CHAPTER 6

SAFE HANDLING OF METAM-SODIUM ROOT CONTROL PRODUCTS

Learning Objectives

After you complete your study of this unit you should be able to:

- understand the significance of the Equation "Hazard = Toxicity X Exposure".
- utilize first aid procedures when using metam-sodium products.
- select and wear appropriate personal protective equipment.
- utilize safe practices when storing, mixing, handling, disposing and transporting pesticides.
- explain a closed handling system
- know how to conduct spill control procedures and contact appropriate authorities.

Most pesticides are designed to kill pests. Because some pests have systems similar to the human system, some pesticides can harm or kill humans. Some pesticides (Danger label) are highly toxic to humans whereas others (warning or caution labels) are less toxic. The chance of an individual being harmed by a pesticides is frequently depicted by the equation: **Hazard = Toxicity X Exposure**. Hazard is the risk of harmful effects from pesticides. Hazard depends on both the toxicity of the pesticide and the amount of contact (exposure) with that pesticide.

Types of exposures. Pesticides contact your body in four ways.

- oral exposure (swallowing a pesticide),
- inhalation exposure (breathing pesticide fumes),
- ocular exposure (splashing pesticide in your eyes), or
- dermal exposure (pesticide on your skin)

Toxicity. The toxicity of a particular pesticide depends on a number of factors:

- type and amount of active ingredient(s),
- type and amount of carriers,
- type and amount of inert ingredients, and
- type of formulation.

Harmful effects. Pesticides can cause three types of harmful effects: acute effects, delayed effects, and allergic effects.

Acute effects usually occur within 24 hours after exposure to a pesticide as a result of a single exposure to a high level of pesticide. These effects are easy to determine.

Delayed effects do not appear until long after exposure to a pesticide. Usually, these effects are a result of repeated exposures to low levels of a pesticide. These

effects are much more difficult to determine. Especially, with conditions such as cancer, birth defects, etc.

Allergic effects are reactions to a substance that do not cause the same reaction in other people. These are thought to occur in a person's first exposure to a substance. The first exposure causes the body to develop a repelling effect, and subsequent exposures will result in the allergic response. These allergic effects can be:

- systemic effects such as asthma,, or life threatening shock,
- skin irritation such as rashes, blisters or open sores, and
- eye and nose irritation, such as itchy, watery eyes and sneezing.

First Aid and Pesticide Poisoning Recognition

Pesticide Poisoning Recognition

Watch for two kinds of clues to determine pesticide related illness or injury. One is where the affected individual experiences such symptoms as nausea or headache. The other, like vomiting or fainting can be noticed by others. The applicator should know what these signs mean, and what signs to look for in coworkers and others who may have been exposed.

Poisoning by certain families of pesticide will result in distinctive signs that help others recognize the cause of poisoning. For example organophosphate and carbamate pesticides are identified by pin pointing pupils of the victims eyes. Arsenic and phosphorus poisoning is often identified by a garlic odor on the victim's breath. If you have been working with pesticides and then develop suspicious signs and symptoms visit your doctor or nearest medical facility. Only a physician can diagnose pesticide poisoning injuries.

First Aid for Metam-Sodium Root Control Products Exposure

Read the first aid instructions on the label of a metam-sodium root control pesticide. Immediately start procedures shown below and transport the victim to a poison control facility, poison control center or a physician. Provide medical personnel with the name of the pesticide, type and extent of exposure, victim's symptoms, and if possible a copy of the pesticide's label. The following practical treatment should be provided if the pesticide was:

- **on the skin:** Immediately flush the skin with large amounts of water while removing contaminated clothing. Seek medical attention if symptoms develop.

- **in the eyes:** Immediately flush the eyes with large amounts of water for at least 15 minutes. Hold eyelids apart to ensure adequate rinsing of the entire eye surface and lids. Seek medical assistance.
- **inhaled:** Remove the victim to fresh air. If breathing has stopped, clear the victim's airway and begin artificial respiration (mouth to mouth). If breathing is

labored give oxygen, preferably under a medical expert's advice. Seek immediate medical assistance.

- **swallowed**: Immediately give several glasses of water. **DO NOT INDUCE VOMITING.** If vomiting does occur, give fluids again. Do not give anything by mouth to an unconscious person. Seek immediate attention.

Protecting Your Body

When a pesticide is purchased, the buyer has very little control over the toxicity of the product. The applicator may select the least toxic of the products available for a particular job. Also, the applicator can select the least toxic formulation available for a particular (dry formulations are less likely to be absorbed than liquid formulations). However most factors are determined by the manufacturer. For root control in sewers, metam-sodium with dichlobenil is the pesticide of choice. This does not allow an applicator many options for selection. The pesticide available has a **DANGER** signal word which indicates it is highly toxic. Further, Metam-sodium is a liquid formulation which is absorbed more readily than a dry formulation, by the body. The only means available to the applicator to control a hazard from metam-sodium is to limit exposure to that pesticide.

Personal Hygiene. Since pesticides can be absorbed through the skin, it is important to shower at the end of every day you have been working with pesticides. Wash your body and scalp thoroughly with soap and water. In addition, wash your hands before eating, drinking, smoking and chewing gum or tobacco. Also, since pesticides are easily absorbed through the genitals, wash you hands before using the bathroom. Always have soap, water and paper towels available on the job site in case you contact the pesticide.

Personal Protective Equipment.The best method of protecting your body from exposure to a pesticide would be to erect an impermeable barrier between you and the pesticide. Since you work with pesticides, that may require mixing and applying in unusual places, this would be impossible. The next best method of placing a barrier, of sorts, between you and the pesticide is through the use of personal protective equipment (PPE). PPE is clothing and devices worn to protect the human body from contact with pesticides or pesticide residues.

Ordinary shirts, pants, shoes and regular work clothing are not considered PPE, although he pesticide's label/labeling may require you to wear specific items of work clothes during some activities. **You are legally required to follow all PPE instructions that appear on the label or in he labeling**.

To prevent pesticides from entering the body you must wear protective clothing and equipment. The applicator must follow all advice about protective clothing or equipment which appears on the chemical product label. However, the lack of any statement or the mention of only one piece of equipment does not rule out the need for additional protection. No safety recommendations can cover all situations. Your common sense and knowledge of pesticide toxicity should help you assess the hazard and select the kind of protection you need. The following protective

clothing is required for those applicators actually engaged in carrying out any operations that are likely to involve direct contact with metam-sodium root control chemicals, including:

- mixing - loading,
- equipment calibrations or adjustments,
- cleaning and repair of application equipment,
- entering into treated areas,
- sampling,
- cleanup of spills,
- rinsate disposal, or
- any other activity likely to result in direct contact with the product.

The following protective equipment must also be used for any operations that are carried out within six feet of unshielded, pressurized hoses containing metam-sodium.

- Splash resistant eye protection,
- Body covering including shirt and long pants or long-sleeved clothing. When a closed system is not used, mixers and loader must also wear chemical-resistant apron or cloth coveralls, and
- Chemical-resistant boots and elbow length gloves.

The following protective equipment must be *worn at all times* by people operating or monitoring metam-sodium root control application equipment:

- Chemical-resistant footwear, and
- Body covering including shirt and long pants or long sleeved clothing.

Also, the following protective equipment must be available, at all times, for use by people operating or monitoring application equipment:

- A proper fit tested NIOSH or MSHA approved, half face, respirator with organic vapor cartridge(s) plus splash resistant eye protection or a NIOSH or MSHA approved full face respirator with organic vapor cartridge(s). **This equipment must be worn in case of emergencies or leaks when the pungent, rotten egg, or sulfur-like odor of metam-sodium is detected.**
- Chemical-resistant gauntlet-type gloves. **These must be worn when a person is engaged in carrying out any operation that is likely to involve direct hand contact with the product.**

Body Covering. Any time you handle pesticides you should wear at least a long-sleeved shirt and long-legged trousers, or a coverall-type garment. This apparel should be made of woven or laminated fabric. The sewer technician mixing or loading chemical must also wear a chemical resistant apron or cloth coveralls.

Gloves. When handling concentrated or highly toxic pesticides wear chemical resistant gloves. For the liquid formulation of metam-sodium root control chemicals chemical resistant gloves are required. The gloves must be long enough to protect the wrist and gauntlet-type to keep pesticides from running down the sleeves. Gloves should not be lined. The lining absorbs chemicals and is hard to clean.

*Hat***.** Plastic "hard hats" with plastic sweatbands are chemical resistant and are cool in hot weather. Hard hats are a normal requirement of sewer technicians and should be worn for confined space entry by the worker and the assistant outside the confined space.

*Shoes and Boots***.** Chemical resistant footwear is required apparel at all times by people operating or monitoring application equipment for metam-sodium root control products. Neoprene or rubber boots are a wise precaution with many pesticide applications because canvas, cloth, and leather shoes can readily absorb pesticides. Wear unlined boots with trouser legs outside the boots so the pesticide will not run down the leg and collect in the boot.

Goggles or Face Shield. Wear goggles or a face shield when there is any chance of getting pesticide in your eyes. Eyes readily absorb pesticides and the temporary blindness caused by an accident may delay or prevent self treatment. You can wear goggles alone or with a respirator.

