rate}}{\text{lb active ingredient/gal}}$	8.47 gal/acre	
7. Injection rate (I_t), gal/min		
$I_t = I_a$ x step 5	0.32 gal/min	

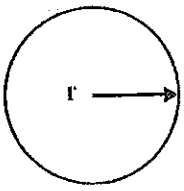
Chemigation Calibration Worksheet – Set/Move or Solid Set

	Example	Your case
Input:		
Lateral length (L), ft	1200 ft	
Spacing between laterals (S), ft	50 ft	
Number of laterals/set (N)	4	
Material to apply	32% N solution	
Application rate, lb/acre etc.	30 lb/acre	
Active ingredient, lb/gal	3.54	
Calculations:		
1. Irrigated area per lateral (A_l)		
A_l = (L x S)/43,560	1.38 acres	
Irrigated area/set (A_s)		
$A_s = A_l$ x N	5.52 acres	
2. Application rate		
(from input information)	30 lb/acre	
3. Total chemical required (W_t), lb		
W_t = (chemical application rate) (A_s[from step 1])	165.616	
4. Injection time (T), min		
30 minutes is minimum set time (use 30 minutes here)	30 min	
5. Total solution volume		
Wt (from step 3) / lb active ingredient/gal	46.8 gal	
6. Injection rate (I_t), gal/min	1.56 gal/min	

$I_t = \frac{\text{step 5}}{T} \quad \frac{(46.8 \text{ gal.})}{30 \text{ min.}}$

Useful Information for Calibration

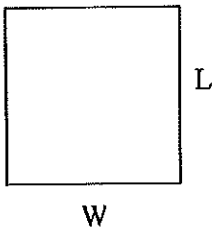
Area of a Circle: $\pi \times r^2$



Example: r = 1455 ft

$$\text{Acres} = \frac{3.1416 \times (1455)^2}{43{,}560\ \text{ft}^2} = 152.6 \text{ acres}$$

Area of a square or rectangle: W x L



Example: W = 2500 ft
L = 1400 ft

$$\frac{2500 \text{ ft} \times 1400 \text{ ft}}{43{,}560\ \text{ft}^2} = 80.3 \text{ acres}$$

The following table shows irrigation amounts for various flow rates (gallons per minute) for a center pivot that covers 120 acres.

Table IX-1. Irrigation Depth (inches applied to surface) vs. Pivot Speed and Flow Rate

Pivot Flow GPM	Pivot Speed, Hours to Complete 120-Acre Circle										
	12	**18**	**24**	**36**	**48**	**60**	**72**	**84**	**96**	**108**	**120**
400	.09	.13	.18	.27	.36	.44	.43	.62	.71	.80	.89
500	.11	.17	.22	.33	.44	.56	.67	.78	.89	.1.00	1.11
600	.13	.20	.27	.40	.53	.66	.80	.93	.1.06	1.20	1.33
700	.16	.23	.31	.47	.62	.78	.93	1.09	1.24	1.40	1.55
800	.18	.27	.36	.53	.71	.89	1.07	1.24	1.42	1.60	1.78
900	.20	.30	.40	.60	.80	1.00	1.20	1.40	1.60	1.80	2.00
1000	.22	.33	.44	.67	.89	1.11	1.33	1.56	1.78	2.00	2.22
1100	.24	.37	.49	.73	.98	1.22	1.47	1.71	1.95	2.20	2.44
Speed of end tower ft/hr	667	445	334	222	167	133	111	95	83	74	67*
Area, ac/hr	10	6.7	5.0	3.3	2.5	2.0	1.7	1.4	1.3	1.1	1.0

* 1,275 feet from pivot to end tower + 15-foot end section.

Source: 1990 Chemigation Workbook, Leon New, Texas AgriLife Extension Service

Formulas for other length pivots

1. Inches = $\frac{\text{GPM x hours to complete rotation}}{\text{450 x Acres in Circle}}$

2. End Pipeline Speed in Feet Per Hour = $\frac{\text{Total length of main pipeline in feet x 2 x 3.14}}{\text{Hours to make rotation from Formula 1}}$

3. Acres Per Hour = $\frac{\text{Acres in Circle}}{\text{Hours to complete rotation}}$

Appendix C

NALAGATE® 54

Soil Fumigant

A SOIL FUMIGANT THAT MAY BE APPLIED BY CHEMIGATION, SOIL INJECTION OR SOIL BEDDING EQUIPMENT TO SUPPRESS AND/OR CONTROL SOIL-BORNE PESTS WHICH ATTACK ORNAMENTALS, FOOD, AND FIBER CROPS.

For control or suppression of weeds such as Bermudagrass, Chickweed, Dandelion, Ragweed, Henbit, Lambsquarter, Pigweed, Watercress, Amaranths species: Watercress, Johnsongrass, Nightshade, Nutsedge, Field Bindweed and Purslane, Nematodes and Symphylids. Soil-Borne diseases such as Rhizoctonia, Pythium, Phyophthora, Verticillum, Sclerotinia, Oak Root Fungus and Club Root of Crucifers. ***Refer to specific cropping and application methods to determine control or suppression of the target.***

EPA REG. NO. 72954-8 **EPA EST. NO 79953-ID-001**

IDACHEM **IDACHEM Inc.**
1313 Small Particle Road
Boise, Idaho 83714

ACTIVE INGREDIENT:

Potassium N-methyldithiocarbamate	54.0%
OTHER INGREDIENTS	46.0%
TOTAL	100.0%

Contains 5.8 lbs. active ingredient per gallon.

KEEP OUT OF REACH OF CHILDREN

DANGER PELIGRO

READ ENTIRE LABEL. USE STRICTLY IN ACCORDANCE WITH LABEL WARNINGS AND DIRECTIONS

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

FIRST AID

If on skin or clothing:

- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15-20 minutes.
- Pall a poison control center or doctor for treatment advice.

If in eyes:

- Hold eye open and rinse slowly and gently with water for 15-20 minutes.
- Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.
- Call a poison control center or doctor for treatment advice.

If swallowed:

- Call a poison control center or doctor immediately for treatment advice.
- Have person sip a glass of water if able to swallow.
- Do not induce vomiting unless told to do so by the poison control center or doctor.
- Do not give anything by mouth to an unconscious person.

If inhaled:

- Move person to fresh air.
- If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible.
- Call a poison control center of doctor for further treatment advice.

HOT LINE NUMBER

Have the container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-877-1737 for emergency medical treatment information.

NOTE TO PHYSICIAN

Probable mucosal damage may contraindicate the use of gastric lavage.

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

DANGER

- Corrosive: causes skin damage. May be fatal if absorbed through the skin. Do not get on skin or clothing.
- Prolonged or frequent repeated skin contact may

cause allergic reactions in some individuals.
- Harmful if swallowed or inhaled.
- Irritating to eyes, nose and throat.
- Avoid breathing vapor or spray mist.
- Do not get in eyes.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Some materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for Category A on an EPA chemical resistance chart.

(1) Handlers Performing Direct-Contact Tasks

Direct-contact tasks include:
- Mixing, loading, or fumigant transfer with or without dry-disconnect fittings
- Equipment calibration or adjustment
- Equipment clean-up or repair
- Product sampling
- Application or soil-sealing outside an enclosed cab
- Any activity less than 6 feet from an unshielded pressurized hose containing this product
- Spill clean-up
- Removal of tarp or plastic film
- Rinsate disposal
- Clean-up of small spills
- Preparing containers for aeration
- Any other handling task not otherwise listed in (2) or (3) below

Applicators and other handlers performing direct-contact activities must wear:
- Coveralls over long-sleeved shirt and long pants
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant footwear plus socks
- Chemical-resistant headgear for overhead exposure
- Chemical-resistant apron when cleaning equipment, or when mixing, or transferring without dry-disconnect fittings
- Face-sealing goggles, unless full-face respirator is worn
- A respirator with an organic-vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approved number prefix TC-23C), or a canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G), or a NIOSH approved respirator with an organic vapor (OV) cartridge or canister with any N, R, P or HE prefilter.

(2) Handlers in Enclosed Cabs

Applicators and other handlers in enclosed cabs must wear:
- Coveralls
- Shoes and socks

Plus, if pungent, rotten-egg odor of this product can be detected inside the enclosed cab, the handlers in the cab must wear:
- Face-sealing goggles, unless full-face respirator is worn
- A respirator with an organic-vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval number prefix TC-23C), or a canister approved for pesticides (MSHA/NIOSH approval number prefix TC -14G), or a NIOSH approved respirator with an organic vapor (OV) cartridge or canister with any N, R, P or HE prefilter.

In addition, the PPE specified in (1) for direct-contact activities must be immediately available in the enclosed cab and must be worn if the handler leaves the enclosed cab to perform any direct-contact activity. After wearing PPE clothing and if exposure or contamination from handling the product occurs, DO NOT store within the enclosed cab as handler may be exposed to vapors. The enclosed cab must meet the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides-40 CFR 170.240(d)(5).

(3) Handlers in Treated Areas While Entry is Restricted

While entry is restricted (see "Entry Restrictions" in the "Agricultural Use Requirements" section elsewhere on this label), only the following handling tasks may be performed in a treated area:
- Assessing/adjusting the soil seal.
- Assessing pest control/suppression, application technique, or application efficacy.
- Sampling air or soil for this product.

All other tasks are prohibited until the entry restriction is over. Handlers performing the above tasks must wear:
- Coveralls over long-sleeved shirt and long pants.
- Chemical-resistant gloves made of any waterproof material.
- Chemical-resistant footwear and socks.

Plus, if pungent, rotten-egg odor of this product can be detected, handlers must wear:
- Face-sealing goggles (unless full-face respirator is worn) and,
- A respirator with an organic-vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval number prefix TC-24C), or a canister approved for pesticides (MSHA/NIOSH approval number prefix TC14G), or a NIOSH approved respirator with an organic vapor (OV) cartridge or canister with any N, R, P or HE prefilter.

USER SAFETY REQUIREMENTS

1. Respirator requirement: When a respirator is required for use with this product, the following criteria must be met:
   a. Cartridges or canisters must be replaced daily or when odor or irritation from this product becomes apparent, whichever is sooner..
   b. Respirators must be fit-tested and fit-checked using a program that conforms to OSHA's requirements (described in 29 CFR, Part 1910.134).
2. Disposal of Contaminated Clothing: Discard clothing and other absorbent materials that have been drenched or heavily contaminated with liquid from this product. Do not reuse them.
3. Clean and maintain PPE: Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry. Wash PPE after each day's use.

USERS SHOULD:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.
- DO NOT transport contaminated clothing inside a closed vehicle. Store in a sealed container and wash or dispose as required under "Disposal of Contaminated Clothing" and/or "Clean and Maintain PPE".

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that it will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation. Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR 170. Refer to supplemental labeling under "Agricultural Use Requirements" in this section for information about this standards.

CALIFORNIA ONLY: Application must be in compliance with Technical Information Bulletin for California entitled "Metam Sodium Guidelines for all Application Methods in California." This information bulletin may be obtained from you local pesticide dealer or a Metam Sodium registrant.

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This standard contains requirements for the protection of agricultural workers on farms, in forests, nurseries, greenhouses and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label and about personal protective equipment (PPE), restricted entry interval and notification to workers. The requirements in this box only apply to the uses of this product that are covered by the Worker Protection Standard (WPS).

Entry Restrictions

OUTDOORS: Entry (including early entry that would otherwise be permitted under the WPS) by any person—other than a correctly trained and equipped handler who is performing a handling task permitted on this label-is PROHIBITED from the start of the application until 48 hours after application. In addition, if tarps are used for application, non -handler entry is prohibited while tarps are being removed.

NOTIFICATION: Notify workers of the application by warning them orally and by posting fumigant warning signs. The signs must state the following:

- "DANGER/PELIGRO"
- "Area under fumigation-DO NOT ENTER/NO ENTRE"
- "Nalagate 54 Soil Fumigant in use"
- The date and time of fumigation
- Name, address, and telephone number of the applicator

Post the fumigant warning signs at entrances to treated areas. Post the fumigant warning signs instead of the WPS sign for this application, but follow all WPS requirements pertaining to location, legibility, size, and timing and removal of posting.

PPE FOR ENTRY DURING THE RESTRICTED PERIOD:PPE for entry that is permitted by this labeling is listed in the "Hazards to Humans and Domestic Animals" section of this label.

GENERAL INSTRUCTIONS

Before applying this product, always thoroughly cultivate the area to be treated by breaking up clods and loosening soil deeply and thoroughly. If soil is not at 50-80% moisture capacity in the treatment in the treatment zone, irrigate 1 to 2 weeks before treatment. Moisten soil after cultivation to the desired depth; sprinkle or flood irrigate. This step essential for all methods of use. Immediately before application, cultivate lightly if the soil has crusted. *Nalagate 54* effectiveness is based on contact of the gaseous phase with a respiring pest. *Nalagate 54* will not control or suppress pests not actively respiring. *Nalagate 54* does not provide residual control. Pests that are dormant, protected by large clods, harbored by undecomposed plant material, not present at the time of application, or not present in the treatment zone will not be controlled. See POTATOES section for specific directions on the application of *Nalagate 54* to potato fields where no-till stubble or cover crop exist.

