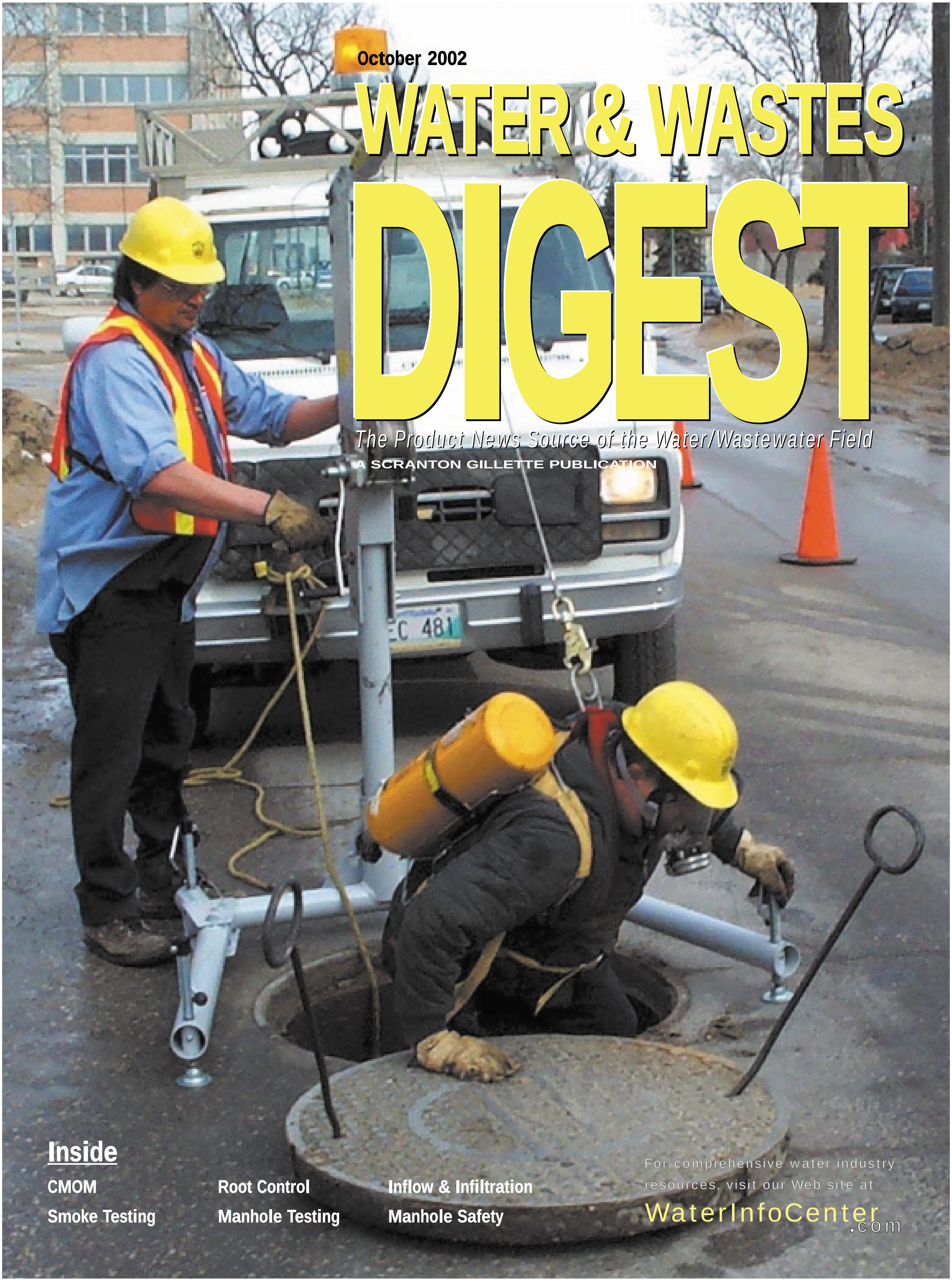

October 2002

WATER & WASTES DIGEST

The Product News Source of the Water/Wastewater Field

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Inside

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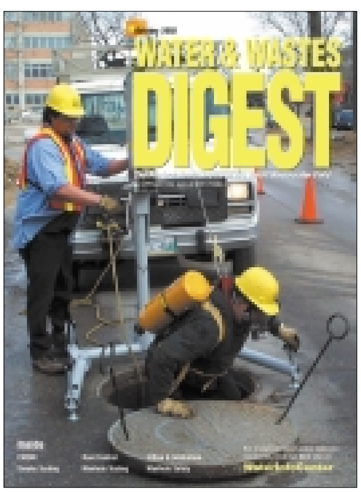

Cover:
This manhole inspection crew is going down in search of damages caused by high sulfide levels. *(Photo courtesy of the City of Winnepeg, Manitoba, Canada)*

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STATEMENT OF PURPOSE

WATER & WASTES DIGEST is published exclusively for the 100,000+ decision makers in the municipal and industrial water, wastewater and water pollution industries. These individuals actively design, specify, buy, operate and maintain the equipment, chemicals and services used for water treatment. Editorial content in this audited publication highlights new products and literature concerning the supply, collection, treatment and distribution of drinking water; the collection, treatment and disposal of wastewater; and hazardous waste pollution control. Regular Editorial Emphasis and High Tech sections feature major equipment and systems. A product directory is included in the annual June *Buyer's Guide*.

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Bill Swibhtenberg, Editorial Director

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Are You Ready for CMOM?

Capacity Management Operations & Maintenance Program Will Change the Operation of Sanitary Sewers

CMOM is the acronym for the new Capacity, Management Operation and Maintenance program that will soon be enacted by U.S. Environmental Protection Agency (EPA). In its simplest form, it has to do with the operation of sanitary sewers to prevent overloading of waste treatment plants and the overflow prevention of sanitary sewage into lakes and streams.