Care of Clothing. Wear clean clothing daily. If clothes get wet with pesticides change them immediately. Always keep a clean changes of clothing on the work site for such emergencies. When laundering contaminated clothing, gloves should be worn and contaminated clothing should not be washed with family laundry. Wash hats, gloves, and boots daily, inside and out. Hang them to dry. Test gloves for leaks by filling them with water and gently squeezing. Check the product's label and labeling for any special instructions

Wash goggles or face shields at least once a day. Wear neoprene headbands, if possible. Elastic fabric headbands often absorb pesticides and are difficult to clean. Have some spares available so you can replace them as necessary.

Respirators. The respiratory tract, the lungs and other parts of the breathing system, is much more absorbent than the skin. You must wear an approved respiratory device when the label directs you to do so. Even if the label does not require it, you should always wear respiratory protection under the following conditions:

- if the pesticide you are mixing or applying has a label precautionary statement such as "do no breathe vapors or spray mist", or "harmful or fatal if inhaled,"
- during calibration and adjusting of equipment if you are using pesticides with the above precautionary statement,
- if you will be exposed to a pesticide for a long time, and
- if you are working in an enclosed area.

If you have trouble breathing while wearing a respiratory device, see your physician to determine if you have a respiratory problem. Note: some states may require a physicians examination before an employee can wear a respirator. Respirator selection and fit are extremely important. Always follow the manufacturers recommendations on fitting procedures. Always use NIOSH or MSHA approved equipment with cartridges or canisters recommended for the pesticide products being used. The metam-sodium root control products require a half-face or full face respirator with an organic vapor cartridge. The respirator is required to be worn when the pungent rotten egg or sulfur-like odor of metam-sodium is detected.

Cartridge Respirator. You should wear this kind of respirator when you will be intermittently exposed to a pesticide. Inhaled air is drawn through both a fiber filter pad and a cartridge to absorb pesticide vapors. Most harmful vapors, gases, and particles are removed. These half-face masks cover the mouth and nose. To cover the eyes also, use one that is combined with goggles, or wear separate goggles.

Canister Respirator (gas mask). You should wear this kind of respirator when you will be continuously exposed to a pesticide. The canister has longer-lasting absorbent material and filters than the cartridge respirator. Gas masks usually provide full-face protection. Neither cartridge nor canister respirators will protect you from high concentrations of vapor, and neither kind is effective when the oxygen supply is low; for example, inside manholes, tanks, or lift stations. In these cases an air supplying respirator or self-contained breathing apparatus (SCBA) will be required.

Maintenance of Respirators. When applying pesticides, change filters, cartridges, and canisters according to the equipment's instruction label or daily. Replacement filters, cartridges or canisters should always be available at the work site. Remove and discard filters, cartridges, and canisters after use. Then wash the face piece with detergent and water, rinse it, and dry it with a clean cloth. Put in an air tight bag and store it in a clean, dry place away from pesticides.

Safety Procedures for Personnel Working in Wastewater Systems

Company Policy and Confined Space

In the wastewater industry the dangers of working with pesticides is coupled with the dangers inherent in the working conditions of the wastewater system. It is very important that the applicator's firm or municipality have procedural policies, for safety, that each employee is aware of and is required to follow.

Company policies should include basic statements noting that no worker is required to undertake a task if the worker: 1) does not feel that the job is safe or healthful, 2) was not provided with adequate training or necessary safety equipment, 3) is not provided with the proper job instructions. Workers should be aware that these basic rights are protected by the Occupational Safety and Health Administration.

Entry Procedures

The sewer applicator should follow the company's or municipality's policies in entering confined spaces. These policies should include specific instructions in:

- testing for toxic gases,

- monitoring air quality,
- ventilating work area, and
- using safety harness for emergency ascent

Transporting, Storage, Mixing, Handling Pesticides

Transporting Pesticides

The sewer applicator is responsible for the safe transport of pesticides in his/her possession. Pesticides should be transported in the back of a truck, and all containers should be secured to prevent breakage and spillage.

Pesticides should be transported only in correctly labeled containers. Be sure to keep paper and cardboard packages dry. If any pesticide is spilled in or from the vehicle, clean it up right away using correct clean up procedures. Refer to specific product labeling and Material Safety Data Sheets (MSDS) for clean up procedures. Do not leave pesticides unattended. Depending on state law, the certified applicator, the company, or all may be found at fault.

Pesticide Storage

The storage building or area should be located away from where people and animals live. This will avoid or minimize any harm to them in case of fire or flooding. The area should be fenced if possible. Keep the building and storage area locked to prevent entry by children and other unauthorized people and post warning signs on doors and windows. The storage area should be in a cool, dry, well-ventilated and well-lighted room or building that is insulated to prevent freezing or overheating. Be sure that the area is fireproof, with a cement floor. As soon as pesticides arrive, store them in a safe place. Check the product label for special storage instructions. In the absence of storage instructions, containers should be rotated as needed. Store all pesticides in the original containers. Do not store them near food, feed, seed, bulbs, tubers, nursery stock, or other vegetation. Store paper containers off the floor. Check every container for leaks or breaks. If one is leaking, transfer the contents to a container that has held exactly the same pesticide. If one is not available, use a clean container of similar construction and label it correctly. Clean up any spills. Keep an up-to-date inventory of the pesticides you have.

Keep a spill kit available. This should include: detergent, hand cleaner, and water; absorbent materials, such as absorbent clay, sawdust, and paper to soak up spills; a shovel, broom, dustpan and chemical resistant bags to collect contaminated material; and a fire extinguisher rated for ABC fires.

Mixing and Loading Pesticides

Studies have shown that pesticide applicators/handlers are most often exposed to harmful amounts of pesticides when handling concentrates.

Workers involved in mixing and loading undiluted highly toxic pesticides are exposed to a high risk of accidental poisoning. Pouring concentrates from one container to another is the most hazardous activity.

By observing some simple precautions the sewer applicator can reduce the risks involved in this part of the job. It is important to keep animals, pets, and people who are not involved in the mixing and loading out of the work area. Do not work alone when using highly toxic pesticides. Choose a place with good light and ventilation. Be particularly careful not to mix or load pesticides unless lighting and ventilation are adequate.

Before handling a pesticide container, put on protective clothing and equipment. Each time you use a pesticide, read the directions for mixing. Do this before you open the container. This is essential because labels can change often.

Do not tear paper containers to open them. Use a sharp knife. Clean the knife afterwards and do not use it for other purposes. When pouring a pesticide from the container, keep the container and pesticide below eye level. This will avoid a splash in the face or eyes.

If you are splashed or spill a pesticide on you body while mixing or loading, stop right away and remove contaminated clothing. Wash thoroughly with soap and water as quickly as possible. Then clean up the spill.

When mixing pesticides, measure carefully. Use only the amount called for on the label and mix only the amount you plan to use.

When loading pesticides, stand so the wind is at your back to blow pesticide away from your body. To prevent spills, close containers after each use.

Closed Handling Systems. Closed handling systems can reduce the applicator's exposure to concentrated pesticides. A closed handling system allows the applicator to remove a pesticide from its original container, rinse the empty container, and transfer the pesticide and rinse solution to the mix tank without contacting the pesticide.

There are two systems to remove the pesticide concentrate from the original container : gravity, and suction.

Gravity systems are sometimes called "punch and drain" system. The unopened pesticide container is inserted into a chamber, which is then sealed. A punch cuts a large opening in the container, allowing all of the material to drain into the mixing tank. A water nozzle attached to the punch sprays the inside of the container to rinse it thoroughly. The rinse water also drains into the mixing tank. The rinsed container is then removed for disposal. A limitation of this system is that only full container quantities can be used. It is not possible to use part of the pesticide in a container and store the rest.

Suction systems use a pump to remove the pesticide through a probe inserted into the container. Some containers are equipped with built-in probes. The pesticide is transferred to the mixing tank by hose and pipe. When the container is empty, it and the transfer system are rinsed with water. The rinse water is added to the mixing tank.

Closed handling systems are not easily obtained. The ones in operation are for use only with liquid formulations. A problem with metam-sodium root control products is introducing the dry formulated ingredient, dichlobenil, to the application. One technique under development is packaging the dry ingredient in a soluble bag. This allows the applicator to put the entire package into the tank where it will dissolve

Cleaning Application Equipment

Never leave pesticide equipment or containers unattended at the application site. If using equipment that has a small chemical mix vessel the equipment can be flushed with water and emptied into the treated manhole. Only cleaning rinsate should be disposed of in this fashion, be sure the cleaning procedure does not include unused product remaining in the chemical vessel or chemical/water mix tank.

Do not contaminate water when disposing of equipment washwaters. Equipment washwaters and wastes resulting from the use of metam-sodium root control products may be disposed of on site by putting it in the treated sewer, or at an approved waste disposal facility. Do not put rinsate in potable water systems, or storm, field or other drains unless the effluent is treated in a sanitary sewer system.

If using equipment with a large chemical/water mixing tank return the equipment to the area designated for equipment cleanup, and clean according to the manufacturer's directions. Application equipment must be cleaned as soon as you finish using it to keep the equipment in good operating condition. Have a special area for cleaning.

Aside from the fact that dirty equipment is a source of potentially hazardous pesticide residue, dirty equipment can cause plug ups or other equipment malfunctions that could be the source of incorrect applications or hazardous equipment failures at the job site. Clean both the inside and outside, including nozzles. Only trained handlers should do this job. They should wear correct PPE and follow the equipment manufacturers cleaning instructions.

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 disposed of according to label instructions, contact your State Pesticide or Environmental Control Agency or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.