To prevent loss from evaporation, use only at times when air temperature is moderate and there is little wind movement (2-10 mph). Soil temperature must be 40 to 90° F in the treated zone. Treated zone is defined as the depth of treatment that *Nalagate 54* achieves at the time of application. For other conditions, see section "Days to Planting/ Cultivation After Application". Do not apply to soil surface, as the sprinkler method, when air temperature is over 90° F or when low humidity or high winds would cause loss of *Nalagate 54* before it can be drenched into the soil with additional water. If fumes become detectable during treatment, apply more water to seal the fumes into the soil where they should be confined to achieve maximum fumigation benefit. The activity of *Nalagate 54* is increased by the use of tarp (plastic, paper or fabric) spread loosely over the treated areas and secured to prevent removal by wind. Keep covered for a minimum period of 48 hours. Seven days after treatment cultivate no deeper than the depth of treatment to aerate the soil. Do not seed or transplant earlier than 21 days or later after application when tarping method is used (see "Testing of Treated Soils Before Planting" section). Use promptly after mixing with water. Do not allow solution to stand. Flush equipment with water after each day's use Disassemble valves and clean carefully.

Mycorrhizae: There are occasions when *Nalagate 54* is known to temporarily reduce mycorrhizae in agricultural

soils. For those crops that are mycorrhizae dependent and planted into *Nalagate 54* treated soils, it is necessary to practice a good fertilizer program until the mycorrhizae repopulate the treated area.

PRODUCT INFORMATION

Nalagate 54 is a water soluble liquid. When applied to properly prepared soil, the liquid is converted into a volatile fumigant. After a sufficient interval of time, the fumigant dissipates leaving the soil ready for planting.

When to Use Maximum and Minimum Rates
The application rate of *Nalagate 54* is dependent on the soil type to be treated and the position in the soil of the pest to be suppressed or controlled. For maximum control or suppression, an understanding of the pest, its location and its respiring state will ensure maximum performance of *Nalagate 54*. Generally, a light sandy soil requires a lower application rate than a heavier mineral soil. In addition, if the pest is in the upper portion of the soil profile (annual weeds), a lower application rate is generally required than if the pest is deeper in the soil profile and deeper penetration is desired (perennial weed seeds and nematodes). When a range of application rates is given in this label, consult your local agricultural extension service for more specific information.

Nalagate 54 is recommended for the suppression or control of the following soil-borne pests that attack ornamental, food and fiber crops (consult specific cropping and application instructions for recommendations): Weeds and germinating weed seeds such as Bermudagrass, Chickweed, Dandelions, Ragweed, Henbit, Lambsquarter, Pigweed, Watercress, Johnsongrass, Nightshade, Nutsedge (suppression only), Field Bindweed and Purslane; Nematodes (suppression only), Symphylids (Garden Centipede) and soil borne diseases such as Rhizoctonia, Pythium, Phtyophthora, Verticillium,, Sclerotinia, Oak Root Fungus and Club Root of Crucifers.

Nematodes and Nutsedge: Nematode suppression is achieved when *Nalagate 54* converts to Methy Isothiocyanate (MITC) and makes contact with active forms of the nematodes, preferably juveniles. Endo-parasites in plant residue may not be suppressed. Plant residues from previously infected crops should be completely decomposed prior to *Nalagate 54* application to ensure maximum exposure. Eggs are more difficult to suppress than juveniles, but are susceptible. Pre-irrigation has been demonstrated to stimulate egg hatch of some species and may enhance overall *Nalagate 54* performance. Nutsedge may be suppressed with *Nalagate 54* if actively growing and a high rate is used (60 gal of product/acre). More often, rhizomes, roots and shoots will be controlled but the tuber will remain viable and at a later time regrow. Treatments made immediately prior to a crop planting (after the necessary waiting period) will give a weed-free period for crop establishment.

USE PRECAUTIONS

Keep children and pets out of treated areas. *Nalagate 54* uses described on this label are intended for pre-plant soil preparation only. All plant foliage and any established plants growing on the treatment sites will be either severely damaged or destroyed. Keep the product off of any desirable turf or plants. Do not apply within 3 ft. of the drip line of desirable plants, shrubs, or trees. Do not use in confined areas without adequate ventilation or when fumes may enter nearby dwellings. Do not use in greenhouses. Keep container tightly closed when not in use. Do not store near feed or food.
NOTE: *Nalagate 54* will suppress and/or control only those pests in the fumigation zone at the time of treatment. Reinfestation may occur subsequent to the fumigants dissipation from the soil.

TREATMENT GUIDELINES

For optimum results, certain procedures should be observed at designated times in the treatment program. Described below are important guidelines for each of the four states of the treatment process. Consult your Sales Representative for the appropriate treatment program for you particular needs.

- Pre-Application
- Field-Preparation Prior to Application
- Application
- Pre-Planting After Application of *Nalagate 54*

PRE-APPLICATION

Nalagate 54 is applied post-harvest and 14 to 21 days before a new crop is planted (see "Testing of Treated Soil Before Planting" section). In some areas, fall application is preferred, as the product will dissipate over the winter that allows planting to begin as soon as favorable springtime conditions arrive.

Application Rate
Apply 30-60 gallons of product per treated acre depending on crop, target pest and soil properties. Some of the soil properties to consider when determining the application rate include soil texture, percent organic matter and depth of soil to be treated.

Target Pest and Depth of Treatment
When application rates for this product are given in ranges, use the higher rate if pests (insects, nematodes, etc.) are present in high numbers or if the area to be treated has a history of pest problems. Consult with your stat's nematologist, entomologist and plant pathologist to determine if crop rotation is more feasible or desirable than fumigation. NOTE: This product will only suppress or control pests that are in the fumigated zone at the time of treatment. For control of weeds and fungi, which cause seed or seedling diseases, treatment of only the top 2-4 inches of soil may be required. Treatment depths greater than 4 inches may required for control of nematodes and fungi which occur throughout the rhizosphere. The required application rate should be increased proportionately with the depth of the treatment required. Always choose the appropriate application method to evenly distribute this product throughout the soil to the required treatment depth.

Soil Characteristics
Soil properties to consider when determining the application rate of this product include the depth of soil to be treated, soil texture, and percent organic matter. Plant materials under the soil surface (except in the case of cover crops) should be thoroughly decomposed before application. Due to the absorbing effect of humus, soils with high levels of organic matter under the surface require higher rates. For example, muck soil may require twice the rate that would be used in mineral soils. Application rates will also vary with soil texture. For example, heavy clay soils require a higher rate than light sandy soils.

FIELD PREPARATION PRIOR TO APPLICATION

Before applying this product, always thoroughly cultivate the area to be treated breaking up clods and loosening soil deeply and thoroughly. Then sprinkle or flood irrigate to moisten loosened soil if needed (see "General Instructions" section). Immediately before treatment, cultivate lightly to breakup soil crust. See POTATOES section for specific directions on the application of *Nalagate 54* to potato fields where no till stubble of cover crop exists.

Soil Temperature During Treatment
Soil temperature must be from 40° to 90° F in the treated zone. Treated zone is defined as the depth of treatment that *Nalagate 54* achieves at the time of application. To prevent rapid evaporation of the product from the soil, avoid treating soil during the time of day when soil temperatures exceed 90° F within the first two inches of soil. Instead, make the application at night or in early morning when the soil temperature is coolest.

Soil Moisture at Time of Treatment
Applications should be made only to fields with good seedbed moisture conditions (50% to 80% of field capacity). As a simple field test, squeeze a handful of soil into a ball and then gently try to break it apart with your fingers. If it does not form a ball, the soil is too dry. If it forms a ball but breaks easily, the soil moisture content is sufficient. If it will not break apart easily or if water can be squeezed out, the soil is too wet. When necessary, sprinkle or flood irrigate the soil 1 to 2 weeks prior to treatment to increase the moisture content. The soil must be moistened to at least the desired treatment depth.

Phytotoxicity
Nalagate 54 is phytotoxic. Protect valuable, non-target plants by stopping soil applications of this product at least three feet short of the drip line of the trees, shrubs and other desirable plants. For sprinkler application, crop injury and lack of effectiveness can result from non-uniform distribution of the treated water.

APPLICATION OF *NALAGATE 54*

Apply according to the methods and rates outlined below under the section "USES, RATES AND APPLICATION METHODS."

Use of Diluted *Nalagate 54*
Do not store the diluted product. Do not allow the diluted solution to stand overnight. Use the diluted solution promptly after mixing with water. Flush all equipment with water after each day's use, disassemble valves and clean carefully.

Odors During or After Application
Strong odors during or after application are a signal that the fumigant is escaping and needs to be sealed in the soil. If increasingly strong odors are occurring, the application should be stopped immediately and not resumed until the source of the odor problem is identified and corrected. For sprinkler applications (or whenever possible with other application methods) a water seal should be applied immediately to the treated areas of the field.

Sealing *Nalagate 54* in Soil
To be most effective, *Nalagate 54* should be sealed in the soil at the time of application. Sealing methods include applying a water seal by sprinkler irrigation, tarping (plastic, paper or fabric), packing soil with a roller, drag or press wheel or covering with an adequate amount of soil. Tarpaulins should be spread loosely of the treated area and secured to prevent removal by wind. They should remain in place for at least 48 hours. If tarped, the sealed area should be cultivated to a depth no deeper than the treated zone to aerated the soil seven days after treatment. When tarpaulins are used to seal the soil, wait at least 21 days before planting.

Application in Tank Mix with Liquid Fertilizer
Nalagate 54 may be injected in a mixture with liquid fertilizers; however, a dual injection system is preferred. Since the composition of liquid fertilizers vary considerably, the compatibility of each *Nalagate 54*/fertilizer tank mix should be checked by using the following procedure:
Mix a small quantity of *Nalagate 54* and liquid fertilizer in the same ratio as they will be applied to the field (e.g., if 30 gallons of *Nalagate 54* and 30 gallons of liquid fertilizer are to applied per acre, then the mixture should be mixed in a 30:30 or 1:1 ratio). Mix in a glass container. Mixing should be done outdoors and out of direct sunlight. Agitate the liquids to attain a complete uniform mixture. IF A UNIFORM MIX CANNOT BE MADE, THE MIXTURE SHOULD NOT BE USE! If the mixture remains uniform for 30 minutes without agitation, the combination may be used. Should the mixture separate after 30 minutes but is readily remixed with agitation, the mixture can be used if adequate agitation is maintained in the tank.
DO NOT PLACE CAPS ON MIX JAR AS INCOMPATIBLE MIXES MAY EVOLVE HYDROGEN SULFIDE GAS. USE PROMPTLY AFTER MIXING WITH WATER OF FERTILZER. DO NOT ALLOW THE SOLUTION TO STAND. FLUSH ALL EQUIPMENT WITH WATER AFTER EACH DAY'S USE. DISASSEMBLE VALVES AND CLEAN CAREFULLY.

General Precautions for Irrigation Systems
Posting of areas to be chemigated is required when (1) any part of a treated area is within 300 feet of sensitive areas such as residential areas, labor camps, businesses, day care centers, hospitals, in-patient clinics, nursing homes or any public areas such as schools, parks, playgrounds, or other public facilities not including public roads, or (2) when chemigated area is open to the public such as golf courses. Posting must conform to the following requirements: (1) Treated areas shall be posted with signs at all usual points of entry and along likely routes of approach from the listed sensitive areas. When there are no unusual points of entry, signs must be posted in the corners of the treated areas in any other location affording maximum visibility to sensitive areas. (2) The printed side of the sign should face away from the treated area towards the sensitive area. (3) The signs shall be printed in English. (4) Signs must be posted prior to application and must remain posted until foliage has dried and soil surface water has disappeared. Signs may remain in place indefinitely as long as they are composed of materials to prevent deterioration and maintain legibility for the duration of the posting. (5) All words shall consist of letters of at least 2-1/2 inches tall and all letters and the symbol shall be a color, which sharply contrasts with their immediate background. At the top of the sign shall be the words KEEP OUT followed by an octagonal stop sign symbol of at least 8 inches in diameter containing the word STOP. Below the stop sign symbol shall be the words PESTICIDES IN IRRI-

GATION WATER. This sign is in addition to any sign posted to comply with the Worker Protection Standard.

CHEMIGATION OF *NALAGATE 54*

When applying by chemigation methods, the following directions or warnings must be observed: Apply this product only through sprinkler including center pivot, lateral move, end tow, side (wheel) roll, traveler, big gun, solid set, or hand move; flood (basin); furrow, border, or drip (trickle) irrigation systems. DO NOT APPLY this product through any other type of irrigation system. Crop injury, lack of effectiveness, or illegal pesticide residues in the crop can result from non-uniform distribution of treated water. If you have questions about calibration, you should contact your State Extension Service Specialist, equipment manufacturers or other experts. Do not connect an irrigation system (including greenhouse systems) used for pesticide application to a public water system unless prescribed safety devices for public water systems stated on the pesticide label are in place. A person knowledgeable of the chemigation system and responsible for its operation or under the supervision of the responsible person shall shut the system down and make necessary adjustments should the need arise.

Chemigation Using a Public Water System
NOTE: IDACHEM, INC. does not encourage connection of chemigation systems to public water systems. The following information is provided for users who have evaluated alternative application and water source options before choosing to make such a connection.