For many years, the natural inclination has been "if waste successfully comes in one end and out the other, don't worry ." With the Clean Water Act, among other things, came the prohibition of untreated sanitary waste overflow. Residents have been increasingly _____ when sanitary sewage backs up into basements.

General lack of attention to sewer systems partially is due to despair over funding and a general lack of political drive to invest in upkeep of sewers and waste treatment facilities. By the time the problems become chronic and the ensuing consent decree is issued, the costs may be enormous.

EPA now points to substantial fines that have been leveled against sewers and the fact that almost all beach closings nationwide have been due to spills. The bottom line, according to EPA, is that systems are going to have to adopt a more proactive approach and CMOM is the "sewer system business plan."

The CMOM Plan

EPA is concerned that many sanitary sewer systems are inadequate to handle current flows, and at times there are overflows and spills during normal operations. EPA regards this situation as an unacceptable public health threat.

Pull Quote 1

Pull Quote 2

The causes of sanitary sewer overflows may include

- System deterioration,
- Build-up of obstructions in the piping,
- Excessive infiltration of storm water and groundwater,
- Pump and power failure,
- Broken and cracked pipes and
- Undersized piping.

The plan has been described as a "consent decree" that you write for yourself. On the one hand, spills are outright prohibited. On the other hand, knowing their inevitability, EPA states that a potential post-spill enforcement action will consider the following: Do you have a CMOM plan in place that represents "best practices" in all areas? Does your plan demonstrate a true commitment to stopping overflows? Are you following the plan? If the answers are all positive, the outcome will be more "favorable" to operations.

As currently proposed in the CMOM rules, all sanitary sewer collection systems will be required to have their own NPDES permit. This includes "satellite collection systems" --systems that only convey wastewater and do not have their own treatment plant. Two or three years after the new rules are finalized, collection system owners will be required to apply for the permit, unless they have a sewer overflow or basement backup incident in the interim. If they do have such an incident, they will have to apply for their permit within six months.

The Present Situation

The proposed CMOM rules and have gone through one informal review. EPA currently is addressing the comments received on the original version, and it is expected that the draft "Notice of Proposed Rulemaking" will be printed in the Federal Register in the Fall 2002. At that time, the official public comment period begins, which probably will extend for approximately four months. After the public comment period closes, EPA will develop a final rule package. How long it will take before the final rule is promulgated will depend in great part on how many changes will be required in response to the public comments.

Although there will be various changes in the final rule, there is no doubt that the new rules are coming, and the general intent basically will be the same as it is now. Several states already are moving ahead with their own CMOM regulations that should dovetail final Federal requirements. A proactive approach now will provide operators with more time to develop a reasonable program and response.

Where Do We Start?

- **Funding**—EPA estimates that this rule will impose an additional total cost for all municipalities of between $93.5 and $126.5 million each year. For a collection system serving a population of 7,500, they estimate the average additional cost at about $6,000 each year to comply. These costs do not include the cost of repairing or upgrading existing sewers to meet Clean Water Act requirements. So, if the system is old and neglected, you might be facing hefty improvement costs.

Before you can even start looking for funding sources, a complete survey of the system conditions and needed improvements is imperative.

- **Mapping—**What do you have in the ground? If your collection system is current, you have a head start. If it is

Major Points of the CMOM Plan

The CMOM Plan generally is a six-part program. The owner/operator of each sanitary sewer system will be required to develop a plan generally meeting the following points.

1. General Standards—You, the permittee, must

- Assure proper management, operation, and maintenance of the system.
- Provide adequate sewer system capacity for base and peak flows.
- Stop and mitigate the impact of overflows.
- Provide notification to parties exposed to pollutants.
- Develop a summary of the program and make it available to the public on request.

2. Management Program—Develop a CMOM program to comply with above requirements.

- **Goals—**Identify the specific goals of your program.
- **Organization —**An organization chart showing responsibilities and the chain or communications for reporting sanitary sewer overflows (SSOs).
- **Legal authority—**Document that your organization has sufficient legal authority to
  - Control infiltration and inflow.
  - Require proper design and construction of sewers and connections.
  - Ensure proper installation, testing and inspection of new and rehabilitated sewers.
  - Address flows from satellite municipal collection systems.
  - Require pretreatment of industrial waste discharges.
- **Measures and Activities—**You should be able to demonstrate that you have in place
  - Adequate facilities and equipment for system maintenance.
  - Adequate maps of the sewer system and a program to keep the maps current.
  - A management system that properly prioritizes construction and maintenance activities.
  - A routine for operation and preventive maintenance activities.
  - An assessment of the current capacity of the collection system and treatment facilities.
  - Identification and prioritization of structural deficiencies and the short-term rehabilitation action to correct each of them.
  - A program for proper training of workers.
  - An equipment and replacement parts inventory.
- **Design and Performance—**Have in place written requirements and standards for
  - Required types of materials, installation and inspection of new pipe, laterals, pumps and other system components.
  - Required materials, installation and inspection of repairs to the system.
- **Monitoring and Measurement—**Keep adequate records to show that you are
  - Monitoring and measuring the effectiveness of each element of the program,
  - Periodically updating the program as appropriate and
  - Modifying the CMOM Plan as appropriate.

3. Overflow Response Plan—Have an emergency plan that will ensure that

- You are aware of sewer overflows;
- There is a plan for appropriate, rapid response;
- There is timely notification to appropriate health and regulatory authorities;
- That personnel are trained, know and follow the plan; and
- Emergency operations are provided.

4. System Evaluation and Capacity Assurance—Evaluate the capacity of the sewer system to ensure that

- Hydraulic deficiencies are identified,
- The deficiencies are prioritzed in scheduling system improvements,
- The performance in monitored after upgrades are made and
- The CMOM plan is kept updated.

5. CMOM Program Audits—As part of the NPDES permit application you must

- Submit an audit report as part of the application.
- Evaluate your compliance with your own CMOM plan.
- Address in the report, identified deficiencies and steps taken to respond to them.
- Make the audit, along with the plan itself, available to the public upon request.