Excess Pesticides. EPA recommends ways to dispose of excess pesticides. Consult local authorities for procedures in your area. Consult the label for disposal instructions or precautions. If you have excess pesticides:

- Use them up as directed on the label.
- Take the pesticides to a landfill operating under EPA or state permit for pesticide disposal. (Most solid waste landfills are not suitable.)
- If you cannot dispose of them right away, store the pesticides in a secure storage area with similar pesticides until you can.

Containers. Do not leave pesticides or pesticide containers at the application site. Never give pesticide containers to children to play with or adults to use. Leftover pesticides should be kept in tightly closed containers in your storage facility. Always triple rinse empty containers of liquid pesticides as follows:

1. Empty the container into the tank. Let it drain an extra 30 seconds.
2. Fill container 1/10th to 1/4th full of water
3. Replace the closure and rotate the container. Invert the container so the rinse reaches all the inside surfaces.
4. Drain the rinse water from the container into the tank. Let the container drain for 30 seconds.
5. Repeat steps 2 through 4 at least two more times for a total of three rinses. Remember to empty each rinse solution into the tank.
6. Rinsate from sewer use pesticides may be disposed of in the sewer system being treated. CAUTION: Do not dispose of unused pesticide concentrate or pesticide/water solution in this manner.

Offer empty containers for recycling or reconditioning, or puncture and dispose of in a sanitary landfill.

Cleanup of Pesticide Spills

Minor Spills

Control the spill. Prevent further spill. Keep people away from spilled chemicals. Rope off the area and flag it to warn people. Do not leave unless someone is there to confine the spill and warn of the danger. If the pesticide was spilled on anyone follow appropriate cleanup procedures.

Confine the spill. Prevent the spill from spreading by building a dike of soil, or sand around the spill.

Clean up the spill. Use absorbent material such as soil, kitty litter, sawdust, or an absorbent clay to soak up the spill. Shovel all contaminated material into a leak proof container or chemical resistant bag for disposal. The disposal container must bear a label indicating contents. Dispose of material as you would excess pesticides. Do not hose down the area, because this spreads the chemical. Always work carefully and do not hurry. Do not let anyone enter the area until the spill is completely cleaned up.

Special Procedures for Foam Spills

Foam spills act very similar to liquid and if left unattended they break down to the liquid form. Therefore the clean up procedures are very similar. However extra measures may be required.

Outdoors. Try to pick up the foam as quickly as possible before it liquifies. Scoop foam up with a sho the foam in a manhole then rinse the area into the manhole. If the spill occurs on soil remove all contaminated soil and place it in sealed containers and dispose of it in accordance with local regulations.

Indoors.- Spills will usually occur in bathrooms, basements or laundry rooms. Evacuate the building if the pungent, rotten egg or sulfur-like odor of metam-sodium is detected. Open exterior doors and windows and ventilate with fans. Seal all heating and air conditioning vents to prevent contaminating the system. Scoop up foam with a shovel or dust pan, and place it in a plastic bag. Seal the plastic bag and remove if from the building. Dispose of foam in the nearest manhole. Triple rinse the plastic bags and dispose of them in a landfill. On hard floors wipe up remaining liquid with rags or other absorbent material and dispose of as directed by local regulations. Wash the floor at least three times with detergent, flushing each down a drain. On rugs and cloth, take them outside, if possible, and dry them before laundering separately. On carpeting use a wet vacuum and flush foam down the drain. Shampoo with detergent at least three times. Ventilate area and allow to dry. If odor persists remove and replace the material.

Major Spills

The cleanup of a major spill may be too difficult for the sewer applicator to handle, or the applicator may not be certain what to do. In either case, keep people away, give first aid if needed, and confine the spill. Call CHEMTREC[1], the local fire department, and state pesticide authorities for help. If the spill occurs on a highway, have someone call the State or local police for help. Do not leave until responsible help arrives.

Report all major spills by phone to your State pesticide authority. Also you may be required to notify other authorities if:

- the spill is on a State highway, call the State police or State highway department,
- the spill is on a county or city road, call the county sheriff or city police, and

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1 CHEMTREC stands for chemical Transportation Emergency Center, a public service of the Manufacturing Chemicals Association. Its offices are located in Washington, D.C. CHEMTREC provides immediate advice for those at the scene of emergencies. CHEMTREC operates 24 hours a day, seven days a week, to receive calls for emergency assistance. For help in chemical emergencies involving spills, leaks, fire, or explosions, call toll-free 1-800-424-9300. **This number is for emergencies only.**

- the spill is on a body of water or waterway, notify the Coast Guard if in coastal waters; the state health department; regional, state, or federal water quality or pollution office and state fish and game/wildlife agency.

Phone numbers of these agencies should be maintained in a convenient place before proceeding work with pesticides. County agricultural extension offices can provide these numbers.

TestYour Knowledge

Q. How may pesticide enter your body?
A. Orally, dermally, by inhalation and through the eyes.

Q. Name the three ways pesticides can cause harmful effects.
A. Acute effects, delayed effects, and allergic effects.

Q. If pesticide is splashed into the eyes you should?
A. Immediately flush the eyes with large amounts of water for at least 15 minutes. Hold the eye lids apart to ensure adequate rinsing of the entire eye. Seek medical assistance.

Q. Why is it necessary to wear PPE?
A. PPE is the best way of protecting your body from exposure to a pesticide.

Q. If you must work in a tight area, treated with metam sodium, where considerable gas is evolving, what is the best respiratory protection to wear.
A. Wear either a air supplying respirator or self contained breathing apparatus.

Q. What is a closed handling system?
A. A closed system allows the applicator/handler to remove a pesticide from its original container, rinse the empty container, and transfer the pesticide and rinse solution to a mix tank without contacting the pesticide.

Q. What are good features to have in a pesticide storage room?
A. The storage room should be cool, dry, well ventilated, well lighted and in a secured building that is insulated to prevent freezing or overheating.

Q. What are the major steps for handling a pesticide spill?
A. Control the spill to prevent spilling more pesticide. Confine the spill to keep it from spreading. Clean up the spill by placing it in labeled containers and disposing of the material in an approved manner.

CHAPTER 7
APPLICATION OF METAM-SODIUM ROOT CONTROL PRODUCTS

Learning Objectives

After you complete your study of this unit you should be able to:

- % have a general understanding of foam application equipment,
- % explain the basic foaming techniques,
- % understand the precautions to follow when filling chemical mix tanks,
- % understand the basic concepts of calculation the amount of chemical required for treatment,
- % understand the importance of communicating with treatment plant personnel,
- % calibrate hose retrieval rate, and
- % determine the effectiveness of a root control treatment.

Using the proper application methods and correctly calibrating equipment will assure the most effective use of a chemical. This way the applicator not only minimizes the chemical and operation costs of the root control application but protects the health and safety of the applicator, the environment, the public, and the sewer collection system.

When assessing the various methods of application the applicator must understand the principals of applying chemicals as well as the conditions that exist in the pipe being treated.

General concepts about pipe conditions:

- % Under normal conditions sewer pipes are not filled with water.
- % Pipe sections with sags or depressions may contain more water than other sections. These sections may even be completely filled with water.
- % Solids may build up and fill a portion of the pipe.

General concepts about roots in sewers:

- % Roots enter sanitary sewers through crack joints and other pipe imperfections from the top and sides and not from below the flow line.
- % Roots do not grow into the liquid flow of the pipe. They only sweep the surface.
- % Root growth is most common in the moist atmosphere of the void above the sewer flow line.
- % With but few exceptions, roots cannot grow without oxygen.

General concepts about root control chemicals in sewers:

- % Root masses are excellent collectors of grease and other solids. Such buildups can inhibit the effectiveness of root control chemicals because they cannot contact the root.
- % Chemicals placed in the void area of the pipe with no surface to attach to, such as a root mass, or pipe wall, enter the sewer flow and are transported to the treatment plant.

- % Chemical root treatment kills roots but it does not eliminate blockages. When a root mass is treated the roots may die quickly, however, those roots may take weeks, months, or even several years to decay and leave the system.

General concepts about chemical root control results:

- % It can be very difficult to determine if a root mass is dead with a visual inspection via TV camera.
- % The effectiveness of chemical root control is only as good as the application.
- % Don"t expect the "gun barrel" look of a new pipe following a chemical treatment.

The term root control as used in this manual refers to "root management". The entire concept of sewer line root control is to reduce the frequency and size of root intrusions into sewer pipes thus reducing the frequency of sewer stoppages and subsequently, over flows.

Application Equipment

Equipment design and specific components of foam generating and application equipment may vary but the basic principal of operation is the same, namely:

- % The chemical and wetting/foaming agent is diluted with water as per chemical manufacturer's label instructions.

  One type of equipment utilizes a mix tank (30 to 300 gallon) in which the chemical ingredients are diluted with water. This mix tank is usually trailer mounted. The trailer is then used to transport the chemical to the various applications sites throughout the municipality. One 200 gallon tank mix is sufficient to treat approximately 1600 feet of 8" pipe. The chemical/water solution is delivered under pressure (100 - 150 psi) to a foam production chamber. A positive displacement pump is then used to pump the chemical/water solution.