OBSERVE THE FOLLOWING PRECAUTIONS IF YOUR CHEMIGATION SYSTEM IS CONNECTED TO A PUBLIC WATER SYSTEM: Public water system is defined as a system for the provision to the public of piped water for human consumption, if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. Chemigation systems must contain a functional, reduced pressure zone, backflow preventer (RPZ) or the functional equivalents in the upstream water supply line from the point of pesticide introduction. As an option to the RPZ, the water from the public water system should be discharged into a reservoir tank prior to pesticide introduction. There shall be a complete physical break (air gap) between the outlet end of the fill pipe and top of overflow rim of the reservoir tank of at least twice the inside diameter of the fill pipe. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid toward the injection pump.

The pesticide injection pipeline must also contain a functional normally-closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.

Sprinkler and Drip Chemigation Systems
The system must contain a functional check valve, vacuum relief valve, and low-pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid toward the injection pump. The pesticide injection pipeline must also contain a functional, normally-closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.

The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops. The irrigation line or water pump must include a functional pressure switch that will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.

Systems must use a metering pump such as a positive displacement injection pump (e.g. diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock. Any alternatives to the above required safety devices must conform to the list of EPA-approved alternative devices.

Do not apply when wind speed favors drift beyond the area intended for treatment.

Flood Basin, Furrow and Border Chemigation Systems using a gravity flow pesticide dispersing system must meter the pesticide into the water at the head of the field and downstream of a hydraulic discontinuity such as a drop structure or weir box to decrease potential for water source contamination from backflow if water flow stops.

PRE-PLANTING AFTER APPLICATION OF *NALAGATE 54*

Effects of Rain
If rain occurs within 24 hours after a *NALAGATE 54* application, lack of control at and near the soil surface may occur.

Recontamination
Precautions must be taken to prevent recontamination of treated fields with plant pathogenic fungi, plant parasitic nematodes or weed seed. Use clean seeds or plants. Before farm equipment is driven into the treated area, it should be rinsed free of untreated oil and weed seeds from other fields.

Days to Cultivation or Planting after Application
Because *NALAGATE 54* is harmful to germinating seeds and living plants, an appropriate interval must be observed between treatments and planting. On well-drained soils which have a light to medium texture and which are not excessively wet or cold following the application, planting can begin 14 to 21 days after treatment. If soils are heavy or especially high in organic matter or if the soil remains wet and/or cold (below 60° F) following the application, a minimum interval of 30 days should be observed. The interval before planting should be extended until the soil is sufficiently dry to allow for cultivation.

Cultivation of Soil before Planting
IMPORTANT: Heavier soils including soils high in clay or organic matter should be allowed to aerate and dry thoroughly after treatment with *NALAGATE 54*. During cold and/or wet weather, frequent shallow cultivation can aid dissipation of *NALAGATE 54* from the treated soil.

On heavy, wet soils, light surface cultivation to break up crusting and promote drying should be done 5 to 7 days after treatment if planting is to occur within 14 to 21 days after treatment. This cultivation may be repeated as necessary.

NOTE OF CAUTION: To avoid contaminating treated soils, care should be taken to assure that untreated soils are not mixed with treated soils.

Testing of Treated Soils before Planting
Fields are fumigated to control soil-borne fungi, nematodes, insects and weeds. The length of time required for fumigants to escape from the soil before plants can safely be planted varies, greatly. Typically, 14 to 21 days are needed under typical conditions; however, circumstances which do not favor evaporation of the fumigant can greatly lengthen the waiting period as much as up to 30 days. The release period is short with (1) low rates of fumigants, (2) light soils, (3) high soil temperatures, (4) low soil moisture, (5) shallow application depth, and (6) repeated cultivations after fumigation. Seeded crops are less susceptible to residual soil fumigant injury than transplanted crops. In general, fumigants escape slowly from cold, wet, heavy soils. If in doubt, perform either the lettuce seed test or the tomato transplant test as described elsewhere in the label. If germination occurs in 1 to 3 days or if tomato plant shows signs of wilting or root burn in 2 days, the product is still available and an extended wait period must be observed.

PACIFIC NORTHWEST STATES OF IDAHO, NEVADA, OREGON AND WASHINGTON

NOTE: When applied in the spring, allow a minimum of 14 to 21 days before planting providing no fumes are detectable. When the soil temperature is below 60° F allow a minimum of 21 days before planting. Check for noxious fumes and aerate as needed. Use a seedling indicator plant with a hot cap to check for activity or fumes (or following instructions in preceding paragraph). DO NOT plant if fumes are detectable or injury to plant has occurred. Re-aerate the soil and check again.

The information below describes two simple tests to assay for harmful residual soil fumigants before planting.

Lettuce Seed Test
1. With a trowel, dig into the treated soil to ro just below the depth of application. Remove 2 to 4 small (1 to 2 oz) soil samples, mix lightly, and immediately place a portion in an airtight jar so that fumes will not escape. Use mason, wheat germ or similar jars with gas-tight lids.
2. Sprinkle lettuce seeds on the moistened surface of the soil and recap immediately. Prepare a similar jar with untreated soil (untreated check) for comparison.
3. Keep the jars at 65 to 85° F; do not place in direct sunlight. Direct sunlight may kill the seed by overheating. Lettuce seed will not germinate in the dark.
4. Inspect the jars for germination in 1 to 3 days.
5. The soil is safe for planting if seeds in the treated jar germinate the same as seeds in the untreated jar.

IMPORTANT: Be sure (1) to sample the field properly in several areas, particularly low, wet areas; (2) that the lids are airtight and have no grit under the seal; and (3) that the jars are placed in indirect sunlight.

Tomato Transplant Test
Transplant 5 to 10 succulent, fast-growing tomato seedlings into fumigated beds approximately 4 to 6 inches deep. Do the same in a non-fumigated area. If there is variation in the field, plant into the heaviest, wettest soil. Inspect the seedlings in 2 days for wilting or "root burn". If plants in the fumigated zone look the same as those in the non-fumigated zone, it is safe to plant.

Which Test is Best?
Both the lettuce seed and tomato transplant test can serve the purpose. The response of tomato seedlings varies somewhat depending on how succulent they are, the relative humidity, soil moisture and temperature. Relative differences between plants in fumigated and non-fumigated areas are key to detecting low level residues. High concentrations should produce clear-cut symptoms. Lettuce seed tested in jars are not subjected to the variations in the field that can affect the response of tomato transplants. However, the process of collecting a soil sample allows some fumigants to escape prior to sealing the jar. In addition, excess soil moisture can inhibit normal lettuce seed germination reducing the sensitivity of the test.

USES, RATES AND APPLICATION METHODS

FIELD APPLICATION WHERE ENTIRE AREA IS BEING TREATED

SOIL INJECTION: Apply with injectors such as shanks, blades; fertilizer wheels, plows, etc. Apply *NALAGATE 54* at the rate of 30 to 60 gallons of product per treated acre. Follow immediately with roller to smooth and compact the soil surface. Light watering tarping after rolling helps prevent fumigant escape It may be necessary to stagger the injector placement on two or more tool bards to prevent soil build-up during application.

When setting up you soil injection equipment with either spray blades, injection knives or coulters make sure they are evenly and closely placed to create an even application width and depth. To accomplish this, it may require multiple tool bars with the injection tools staggered. This will help prevent build-up of trash and aid in the soil sealing. For example, apply *NALAGATE 54*, through injectors placed 4 inches below the soil surface and 5 inches apart.

SOIL COVERING: *NALAGATE 54* may be applied as a broadcast application immediately in front of soil covering equipment such as bed shapers, rotary tillers, disks, etc. to a minimum depth of 6 inches using a single pass to incorporate. Use 30 to 60 gallons of *NALAGATE 54* per treated acre followed immediately by roller/packer to smooth and compact the soil surface.

ROTARY TILLER OR POWER MULCHER: Spray *NALAGATE 54* immediately in front of the tiller or mulcher, set to the depth to where control is desired. Use 30 to 60 gallons of product per treated acre. Follow immediately with a roller, power roller or bed shaper to seal soil surfaces. Light watering or a tarp after rolling may be used to help prevent fumigant escape.

SPRINKLER SYSTEM: Use only those sprinkler systems which give large water droplets to prevent excessive loss. Use 30 to 60 gallons of *NALAGATE 54* per acre. Meter continuously throughout the injection period all of the *NALAGATE 54* required to come in contact with the targeted pest in the treated zone. The desired depth of treatment obtained may be contingent upon soil moisture and type. Soil conditions must facilitate even moisture penetration without runoff. Flush lines following injection of *NALAGATE 54*. For proper application rate and placement, consult your local *NALAGATE 54* Sales Representative or County Extension Expert.

Follow instructions under "GENERAL PRECAUTIONS FOR IRRIGATION SYSTEMS" section of this label.

Application Over Cover Crops: *NALAGATE 54* can be applied through sprinkler irrigation systems on cover crops such as alfalfa, clover, and grasses such as rye, oats, wheat, and sudan. When applied on cover crops, no soil cultivation is required before the application.

Effects of Air Temperature & Winds on Sprinkler Applications: When using the sprinkler application method, apply *NALAGATE 54* only when the air temperature is below 90° F. This precaution is recommended to guard against evaporation of the product. Low humidity or high wind velocity can also cause premature evaporation of the fumigant before drenching into the soil. Do not apply when wind conditions favor drift from treated field.

Prevention of Treatment Runoff: To prevent runoff of the treatment during a sprinkler application, do not apply *NALAGATE 54* at a rate greater than the absorption capacity of the field. Should runoff occur, isolate it from growing crops and water sources. Once collected, reapply to the treated field.

Check Flood (Basin), Furrow and Border: Meter *NALAGATE 54* at a steady rate into water during irrigation. Depending on the kind of pest and the treatment depth, use 30 to 60 gallons of product per treated acre in 3 to 18 inches of water per acre. Meter *NALAGATE 54* into the irrigation water at the head of the field at a point with enough turbulence to assure adequate mixing of the product in the water.
Important: Prior to starting the application, always inspect ditches and border areas to ensure containment of the irrigation waters. Damage to bordering crops will occur if leaks develop. Apply only into field head ditch. DO NOT APPLY INTO ANY LATERAL DITCHES.
Follow instructions under "GENERAL PRECAUTIONS FOR IRRIGATION SYSTEMS" section of this label.

DRIP IRRIGATION SYSTEM: *NALAGATE 54* must be applied through a drip irrigation system designed to wet the soil thoroughly in the area being treated. Meter 30 to 60 gallons of *NALAGATE 54* per treated acre into the drip system during the entire irrigation period. APPLICATION MUST BE CONTINUOUSLY SUPERVISED. Flush irrigation system with adequate water after completion of application.
Important: WEED ELIMINATION WILL NOT BE SATISFACTORY IF TOO MUCH WATER IS APPLIED. AN ADEQUATE CONCENTRATION OF *NALAGATE 54* MUST BE PRESENT AT THE TIME OF WEED SEED GERMINATION IN ORDER TO BE EFFECTIVE.

Further directions for use are as follows:
1. Ground must be in seedbed condition, no clods larger than 5 inch in diameter.
2. Beds must be lifted, shaped and ready for planting.
3. Soil moisture must be 50% to 80% of field capacity in the top 2 to 3 inches at the time of application.

NOTE: If *NALAGATE 54* is applied to established plant beds under plastic tarps to terminate growth of a previous crop and to fumigate the bed in preparation of planting a subsequent crop, the termination crop must not be used for any food or feed purposes after *NALAGATE 54* has been applied.
Follow instructions under the "GENERAL PRECAUTIONS FOR IRRIGATION SYSTEMS" in the previous section.

PACIFIC NORTHWEST ONLY

FIELD PREPARATION: To remove compacted areas that are in the field to be treated, rip and disc the field prior to the *NALAGATE 54* application. After this soil preparation and 7 to 10 days prior to the *NALAGATE 54* application, irrigate the field applying enough water so that at time of the application the soil moisture will be 50% to 85% of field capacity.

SOIL INJECTION: *NALAGATE 54* may be applied using (1) a single shank spaced no more than 6 inches apart and a spray nozzle 6 inches deep; (2) a single shank spaced no more than 6 inches apart and spray nozzles spaced 6 to 12 inches deep; (3) a single sweep spaced no more than 12 inches apart and sweep blades 12 inches wide with a spray nozzle that will give broadcast coverage from sweep tip to sweep tip; (4) a double-winged shank spaced no more than 12 inches apart and 9 inches between the wings with spray nozzles giving uniform coverage; (5) a Noble Plow Blade with spray nozzles spaced every 6 inches and set to 12 to 14 inches deep using a disc to immediately incorporate the *NALAGATE 54* placed on the surface. All soil injection applications must be followed immediately with a roller/packer to smooth and compact the soil surface. Regardless of which method used, you must use 30 to 60 gallons of *NALAGATE 54* per treated acre. When apply *NALAGATE 54* with injector blades such as Noble Plow Blades in spring, the following precautions must be followed:

- Apply all fertilizer after the *NALAGATE 54* application. Wait a minimum of 7 days before making the application.
- Thoroughly aerate the soils to 7 days after the *NALAGATE 54* application by plowing, shallow ripping or disking, or the combination thereof to allow the fumes to dissipate. Do not work soil deeper than the depth of treatment.
- Planting may take place 14 to 21 days after the *NALAGATE 54* application provided no fumes are detected at the time of planting.
- If noxious fumes are noticeable at planting, do not plant and rework the soil.
- If soil temperatures are below 60° F, delay planting for a minimum of 21 days from the day of the *NALAGATE 54* application, regardless of any other precautions that may have been taken.
- In conjunction with the delayed planting, set indicator plants (such as tomatoes) in various places in the treated field with "hot cap" left undisturbed for a minimum of 24 hours to ensure all of the *NALAGATE 54* has left the soil. (See "Testing of Treated Soil Before Planting" section.)