6. Communications—You regularly should

- Communicate with interested parties on the implementation and performance of your CMOM program.
- Allow interested parties to provide input to the program.

inaccurate or you are not sure, bring it up-to-date. If a map is non-existent, it is the first step.

A suggested way of checking map accuracy is to inspect every manhole and identify every pipe that enters or leaves. A pipe locator with sonde is the ideal method of identifying unknown pipe. The sonde, strapped to a sewer rod end, is a miniature transmitter that communicates with the surface locator unit via a unique frequency.

- **Illegal connections—**In most sanitary sewer systems, the biggest contributors to excessive flow during rain storms are downspout, sump pump and area drains that quietly were connected by residents. If you already have surveyed the system to identify and disconnect these storm water sources, you have a head start. If you have not, you had better start planning.

  Suspected downspouts can be checked by pouring in dye at the source and observing downstream manholes to see if it passes. The fastest method is smoke testing. If your testing program is well- organized, an experienced crew quite possibly can test a small system in a matter of days. And, at the same time they also will identify some broken pipes, leaking manholes and other sources of storm water inflow.

- **Pipe condition—**Unless a collection system is brand new and perfectly installed, it almost is essential to do a television inspection of piping. Broken pipes, leaking joints, protruding lateral connections, globs of roots and a variety of other items will be encountered.

TV inspection can be done by specialized contract firms, but the cost of good, portable TV inspection equipment has become so reasonable that many systems are now buying their own. An advantage of ownership is that it readily is available anytime. A sudden blockage can be examined and diagnosed prior to digging.

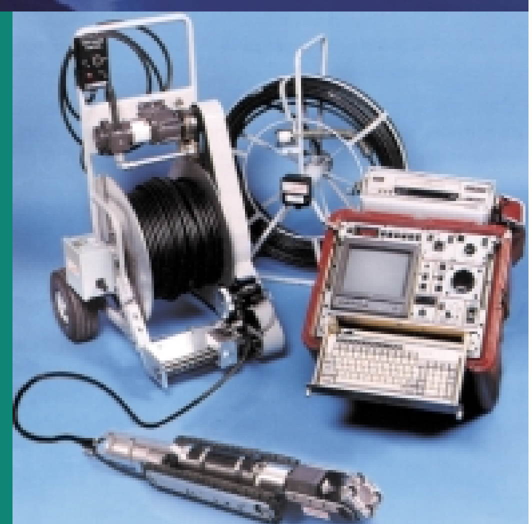
The TV inspection will, of course, identify most of what you are going to have to do. Some locations will require digging and repair. Other whole sections of pipe require lining or laying new pipe.

Sources for Additional Information

This is not intended to be an exhaustive discussion on CMOM. More information will be available as implementation draws nearer. Regulations are coming, and a jumpstart will assist in easier compliance when the regulations become law.

For more information on the status of the new rules, these sites provide information as well as links to additional resources.

- www.epa.gov/npdes/sso
- www.wef.org
- www.comom.net



Smoke Testing

Smoking Out Sewer Leaks

An Overview of Smoke Testing, an Important Part of I&I Studies

Smoke testing can be performed to determine the sources of excess inflow. *(Photo courtesy of Woolpert LLP.)*

By Paul Tashian, Superior Signal Company, Inc.

Used extensively for more than 40 years, smoke testing has proven to be a vital ingredient of successful inflow and infiltration (I&I) studies. It is as important now as it ever has been as growing municipalities increase demands on aging, often deteriorating collection systems. In addition, programs such as the U.S. Environmental Protection Agency's (EPA) new capacity, maintenance, operations and maintenance (CMOM) program emphasize a focus on proactive, preventive maintenance practices. Smoke testing can aid in documenting sources of inflow and should be part of any CMOM program.

Just as a doctor would require the aid of several instruments to evaluate the status of a person's health, various test methods should be used in performing a complete sanitary sewer evaluation survey (SSES). In addition to smoke testing, these could include dyed water testing, manhole inspection, TV inspection and flow monitoring. Specializing in sanitary sewer evaluation surveys, Wade & Associates of Lawrence Kansas reports a reduction of 30 to 50 percent in peak flows can be expected as a result of implementing these types of programs.

Smoke testing is a relatively simple process that consists of blowing smoke mixed with large volumes of air into the sanitary sewer line usually induced through the manhole. The smoke travels the path of least resistance and quickly shows up at sites that allow surface water inflow. Smoke will identify broken manholes, illegal connections including roof drains, sump pumps and yard drains, uncapped lines and even will show cracked mains and laterals, providing there is a passageway for the smoke to travel to the surface. Although video inspection and other techniques certainly are important components of an I&I survey, research has shown that approximately 65 percent of all extraneous stormwater inflow enters the system from somewhere other than the main line (see private sector diagram). Smoke testing is a method of inspecting both the main lines, laterals, etc. Smoke travels throughout the system, identifying problems in all connected lines--even sections of line that were not known to exist or thought to be independent or unconnected. Best results are obtained during dry weather, which allows smoke better opportunity to travel to the surface.

Necessary Equipment

Blowers—Most engineering specifications for smoke testing identify the use of a blower, which is able to provide 1,750 cubic feet of air per minute (cfm) However, in today's world it seems to be the mindset that bigger is better. New smoke blowers on the market can deliver more than 3,000 cfm. The question is: Is this really needed? Once the manhole area is filled, the smoke only needs to travel sections of 8- or 10-inch pipe. Moving the air very quickly is useless if the blower does not have the static pressure to push that air/smoke through the lines. If you have used high CFM blowers and found that smoke frequently backs up to the surface, this may be the problem.