  A second type of equipment utilizes a small (3 to 6 gallon) chemical tank in which the chemical ingredients are mixed but, water is not added. This unit utilizes a positive displacement roller pump or else the pump on a hydrojetter unit to deliver water (without chemical) under pressure (100 - 150 psi) to a venturi at which point the chemical is introduced into the water stream and mixed just ahead of the foam production chamber. The chemical is then diluted with water during the application process. The chemical/water dilution ratio is based on the products' concentration of active ingredients which can be found on the product label.

- % Ten to fifteen CFM (80 - 140 psi) of air from a compressor is combined with the water/chemical solution in the foam production chamber producing the desired foam.

- % Foam is delivered to the interior of the pipe being treated through hoses varying in size of 3/4 to 1-1/4" and means.

Foaming Techniques for Applying Metam-Sodium Root Control Chemicals

Hose Insertion Method

The hose insertion method is the most common and lowest risk method of foam application. A foam delivery hose is inserted through a section of pipe to be treated. Foam is then pumped from a foam generator through the hose as it is being retracted at a predetermined rate. The foam delivery hose may require an external mechanism such as a hydrojetter or rodding-machine to convey the hose through the pipe prior to the foaming process. This procedure utilizes a two stage nozzle and foam generation equipment adapted to a standard high pressure hydro jetter. The two stage nozzle allows the hydrojetter to "jet" through the pipe to be treated then when the pressure drops the large portion of the nozzle opens to allow the unrestricted flow of foam to be pumped out. See Figure 6.

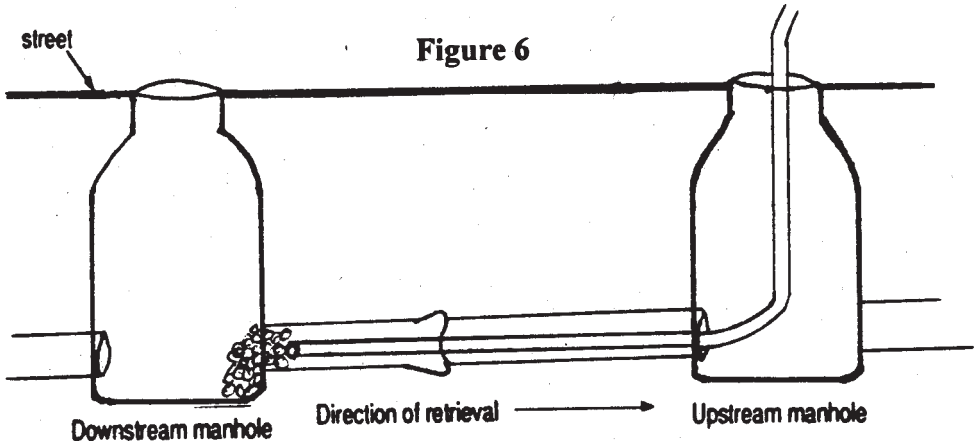


Figure 6

The insertion manhole may be upstream or downstream however, whenever possible, use the upstream manhole for insertion as this avoids drift towards the applicator. Once the hose reaches the other manhole, start the equipment and wait for foam to appear. Retrieve the discharge hose at the desired rate. With jetters it is recommended that moderate pressures be used when inserting the hose into the pipe. High pressures and excessive cleaning may result in excessive root damage which can affect the effectiveness of the root control application.

Hose Insertion Method, Split Treatments

In some cases, the sewer stretch may be longer than the amount of discharge hose, or it may not be possible to get the discharge hose completely through the sewer. In this case, it may be necessary to use two set-ups to treat a section. With this technique, treat the downstream portion first, as this reduces drift towards the applicator and lowers exposure of the applicator to chemical.

Hose Insertion Method: "Pushing a Slug"

Foam will penetrate a distance beyond the discharge nozzle. This is known as "pushing a slug". If, for instance, masses of roots or physical obstructions do not permit the hose to be conveyed completely through the sewer, the equipment may be "allowed to pump" at a fixed location, until the foam works its way

through the obstruction. The equipment is then set up at the opposite manhole, and the procedure is repeated until the two "slugs" from the two set-ups overlap.

EXTREME CAUTION: Extreme caution should be employed when using this method as foam may travel farther than desired up service laterals. Foam will always take the path of least resistance, which may be up a cellar floor drain or through outside building clean-outs.

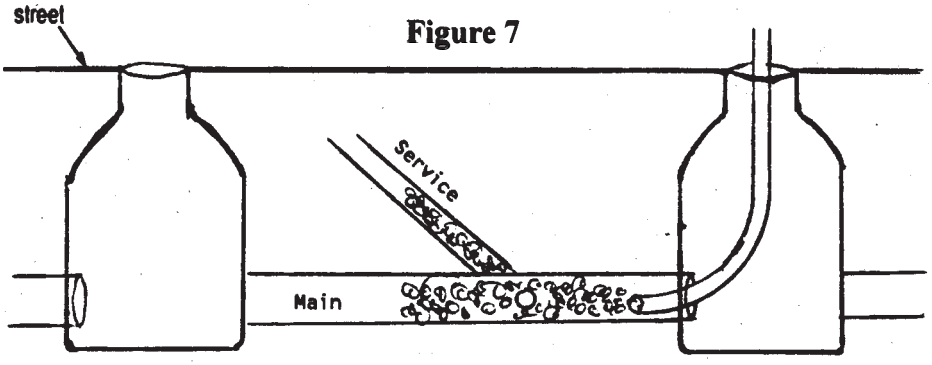
Hose Insertion Method: "Pulling the Water Out"

In some cases sewer pipe may have inadequate slope or swales in which water collects. As the foam is injected it displaces the water in the pipe. Under these conditions it is often advisable to treat using the downstream manhole as the insertion manhole. As the hose is retrieved excess water is pulled toward the insertion manhole. If the upstream manhole is used as the insertion manhole, then water may pond in the upstream manhole. If this happens, equipment must then be shut down until water recedes.

Hose Insertion Method: Treating "Wye" Connections from the Main

Often it is desirable to treat service connections from the main. This provides an important side benefit to homeowners. Generally treating service connections from the main is only feasible in small diameter (6" through 10") pipe. In large diameter pipe it is not possible to build up the pressures needed to penetrate service connections. See Figure 7.

Figure 7



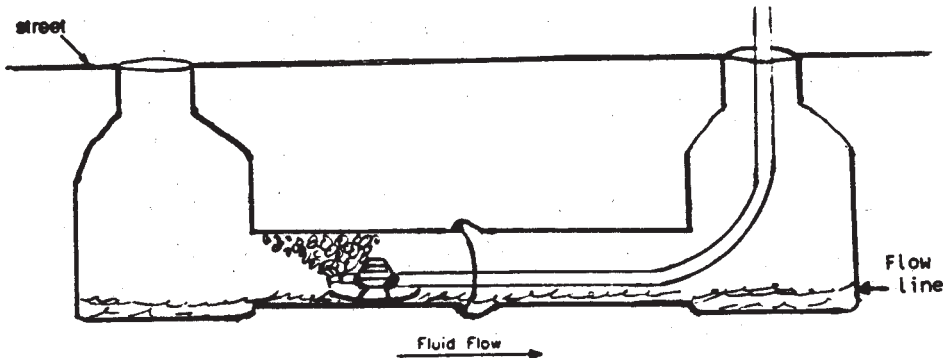
Additional foam is required per foot to use this method. Calculate the amount of additional foam required for the given number and pipe size of building laterals, and vary retrieval rates accordingly. **USE EXTREME CAUTION** to prevent foam from reaching building drains or outside sewer cleanouts.

Surface Coating Large Diameter Pipe

When treating large diameter pipe it is often impossible, or too costly, to completely fill the sewer with foam. Only that chemical which contacts roots is useful. Excess chemical that drifts downstream is wasted and could affect the wastewater treatment plant. To coat the pipe surface an elevated nozzle (Figure 8) is pulled through the sewer. Foam is ejected through the nozzle above the flow where it contacts and sticks to

pipe surfaces. It is very important that the nozzle be elevated above the flow. If the foam is ejected into the flow it will not contact pipe surfaces. To calculate the volume of foam required to coat the surface, contact your chemical supplier for instructions.

Figure 8



Surface coating often does not yield the results obtained by filling the pipe, since the foam is not under pressure and will not penetrate root masses as effectively as it would when filling the pipe. Repeat treatments may be necessary as succeeding "layers" of root tissue are killed off. Also, surface coating will not result in foam penetrating service connections.
Surface coating is also used on small diameter pipe with heavy flow where the flow rates preclude filling the pipe with foam.

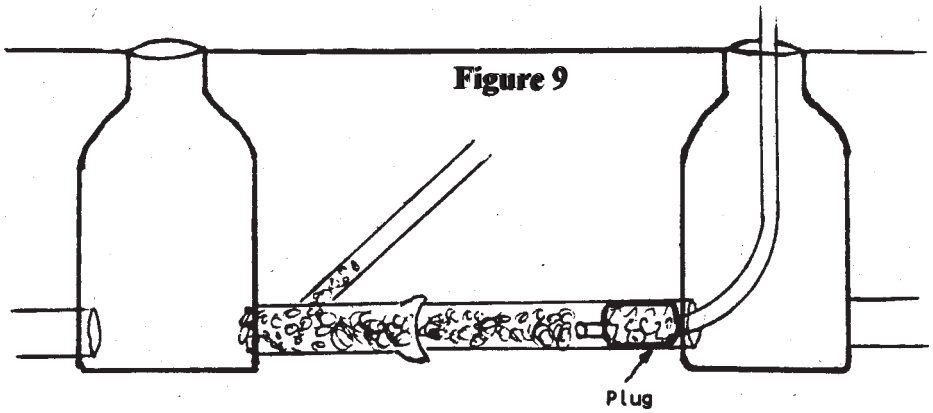
Spot Treatments

Spot treatments may be used with either foam filling techniques or surface coating techniques. Spot treatments involve treating only where the roots are. The advantage of spot treatments is that less material is required to treat a given length of sewer pipe. The disadvantage is that it is first necessary to know exactly where the roots are which requires television inspection. If the TV inspection is dated additional root penetration may have occured. Additionally, initial root penetrations frequently are unnoticed or missed by TV inspection. Spot treatments are most useful in large diameter lines where the increased cost of material offsets the cost of TV inspection. The amount of chemical which can be saved on small diameter pipe is usually negligible and not worth the cost of TV inspection.