FIELD APPLICATION TO BEDS OR ROWS

SOIL INJECTION (Pre-formed Beds): *NALAGATE 54* may be injected into preformed plant beds following the directions in the "Soil Injection" section above. If a wider treated bad is desired, space 2 or more shanks at intervals of 5 inches to cover the desired treating width. Use thin injection shanks and inject *NALAGATE 54* 4 inches deep into well-prepared soil. Follow immediately with a bedshaper, roller press wheel or similar device, or cover with an adequate amount of soil to seal the fumigant into the soil. Light watering or a tarp after rolling may be used to help prevent fumigant escape. Apply at the rate of 30 to 60 gallons of product per treated acre (see "Method of Determining Fluid Ounces per 100 feet

of Linear Row" section). Place shanks 5 inches apart to cover the desired treating width.

SOIL INJECTION (At Bed Forming Operation): *NALAGATE 54* may be injected during the bedding or row building process, or to pre-formed beds, using one of the following delivery systems: (1) single narrow knife blade, (2) a series of harrow knife blades set no more than 5 inches apart, (3) a spray blade, (4) tiered shanks, (5) spray rake or (6) similar equipment that places *NALAGATE 54* in contact with pest to be controlled or suppressed. The rate for the above operations is 30 to 60 gallons per acre based on a broadcast application rate. Reduced rates will vary depending upon the actual width of the treated band desired (se "Method of Determining Fluid Ounces per 100 Feet of Linear Row" section). Apply the *NALAGATE 54* at the desired depth in the soil and follow immediately with the soil capping operation, bedding process, or roller/packer to seal the fumigant into the soil.

SOIL COVERING METHOD (Bed-Over Method): *NALAGATE 54* may be sprayed in a bed wide band onto the oil immediately ahead of bed shaping equipment. Cover the *NALAGATE 54* with soil to a depth of 3 to 6 inches. The soil should be rolled and compacted immediately. Apply at the rate of 30 to 60 gallons of product per acre of treated soil or 11 to 22 fluid ounces per 100 linear feet of row (12 –inch bed). If a narrower or wider bed is to be treated, adjust the fluid ounces/100 linear feet of row to reflect the actual treated acres (see "Method of Determining Fluid Ounces per 100 Feet of Linear Row" section).

DRENCH APPLICATION ON BEDS OR ROWS:*NALAGATE 54* may be applied to finished beds for control of shallow seeded weeds. Cultivate the area to be treated and pre-irrigate in accordance with Use Directions. Apply 30 to 60 gallons of *NALAGATE 54* per treated acre in a band or bands in enough water to soak at least 2 inches deep (see "Method of Determining Fluid Ounces per 100 Feet of Linear Row" section). To avoid contamination by untreated soil, do not disturb the treated area.

ROTARY TILLER or POWER MULCHER: Spray *NALAGATE 54* immediately in front of the tiller or mulcher, set to the depth to where control is desired. Use 30 to 60 gallons of product per treated acre (see "Method of Determining Fluid Ounces per 100 Feet of Linear Row" section). Follow immediately with a roller, power roller or bed shaper to seal soil surface. Light watering or tarp after rolling may be used to help prevent fumigant escape.

Method of Determining Fluid Ounces per 100 Feet of Linear Row

1. Determine width of treated band in feet by dividing width of band in inches by 12 (e.g.: 8 in. band = 8 in. ÷ 12 in/ft. = 0.666 ft.)
2. Determine square feet in 100 linear feet of band by multiplying the width of the band by 100 (e.g.: 0.666 ft. X 100 ft. = 66.66 sq. ft.)
3. Determine the treated acres per 100 linear feet of band by dividing the square feet by 43,560 (square feet in an acre) (e.g.: 66.66 sq.ft. ÷ 43,560 = 0.0015)
4. To determine fluid ounces per 100 linear feet:
   a. 1 gal = 128 fl. Oz; 50 gals = 6,400 fl. oz.; 100 gals = 12,800 fl. Oz.
   b. Multiply fluid ounces by acres. Example: 50 gals = 6,400 fl oz. X 0.0015 = 9.6 fl. oz. Per 100 linear feet row.

ADDITIONAL RECOMMENDATIONS

SEED TREATMENT: A suitable fungicide should be used to treat all crop seed being planted into the treated soil.

PEANUTS: For suppression and/or control of Cylindrocladium Black Rot (CBT) and nematodes, apply *NALAGATE 54* at the rate of 6 gallons per acre (5.*I*3 fluid ounces per 100 linear feet of row). Use with partially resistant cultivators (NC -10C or others as designated by you local Agricultural Extension Service) incases of severe disease pressure. Plant other varieties only in cases of light CBR pressure.

Soil Preparations: Before applying *NALAGATE 54*, all residues from the previous crop should be decomposed (enhance by fall discing) and plowed under in the spring with a moldboard plow. Soil incorporation pre-plant herbicides must be applied prior to the application of *NALAGATE 54*.

Tillage and Planting after Application: Do not mix untreated soil with treated soil by tillage or other cultural practices. Plant the peanuts in the center of the treated beds no earlier than 14 days following the application of *NALAGATE 54*. An at-planting nematicide treatment will be necessary in fields with heavy infestations of Root Knot, ring and/or sting nematodes.

MINT (SUPPRESSION OF VERTICILLIUM WILT): When infestation is limited to small spots in a field, the spread of Verticillium can be reduced by treating the infected spots. Apply at the rate of up to 60 gallons of *NALAGATE 54* per treated acre using injector blade or thin shank injector rig. Follow directions for "Field Application Where Entire Area is Being Treated".

POTATOES: For suppression of potato pests such as nematodes, weed seeds and Verticillium dahliae (Early Maturity Disease).

For soil injection, apply a minimum of 30 gallons per treated acre of *NALAGATE 54* following the directions for "Field Application Where Area Is Treated". *NALAGATE 54* may also be applied at the rate of 40 to 60 gallons of product per acre using a Noble Plow Blade set to 12 to 14 inches deep with spray nozzles spaced every 6 inches apart to give uniform coverage, plus a surface application using a disc to immediately incorporate the *NALAGATE 54* placed on the surface.

Early Maturity Diseases of Potatoes In The Pacific Northwest: Apply 40 gallons *NALAGATE 54* per treated acre using the soil injection method as described in the "Field Application Where Entire Area Is Being Treated" section.

SPRINKLER SYSTEM PRE-PLANT APPLICATION: Apply 30 to 60 gallons of *NALAGATE 54* per acre in sufficient water to penetrate to the desired treatment depth. Meter continuously into the irrigation system throughout the entire application period. Soil temperature should be in the range of 40° F to 90° F in the treatment zone. Soil moisture immediately prior to treatment must be 50% to 80% of field capacity down to the 24-inch level. Soil condition must facilitate even water penetration without runoff.

NOTES:

1. *NALAGATE 54* may be applied where a crop stubble or vegetation exists without prior tillage, provided there is adequate penetration of the product.
2. *NALAGATE 54* will suppress Rot Knot nematodes in the

treatment zone at the time of treatment. The treatment zone is defined as the depth of penetration that *NALAGATE 54* achieves at the time of application. If high numbers or deep nematodes are identified, anticipate nematodes to build up throughout the growing season. Some damage may occur unless additional action is taken. *NALAGATE 54* has no residual activity and re-infestation of a treated field can occur from numerous sources such as deep nematode populations, seed pieces, irrigation water, equipment contamination and blowing wind.

TREATMENT OF TREE REPLANT SITES IN COMMERCIAL ORCHARDS

After removing dead or diseased trees and as much of the root system as possible, make a shallow basin over the planting site. Add *NALAGATE 54* to the stream of water while filing the basin. Use 20 fl. oz. of *NALAGATE 54* per 100 sq. ft. in sufficient water (depending on the soil type) to penetrate at least 6 ft. For control of Oak Root Fungus, use a basin of at least 20-ft. X 20-ft.; increase dosage to 26-40 fl.oz. of product per 100 sq. ft. in sufficient water to penetrate to the depth of the root system. If water is tanked to the planting site, add *NALAGATE 54* to the water and mix before filling the basin.

ESTABLISHMENT OF TRANSPLANT ORCHARDS AND VINEYARD

Apply 40 to 60 gallons of *NALAGATE 54* per broadcast acre to properly prepared fields by chemigation in sufficient water (e.g. 3 to 18 acre inches) to place the *NALAGATE 54* in contact with the target pest in the treated zone and to penetrate the desired root zone (to 6') of the crop to be transplanted. The percent field capacity of the soil prior to irrigation will help determine the amount of water to use to penetrate the desired zone. A lethal concentration of *NALAGATE 54* must be present while the target species is actively respiring. *NALAGATE 54* should be placed at or slightly below the soil level of the target pest. Deep-soil ripping is recommended prior to treatment.

SYMPHYLID SUPPRESSION: Soil should be in good seedbed condition to a depth of 8 to 10 inches. Maintain adequate moisture during the spring season to bring symphylids to the upper soil surface. Treat during July to August when symphylids are in the upper soil surface. Apply a minimum of 15 gallons of *NALAGATE 54* per treated acres (0.3 pints per 100 square feet of treated soil) using blade or thin blade chisel injectors spaced 5 inches apart. Inject below the level of symphylid concentration, usually 6 to 8 inches. Pack soil immediately after the application.

TOBACCO PLANT BEDS

Fall applications are recommended whenever possible. Read and follow the use directions carefully

TARP METHOD: Prepare the bed 5 to 7 days before application to insure best conditions for weed seed germination and fumigant action of *NALAGATE 54*. The bed should be free of clods, level and in good tilth. Apply 0.6 to 0.9 gallons of *NALAGATE 54* in a minimum of 30 gallons of water per 100 square yards. Apply uniformly over the entire bed. Cover the bed immediately with a plastic cover. Keep covered no less than one day, but no more than two days. The cover need not be tented, but should be secured to prevent wind from uncovering the treated area. Seven days after the date of application loosen the treated soil to a depth of 2 inches. Do not seed Tobacco earlier than 21 days after the *NALAGATE 54* application.

DRENCH METHOD: Apply 1.5 gallons *NALAGATE 54* in 150 to 200 gallons of water per 100 square yards. Application may be made with sprinklers, sprayers with nozzles or any suitable equipment. Follow directions given above for "Field Applications Where Entire Area is Being Treated" section.

PACIFIC NORTHWEST (IDAHO, NEVADA, OREGON AND WASHINGTON)

CARROTS: Apply a broadcast application of 30 to 60 gallons per acre of *NALAGATE 54* for the suppression of Root Knot Nematodes or 30 to 60 gallons for pre-plant suppression of soil-borne diseases.

MINT (Including Peppermint and Spearmint): Apply a pre-plant broadcast application of 30 to 60 gallons per acre of *NALAGATE 54* for the suppression of Root Knot Nematodes and Verticillium dahliae.

ONIONS: Apply a broadcast or banded application of 30 to 60 gallons per acre of *NALAGATE 54* for the suppression of Root Knot Nematodes or 30 to 60 gallons for suppression of soil-borne diseases.

POTATOES: Apply broadcast sprinklers application of 30 to 60 gallons per acre of *NALAGATE 54* for the suppression of Root Knot Nematodes and Verticillium dahliae. Apply a broadcast soil application of 30 to 60 gallons per acre *NALAGATE 54* for the suppression of Verticillium dahliae.

SUGAR BEETS: Apply broadcast or a banded application of 30 to 60 gallons per acre *NALAGATE 54* for the suppression of soil-borne diseases. A fall application for RO-NEET® herbicide followed by or tank mixed with *NALAGATE 54* in a broadcast application or band application will enhance the overall weed control.

ORCHARD RE-PLANT: Apply a broadcast application rate of 56 to 60 gallons per acre of *NALAGATE 54* in a minimum of 1-acre inch of water through a sprinkler system, or a row treatment of 56 to 60 gallons broadcast equivalent, to the future tree row using a weed sprayer by applying multiple passes of *NALAGATE 54* while the sprinkler are running until the desired rate has been applied for the treatment of specific orchard replant disease. Trees should not be replanted into the replant site for at least 21 days after treatment. Check for noxious fumes in the soil before planting. *NALAGATE 54* may also be applied at the rate of 40 to 60 gallons of product per acre using a Noble Plow Blade set 12 to 14 inches deep with spray nozzles spaced every 6 inches apart to give uniform coverage, with a surface application using a disc to immediately incorporate the *NALAGATE 54* placed on the surface.

WHEAT AND BARLEY: Apply *NALAGATE 54* at a rate of 1.5 to 6 gallons of product per acre 14 to 21 days prior to planting for the suppression of certain early season soil fungi which cause root diseases of small grains. *NALAGATE 54* may be diluted with water or, if compatible, non-acidic liquid fertilizers (see "Application in Tank Mix with Liquid Fertilizer" section) and injected into moist soils to 8 inches before planting.

IN THE PACIFIC NORTHWEST, IF THE FIELD HISTORY OR SOIL SPMPLING SHOWS HIGH POPULATIONS OF NEMATODES, FUMIGATION USING BOTH *NALAGATE 54* AND PLAN-FUME II SHOULD BE USED. CONSULT YOUR

IDACHEM, INC. REPRESENTATIVE FOR ADDITIONAL INFORMATION.