There are two types of blowers available for smoke testing sewers: squirrel cage and direct drive propeller. In general, squirrel cage blowers usually are larger in size but can provide more static pressure in relation to CFM. The output of the squirrel cage type usually is adjustable by alternating pulleys and belts to meet the demands of the job. Propeller-style blowers usually are more compact and generally offer approximately 3,200 CFM. Other than reducing the engine throttle, the output is not adjustable since the fan blade is attached directly to the engine shaft. If purchasing a smoke blower, you should ask the manufacturer if the CFM and static pressure output it is quoting is the specification of the propeller itself (uninstalled/free air) or if it is the actual performance when installed in the blower assembly. These two numbers can vary significantly.

Smoke Types—There are two types of smoke currently offered for smoke testing sewers: classic smoke candles and smoke fluids.

Smoke candles first were used for testing sewers when the process began its popularity in 1961, and continue to be the most widely used. They are used by simply placing a smoke candle on the fresh air intake side of the blower. Once ignited, the exiting smoke is drawn in with the fresh air and blown down into the manhole and throughout the system. Smoke candles are available in various sizes that can be used singularly or in combination to meet any need. This type of smoke is formed by a chemical reaction, creating a smoke that contains a high content of atmospheric moisture. It is very visible even at low concentrations and extremely effective at finding leaks.

Another available source of smoke is a smoke fluid system. Although they just recently have been more aggressively marketed, smoke fluids became available for sewer testing shortly after smoke candles, some 30 years ago. They certainly can be used effectively, but it is important to understand how they work. This system involves injecting a smoke fluid--usually a petroleum-based product--into the hot exhaust stream of the engine where it is heated within the muffler (or heating chamber) and exhausted into the air intake side of the blower. One gallon of smoke fluid generally is less expensive than 12 smoke candles. However, smoke fluids do not consistently provide the same quality of smoke. When using smoke fluid, it is important to understand that as fluid is injected into the heating chamber (or muffler) it immediately begins to cool the unit. The heating chamber eventually will reach a point where it is not hot enough to completely convert all the fluid to smoke, thus creating thin/wet smoke. This actually can happen quickly depending on the rate of fluid flow. If the smoke has become thin, it can be especially difficult to see at greater distances. Blocking off sections of line usually is a good idea with any type of smoke but becomes almost a necessity when using smoke fluid. Some manufacturers have taken steps to address this issue and now offer better flow control, fluid distribution and, most importantly, insulated heating chambers to help maintain necessary temperatures.

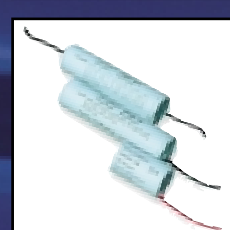
Safety—Maybe one of the more talked about, yet least understood aspects of smoke testing, is the use and safety of these products. As manufacturers have become more competitive, some marketing programs and advertisements have implied danger in the use of competitive types of smoke products. Laboratory reports, scientific studies and even Material Safety Data Sheets can be quite confusing to most of people who are not trained nor qualified to make scientific judgements on this data. Having this information delivered to the public in the form of advertising can be dangerous, as most people tend to believe what they read. An author of an associated industry publication once stated, "Do not use smoke bombs, as they give off a toxic gas." Although the author quotes no scientific literature to support this statement, competitive propaganda has made such implications. It is interesting to note that the same exact statement could be made for smoke fluids. Smoke from fluid is created in the exhaust system of the engine, which contains carbon monoxide.

Other statements that have been made include warnings to wear a respirator while smoke testing. While certain manufacturers have issued this warning about competitive products, they do not qualify the statement, nor do they mention the fact that the same thing could be said of similar products. The fact is that a respirator should be worn whenever a person would be exposed to any substance in quantities that exceeded OSHA limits. Would smoke- testing personnel be exposed to enough smoke to exceed these limits? Not very likely. The bottom line on safety is that it is important to use common sense. All smokes, candles and fluids can be used safely and effectively when used as directed.

When planning to smoke test, it is important to develop a proactive public notice program. Ads in local papers, door hangers, mailers and door-to-door inquiries are recommended. It is helpful to educate the public as to why the test is being performed and the positive benefits to the community. In addition, it should instruct residents on what to do and who to call if smoke should enter their homes. It also is important to notify local police and fire departments daily as to where and when smoke testing will be taking place.

Reducing stormwater inflow into collection systems means reduced chances of overflows, less emergency maintenance and less money spent on treatment.

About the Author
Paul Tashian is employed by Superior Signal Co., Inc., a manufacturer of all types of smoke testing equipment, and a major contributor to the original development of smoke testing practices. Also, a thanks to Wade & Associate, a company specializing in sanitary sewer evaluation surveys, for offering reference material, and providing artwork and photographs used in this article.



Root Control

New Generation of Chemical Root Control Available to Municipalities and Contractors

Workers mix the dry RootX chemical and load it into the dispersal unit. The chemical then is applied using standard sewer-cleaning equipment.

As the Foam Dispersal Unit passes through the pipeline, a powerful root-killing foam is created that completely fills the pipe, including the crown where 90 percent of root growth occurs.

The U.S. Environmental Protection Agency (EPA) currently is developing an audit program that will evaluate compliance of all aspects of collection system capacity, management, operation and maintenance (CMOM). So, maintaining full pipeline capacity and avoiding sewer backups and overflows are more important than ever. Effective root control, which minimizes hazards to humans, the environment and treatment plants, can be a critical element in maintenance planning for sewer lines.

Root control always has been a challenge for municipal sewer agencies. Some municipalities cut the roots out when they are found, but too often the problem is not found until a blockage and perhaps an overflow has occurred. Cutting the roots is a short-term solution and possibly can compound the problem. Roots respond to cutting the same way a hedge does; each cut produces a half-dozen new sprouts. Within three months, the roots usually are much thicker than before the cutting.

Chemicals have been used to kill roots since the mid-1970s. Until recent years, chemicals could produce negative impacts on people, treatment plants and the surrounding environment. Now there is a new generation of root control chemicals that does not produce negative impacts on the treatment plant or the people who use it, yet still effectively eliminates troublesome root problems. The simplicity and effectiveness of this new generation of root control allows any applicator, whether it be a municipal sewer agency or contractor, to become a root control professional--even with minimal experience.