When using spot treatment techniques, allow a certain amount of "overlap on each side of the root masses, approximately 10 feet to each side of the root intrusion.

"Pushing" Foam Through Inflatable Plugs

In some cases it may be desirable to "push" the foam through inflatable, hose-through plugs (figure 9). These plugs are available through plug vendors in the sewer industry. Insert the plug at one end of the line with the hose running through it. Inflate the plug and inject foam in a volume required to fill the pipe or until foam appears at the opposite manhole.



CAUTION: This is a high risk method. When using this method there is a significant hazard of foam backing into buildings, because foam will always follows the path of least resistance. This method should only be used where there are no service connections on the main-line sewer or where buildings are set far back from the main.

Treating Building Sewers

Treating house lines also involves the use of hose-through inflatable plugs. Some equipment manufacturers have developed specialized, portable equipment for treating building sewers.

Insert the hose-through plug in a cleanout which is downstream from all other cleanouts and fixtures. If there are cleanouts or fixtures downstream from the insertion cleanout, they must be plugged. Calculate the volume of foam necessary to treat the given distance of building sewer. Turn on the equipment until the desired quantity of foam has been pumped.

Treating house lines should only be attempted by applicators familiar with the design of building sewer systems or under the supervision of a licensed plumber. Improper application may result in foam being discharged into houses. **Building occupants should be advised to exit a structure, until the building is ventilated,** if a rotten egg or sulfur-like odor of metam-sodium is detected.

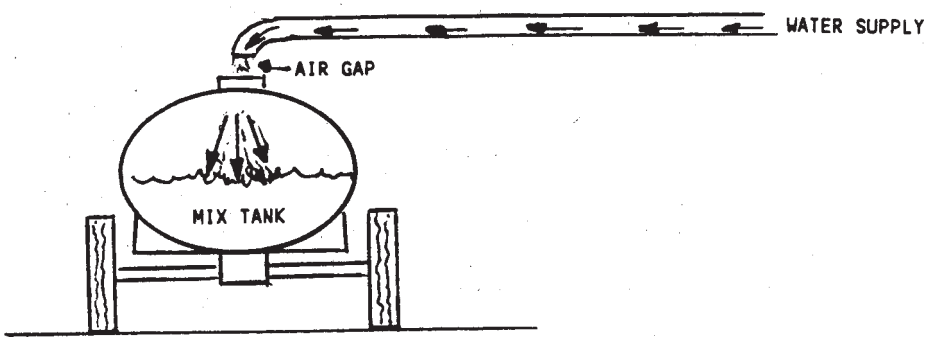
Filling Chemical Mix Tanks

When using chemical mix tanks certain precautions must be followed. Applicators often fill mix tanks from fire hydrants, garden hoses, or other fresh water sources. If there is a pressure drop in the water distribution system the solution in the mix tank could back-siphon into the fresh water system, contaminating the entire fresh water distribution system. Also, this could happen when drawing water form any other source, such as a farm pond. Whenever a tank is being filled with water it should never be left unattended. Back-siphoning can be prevented with one of the following measures:

- % use an air-gap,
- % use back flow prevention device such as a double check valve, or
- % use an intermediate water source, such as a jetter.

An air gap is shown in Figure 10

Figure 10

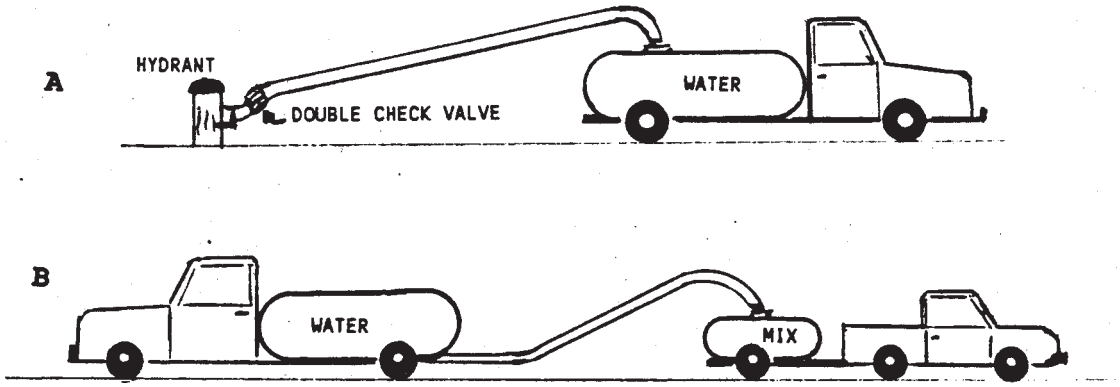


For an air-gap to be effective, the distance between the inlet line and the tank (d) must be at least twice the diameter of the inlet line (D). In the event of a reversal of pressure, air will rush through the air-gap, preventing siphoning. It is difficult to use an air gap with foaming root control chemicals, as the residual material in the tank will foam and prevent the tank from being filled.

Back flow preventer
This is a device that is connected between the water source and filling hose. If the pressure on the outlet side of a reduced pressure zone (RPZ) ever exceeds the pressure on the inlet side, relief valves discharge onto the ground, preventing back-siphoning. (For a more complete technical description of how a RPZ device works consult a manufacturer.)
Double check valves are mechanical devices that prevent backflow.

Filling from an intermediate source. It is often useful to fill mix tanks from an intermediate source, such as a sewer jetter. In these cases, of course, the sewer jetter must itself be filled using an air-gap or double check valve. The advantage is that in the event of back-siphoning from the mix tank into the intermediary source there is no danger of contaminating fresh water supplies. See Figure 11.

Figure 11



Obtaining water from a jet truck will also prevent back siphoning because the truck has built-in siphoning brakes.

When mixing metam-sodium with water remember that metam-sodium decomposes to the more volatile and toxic MITC. This process starts immediately and proceeds rather rapidly. Therefore, plan to use the solution soon after mixing, otherwise the material will be ineffective.

Calculating Amount of Chemical Required

The applicator can use the worksheets in Figures 12 and 13 to calculate the amount of chemical required for a specific job. Figure 12 is the calculation for the *foam fill* method. In larger pipe the foam/chemical is directed toward the pipe walls rather than filling the whole pipe. The *foam spray* method (figure 13) requires less chemical thus protecting the system from injecting too much chemical at one time. When using these figures the applicator needs to add to the formula: 1) the number of feet of each pipe size that will be treated and, 2) the dilution ratio.

To determine the dilution ratios the applicator should refer to the label of the product being used. For example, if the product label states "mix 25 parts water to 1 part of chemical" then insert "26" (26 parts of chemical/water solution) in the "dilution ratio required" column of either figure 12 or 13 and comlete the calculation.

FOAM FILL APPLICATION

Pipe Size	Gallons per/foot		Length of Pipe	Gallons of Foam	Service Laterals 15 - 25%	Total Foam Required	Expansion Ratio 1:20 Required	Chem/Water Solution	Dilution Ratio Required	Total CMG	Round Up
4"	0.7	x		=	+	=	÷ 20	+	÷	=	
6"	1.5	x		=	+	=	÷ 20	+	÷	=	
8"	2.5	x		=	+	=	÷ 20	+	÷	=	
10"	4.0	x		=	+	=	÷ 20	+	÷	=	
12"	6.0	x		=	+	=	÷ 20	+	÷	=	

Figure 12

FOAM SPRAY APPLICATION

Pipe Size	Gallons per/foot		Length of Pipe	Gallons of Foam	Service Laterals 15 - 25%	Total Foam Required	Expansion Ratio 1:15 Required		Chem/Water Solution	Dilution Ratio Required	Total CMG	Round Up
12-14"	3.0	x		=	+	=	÷	15	+	÷	=	
15-16"	3.5	x		=	+	=	÷	15	+	÷	=	
18"	4.3	x		=	+	=	÷	15	+	÷	=	
20"	4.5	x		=	+	=	÷	15	+	÷	=	
21"	4.75	x		=	+	=	÷	15	+	÷	=	
22"	5.0	x		=	+	=	÷	15	+	÷	=	
24"	5.5	x		=	+	=	÷	15	+	÷	=	
26"	6.0	x		=	+	=	÷	15	+	÷	=	
27"	6.75	x		=	+	=	÷	15	+	÷	=	

Figure 13

Application Check-List

This check list should be reviewed before applying root control chemicals containing metam-sodium to a sewer section. (This list is adapted, in part, from a product label under sections labeled "USE PRECAUTION" - **READ THE PRODUCT LABEL COMPLETELY PRIOR TO APPLICATION**.)