APPLICATION DIRECTIONS FOR *NALAGATE 54*

Soil conditions at the time of application of *NALAGATE 54* must be between 40 and 90° F in the treated zone and at 50 to 85% field capacity. If necessary, pre-irrigate about a week prior to treatment to adjust soil moisture to desired levels. Immediately before application, cultivate lightly if the soil has crusted. Apply *NALAGATE 54* either by chemigation of by soil injection

For Chemigation: Apply *NALAGATE 54* at the minimum rate of 30 gallons per acre in a minimum of 0.5 acre-inch of water to the desired depth of treatment. Heavier soils may require a higher amount of water. Use only those sprinkler systems that give large water droplets to prevent excessive fumigant loss. Do not apply when wind speed favors drift beyond the area intended for treatment or when conditions of thermal inversion exist. If for any reason chemigation is interrupted prior to completion (e.g., excessive wind, equipment malfunction, etc.), back the system up prior to restarting to ensure full application to the area affected prior to shutting down the system and to allow full distribution of the *NALAGATE 54* solution throughout the irrigation system prior to moving over untreated soil. After application is completed, flush equipment until all *NALAGATE 54* is eliminated from the system. Follow all application directions described in the "General Precautions for Irrigation Systems" and "Sprinkler Chemigation Systems" sections).

For Soil Injection: Apply *NALAGATE 54* at the minimum rate of 30 gallons per acre using either shanks, sweep blades, double-winged shanks, or a Noble Plow Blade combined with a surface application. Single shanks should be spaced no more than 6 inches apart with either single injection outlets no more than 6 inches deep or dual injection outlets spaced at 6 and 12 inches deep. Single sweep blades should be spaced no more than 12 inches apart with sweeps 12 inches wide and a spray nozzle that will provide broadcast coverage from sweep tip to sweep tip. Double-winged shanks should be spaced no more than 12 inches apart with no more than 9 inches between adjacent wings and with spray nozzles that provide uniform coverage. The Noble Plow blade should have spray nozzles spaced 6 inches apart to give uniform coverage, an injection depth set at 12 to 14 inches deep, and be combined with a surface application using a disc to immediately incorporate the *NALAGATE 54* placed on the surface. Follow all the above applications immediately with a roller/packer to smooth and compact the soil surface.

For Surface Incorporation: Apply *NALAGATE 54* at the minimum rate of 30 gallons per acre as a broadcast application to the soil surface immediately in front of soil covering equipment such as rotary tillers, discs, etc., to a minimum depth of 6 inches using a single-pass incorporation, followed immediately by a roller/packer to smooth and compact the soil surface.

SOIL FUMIGATION INTERVAL: Planting may take place only after odors of *NALAGATE 54* are no longer present within the zone of fumigation. If *NALAGATE 54* is applied in the spring with Noble Plow Blade, apply all fertilizers at least 7 days after the application. Thoroughly aerate the soils to 7 days after the application of *NALAGATE 54*. Thoroughly aerate the soils to 7 days after the application of *NALAGATE 54* by shallow plowing and/or discing to allow the fumigation odors to dissipate. Wait 14 to 21 days after the application of *NALAGATE 54* before planting the crop. Use the 21-day interval if soil temperatures are below 60° F regardless of any other precautions that may have been taken. In addition to waiting 21 days, set indicator plants (e.g., tomato seedlings) in various places in the treated field and cover the plants with a "hot cap", plastic sheeting, bucket, etc., to trap and confine any fume3s present. Leave the plants undisturbed for a minimum of 24 hours, then examine for injury before planting the crop. Do not plant the crop if injury to indicator plants is observed. If noxious fumes are noticeable at time of planting, stop planting and rework the soil. Do not till the soil so deep as to move untreated soil from below the treated zone into the treated soil.

Special Considerations and Precautions:
Use of this sequential application program of reduced rates of *NALAGATE 54* does not guarantee pest-free potatoes at harvest. Use of *NALAGATE 54* according to these use directions will control Root Knot and Lesion nematode populations present within the fumigated zone at time of fumigation. The fumigated zone can vary depending upon a number of factors such as fumigant rate, application methods used, depth of fumigant application, soil moisture soil type, soil temperature and soil tilth (including soil compaction and soil porosity). The sequential combination of reduced rates of *NALAGATE 54* will not control or prevent re-infestation subsequent to the treatments. Subsequent pest populations may infest the fumigated zone from irrigation water, equipment potato seed or other sources of contamination or may invade the fumigated zone from surrounding untreated soil such as from beneath the fumigated zone or from non-fumigated pockets within the fumigated zone.

Use of PLAN-FUME II Soil Fumigant in Conjunction With *NALAGATE 54*: In fields with a history of severe Columbia Root Knot nematode problems, the maximum Federal label rate 20 gallons of PLAN-FUME II per acre is recommended in sequential combination with a minimum of 30 gallons *NALAGATE 54* per acre per these label directions.

If the application of PLAN-FUME II occurs in the fall and the application of *NALAGATE 54* is not planned until spring, a cover crop such as wheat or grass can be planted following the undisturbed soil interval associated with the application of PLAN-FUME II to reduce the potential for over-winter soil erosion. Refer to the product labels affixed to the containers for both PLAN-FUME II and *NALAGATE 54* for recommended soil conditions; product performance can be expected to improve as the soil conditions move towards optimum. Use this sequential application program of PLAN-FUME II and *NALAGATE 54* under soil conditions outside the recommended range of soil conditions can be expected to yield less than satisfactory performance.

posed of by use according to label instructions, contact you State Pesticide or Environmental Control Agency or the Hazardous Waste representative at the nearest EPA Regional office for guidance.

CONTAINER DISPOSAL: Triple rinse (or equivalent) and then, offer for recycling or reconditioning; puncture and dispose of in a sanitary landfill; or, if allowed by State and local authorities, burn or incinerate. Stay out of smoke, if container is burned.

FOR BULK AND MINI-BULK CONTAINERS
CONTAINER DISPOSAL: Reseal container and offer for recycling or reconditioning; triple-rinse (or equivalent); or clean in accordance with manufacturer's instructions.

CONTAINER PRECAUTIONS: Before refilling, inspect thoroughly for damage such as cracks, punctures, bulges, dents, abrasions, and damage or worn threads on closure devices.

REFILL ONLY WITH *NALAGATE 54* SOIL FUMIGANT
The contents of this container cannot be completely removed by cleaning. Refilling with materials other than *NALAGATE 54* soil fumigant will result in contamination and may weaken the container. After filling and before transporting, check for leaks. Do not refill or transport damage or leaking container.

NOTE OF WARNING: CONTAINER IS NOT SAFE FOR FOOD, FEED OR DRINKING WATER!

For transportation emergencies, phone 24 hours a day: CHEMTREC 1-800-424-9300

LIMITED WARRANTY AND DISCLAIMER

THE MANUFACTURER WARRANTS (A) THAT THIS PRODUCT CONFORM TO THE CHEMICAL DESCRIPTION ON THE LABEL; (B) THAT THIS PRODUCT IS REASONABLY FIT FOR THE PRUPOSES SET FORTH IN THE DIRECTIONS FOR USE, SUBJECT TO THE INHERENT RISKS REFERRED TO HERE-IN, WHEN IT IS USED IN ACCORDANCE WITH SUCH DIRECTIONS; AND (C) THAT THE DIRECTIONS, WARNINGS, AND OTHER STATEMENTS ON THIS LABEL ARE BASED UPON RESPONSIBLE EXPERTS' EVALUATIONS OF REASONABLE TESTS OF EFFECTIVENESS, OF TOXICITY TO LABORATORY ANIMALS AND TO PLANTS AND RESIDUES ON FOOD CROPS, AND UPON REPORTS OF FIELD EXPERIENCE. TESTS HAVE NOT BEEN MADE AN ALL VARIETIES OF FOOD CROPS AND PLANTS, OR IN ALL STATES OR UNDER ALL CONDITIONS.

MANUFACTURER AND SELLER MAKE NO WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE NOR ANY OTHER EXPRESS OR IMPLIED WARRANTY EXCEPT AS STATED ABOVE. IN NO EVENT SHALL MANUFACTURER OR SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM THE USE OR HANDING OF THIS PRODUCT. THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE EXCLUSIVE LIABILITY OF MANUFACTURER AND SELLER FOR ANY

STORAGE AND DISPOSAL

PROHIBITIONS: Do not contaminate water, food or feed by storage or disposal.

STORAGE: Store in a cool, dry place. Keep container closed when not in use. Avoid freezing by storing above 5° F as product crystallizes at lower temperatures. If product crystallizes, move to a warmer location, then thoroughly shake or stir product until crystals are dissolved. Do not use this product until crystals are dissolved and no crystals remain in the product.

PESTICIDE DISPOSAL: Pesticide wastes are toxic. Improper disposal of excess pesticide spray mixture or rinsate is a violation of Federal law. If these wastes cannot be dis-

AND ALL CLAIMS, LOSSES, INJURIES OR DAMAGES (INCLUDING CLAIMS BASED ON BREACH OR WARRANTY, CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE) RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT, SHALL BE THE RETURN OF THE PURCHASE PRICE OF THE PRODUCT OR, AT THE ELECTION OF MANUFACTURER OR SELLER, THE REPLACEMENT OF THE PRODUCT.

Manufacturer and Seller offer this product and Buyer and User accept it, subject to the foregoing conditions of sale and limitations of warranty and of liability, which may not be modified except by written agreement signed by a duly authorized representative of Manufacturer.

For product information, call:
1-888-IDA-CHEM

Visit our website at:
www.idachem.com/ag/com/

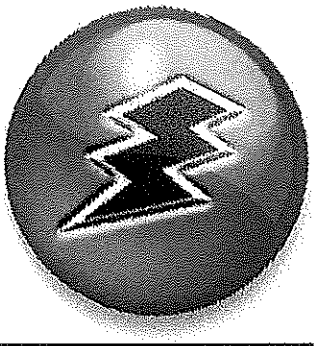
IDACHEM

IDACHEM Inc.
1313 Small Particle Road
Boise, Idaho 83714

This is a fictitious pesticide label for training and testing purposes only.

Appendix D

Vexsion Supreme™ Fungicide



For the control of certain diseases in conifers, nonbearing citrus, nonbearing deciduous fruits and nuts, ornamentals, and turf. .

Active Ingredient:
Mefenoxam.....22.0%
Inert Ingredients.....78.0%
TOTAL 100.0%

IDACHEM
IDACHEM Inc.
1313 Small Particle Road
Boise, Idaho 83714

EPA Registration No. 100-736 *Net Contents: 2.5 Gals* EPA Establishment No. 62171-ID-001

KEEP OUT OF REACH OF CHILDREN

CAUTION

Hazard to humans and domestic animals.

WARNING: Causes moderate eye irritation. Harmful if swallowed or absorbed through skin. Avoid contact with eyes, skin, or clothing. Wash thoroughly with soap and water after handling.

FIRST AID

IF IN EYES	Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. Call a Poison Control Center or doctor for treatment advise.
IF ON SKIN	Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.
IF SWALLOWED	Call a Poison Control Center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a Poison Control Center or doctor. Do not give anything by mouth to an unconscious person.

Have the product container or label with you when calling a Poison Control Center or doctor or going for treatment. In case of medical questions, emergencies or accidents involving this product, call INFOTRAC at (800) 535-5053. ***HOT LINE NUMBER***: For 24 Hour Emergency Assistance (Human or Animal) or Chemical Emergency Assistance (Spill, Leak, Fire, or Accident), Call **1-800-888-8372.**

Personal Protective Equipment

Applicators and other handlers must wear:
- Long-sleeved shirt and long pants
- Waterproof gloves
- Shoes plus socks

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

Engineering Control Statements
When handlers use closed systems or enclosed cabs in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

User Safety Recommendations
User should:
- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

Environmental Hazard

Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate when disposing of equipment wash waters or rinsate. Apply this product only as specified on the label.

Ground Water Advisory Statement

This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination.

Physical or Chemical Hazards

Do not use, pour spill or store near heat or open flame. Use only with adequate ventilation. Close container when

not in use.

CONDITIONS OF SALE AND LIMITATIONS OF WARRANTY AND LIABILITY

Notice: Read the entire Directions for Use and Conditions of Sale and Limitation of Warranty and Liability before buying or using this product. If the terms are not acceptable, return the product at once, unopened, and the purchase price will be refunded.

IDACHEM and Seller warrant that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated in the Directions for Use, subject to the inherent risks referred to above, when used in accordance with directions under normal use conditions. This warranty does not extend to the use of this product contrary to the label instructions, or under abnormal conditions or under conditions not reasonably foreseeable to or beyond the control of Seller or IDACHEM, and Buyer and User assume the risk of any such use. IDACHEM AND SELLER MAKE NO WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE NOR ANY OTHER EXPRESSOR IMPLIED WARRANTY EXCEPT AS STATED ABOVE.

IN NO EVENT SHALL IDACHEM OR SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM THE USE OR HANDING OF THIS PRODUCT. THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE EXCLUSIVE LIABILITY OF IDACHEM AND SELLER FOR ANY AND ALL CLAIMS, LOSSES, INJURIES OR DAMAGES (INCLUDING CLAIMS BASED ON BREACH OR WARRANTY, CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE) RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT, SHALL BE THE RETURN OF THE PURCHASE PRICE OF THE PRODUCT OR, AT THE ELECTION OF MANUFACTURER OR SELLER, THE REPLACEMENT OF THE PRODUCT.