The new generation of chemical root control utilizes Dichiobenil, an aquatic herbicide, as its active ingredient with a label designation of “warning” as opposed to “dangerous.” This new generation of chemical root control also is classified as a general use herbicide by the EPA, which means licensing may not be required for application. The formulation also contains surfactants to strip away grease and grime so the active ingredient more easily can reach the surface of the root. The rest of the formulation encourages bacterial growth to speed the natural decomposition of the dead roots.

Appling to Mainline Sewer

The new generation of chemical root control is able to foam on contact with water. This means the application process can be done directly from the package or with existing sewer cleaning equipment. The foaming action carries the active ingredient to the top of the pipe where 90 percent of root growth occurs. The foaming action also leaves a residual on the roots and pipe walls to eliminate new growth for a period of time. By pouring the dry powdered product directly into the manhole or cleanout, the product will foam by adding water or coming in contact with the existing flow. The foam will expand and move down pipe with the flow, leaving a residual on the roots and pipe walls.

The product also may be applied with existing sewer cleaning equipment by using a foam dispersal unit, which is a nozzle that fits onto the end of a jetter hose. Starting at the upstream manhole, the applicator fills the nozzle with the dry powdered product and attaches the nozzle to the jetter hose. As the jetter operator retrieves the hose he turns the jetter on idle to add water into the nozzle that disperses the foam spray throughout the pipe, coating the roots with the root-killing formula. This also adds value to the jetter unit by being able to use the jetter as a root control machine while in the field doing other maintenance projects such as cleaning.

A regular maintenance program with chemical root control can help municipalities meet the local, state, regional and national regulations that are set up to avoid sewage overflows. CMOM is an example of those regulations. Utilizing applied chemistry such as the new generation of chemical root control will allow municipalities and contractors to meet these challenges cost-effectively, while being a valuable tool in complying with these regulations.

Pull Quote or Sidebar

Manhole Testing

Preventing I&I

By Greg Lawrence, Cherne Industries, Inc.

The most effective solution for eliminating infiltration and exfiltration is to accurately test sewer lines and manholes. The two commonly used methods to test sewer lines and manholes are with water and pressure. Pressure testing is a proven method of testing sanitary sewer systems.

Water Testing

Historically, water testing of pipe was the norm up until the mid- to late-1960s. In regards to manholes, water testing was common through the mid-1990s. Some areas today still allow testing of new pipes and manholes using water through either an infiltration or exfiltration test. In an infiltration test, groundwater entering into the pipe is monitored through the use of a weir. Conversely, in an exfiltration test, water is introduced into the pipeline or manhole and the water level is monitored over a specified period of time, usually 24 hours.

Water testing for infiltration presents problems. For instance, a faulty segment of pipe could pass the test due to no groundwater being present. Als, it is difficult to use the metering equipment to measure water flow.

Water exfiltration tests also present certain problems. First, a water test is impacted by the moisture content of the soil--for instance, if the groundwater pressure is greater than the test pressure in the manhole or pipe, no water will leak out, thus giving a false passing reading.

Secondly, use of water also is much more costly to the contractor and city and is lengthy to conduct (24 hours). All water must be brought to the job site and must be pumped out after the test. In either case, once it is determined that there is a leak, there is no method of determining where the leak is.

Pressure Testing

Conducting a low-pressure air test on new sewer lines will ensure pipe joints are tight and leak-free. Performing vacuum tests on

Things to Remember

- Infiltration and inflow wastes millions of dollars annually.
- Exfiltration is endangering our ground water daily.
- Mandating pressure tests on all new sewer lines and vacuum testing of manholes eliminates potential I/I and exfiltration problems in the future.
- Both pressure testing pipes and vacuum testing manholes allows for leak location, where water testing does not.
- Both pressure testing pipes and vacuum testing manholes can save contractors and municipalities time and money.

new manholes ensure that they are structurally sound, correctly installed and leak free.

It is recommended that all sewer lines are pressure tested to verify the integrity of pipe (line acceptance test). A line acceptance test generally is performed to establish the tightness of a section of newly laid sewer pipe. A specific drop in air pressure within a pipe section over a specified length of time determines acceptance or failure of the line in question. Typically, a test can be accomplished in a matter of minutes compared to a 24-hour exfiltration test.

When a drop in pressure is recognized, two plugs can be used to isolate the leak to within five feet of pipe (leak location test). Leak location testing also can be done in a matter of minutes.

It is recommended that a vacuum test be given to verify the integrity of all manholes. Manhole testing is performed by creating a vacuum in the manhole and monitoring a gauge for vacuum loss. Vacuum testing identifies potential infiltration and exfiltration problems. A manhole testing system allows you to test manholes in approximately 20 minutes from start to finish compared to a 24-hour water exfiltration test. It provides immediate leak detection, before or after ring installation and backfilling, while also eliminating expensive/time-consuming water tests. Vacuum testing is an efficient, accurate and cost-effective method of testing new, existing and rehabilitated manholes.

Low-pressure air testing has successfully been used in the United States to test pipelines for more than 35 years. Vacuum testing, introduced in the last 15 years, now is the primary method for testing manholes. These methods of testing have proven to be a fast, economical and accurate method for testing newly installed sanitary systems.

References

ASTM specs C828, C924, C1103, and F1417 for pressure testing pipe.

ASTM specs C1244, C1227 for vacuum testing manholes and septic tanks.

I&I

Preserving Pipelines

Chemical Grouting a Key Component of Sewer System Maintenance

By Richard N. Schantz, P.E.

The heart of a chemical grouting system is the truck, which carries all necessary equipment and operator controls. In this photo, a technician washes a packer after its removal from a line.

Sewer line joint testing and chemical grouting provide new opportunities for sewer cleaning and televising companies to expand their maintenance and rehabilitation services. Well-maintained and functional sewer systems are a major asset in any community, but they require regular cleaning, inspection and maintenance. Chemical grouting too often is viewed as a stopgap measure to reduce groundwater infiltration. In reality, grouting does much more to maintain sewer line integrity. It also is a soil-sealing process that stabilizes the sewer bedding soil, preventing washout of bedding fines and resulting pipe misalignment and joint failure.