1. Read the chemical product label thoroughly.
2. Notify the wastewater treatment plant operator and workers of treatment site and date.
3. Know the distances between buildings and the sewer.
4. Know the depth of the sewer compared to the drains in the buildings.
5. Are there any obstructions in the line?
6. Are there broken or empty traps?
7. Are there drains without traps that would allow easy emergence of foam? (Building drains may be plugged to protect against back up and flooding.)
8. Product labels and Material Safety Data Sheets should be available at job site for quick reference.
9. Provide job site with all necessary equipment for proper traffic control (i.e., barricades, cones).
10. Provide the job site with proper equipment for safely opening manholes.
11. Povide the job site with proper equipment for conforming with OSHA standards, for confined space entry (including but not limited to air monitor, harness, and retrieval systems).
12. Have the proper PPE available:
    - % gauntlet type chemical resistant gloves,
    - % rubber boots,
    - % chemical resistant, full length, plastic or rubber apron,
    - % respirator and goggles or a full face respirator with cartridges approved for pesticide use, and if required air supplied respirator or SCBA,
    - % long pants and long sleeved shirts, and
    - % hard hat

Communication with the wastewater treatment plant personnel.
Coordination and cooperation with plant operations is very important. Notification prior to treatment is a definite priority, especially with the pre-treatment program, which may require issuance of a discharge permit. Treatment plant personnel should be made aware of any unusual side effects of metam-sodium such as H_2S.

The applicator should obtain as much information about the treatment area as possible. For example, the times of high flows, the size of the sewer lines being chemically treated and the distance of the sewer line from the nearest lift station and sewage treatment plant. These are important determinants of the effects of chemical root control on a wastewater treatment plant processes. Sewer line size is an important consideration because of the amount of material required to chemically treat them. Depending on the application method

used, it can take up to 9 times as much chemical per foot to treat a 24" sewer as an 8" sewer.

Dosage of Product to a Particular System

In order to minimize the effects of root control chemicals on a sewer system it may be necessary for the applicator to reduce the volume of material to be applied. Knowing the volume and hourly flows for the system and the manufacturer's recommended maximum concentrations, the applicator can determine the maximum amount of product that can be injected into the system for any given day or hour.
If adverse effects are indicated at the treatment plant, i.e., the rotten-egg odor of metam-sodium is detected, or beginning of biological upset, the application process should be immediately discontinued. When applications are re-started the applicator should use reduced application rates, namely fewer total gallons of concentrate per hour or day. The treatment plant operators should continue to monitor the plant to insure against a reoccurrence of adverse effects.

Metam-Sodium Root Control Application

The three phases of applying the metam-sodium root control chemicals are 1) mixing the chemicals or the chemical/water solution, 2) calibrating a 1 part chemical/water solution to 20 parts foam, and 3) calibrating the hose retrieval rate.

Mixing the Chemical
Due to the differences in packaged products, specific mixing instructions must be obtained from the label of the metam-sodium root control products being applied. Mixing instructions must also be obtained from the equipment manufacturer for the specific application equipment being used.

The active ingredients, metam-sodium and dichlobenil, can only be used in combination with each other and with a foaming agent, as per the product label. Depending on the equipment being used the ingredients may be mixed with the proper amount of water in a mixing tank or may be mixed only with themselves in a small chemical tank to be automatically mixed with water at the moment of application.

The ingredient, dichlobenil, should be mixed with the other root control ingredients vigorously before mixing with water. The mixed solution should not be allowed to stand as mild agitation is necessary to keep the dichlobenil in suspension.

The chemical mixture should be used promptly after mixing and the applicator should not mix more solution than can be used in one day. To mix the proper amount of needed solution the applicator must, 1) determine the method of treatment, 2) determine the total footage of pipe by pipe diameter and method of

treatment, and 3) calculate the chemical mix ratio and the amount of chemical/water solution to prepare depending on the pipe diameter and method of application.

Methods of treatment include the foam fill and foam spray. Pipe diameters 12" - 14" or less require filling the entire pipe void with foam (Foam Fill). Pipe diameters 12" - 14" or larger are more economically treated by surface coating on the root masses and pipe surface (Foam Spray). Other factors may dictate the method of application e.g., wastewater level, velocity of flow and root density.

Calibrating Foam/Solution Expansion Ratio

The applicator should know how to calibrate the application equipment to get the proper consistency and volume. This section provides general guidelines for equipment and foam calibration. Consult with the equipment manufacturer for more specific calibration details of their equipment.

Metam-sodium root control products require a foam application. The ingredients are mixed with water, according to the package instruction, and then air is introduced with an air compressor. Foam quality, the proper chemical/water to foam expansion ratio, is an important factor in achieving a successful root control application. The proper expansion ratio is that 1-part, or 1-gallon, chemical/water solution will expand to 20 parts, or gallons, of chemical/foam solution.

The proper foam will be dense, have small bubbles, "cling" to the pipe surfaces, maintain its shape for a specified period of time, and contain the proper concentration of active ingredient per cubic foot of foam.

An expansion ratio less than 1:20 produces a "wetter" foam. A wet foam will be "runny" and not stick to pipe surfaces. It will also be "heavy" and quickly collapse, not holding its shape in the pipe. Additionally, wet foams will not fill pipe volumes at normal retrieval rates, or penetrate wye connections.

An expansion ratio greater than 1:20 produces a "dryer" foam, with large bubbles and not carry a sufficient concentration of active ingredient per cubic foot to be active on tree roots.

Variations in foam quality can be made by adjusting the water/chemical solution volume (gallons per minute(gpm)) versus the air volume (cubic feet/minute (CFM)). Follow the equipment manufacturers guidelines to make these adjustments.

The water quality, i.e., hardness may effect foam quality. If this is a problem check with the chemical manufacturer or supplier for technical assistance.

A simple test of the quality of foam is for the applicator to observe the foam discharging unobstructed from the hose into a manhole. A good foam is when the stream breaks into light balls and flakes of foam about 2 - 3 feet from the point of discharge.

These tests for foam quality or equipment calibrations, can be performed at a testing site by using the appropriate amount of wetting/foaming agent only; without adding the products' active ingredients. This reduces the risk of exposure for the operators performing the test. The wetting/foaming agents can readily be obtained from the product manufacturer. Contact the equipment manufacturer for detailed calibration procedures specific to their respective equipment.
To measure the foam more accurately from the mound of created foam fill a 2000 ml graduated cylinder to the top. Once filled place the cylinder in a location free of wind (wind causes unnecessary breakdown of the foam). When the foam has settled a liquid remains. The desired result is to have the remaining liquid measure 100 ml or 1/20th of the foam volume.

Each piece of equipment should be calibrated separately to determine its proper flow rate. If a piece of equipment shows wide variances in foam consistency, there may be a problem with the equipment. Service the equipment per the equipment manufacturer's recommendations.

Calibrating the Hose Retrieval Rate
To determine the hose retrieval rate the operator must know:

1) the gallons of foam required per foot of sewer pipe, and
2) the amount of gallons per minute that the application equipment is producing.

Then divide the amount of foam produced per minute by the amount of foam required per foot to determine the hose retrieval rate in feet per minute.

Figure 14 provides a quick method of determining retrieval rates.

Figure 14

Pipe Size	Foam Fill gal/ft	Feet per minute
4"	0.7	143
6"	1.5	67
8"	2.5	40
10"	4.0	25
12"	6.0	17

This same procedure can be used when using surface coating techniques. For example: to surface coat a 24" pipe carrying 7" of flow, with 3" of foam for 300 feet in length it requires 2,221 gallons of foam. This breaks down to 7.4 gallons of foam per foot. If the equipment is generating 90 gallons of foam per minute then the proper hose retrieval rate would be 12.16 feet per minute (90 ÷ 7.4).

To Calculate Pipe Volume

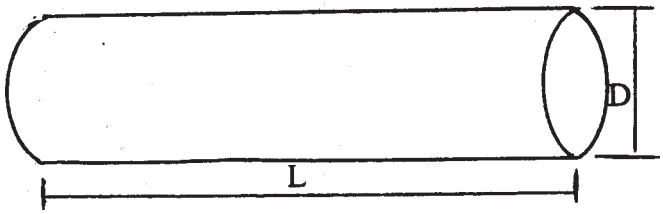
Calculating the correct volume of a pipe to be treated is important. If pipe volume is over estimated too much foam could be pumped into the line and forced up building laterals and into the buildings. An underestimation could result in a bad application. The following conversion table may help in your calculations:

Figure 15

Conversion Table

Multiply	By	To Obtain
# of cubic feet	1728	#of cubic inches
# of cubic feet	7.481	# of gallons
# of gallons	0.1337	# of cubic feet
# of gallon	231	# cubic inches

A pipe is a cylinder open on both ends. The calculation for volume of a pipe (cylinder), is the area of the circle (cross section of the pipe) x length of he pipe. The area of a circle is the radius (1/2 the diameter) times the radius times 3.14.



$3.14 \times R^2 \times L = \text{Volume}$

Example: Find the volume of foam required to treat a pipe 10 inches diameter and 400 feet long.