IDACHEM and Seller offer this product and Buyer and User accept it, subject to the foregoing conditions of sale and limitations of warranty and of liability, which may not be modified except by written agreement signed by a duly authorized representative of IDACHEM, Inc.

Directions For Use

It is a violation of federal law to use this product in a manner inconsistent with its labeling.

Vexsion Supreme™ must be used only in accordance with recommendations on this label or in separately published IDACHEM supplemental labeling approved by EPA for this product.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.
FAILURE TO FOLLOW THE DIRECTIONS FOR USE AND PRECAUTIONS ON THIS LABEL MAY RESULT IN POOR DISEASE CONTROL OR CROP INJURY.

General Information

AGRICULTURAL USE REQUREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 48 hours. Exception: If the product is soil-incorporated, or applied by drenching, the Worker Protection Standard, under certain circumstances, allows workers to enter the treated area if there will be no contact with anything that has been treated.

The REI for chemigation via microsprinklers, flood floor, and drip line irrigation application is zero hours.

The REI for soil surface application is zero hours after sufficient rainfall occurs or overhead or hand held irrigation is sued to thoroughly wash the product into the soil and off any foliage.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water is:

- Coveralls
- Chemical-resistant gloves made of any waterproof material
- Shoes plus socks

NON-AGRICULTURAL USE REQUIREMENTS

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Do not enter treated areas without footwear until sprays have dried.

Vexsion Supreme™ is a systemic fungicide for use on ornamentals; turf; nonbearing citrus grown in nurseries and as landscape plantings; conifers grown in nurseries and plantations, including Christmas trees; and nonbearing deciduous fruit and nut trees grown in nurseries

Resistance Management: Vexsion Supreme™ is a systemic fungicide having a specific mode of action. Use of **Vexsion Supreme™** could result in development of insensitive strains of fungi. Development of insensitivity cannot be predicted, Therefore, IDACHEM cannot assume liability for crop damage resulting from insensitive strains of fungi. Consult with your State Agricultural Experiment Station or

Extension Service Specialist for guidance and ways to control any possible **Vexsion Supreme™** insensitive strains of fungi which may occur.

Some turf disease pathogens are known to have developed resistance to fungicides used repeatedly for their control. **Vexsion Supreme™** should be applied in an alternation or tankmix program with other registered fungicides that have a different mode of action and to which pathogen resistance has not developed. Do not make more than three (3) sequential applications of **Vexsion Supreme™** before alternating with a fungicide of a different mode of action. A sound resistance management program would include blocks of three **Vexsion Supreme™** application separated by blocks of two alternate fungicide applications.

To help decrease the chance of downy mildew insensitivity, do not use **Vexsion Supreme™** for control of downy mildew disease, except for use in turf. Use **Vexsion Supreme™** only as a soil application for control of soil-borne diseases, except for use in turf.

To avoid spray drift, do not apply under windy conditions. Avoid spray overlap, or crop injury may result.

Mixing Instructions

Vexsion Supreme™ is usually compatible with Banner MAXX®, Pennant®, Daconil®, Fore®, and Heritage®.

To determine the compatibility of **Vexsion Supreme™** with these and other products, pour the products into a small container of water in the correct proportions. After thorough mixing, let stand for 5 minutes. If the combination remains mixed, or can be remixed readily, the mixture should be considered compatible.

Prepare not more spray mixture than is required for the immediate operation. Agitate the spray solution continuously during mixing and during application. Rinse the spray tank thoroughly with clean water after each day's use and dispose of pesticide rinsate by application to an already treated area.

Vexsion Supreme™ Alone: Add 1/4-1/2 of the required amount of water to the spray tank. Start the agitator before adding any tank-mix partners. In general, tank-mix partners should be added in this order: wettable powders, dry flowable formulations, liquid flowable formulations, microencapsulated formulations such as **Vexsion Supreme™**, and Emulsifiable concentrates. Always allow each tank-mix partner to become fully dispersed before adding the next product. Provide sufficient agitation while adding the remainder of the water and the **Vexsion Supreme™** to the spray tank. Allow the **Vexsion Supreme™** to completely dispersed into the mix water. Maintain agitation until all of the mixture has been sprayed.

Note: When using **Vexsion Supreme™** in tank mixtures, all products in water-soluble packaging should be added to the tank before any other tank-mix partner, including **Vexsion Supreme™**. Allow the water-soluble packaging to completely dissolve and the product(s) to completely disperse before adding any other tank-mix partner to the tank.

If using **Vexsion Supreme™** in a tank mixture, observe all directions for use, crops/sites, use rates, dilution ratios, precautions, and limitations which appear on the tank-mix partner label. No label dosage should be exceeded and the most restrictive label precautions and limitations should be followed. This product should not be mixed with any product which prohibits such mixing. Tank mixtures or other applications of products referenced on this label are permitted only in those states in which the products area registered.

Application Instructions

For banded applications, calculate the amount of **Vexsion Supreme™** needed as follows:

Bandwidth in inches ÷ row width in inches X broadcast rate per acre = Amount needed per acre

Application Through Irrigation Systems

Vexsion Supreme™ alone or in tank mixture with other pesticides registered for application through irrigation systems may be applied in irrigation water at rates recommended on this label. This product may be applied through microsprinkler or drip irrigation systems. Do not apply this product through any other type of irrigation system. Plant injury or lack of effectiveness may result from non-uniform distribution of treated water. If you have questions about calibration, you should contact State Extension Service specialists, equipment manufacturers, or other experts. Do not connect an irrigation system (including greenhouse systems) used for pesticide application to a public water system, unless the label-prescribed safety devices for public water supplies are in place. A person knowledgeable of the chemigation system and responsible for its operation shall shut the system down and make necessary adjustments should the need arise.

Dilute **Vexsion Supreme™** with water in the solution tank at a ratio of at least 1 part of **Vexsion Supreme™** to 15 parts water. Liquid fertilizer may replace all or part of the water. If diluted in liquid fertilizer, the pH level must be less than 7.5. Inject **Vexsion Supreme™** solution at a ratio 50:1 or greater. Injecting a larger volume of a more dilute mixture will usually allow a more accurate calibration of the metering equipment. Meter the fungicide into the irrigation water during the first part of the irrigation cycle.

Safety Devices for Irrigation Systems Connected to Public Water Supplies

If the source of water for your irrigation system is a public water supply, follow the instructions below.

1. Public water system means a system for the provision to the public of piped water for human consumption if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year.
2. Chemigation systems connected to public water systems must contain a functional, reduced-pressure zone, backflow preventer (RPZ) or the functional equivalent in the water supply line upstream from the point of pesticide introduction. As an option to the RPZ, water from the public water system should be discharged into a reservoir tank prior to pesticide introduction. There shall be a complete physical break (air gap) between the outlet end of the fill pipe and the top or overflow rim of the reservoir tank of at least twice the inside diameter of the fill pipe.
3. The pesticide injection pipeline must contain a functional, automatic, quick-closing check-valve to prevent the flow of fluid back toward the injection pump.

4. The pesticide injection pipeline must contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
5. The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops, or in cases where there is no water pump, when the water pressure decreases to the point where pesticide distribution is adversely affected.
6. Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump), effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock.

Safety Devices for Irrigation Systems *NOT* Connected to a Public Water Supply

1. The system must contain a functional check-valve, vacuum relief valve, and low pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.
2. The pesticide injection pipeline must contain a functional, automatic, quick-closing check-valve to prevent the flow of fluid back toward the injection pump.
3. The pesticide injection pipeline must also contain a functional, normally closed solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
4. The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.
5. The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where the pesticide distribution is adversely affected.
6. System must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump), effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock.
7. Do not apply when wind speed favors drift beyond the area intended for treatment.

Application Instructions

Vexsion Supreme™ must be applied on the schedule specified in the use recommendations, not according to the irrigation schedule.

The following calibration and application techniques are provided for user reference, but do not constitute a warranty of fitness for application through sprinkler irrigation equipment. Users should check with state and local regulatory agencies for potential use restrictions before applying any agricultural chemical through sprinkler irrigation equipment.

General Instructions

1. Each run of the irrigation system must be calibrated separately to determine the time it takes water to move through the system and to make sure all emitters in the system are putting out the same amount of water.
2. Only pressure injection or venturi equipment is recommended.
3. Determine the area to be treated in each irrigation run.
4. Measure the output of each of the emitters or drip tubes closest to and farthest from the injector site.
5. For calibration, substitute a concentrated detergent (such as Wisk) for the **Vexsion Supreme™** in the injector tank. It is important to use the same volume of soap solution as the planned volume of **Vexsion Supreme™** solution when calibrating the system. The detergent will bubble as it leaves the emitters. If these times are not within 2 minutes of each other, adjust the dilution ration and/or the injection rate.

Step-by-Step Instructions

1. Before starting to calibrate, operate the system until all the emitters are putting out at equal flow rates or until the system is operating at full pressure.
2. Make up an indicator solution of detergent or fertilizer, using the same ration to be used with mixing **Vexsion Supreme™**.
3. Set the injector to apply the indicator solution at the injection rate to be used in the actual **Vexsion Supreme™** application.
4. Attach a 5-inch length of flexible tubing over the emitter closest to the injection point, another length over the emitter farthest away. Both emitters should be monitored to determine the time intervals that the indicator solutions are observed.
5. Begin injecting the indicator solution. Direct the flow from the tubes at the emitters into a small container. Begin timing when the indicator solution is first detected, stop timing when the indicator solutions are no longer detected.
6. If the period of detection of the indicator solution between the 2 emitters are within 2 minutes of each other, comparable coverage will be obtained. If they are not, make adjustments by increasing the dilution ratio, using more water per part of **Vexsion Supreme™**, or adjust the injector to a slower flow rate.
7. Once the system is calibrated, dilute the needed amount of **Vexsion Supreme™** with water using a minimum of 15 parts water to 1 part of **Vexsion Supreme™** in the solution tank.
8. Do not begin to inject **Vexsion Supreme™** into the system until all emitters are producing equal flow rates, or until the system is at full pressure.
9. Inject the **Vexsion Supreme™** into the system at the beginning of the irrigation set in 1/2-1 inch of irrigation water.

Ornamentals

Use **Vexsion Supreme™** on container, bench, or bed-grown ornamentals in greenhouses or outdoor nurseries, and for use on ornamentals grown for indoor and outdoor landscaping, for control of damping-off, and root and stem rot diseases caused by Pythium and Phytophthora. **Vexsion Supreme™** may be applied through irrigation systems, as a soil drench or as a soil surface spray, or incorporated into a pre-potting growing media for subsequent seeding or transplanting of ornamentals. *Within a rate range given for a specific group of ornamentals, use*

the lower rate for the shortest interval listed and the higher rate for the longest interval. Under severe disease conditions, use the highest rate and the shortest interval.

For drench applications, use enough of the specified **Vexsion Supreme™** water solution to wet the root zone of plants. In general, 1 pt./sq. ft. of this solution is sufficient for ornamentals growing in containers with 4 inches of growth media. Containers with growth media depth greater than 4 inches generally require 1 1/2-2 pts./sq. ft. of the solution.

For best efficacy with soil surface applications, irrigate in with at least 1.2 in. of water within 24 hours.

NOTICE TO USER: Due to the large number of species and varieties of ornamentals and nursery plants, it is impossible to test every one for tolerance to **Vexsion Supreme™**. Neither the manufacturer nor the seller has determined whether or not **Vexsion Supreme™** can be used safely on ornamentals and nursery plants not specified on this label. The professional user should determine if **Vexsion Supreme™** can be used safely prior to commercial use. In a small area, test the recommended rates for a particular group of unlabeled plants, i.e., bedding plants, foliage, etc., for phytotoxicity prior to widespread use.

Foliage Plants Aglaonema Aphelandra Dieffenbachia Peperomia Philodendron* Pothos Schefflera Sedum Sempervivum Zygocatus	**Drench:** Mix 0.3-0.6 fl.oz. with 100 gals. of water. Apply 1 pt. of solution per sq. ft. to the soil surface. For growth media depth greater than 4 inches, apply 1 1/2-2 pts. of solution per sq. ft. to the soil surface. Repeat applications at 2 to 3-month intervals, if necessary. *On philodendron, use 0.5-1 fl.oz./100 gals. *Precaution: To minimize the potential for injury to Pothos, do not use more*
Foliage Plants *(continued)*	*(continued)* *than 0.38 fl.oz./100 gals. and do not apply more frequently than once every 3 months* **Pre-Potting Growing Media Mix:** Apply to growing media mix just before planting. Mix only enough for current use. Do not store. Thoroughly mix 0.13-0.25 fl. oz. With each cu. yd. of pre-potting growing media. **Soil Surface Spray:** Apply 1 fl.oz./1,000 sq.ft. to the soil surface in a broadcast or banded spray in sufficient water to obtain thorough coverage of the plant root zone. For best efficacy, irrigate in with at least 1/2 inch of water within 24 hours.
Bedding Plants Ageratum Algerian ivy Artemisia Aster Begonia Caladium Carnation Chrysanthemum Coleus Daisy English ivy Foxglove Gaillardia Geranium Impatiens Marigold Pansy Petunia Phlox Pinks Primrose Prostrate Rosemary Salvia Snapdragon Verbena Vinca Zinnia	**Drench at Seeding** (Soil 2-3 inches deep): Mix 0.13-0.25 oz. with 100 gals. of water and apply 1 pt. Of solution per sq. ft. to the soil surface. **Drench at Transplanting** (Soil 2-3 inches deep): Mix 0.5-1 fl. oz. with 100 gals. of water and apply 1 pt. of solution per sq. ft. to the soil surface. For growth media depth greater than 4 inches, apply 1 1/2-2 pts. of solution per sq. ft. to the soil surface. Repeat application at 1 to 2-month intervals, if necessary. Do not apply rates of 0.75-1 fl. Oz/100 gals. more often than once every 6 weeks. **Pre-Potting Growing Media Mix At Seeding and at Transplanting:** Apply to growing media mix just before planting. Mix only enough for current use. Do not store. Thoroughly mix 0.13 fl. oz. With each cu. yd. of pre-potting growing media. **Soil Surface Spray:** Apply 1 fl. oz./1,000 sq. ft. to the soil surface in a broadcast or banded spray in sufficient water to obtain thorough coverage of the plant root zone. For best efficacy, irrigate in with at least 1/2 inch of water within 24 hours.
Flowers African violet Anthurium Baby's breath Carnation Chrysanthemum Columbine	**Drench:** Mix 0.5-1 fl. oz. with 100 gals. of water and apply 1 pt. of solution per sq. ft. to the soil surface. For growth media depth greater than 4 in., apply 1 1/2-2 pts. of solution per sq. ft. to the soil surface. Repeat applications at 1 to 2-month intervals, if necessary. Do not apply rates of 0.75-1 fl. oz./100 gals. more often than every 6 weeks.