Recent draft changes to EPA-administered permit programs, specifically the Capacity, Management, Operation and Maintenance (CMOM) program, requires each permittee to "properly manage, operate and maintain at all times, all parts of the collection system" that they own or control. The CMOM program specifically requires the following.

Chemical grouting is more than a stopgap repair to reduce groundwater infiltration. It is a key component of a sewer system maintenance and rehabilitation program.

- Routine preventive operation and maintenance.
- Identification and prioritization of structural deficiencies, and identification and implementation of short-term and long-term rehabilitation actions to address each deficiency.
- Standards for the installation of new sewers and for rehabilitation and repair projects.
- Procedures and specifications for inspecting and testing new sewers and rehabilitated and repaired facilities.

This means increased opportunity for contractors in sewer system inspection, maintenance and rehabilitation, especially in communities that have neglected their collection systems.

Why Chemical Grouting?

Chemical grouting is a proven process that has been successfully used for more than 40 years. The process preserves existing sewer systems by stopping groundwater infiltration and stabilizing the bedding soil around structures. It also stops migration of wastewater and groundwater through sewer bedding and prevents the washing of fines from the bedding soil into the system.

Chemical grouts immobilize water in the voids between soil grains and particles. In this way, they stabilize the soil and prevent the flow of groundwater through the soil and into the sewer through joints, connections or cracks.

Chemical grout is not cement that fills a void or crack and then hardens to form a new structure. Instead, it is a low-viscosity liquid that, when applied, flows through the sewer joint, connection or crack into the bedding soil around the area of injection.

Low viscosity is what makes chemical grouts so effective in soil stabilization and sealing. Once injected, the chemicals easily flow between the soil grains into the surrounding soil and gel or coalesce, entrapping the water and soil to form a large "doughnut" of sealed, stabilized soil around the point of injection. The result is a mass of solid soil that seals off the flow of groundwater.

When jetting a sewer line, technicians often will find an inordinate amount of soil and sand being drawn from the pipe. Experienced operators know this can be a sign of open joints or cracks where bedding material fines are being liquefied outside the sewer pipe wall and flushed into the system through adjacent joints and cracks.

The jetting process is, in fact, removing this bedding. With the loss of pipe bedding material, the pipes settle, losing their alignment and opening joints to additional infiltration. Older sewer systems that show any type of groundwater infiltration or misalignment should be joint-sealed using chemical grout as a first step in maintenance and rehabilitation.

Successful Grouting Factors

Any successful project depends upon cooperation between the contractor and the customer. The same applies to chemical grouting. The contract must reflect the realities of grouting, and each party must understand its contractual responsibilities.

For example, the contractor typically is responsible for equipment, crew, application knowledge and productivity. The municipality, meanwhile typically is responsible for grout usage, as the quantity of grout used depends on sewer line and bedding soil conditions that the contractor cannot control.

While the contractor's labor and equipment may be at a fixed price, the chemicals are paid for on a unit-cost basis. This ensures a full chemical injection into all areas that require sealing and restabilization of the pipe and surrounding soil. Fixed-price contracts may limit the amount of chemical grout applied--to the detriment of the final result.

The grouting operator is critical to the project. The operator works at the control panel of a test-and-seal grouting truck, observing the operation on a video inspection camera. A quality operator understands through experience the chemical pump flow rates, discharge pressures, injection point pressures and chemical cure times required to seal and stabilize each area.

Test and Seal Equipment

Grouting operations are performed between manholes. Every test-and-seal system has the same basic components.

- A truck to carry controls, electric generator, grouting equipment, chemicals and a TV system to the point of operation and provide a work platform.
- A video system with a skid-mounted TV camera coupled to the monitor in the control room.
- A winch at the remote manhole, powered through a cable and controlled by the operator in the control room.
- A grout chemical injection system, consisting of two separate chemical tanks, pumps, valves and hosing. The two pumps work in unison at a preset ratio of one chemical to the other (1:1 for acrylamide, 8:1 for urethane).
- A four- or five-part reel-mounted hose, 500 to 700 feet long, that delivers two separate chemicals, packer inflation air, test air and lateral plug air pressure or vacuum (for lateral grouting) to the test-and-seal packer at the working point in the sewer line.
- A test-and-seal packer--The joint isolation, testing and chemical injection device that is moved through the sewer line from joint to joint.

The Grouting Process

Before grouting, the sewer line must be cleaned and dirt, grease and stones removed. To start grout operations, a power winch is located at the remote manhole, and a towing cable is threaded through the sewer line back to the grout truck at the local manhole. The TV camera is mounted on a skid looking backward toward the local manhole. The grout packer is then attached to the camera skid, and the grout hose assembly is attached to the packer.

This train of equipment is launched through the local manhole. The remote winch, controlled by the operator on the truck, tows the chain of gear with rear-viewing TV camera, packer, hose and TV cable through the sewer line from the local manhole toward the remote manhole.

The operator uses the TV camera to locate each sewer joint. The packer is positioned over the joint and is inflated at both ends, isolating the joint at the midpoint of the packer. This resulting space is called the void area.

The packer is fitted with a void pressure transmitter that provides continuous void pressure information to the operator. This pressure data tells the operator how the test-and-seal operation is proceeding.

Either air or chemical grout is pumped into the void area to pressurize and test the joint. If the joint fails to hold pressure, chemicals are injected until the injection pressure reaches a predetermined level. The chemical pressure slowly rises in the void area as material is injected, until there is a sudden increase in void pressure, signifying that chemical has been injected to the point of refusal and that sealing should be complete.

The chemical grout then cures rapidly (in 40 to 60 seconds). The joint is retested to confirm a complete seal. If necessary, the joint is regrouted and retested.