Answer: 1). Find the area of the circle. Area = Radius X Radius X 3.14
(Radius = 1/2 Diameter) 5" X 5" X 3.14 = 78.5 Inches^2

2). Convert Square inches to square feet:
Divide square inches by 144 (144 in.^{2} = 1ft^2).
$78.5 \div 144 = .545ft^2$

3). Pipe Volume = $.545ft^2 \times 400ft = 218ft^3$

4) Volume of foam in gallons required. Refer to the conversion table, figure 15.
$218ft^3 \times 7.481 = 1630.85$ gallons
round to 1631 gallons

If a pipe is partially full of water, the water also takes up volume. The applicator should be able to compensate for the reduced volume. Roots do not grow below the water level and chemicals are not effective when diluted in sewer flows. Proper application requires that the foam be discharged above the flow line. Under certain field conditions where a pipe has slow moving flow the applicator should compensate for the volume displaced by the water in order to avoid overcharging the pipe.

Figure 16

Figure 2

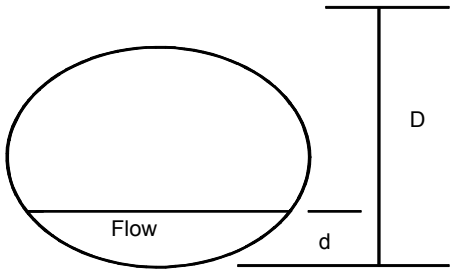


Figure 16: "D" is the diameter of the pipe and "d" is the depth of the flow. The wetted perimeter is that portion of the circumference submerged with water and the dry perimeter is the portion of the circumference above the water line.

By comparing the wetted perimeter of the pipe to the entire perimeter (circumference) the applicator can determine the percent by volume of the pipe filled with water.

The relationship between d/D and the wetted perimeter is illustrated in the chart below:

d/D	Wetted perimeter % of Circumference
O.1	20%
0.2	30%
0.3	37%
0.4	44%
0.5	50%
0.6	56%
0.7	63%
0.8	70%
0.9	80%
1.0	100%

Determining Effectiveness of Root Control Treatments

Determining the effectiveness of chemical root control treatments is an important issue for contractors and public works officials. The results of chemical root control are sometimes difficult to assess because they can not be seen by the naked eye.

Tracking results can also be a learning tool for the applicator as well as the public works director by pointing out deficiencies in application methods.

Conditions which may influence effectiveness include:

- % Improper application techniques, in particular, poor contact and exposure time,
- % High sewer flows or surcharging conditions soon after application,
- % Severe hydraulic sewer cleaning before or after treatment,
- % Heavy grease deposits which interfere with chemical contact, and
- % Old or ineffective chemical, or improperly mixed chemical.

Due to the remoteness of root masses in sewer pipes it is extremely difficult to accurately assess the percentage of the root kill. An important fact to remember is that treating roots with chemicals kills the roots, however, these treatments do not make the roots disappear. A complex of decaying organisms is constantly present in the sewer, feeding on the dead roots. In addition, the build up of solids and ever constant pressure caused by wastewater flows breaks the dead roots off, sending them to the treatment plant. This process may take weeks, months, or even years.

NOTE: If a sewer line is experiencing frequent blockage problems chemically treating roots will not immediately eliminate these blockages. You need to address these blockages with a good cleaning, preferably

with a high pressure jetter. Once the blockage problem is resolved the long term solution of chemically treating roots can be addressed.

As discussed previously, in the section on how roots grow, root masses are made up of a central trunk dividing into a series of smaller and smaller branches, ending as microscopic hair roots. A specific root mass in a pipe may be the result of single rootlets entering the pipe through a faulty pipe joint. This then grows and divides into more rootlets which in turn divide and grow forming a "root mass". As the root mass grows the supporting branch (the original root hair entering the pipe) grows in size and is frequently protected by the surrounding root mass.
The most difficult part of a successful chemical root treatment is determining with any degree of accuracy the percent kill of a specific root mass or root masses in a specific section of pipe. When viewing the root masses insitu (in place in the pipe) with the use of closed circuit TV., a live root mass looks brown and dirty and due to equipment lighting the root masses tend to reflect light causing glare and "hot spots". The same closed circuit TV. of a dead root mass also looks brown and dirty with glare and hot spots. The insitu inspection becomes a case of judgment on the part of the inspector. With time the root mass becomes smaller due to decay and breakage. The contents of a dead root mass becomes soft or brittle and break off easily as the camera passes. These factors all become part of the assessment of the success of a specific chemical root control treatment. The confidence level of these judgment calls can be significantly increased by removing a root mass from the pipe for a detailed visual inspection.

Like the trees above ground, roots grow in diameter by adding cells between the dead tissue in the root center and the dead bark (skin) on the outside. These healthy living cells create a light colored almost white layer under the bark. When a root is killed this layer turns brown. By stripping the bark layer off the individual roots in a root mass the effectiveness of a specific chemical treatment can be determined. When performing this visual test you need to remember that you are examining only one of perhaps hundreds of root masses from the specific section(s) of treated line. Due to non standardized conditions in a sewer system what you find in one root mass may not be what you find in the next.

Perhaps the most reliable method of judging the success of a chemical root control program is to determine the rate of reduction in sewer stoppages, overflows, emergency calls, and other root-related sewer problems. If a municipality experiences, say, 100 stoppages per year in the year prior to implementation of a chemical program, and 2 stoppages per year the year following implementation of the program, the program has shown positive results. The program could be justified by weighing the cost of the root control program against the cost of relieving stoppages, damage caused by stoppages.

Although the ultimate goal of a root control program is to totally eliminate all root masses, in reality a successful program is one in which the roots are managed at a level below which the cost and risk of application is less than the cost and risks of unwanted sewer blockages and damaged pipe.

Note: The application of foam into sewer pipes involves the use of various conversion tables. To use these tables the certified applicators must be capable of calculating volumes and perform basic mathematical functions such as multiplication, division and use of percentages.

Test Your Knowledge

Q. Briefly describe two types of foaming equipment.
A. 1) utilizes a 30 - 300 gallon mix tank in which chemical and water are mixed. The solution is delivered under pressure to a foam production chamber then pumped out as a chemical-foam.
2) utilizes a small (3-6 gallon) tank into which only chemical is mixed. The chemical is pumped under pressure to an venturi where it is introduced into the water stream and into a foam chamber. Foam is then pumped out as in 1) above.

Q. Name the foaming techniques used for applying metam-sodium root control chemicals.
A. Hose insertion method, Split hose insertion method, hose insertion - "pushing a slug", hose insertion "pulling the water out", hose insertion "treating wye connections", surface coating large diameter pipe, spot treatments, and pushing foam through inflatable plugs.

Q. When filling a mix tank how can you prevent back-siphoning.
A. By, using and air gap between hose and tank, by using a back flow preventer or double check valve, or by using and intermediate water source, such as a jetter.

Q. How can an applicator calculate he amount of chemical required for a specific job?
A. Determine if the foam fill or foam spray method will be used. Select the appropriate chart for that method. Then refer to the product's label to determine the amount of water to mix with 1-part of chemical. This total will be used in the "dilution Ration Required " column to complete the calculation.

Q. Why is it necessary for the certified applicator to communicate with treatment plant personnel?
A. First to alert personnel than a chemical will be introduced into their system so they may monitor of signs of upset and any unusual side effects from the chemical. Also, it may be necessary for the pretreatment program to obtain a discharge permit. Second, the applicator should obtain information about times of high flow, sizes ofpipe to be treated, and distances between different sewer structures such as liftstations and treatment plant.

Q. How do you calibrate the hose retrieval rate?
A. Determine the gallons of foam required per foot of sewer pipe. Next, determine the gallons per minute that the application equipment produces. Then divide the amount of foam produced per minute by the foam required per foot to determine hose retrieval in feet per minute. A chart is also available to assist the applicator.

Q. How can the applicator determine he effectiveness of root control treatments.

A. This is not easy. Several methods must be used. Television is useful. Pulling treated root masses and inspecting them for live tissue. Compare the rate of sewer stoppages before and after treatment.

GLOSSARY

Activated Charcoal: Finely ground or granulated charcoal which adsorbs chemicals.

Active Ingredient: The chemical or chemicals in a product responsible for pesticidal activity.

Acute Oral Toxicity: Injury produced from a single exposure.

Acute Toxicity: The short-term, single exposure effects of pesticide.

Adherence: The ability of a pesticide or substance to stick to a surface.

Adjuvant: A substance added to a pesticide to improve its effectiveness or safety. Same as additive. Examples: penetrants, spreader-stickers and wetting agents.

Adsorption: The process where chemicals are held or bound to a surface by physical or chemical attraction. Clay, charcoal, and high organic soils adsorb pesticides.

Agitation: Process of stirring a pesticide solution so as to keep wettable powders, etc. in suspension.

Anti-Siphoning Device: A mechanism used to prevent the flow of a pesticide solution from a mix tank to a water source.

Back-Flow Preventor: see "Anti-Siphoning Device."

Bactericide: A pesticide that destroys or prevents the growth of bacteria.

Basal Application: Application of a pesticide to plant stems or tree trunks just above the ground line.

Building Sewer: That portion of a sewer system which lies between the building foundation and the collector sewer. Also called lateral sewer.

Bypass Pumping: The process of temporary re-routing sewer flows around a given section of sewer.

Calibration: The process of adjusting application equipment so that pesticides are applied at the proper rate. Also, the process of determining the rate at which a given piece of application equipment discharges pesticides.

Carrier: An inert ingredient used to dilute a mixture of pesticides, or to transport a pesticide to target.