Flowers *(continued)* Delphinium Easter Lily Geranium Gloxinia Poinsettia Rose	*(continued)* *Precaution: Do not apply more than 0.5 fl. oz./100 gals. of water to Easter lily and only make one at-planting application.* **Soil Surface Spray:** Apply 1 fl. oz./1,000 sq. ft. to the soil surface in a broadcast or banded spray in sufficient water to obtain thorough coverage of the plant root zone. For best efficacy, irrigate in with at least 1/2 in. of water within 24 hours.
Azaleas	**Drench:** Phytophthora root and crown rot—Mix 0.63-1.25 fl. oz. with 100 gals. of water and apply 1 pt. of solution per sq. ft. to the soil surface. For growth media depth greater than 4 in., apply 1 1.2-2 pts. of solution per sq. ft. to the soil surface. Repeat applications at 2 to 4-month intervals, if necessary. **Soil Surface Spray:** Apply 1.25-2.50 fl. oz./1,000 sq. ft. to the soil surface in a broadcast or banded spray in sufficient water to obtain thorough coverage of the plant root zone. For best efficacy irrigate in with at least 1/2 in. of water within 24 hours. *Precautions: (1) To minimize the potential for injury to azaleas, do not apply repeat soil applications of 1.25 fl. oz./100 gals. closer than every 3 months, and do not exceed a total of 2.5 fl. oz. in 6 months. (2) Use the lower rate for "Coral Bell" variety.*
Woody Ornamentals Other Than Azaleas Aucuba japonica Arborvitae Boxwood Ceanothus Cotoneaster Dogwood Ficus "Halls" Honeysuckle Ilex *Juniperus* spp. Photinia *Pieris japonica* *Pinus* spp. Pittosporum Rhododendron White cedar White pine Yew	**Drench:** Mix 1-2 fl. oz. with 100 gals of water and apply 1 pt. of solution per sq. ft. to the soil surface. For growth media depth greater than 4 in., apply 1 1/2-2 pts. of solution per sq. ft. to the soil surface. Repeat application at 2 to 3-month intervals, if necessary. Do not apply rates of 2 fl. oz./100 gals. more often than every 10 weeks. **Soil Surface Spray:** Apply 1.25-2.50 fl. oz./1,000 sq. ft. to the soil surface in a broadcast or banded spray in sufficient water to obtain thorough coverage of the plant root zone. For best efficacy, irrigate in with at least 1/2 in. of water within 24 hours.

Interiorscape and Individual Plant Use

In situations where water volumes used are much less than 100 gals. and the area treated is small, the following table provides the **Vexsion Supreme™** rates to make small quantities of solution. Refer to the plant type for the correct fl. oz. of product to use when utilizing this table.

Rate of Vexsion Supreme™ (fl. oz.)	Amount of Vexsion Supreme™ to add to water to make the following quantities			
	1 gal.	5 gals.	10 gals.	25 gals.
0.25	4 drops	18 drops	37 drops/ 0.75 ml	1.9 ml/ 3/4 tsp.
0.5	7 drops	37 drops/ 0.75 ml	75 drops/ 1.5 ml	3.8 ml/ 3/4 tsp.
1.0	15 drops	75 drops/ 1.5 ml	3.0 ml/ 1/2 tsp.	7.5 ml/ 1.5 tsp./ 1/2 Tbsp.
1.5	22 drops	3.0 ml/ 1/2 tsp.	4.5 ml/ 1 tsp.	11.3 ml/ 2.25 tsp./ 3/4 Tbsp.
2.0	30 drops	4.5 ml/ 1 tsp.	6.0 ml/ 1.5 tsp.	15 ml/ 3 tsp./ 1 Tbsp.

Soil Drench: Apply enough solution to the soil surface to wet the root area of the plant.

Citrus in Nurseries and Landscape Plantings (Nonbearing)

Use **Vexsion Supreme™** on nonbearing citrus for control of citrus foot rot, root rot, and trunk canker caused by *Phytophthora* spp. Apply to the soil as a drench or as a spray in a banded application.

Make the first application of **Vexsion Supreme™** at the time of planting. Make repeat applications at 3-month intervals during the period when trees are actively growing.

Soil Drench: Mix 2-3 fl.oz./100 gals. of water and apply as a drench to the soil at the rate of 100-250 gals./1,000 ft. of row. The width of the drench treatment should be wide enough to cover the root systems of the plants. Avoid application to the foliage.

Soil Surface Spray: Apply 1 gal./A of treated soil in a broadcast or banded surface spray to seedbeds, liners, or bedded stock in sufficient water to obtain uniform coverage. If applications are banded, the treated area should be wide enough to cover the root systems of the plants. Avoid application to the foliage. For best efficacy, 1/2 in. irrigation or rainfall is required within 24 hours after application.

Calculate the amount of **Vexsion Supreme™** needed for a banded treatment by using the formula at the end of the General Information section of this label.

Attention: Do not use in greenhouse citrus nursery stock intended for commercial fruit production.

Conifers in Nurseries and Plantations (Including Christmas Trees)

Vexsion Supreme™ provides control of Phytophthora root rot of conifers. For best efficacy, 1/2 in. irrigation or rainfall is required within 24 hours after application.

Conifers in Nurseries

Conifers in Plantations
Use of **Vexsion Supreme™** will aid in the control of Phytophthora root rot when used in conjunction with good cultural practices. The use of **Vexsion Supreme™** will not overcome poor management practices, such as planting on sites that are prone to flooding or are poorly drained. **Vexsion Supreme™** fungicide will not revitalize trees showing moderate to severe disease symptoms.

Seedlings and Plug-Plantings	**Soil Surface Spray:** Apply 1.25 pts. of **Vexsion Supreme™** in at least 50 gals. of water per acre in the spring and again in the fall.
2-0 Transplants	**Soil Surface Spray:** Apply 2.5 pts. of **Vexsion Supreme™** in at least 50 gals. of water per acre in the spring and again in the fall.

Soil Surface Applications: Apply 0.63-1.25 gals. of **Vexsion Supreme™** per acre in a minimum of 50 gals. of water as a directed soil spray. Do not apply as a foliar spray. Applications should be made in early spring before growth starts and in the fall before the ground freezes. Calculate the amount of **Vexsion Supreme™** needed for a banded treatment by using the formula the end of the **General Information** section of the label.

Deciduous Fruits and Nuts in Nurseries (Nonbearing)

Vexsion Supreme™ provides control of Pythium root rot and Phytophthora root, crown, and collar rot of nonbearing deciduous fruits and nuts.

Soil Surface Application: Apply 3 fl. oz./1,000 sq. ft. in sufficient water to obtain thorough coverage of the soil under the canopy of the trees. Avoid application to the foliage. Treat sufficient surface area in nurseries to cover the root zone of the plants. Additional applications may be made as necessary at 3-month intervals during the growing season. For best efficacy, 1.2 in. irrigation or rainfall is required within 24 hours after application.

Notes: (1) Do not apply to trees that will bear harvestable fruit within 12 months of the last application, or possible illegal residues may results. (2) Do not apply more than 9 fl. oz.1,000 sq. ft. (3 gals./A) of **Vexsion Supreme™** per year.

Turf (Golf Courses, Lawns, Landscape Areas around Residential, Institutional, Public, Commercial and Industrial Buildings, Parks, Recreational Areas, And Athletic Fields, Sod Farms)

Vexsion Supreme™ Controls Pythium blight and Pythium damping-off in turf, yellow tuft (downy mildew) in bluegrass, and downy mildew in St. Augustinegrass. *Within the rate range given for turf, use the lower rate or the shortest interval listed and the higher range given for turf, use the lower rate for the shortest interval listed and the higher rate for the longest interval. Under severe disease conditions, use the highest rate and shortest interval.*
Note: For control of other diseases of turf, use Banner alone or in a tank-mix combination with **Vexsion Supreme™**. Refer to Banner label for rates, precautions, restrictions, etc.

Resistance Management Precautions: To minimize the potential for insensitivity, (1) make no more than 3 applications per season of any product in which the **Vexsion Supreme™** *active ingredient is applied alone, and (2) apply an alternate EPA-registered fungicide for Pythium control at least once during the season.*

Established Turf Pythium Blight Yellow Tuft Downy Mildew	**Foliar Application:** Apply as a preventive treatment at 0.5-1 fl. oz. in 1-5 gals. of water per 1,000 sq. ft. Retreat at 10 to 21-day intervals. During periods of prolonged conditions favorable for disease development, use 0.5-1 fl. oz. on a 14-day schedule.
Newly Seeded Areas Pythium Damping-off Pythium Blight Yellow Tuft Downy Mildew	**Soil Surface Spray:** Apply 0.5-1 fl. oz. in 1-5 gals. of water per 1,000 sq. ft. immediately after seeding. Re-treat at 7 to 14-day intervals if conditions remain favorable for disease. For best efficacy, 1.2 in. irrigation or rainfall is required within 24 hours after application. **Note:** For long-term control of Pythium in areas when using seed treated with the active ingredient contained in **Vexsion Supreme™**, make an application of **Vexsion Supreme™** 7-10 days after seeding.

Rotational Crops

Do not plant any crop which is not registered for use with the **Vexsion Supreme™** active ingredient in soil treated with this active ingredient for a period of 12 months.

Storage and Disposal

Do not contaminate water, food, or feed by storage or disposal. Open dumping is prohibited.

Pesticide Storage
Store in original containers only. Keep container closed when not in use. Do not store near food or feed. In case of spill on floor or paved surfaces, mop and remove to chemical waste storage area until proper disposal can be made if product cannot be used according to label.

Pesticide Disposal
Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law. If these wastes cannot be disposed of

by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office.

Container Disposal
Do not reuse empty container. Triple rinse (or equivalent), then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill or alternatives allowed by State and local authorities.

Container Refilling and Disposal
This is a refillable container. If the container is to be refilled, do not rinse with any material or introduce any pesticide other than **Vexsion Supreme™**. Reseal and return the container to an authorized IDACHEM refilling facility. If the container is not to be refilled, triple rinse (or equivalent) and offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill or alternatives allowed by State and local authorities.

For Bulk and Minibulk Containers
Container Disposal: Reseal container and offer for reconditioning, or triple rinse (or equivalent) and offer for recycling or reconditioning, or clean in accordance with manufacturer's instructions.

Container Precautions: Before refilling, inspect thoroughly for damage, such as cracks, punctures, bulges, dents, abrasions, and damage or worn threads on closure devices.

Refill Only With Vexsion Supreme™. The contents of this container cannot be completely removed by cleaning. Refilling with materials other than **Vexsion Supreme™** will result in contamination and may weaken container. After filling and before transporting, check for leaks. Do not refill or transport damaged or leaking containers.

For minor spills, leaks, etc., follow all precautions indicated on this label and clean up immediately. Take special care to avoid contamination of equipment and facilities during cleanup procedures and disposal or wastes. In the event of a major spill, fire or other emergency, call 1-800-888-8372, day or night.

Container is not safe for food, feed or drinking water.

For product information, call:
1-888-IDA-CHEM

Visit our website at:
www.idachem.com/ag/com/

IDACHEM Inc.
1313 Small Particle Road
Boise, Idaho 83714

IDACHEM

This is a fictitious pesticide label for training and testing purposes only.

Appendix E – Section 25(b) Label

This product has not been registered by the United States Environmental Protection Agency. Inventek Colloidal Cleaners, LLC represents that this product qualifies for exemption from registration under the Federal Insecticide, Fungicide, and Rodenticide Act. Per EPA PR Notice 2000-6 minimum risk criteria under FIFRA Section 25(b).

Appendix F – Chemigation Advisory

STATE OF IDAHO

DEPARTMENT OF AGRICULTURE

C.L. "BUTCH" OTTER
Governor
CELIA R. GOULD
Director

Chemical Injection Systems for Residential, School, Commercial and Municipal Landscapes

January 2008

The purpose of this notice is to provide manufacturers, retailers and operators of residential, school, commercial and municipal chemical injectors with information that will help them understand Idaho State Department of Agriculture (ISDA) requirements associated with these chemical injectors and the chemical products used in the injectors.