Grouting Cost Factors

The major cost components in grouting are equipment, crew and chemicals. These items must be related to expected production rates in order to project test-and-seal cost on a per-joint or per-line basis.

A grouting crew usually consists of two people: an experienced lead operator and a supporting member of the crew to help install and remove equipment and mix chemicals.

Chemical usage varies greatly, from one to three gallons or more per joint for 8-inch pipe. Higher usage is not unusual on lines where extensive washout of backfill has occurred. That is why it is misleading to quote firm-price chemical costs per joint or line.

Production rates also vary but can be reliably predicted based on pipe diameter, pipe segment length, number of joints, manhole access and set-up time. For example, an 8-inch clay pipe in 3-foot segments covering about 300 feet, manhole to manhole, has 100 joints. At production rate of five minutes per joint including set-up and knockdown, a crew could test and seal about 12 joints per hour and complete one segment, manhole to manhole, in a typical working day.

A Practical Solution

Complete grouting of sewer joints substantially extends sewer life. Municipal sewer agencies will benefit from a complete job that fully saturates the soil around each leaking joint with chemical grout. Saturation will not only stop infiltration but eliminate bedding soil washout and thus stabilize the sewer line, maintain sewer alignment and stop shifting of pipes and joints caused by ground water action.

About the Author

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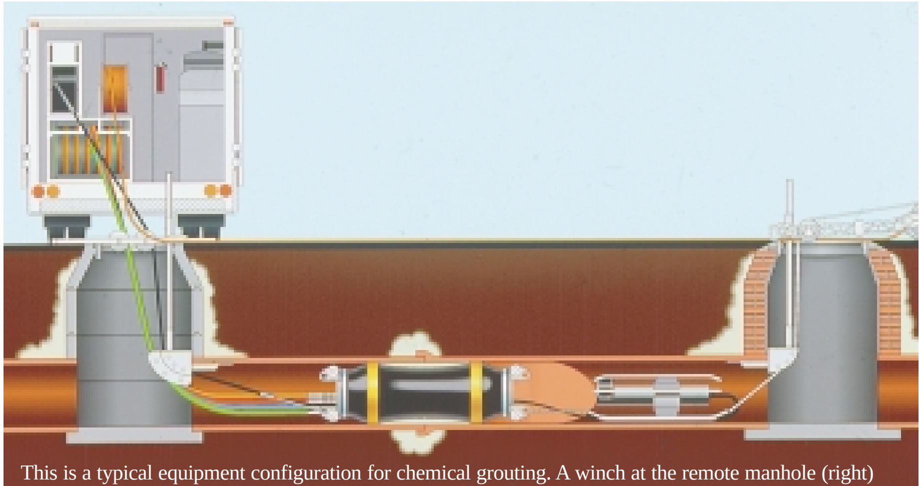

This is a typical equipment configuration for chemical grouting. A winch at the remote manhole (right) pulls the equipment train through the line, applying grout at each joint.

Safety

Confined Space Safety - unedited

By Don Renner

Following the proper safety precautions when entering or working in confined spaces is an important function for anyone who subjects themselves to the hazards of this kind of vocation. we all know of the horror stories 'of persons getting buried alive or of these who die from lack of oxygen in confined spaces. And yet, these accidents and deaths continue to occur; mostly because people are in too much of a hurry or feel that they are not in any danger when working in these situations. In some cases, people fail to "read" the condition of excavations and think that they can work without the aid of a trench box or proper shoring, only to become another statistics aefore a person tries to learn any safety precautions they must first know what conditions or circumstances consitiute a confined space, and what sort of rules apply to working in these spaces. once this is known, you can then proceed to follow the regulations that relate to a particular situation so you are working safely. Presuming of course, that you know the proper safety regulations.

Knowing and understanding the proper safety precautions is only a part of following safety procedures. Having the proper equipment necessary to prevent accidents and save lives, and practicing with this equipment is also important.

Defining Confined Spaces

A confined space as defined by OSHA in Part 1910.146(b) of the Federal Register (www.asha.gov) is any space that is large enough for an employee to enter anj,perform work, has a restricted means of entry and exit, and is not designed for continuous occupancy. Additionally, the space may contain a hazardous atmosphere that can result in employee injury or death. A hazardous atmosphere is defined as one with a flammable gas, vapor, or mist at 10 percent or more than the lower flammable limit, as well as an atmospheric oxygen concentration below 19.5 percent or above 23-S percent, or other gasses such as hydrogen sulfide or carbon monoxide above 10 ppm or 35 ppm respectively.

Whether the space is a below grade vault or and above ground building with a door is not revelant. It is the interior space and atmosphere that determines if i.t a confined space. There are, however, some considerations that can be taken into account in order to determine if the space can be considered "confined".

For example, a chlorine room or other chemical feed/storass room can be a confined space because of the possibility of chlorine or other chemical fumes existing if the ventilation fan was not turned on to cleat* the space before entering. At the same time, if chemical solutions or chlorine tanks are being changed or handled, the atmosphere could have vapors or trace gasses that would qualify the room as a confined space. On the other hand, an open trench could be considered a confined space if it was deep enough and had limited escape access ladders and restricted movement in the bottom because of pipe structures and shoring supports. Another consideration that inust be taken into account when dealing with confined spaces is the determinaton of whether or not the space may or may not require a permit for entry. Some spaces may be entered without a permit, and by anyone who has need to enter the soace- On the other hand, many spaces cannot be entered by anyone (even those that are authorized) with a permit that is signed by a responsible person.

Although, this may seem a complicated issue, there is some guidance provided by the Federal Register under Section 1910.146, Appendix A: Permit-required confined space decision flow chart, and Appendix C: Examples of permit-required confined space programs

Appendix A (decision flow chart) begins with the utility as a whole entity, asking the question, "Does the workplace contain confined spaces as identified.by 1910-146(b)?" if it does not, there is no problem. However, if it does, then there are a series of checks and determinations that must be made in order to determine if an entry permit is required. it also requires that the employees be informed of the hazard and the procedures necessary to work in the space, including safety equipment and evacuation or emergency procedures. The appendix also covers outside contractors that may work in the space.