Chemical Name: The scientific name for a chemical substance. Example: Sodium

Methyldithiocarbamate is the chemical name for metham.

CHEMTREC: The Chemical Transportation Emergency Center. This organization operates a 24-hour information hot-line for pesticide spills, fires, and accidents. 1-800-424-9300.

Chronic Toxicity: The long-term effects of exposure to a pesticide.

Collector Sewer: A sewer, typically small diameter, which collects wastewater flows from buildings and transports those flows to an interceptor sewer.

Combined Sewer: A sewer which is designed to carry both sanitary flows and storm water, either all or part of the time.

Combined Sewer Overflow: see Overflow.

Commercial Applicator: One who applies pesticides for hire. Many states require commercial applicators to also be certified applicators, regardless of the type of pesticide applied.

Common Name: A generic name given to an active ingredient that is generally accepted in pesticide nomenclature. Distinguished from chemical name or brand name. Examples: Metham, Dichlobenil, Copper Sulfate.

Compatibility: The ability of two pesticides or substances to mix without reducing the effectiveness or usefulness of either substance.

Contact Herbicide: A chemical that kills primarily by contact with plant tissue, with little or no translocation.

Decomposition/Degradation: The process by which a chemical substance is broken down into simpler substances. This process can take place through chemical, biological, or physical means.

Deposit: The amount of pesticide left on a treated surface (noun). Also, the process of leaving a pesticide on a treated surface (verb).

Dermal Exposure: The absorption of a pesticide through the skin, eyes, or mucous membranes.

Dermal Toxicity: The ability of a pesticide to to cause injury to a human or animal when absorbed through the skin.

Dessicant: A chemical thatpromotes drying or loss of moisture from plants and animals such as insects.

Detoxify: The ability of a substance or process to render a pesticide harmless.

Dust: A dry mixture containing pesticide(s) and inert ingredients.

Easement: In sewer work, the location of a sewer line in back-yards, parks, public lands, off-road, or other areas which are typically more difficult to access than sewers located beneath street surfaces. Also, the right of government to access manholes and sewer lines which are located on private property.

Effluent: Water which is leaving a structure. Example: the discharge from a water treatment plant.

Engineer: In sewer work, the designated official of a municipality who represents and is authorized to act on behalf of a municipality with respect to the municipality's dealings with a contractor.

Exfiltration: The leakage of water or other substances from a sewer pipe into the ground through joints, cracks, or defects.

EPA: The Environmental Protection Agency, the federal agency responsible for regulating and enforcing the registration, sale and use of pesticides.

EPA Registration Number: The number assigned to a pesticide by the EPA. This number must appear on all pesticide labels.

FIFRA: The Federal Insecticide, Fungicide, and Rodenticide Act. Most important legislation concerning pesticide usage.

Foaming Agent: An adjuvant used to convert a pesticide solution into a thick foam. Used in agriculture to prevent drift; in sewer line root control as a carrier and to prevent drift.

Foam Retardant: An adjuvant used to prevent foaming of a pesticide mixture.

Formulation: A mixture of pesticide(s) and inert ingredients. The pesticide product as purchased.

French Drain: A perforated or porous conduit used to remove groundwater from an area and convey it downstream.

Fumigants: Pesticides which form a vapor or gas, usually in a confined space or enclosed area, that are toxic when absorbed or inhaled.

Fungicide: A pesticide that kills or controls fungi.

General Use Pesticide: A pesticide which can be purchased and used by the general public. (see Restricted Use Pesticide).

Germicide: A pesticide that kills or controls pathogenic (disease carrying) bacteria.

GPM: Gallons per minute.

Groundwater: Water beneath the earth's surface that is the source of wells.

Grouting: The process of sealing pipe joints or other open sewer defects against groundwater infiltration.

Herbicide: A pesticide used to control or kill undesirable plants.

Incompatible: Two pesticides or substances that cannot be mixed together without adversely effecting their usefulness.

Inert Ingredients: A material that has no pesticidal effect, but which is contained in a pesticide formulation. See "adjuvant."

Infiltration: Ground water which enters sewer systems through joints or other defects.

Infiltration/Inflow Control (I/I): In general, the process of abating or controlling the introduction of extraneous water in a sewer system. Examples: grouting, re-lining, manhole rehabilitation, etc.

Inflow: Distinguished from infiltration, extraneous water other than groundwater that enters a sewer system. Examples: surface water which enters through manhole covers, water coming from roof leaders and foundation drains.

Inhalation: Exposure to a pesticide by breathing it in.

Influent: Water that is entering a structure. Example: sanitary sewer flows entering a wastewater treatment plant.

Inspector: A representative of the Owner or municipality who is actually on the job site supervising the quality of workmanship and materials.

Interceptor Sewer: Typically a large diameter sewer without service connections, which receives flows from collector sewers and transports the flows to a wastewater treatment plant.

Invert: The lowest point of a pipeline or conduit. The bottom part of a manhole that is rounded to conform to the shape of the sewer line.

Joints: The connection between two contingous pieces of sewer pipe.

Lateral Sewer: Same as building sewer.

Leaching: The movement of a pesticide through soil by the movement of water.

Lineal Feet: A measurement of distance, in a straight line, between two contingous manholes in a sewer system.

LD_{50}: The average lethal dose of a given pesticide for a given species. The amount that will theoretically kill 50% of a test group. Usually expressed in parts per million.

Manhole Section: Same as Sewer Section.

MGD: Millions of gallons per day. Used to express the design flow capacity, or actual flow, of a wastewater treatment facility.

Nematicide: A pesticide used to kill or control nematodes.

Nematode: Microscopic, colorless, worm-like animals that live as saprophytes or parasites. Many cause diseases or plants and animals.

Non-Systemic: A pesticide, usually a contact pesticide, which has a localized pesticidal effect only on the part of the plant or animal actually not transported through the plant or animal system in pesticidal concentrations.

Nonselective: A pesticide which kills or controls any living thing, or which is toxic to a wide range of organisms.

Oral toxicity: The occurance of injury when a pesticide is taken by mouth.

Overflow: An undesirable discharge of sanitary or combined sewer flow into a river, stream, or other surface waters.

Owner: In sewer work, the municipality or public agency that maintains public sewers.

Parts per million (ppm): A typical measure of the concentration of a pesticide in another substance, or pesticide residues. One gallon of active ingredient in 1,000,000 gallons of water which represent 1 part per million.

Persistence: The ability of a pesticide to resist chemical or biological degradation, and therefore remains in the environment for an extended period of time. Persistent Herbicide.

Pesticide: Any chemical that will kill, repel, or otherwise control an unwanted plant, animal, fish, bird, insect, or microorganism.

Phytotoxic: The deleterious effect of a pesticide on the photosynthetic processes of a plant. Can be desired or undesired.

Receiving Waters: The body of water to which a wastewater treatment plant or storm sewer discharges.

Restricted Entry Interval: The period between the application of a pesticide and the time when people can reenter the treated area without having to wear PPE. protective equipment.

Residual Pesticide: A pesticide which remains active for an extended period of time.

Residues: The amount of pesticide which remains on the target or other surfaces following treatment.

Restricted Use Pesticide: A pesticide which can only purchased by a certified pesticide applicator and used only by certified applicators or persons directly under their supervision. Not available to the general public because of high toxicities and/or environmental hazards.

Rodenticide: A pesticide used to kill or control rats, mice or other rodents.

Run-off: The movement of pesticides on soil surface by means of water.

Sanitary Sewer: A sewer designed to carry only residential or commercial waste. As opposed to a storm sewer.

Selective Pesticide: A pesticide which is toxic to some species, but not to others.

Sewer Section: The length of sewer pipe connecting two manholes.

Soil Fumigant: A pesticide that forms a vapor or gas in soil, used to control pests in soil such as weed seeds, nematodes, bacteria, viruses, fungi, etc.

Soil Sterilant: Similar to soil fumigant, except that it kills all living organisms in soil usually for an extended period of time.

Solution: A mixture of one or more pesticides with another substance, usually water, in which all materials are dissolved or in suspension. The preparation of pesticides with water.

Spot Treatment: A local application of a pesticide to only a small area.

Storm Sewer: A sewer designed to carry only rain water, ground water or surface water.

Surcharge: The condition that exists when the volume of water exceeds the hydraulic capacity of a sewer.

Surfactant: A type of adjuvant which improves the spreading and/or wetting qualities of a pesticides.

Suspension: A pesticide mixture in which fine particles, usually a solid, float or mix evenly in water or oil.

Swale: A dip or sag in a sewer pipe, in which water and debris often collects.

Synergism: The action of two or more pesticides or substances which yields a result greater than that which any one of the substances is capable of achieving individually.

Systemic Pesticide: A chemical that is absorbed and translocated within a animal or plant. Some systemic pesticides are designed to protect the plant or animal against pests or else they are designed to cause injury to the organism.

Target: The organism to which pesticides are applied.

Translocation: The movement of a pesticide through vascular plant tissue.

Trade Name: A brand name of a pesticide. The same active ingredient may be sold under different trade names. Example: "Vapam" is a trade name for metham.

Volatility: The tendency for a substance to turn from a solid or a liquid to a gas.

Water Table: The upper level of water saturated ground.

Weed: Any plant, that because it is in the wrong place at the wrong time, is deemed undesirable by man.

Wettable Powder: A pesticide formulation made by impregnating a powder with an active ingredient and wetting agent.