Chapter 34, Title 22, Idaho Code, known as the Pesticides and Chemigation Law, and IDAPA 02.03.03, Rules Governing Pesticide and Chemigation Use and Application, are referenced in this document to establish a clear understanding of chemigation equipment certification, chemigation equipment requirements for injection of chemicals into water sources and licensing requirements. The referenced documents are available at ISDA offices or on the ISDA web site at www.agri.idaho.gov/Categories/Pesticides/pesticidelawsandrulesphp.php

Chemicals

Is the product you manufacture/sell or recommend to be used in the injector you manufacture/sell considered by Idaho Code to be a chemical?

Idaho Code section 22-3401 defines the following terms:

> (4) "Chemical" means any fertilizer or pesticide.
> . . .
> (15) "Fertilizer" means any formulation or product used as a plant nutrient which is intended to promote pant growth and contains one (1) or more plant nutrients.
> . . .
> (23) "Pesticide" means but is not limited to (a) any substance or mixture of substances intended to prevent, destroy, control, repel or mitigate any insect, rodent, nematode, snail, slug, fungus, weed and any other form of plant or animal life or virus, except virus or fungus on or in living man or other animal, which is normally considered to be a pest or which the director may declare to be a pest, and (b) any substance or mixture of substances intended to be used as a plant regulator, defoliant or desiccant, and (c) any spray adjuvant.

If the product you sell or recommend to be used in an irrigation system injector is a "Fertilizer" or "Pesticide" as defined by Idaho Code, injection of the product must be in compliance with the Idaho chemigation laws and rules.

Plant nutrients such as nitrogen, phosphorus, potassium (NPK) and micronutrients (i.e. boron (B), chlorine (Cl), cobalt (Co), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), sodium (Na), etc. are fertilizers that are regulated by Idaho chemigation laws and rules. Injection of any product that contains one (1) or more of these elements into an irrigation system to promote plant growth is considered chemigation under Idaho Code (Idaho Code § 22-3401(5)).

Although a pesticide product may contain what is considered to be "organic" compounds (i.e. eugenol, cedarwood oil, lemongrass oil, peppermint oil, citronella, etc.) it is, by Idaho Code definition, a pesticide if labeling or technical data makes claims that the product prevents, destroys, controls, repels or mitigates pests. EPA registered pesticides approved for application by chemigation will contain chemigation information (authorization) in the product's label directions.

Unprocessed animal manure, composted materials, hydro-compost, humic acid, yeast, amino acids, fulvic acid and soil amendments are not defined as chemicals under Idaho Pesticides and Chemigation Law. Injection of these materials into irrigation systems is not regulated by IDAPA 02.03.03, Rules Governing Pesticide and Chemigation Use and Application, but, in some cases, may be regulated by other Idaho statutes or federal regulations to protect the waters of the state.

If distributed in Idaho, all pesticides, adjuvants and fertilizers must be registered with ISDA. Contact ISDA Pesticide Registrations at 1-208-332-8593 for pesticide and adjuvant registration or ISDA Plant Industries, Feed and Fertilizer Program at 1-208-332-8625 for fertilizer registrations. Or visit the ISDA web site at www.agri.idaho.gov and go to the Division of Agricultural Resources (pesticide registration – includes adjuvants) or Division of Plant Industries (fertilizer registration).

Chemigation

Idaho Code section 22-3401 defines the following terms:

> (5) "Chemigation" means any process whereby chemicals are added to irrigation water applied to land, crops or plants through an irrigation system, such as, but not limited to, agricultural, nursery, turf, lawn, golf course and greenhouse sites.
>
> . . .
>
> (17) "Irrigation system" means any device or combination of devices having a hose, pipe, or other conduit which connects directly to any source of ground or surface water, through which water or a mixture of water and chemicals is drawn and applied to land, crops or plants. The term does not include any hand-held sprayer or other similar device which is constructed so that an interruption in water flow automatically prevents any backflow into the water source.

Note that, by definition, addition of chemicals to lawn irrigation systems is chemigation and is subject to ISDA chemigation laws and rules.

Chemigation Equipment Requirements

Chemigation laws and rules in Idaho specifically require the installation of ISDA approved anti-backflow devices and other equipment to prevent backflow of chemicals into the water source and/or chemical supply tank.

IDAPA 02.03.03.962.03 lists specific equipment requirements:

> Domestic Water Supply System Cross-Connected for Chemigation. Any irrigation system used for chemical application cross-connected to a domestic water supply system shall verify that the system complies with either Subsection 962.03.a or 962.03.d. and shall include all other additionally specified equipment for each;
>
> a. Reduced Pressure Principle Backflow Prevention Assembly (RP). The irrigation system shall contain a functional reduced pressure backflow preventer assembly (RP); and
>
> i. The RP assembly shall be located on the irrigation pipeline between the water supply pump and the point of chemical injection, and downstream from any domestic water supply diversion point.
>
> ii. The purpose of a Reduced Pressure Principle Backflow Prevention Assembly (RP) is to keep contaminated water from flowing back into a domestic water supply system when some abnormality in the system causes pressure to be temporarily higher in the contaminated part of the system than in the domestic water supply system piping.

IDAPA 02.03.03.962.03.a.iii continues with information on RP valve testing and certification.

The chemigator must assure the RP valve is installed and in operable condition before injecting chemicals into an irrigation system that uses a municipal or domestic water supply. Manufacturers of chemical injectors that are installed in irrigation systems that use domestic or municipal water as the water source typically list the RP valve as a necessary component of the injector installation.

An alternative to the RP valve is the Air Gap backflow prevention configuration as described in IDAPA 02.03.03.962.03.d:

> Air Gap (AG). The water from the domestic water supply system shall be discharged into a reservoir tank prior to the chemical injection. An air gap shall be at least double the diameter of the supply pipe measured vertically above the overflow rim of the vessel – in no case less than one (1) inch. Chemical injection shall not occur upstream of the air gap.

The air gap configuration is typically used in greenhouse chemigation systems.

Chemical Injection System

The chemical injection system can be a metering pump that is constructed of materials that are compatible with chemicals and capable of being fitted with a system interlock or a Venturi system which must also be constructed of chemically resistant materials.

IDAPA 02.03.03.965 discusses chemical injection systems and states:

> All chemical injection systems, except for flood, basin, furrow, or border chemigation through a gravity flow system, shall use:
>
> 01. Metering Pump. A metering pump such as a positive displacement injection pump effectively designed and constructed of materials that are compatible with chemicals and capable of being fitted with a system interlock; . . .

Injection pumps that meter the amount of chemical being distributed into irrigation systems by means of moving parts such as diaphragms, impellers, pistons, etc. and are powered by electricity, water pressure or other power sources are considered metering pumps.

IDAPA 02.03.03.965 also discusses Venturi systems and states:

> 02. Venturi System. Venturi systems including those inserted directly into the main water line, those installed in a bypass system, and those bypass systems boosted with an auxiliary water pump. Booster or auxiliary water pumps shall be connected with the system interlock such that they are automatically shut off when the main line irrigation pump stops, or in cases where there is no main line irrigation pump, when the water pressure decreases to the point where pesticide distribution is adversely affected. Venturies shall be constructed of chemically resistant materials. The line from the chemical supply tank to the Venturi shall contain a functional, automatic, quick closing check valve to prevent the flow of liquid back toward the chemical supply tank. This valve shall be located immediately adjacent to the Venturi chemical inlet. This same supply line shall also contain either a functional normally closed solenoid-operated valve connected to the system interlock or a functional normally closed hydraulically operated valve which opens only when the main water line is adequately pressurized. In bypass systems as an option to placing both valves in the line from the chemical supply tank, the check valve may be installed in the bypass immediately upstream of the Venturi water inlet and either the normally closed solenoid or hydraulically operated valve may be installed immediately downstream of the Venturi water outlet.

Injection equipment that does not depend on electric power, an internal combustion engine or water pressure to operate a diaphragm, piston or other moving part is considered a Venturi system. Pressure differential type injectors are Venturi systems when considered under IDAPA 02.03.03 and must meet Venturi system interlock requirements.

System Interlock

IDAPA 02.03.03.965.01 states that a metering pump "must be capable of being fitted with a system interlock." While ISDA encourages manufactures to include the components of the system interlock with the chemical injector, the rule requires that the components must be capable of being fitted with a system interlock as listed in IDAPA. The burden lies on the person using the chemigation system to assure the system interlock is in place and operational.

IDAPA 02.03.03.963 discusses chemical injection line shut down (system interlock) and states:

> In every chemigation system, there shall be a functional system interlock designed and installed to shut down the chemical injection unit when chemical distribution is adversely affected. The system interlock shall connect the water supply pump and the chemical injection unit or connect the irrigation line pressure switch and the chemical injection unit if there is no water supply pump and the system is pressurized. The chemical injection line shall contain one (1) of the following options found in Subsections 963.01 through 963.05, to ensure that a chemical injection pump will stop if the irrigation pump stops to prevent the entire chemical mixture from emptying from the supply tank into the irrigation pipeline:

The interlock options discussed in IDAPA 02.03.03.963 are electrical, mechanical, hydraulic, and human.

Electrical Interlock: Interlocks irrigation pump with electric powered injection pump (chemical injector).

Mechanical Interlock: Interlocks an internal combustion engine driven pump with the injection pump (chemical injector).

Hydraulic Interlock: Interlocks main water line pressure with a normally closed, hydraulically operated check valve located in the injection line between the chemical tank and the injection point.

Human Interlock: Human supervision on-site during the injection of a chemical into the irrigation system. Injection is limited to less than one (1) hour injection time.

Each of these four system interlocks have their own requirements (i.e. must have an injection line check valve installed, must use solenoid operated valves, pressure switches, etc.). System Interlock requirements can be viewed on pages 26 and 27 of IDAPA 02.03.03, Rules Governing Pesticide and Chemigation Use and Application. Manufacturers of chemical injection equipment should consider which type of system interlock works best for their equipment and design the equipment to accommodate the system interlock.

If an Injection Line Check Valve is installed, as required in IDAPA 02.03.03. 963.01 (Electrical Interlock), -02 (Mechanical Interlock) and -04 (Human Interlock), it must have a minimum of ten (10) psi opening (cracking) pressure plus one (1) psi per foot of chemical tank elevation above the point of chemical injection.

Refer to **IDAPA 02.03.03 964.01.a, b, c, d** for other information concerning the Injection Line Check Valve.

Injection line check valves must meet ISDA approval criteria and be placed on ISDA's list of approved chemigation equipment before being used for chemigation purposes in Idaho. All of ISDA approved check valves have at least a 10 psi cracking pressure and, currently, only one company has an ISDA approved valve that is ¼" inside diameter. The list of approved injection line check valves may be viewed on the ISDA web site at www.agri.idaho.gov/Categories/Pesticides/Documents/Chemigation/ApprovedChemEquip11-13.pdf (page 3).

Chemigation Licensing

Idaho Code section 22-3401(28) defines a "Private Applicator" as:

> [A] person who (a) uses or supervises the use of restricted-use pesticides to produce agricultural commodities or forest crops on land owned or rented by him or his employer; or (b) applies restricted-use pesticides on the property of another without compensation other than the trading of personal services between producers of agricultural commodities; or (c) applies chemicals through irrigation systems on land owned or rented by him or his employer.

Operators of chemical injectors used in residential, school, commercial and municipal irrigation systems fall under the definition of "Private Applicator" if the operator or his employer owns or rents the land being treated. ("... (c) applies chemicals through irrigation systems on land owned or rented by him or his employer.")

Anyone who applies chemicals through an irrigation system (including lawn irrigation systems) for compensation would fall under the definition of a "Professional Applicator."

Idaho Code section 22-3401(29) defines "Professional Applicator" as:

> [A] person who (a) applies pesticides upon the land or property of another for compensation, or applies chemicals through irrigation systems upon the land or property of another for compensation; ..."

Complianee with chemigation licensing requirements is the responsibility of chemical injector operators. This licensure is also a concern to chemical dealers (including landscape companies and retail outlet stores) who carry the burden of assuring the person purchasing the product for use in a chemigation system has an ISDA applicator license (Private or Professional) with a chemigation (CH) category.

Idaho Code section 22-3406A states the responsibilities of chemical suppliers;

> Any person who supplies or sells at retail a chemical and who knows or has reason to know that the chemical will be applied by chemigation shall sell chemicals only to licensed professional or private applicators with a chemigation category.

ISDA has provided this information to help you understand Idaho's laws and rules as applied to the certification of chemical injection systems for use on irrigation systems and licensing of operators of chemical injection equipment. Our goal is to protect water supplies from contamination by assuring that chemical injectors meet ISDA requirements, operators of chemical injection systems are licensed and that all chemigation laws and rules are followed. If you have questions concerning Idaho chemigation laws and rules, equipment certification, product registration or operator licensure, please contact Jim Childs, ISDA Chemigation Program Specialist at (208) 736-4790 or e-mail your questions to jchilds@agri.idaho.gov.

This manual produced by the Idaho State Department of Agriculture to promote the education and training of chemigators throughout the state. Idaho State Department of Agriculture provides pesticide applicator and chemigator certification and training programs, activities and materials without regard to race, color, religion, national origin, sex, age or disability in accordance with state and federal laws.

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