At this point, it is important to note that any outside contractor working within your premises is under your responsibility, whether he reports directly to you or not. You are responsible for his well being even though he is not on your payroll. if he enters a permit required space, he must get a permit from you and you must have someone around the jobsits to make sure that he follows all-of the necessary work and safety procedures.

Addendix C uses examples to show when a permit is or is not required. Basically, it states, "entry into a space can be made without a permit or attendant providing the space can be maintained in a safe condition with the use of mechanical ventilation, as provided in 1920-146(c)(5)." Of course, a fully trained and qualifed employee must do a pre-check of the space to check for any hazardous gasses or conditions. He is also required to fill out a Confined Spaces Pre-Entry Check List to ensure that all of the necessary procedures are being followed. This includes testing of the atmosphere in the space, blocking off (where possible) of any lines that could bring contaminants into the space, and the surveillance of the surrounding area for drifting vapors.

Entering Confined Spaces

Whenever entering any confined space it is important to remember the need for safety and to follow recommended safety procedures that correspond to each area- Although, confined space entry may be briefly separated into permit.and non-permit entry, there are many circumstances listed in 1920-146 that provide flexibility in exactly how to define a confined space. Therefore, any employer should thoroughly investigate the statue to ensure that his employees are following the proper procedures when entering any sort of confined space.

For example, non-permit entry was previously described and referenced as Appendix C of the code. Appendix E of 1910.146 goes one step further to explain sewer entry and its requirements- it states that only employees that are trained for this work should be used, and that the air should be tested for specific substances (CO, ft, LLC and combustibles-LEL) before entry and at regular intervals while the employees are working. Also, continuous ventilation should take place. Additionally, in large bore sewers, employees should be equipped with audible alarm devices and an escape self-contained breathing apparatus (ESCBA) with at least a 10 minute air supply or some other NIOSH approved self-rescuer, and other emergency equipment (flashlights, radios, etc.).

Permit-required entry into confined spaces is more clearly defined in 1910.146(c) of the Federal Register, It starts out with the requirement that an employer must evaluate the workplace to determine in a space is a permit-required area. if so. all employees should be notified and a sign reading DANGER - PERMIT- REQUIRED CONFINED SPACE, DO NOT ENTER be papsted. (There are also other sections of the OSHA Code that refer to other vocations- mining, shipyard, meat packing, etc. that have their own specific regulations that define hazardous work environments.)

Once a space has been designated as a perrnit-required area the employer may or may not permit employees to enter the space. if entry is permitted, then the employer must develop and implement a written space permit program that complies with 1910.146(c) regulations. This regulation, howeve@, can be side-stopped if the space only has a Potential hazardous atmosphere that can be eliminated by forced air ventilation, as defined in 1910.146(c)(S)-

The details ofimplarnenting 1910.146(c) are further spelled out in 1910.146(d). These include such items as identifying the hazard, specifying acceptable entry conditions, providing protection barriers, providing testing, communications, personal protection equipment. ladders, and emergency rescue equipment. It also includes the requirements that each employee be able to observe and know the results of any tests that were made prior to entering the space. Additionally, the regulation reouires that an entry supervisor be present to determine if entry is allowable, and then remain at the site, or have another person available as an attendant during the time when an employee is working in the confined space. it is also suggested that a third person be nearby in case of emergency arises and the attendant must enter the space to assist the worker. And, the regulation spells out the procedures for calling for assistance as well as the actions to be taken by the crew for extracting a worker from the.confined.space.

Safety Precautions

Most confined soace safety procedures are just common sense. You would not attempt to change a tire on a vehicle without setting the brakes and blocking at least one Whadl to prevent the vehicle from moving. The same rules apply to the procedures that should be followed before entering.a confined space, and are spelled out in the Federal Register 1910.146.

As has been previously mentioned, proper ventilation, sample air testing, and the use of protective safety equipment are all necessary before entering a confined space- However, there are some specific items that should be pointed out because their selection depends on the conditions within the confined space. The following are examples of some of these selection possibilities.

Ventilation equipment can be of the "suction" or- "blow-in" style. if a suction style is used, then the ventilator must be placed somewhere other than the work.area in order to provide fresh air at the work area and to eliminate other fumes from entering the work area. if a blow-in style is used, then the blower must be located away and downwind of the work area. Also, the blower discharge hose must extend to the bottom of the confined space to permit full purging of the atmosphere- The amount of time for the air purge that is required can be calculated by dividing the manhole volume (cubic feet) by the cfm of the-blower. The air must also be tested for purity.

C3as detectors are available.in a.variety of styles. However, those that are most often used measure specific gasses - Co, *I, Oa and combustibles (LEL)- Additionally, there are audible warning devices that can be warn by the worker as added protection against an unexpected surge of.'hazardous gas.

Remember that the test equipment/device is only as good as its calibration. Therefore, the device must be checked and calibrated at regular intervals if it is to provide the required data. Also, the permit entry form requires that the gas test equipment be identified, as well as the person performing the test.

The selection of hoisting equipment depends upon whether the confined space is a ladder or ladderless entry. Also, whether or not the hoist is used for materials or personnel. Work winches should never be used to hoist personnel. The various manufacturers have diffrent stipulations on how their winches should be used. and are reflections of OSHA regulations published under several different rulings.

For example, 1910.146(k)(3)(ii) requires a mechanical type device for rescue in vertical conditions more than 5 feet deep. on the other hand, OSHA 1910 general industry and 1926 construction industry standards stipulate specific requirements for the selection of a tripod/manually operated winch system. Additionally, 1910.28 and 1926.451 require the use of a backup fall arrest system for use when entering ladderiess structures. Both regulations also require that the tripods and winches be tested and listed by a nationally recognized testing laboratory (Underwriters or Factory Mutual). The winches also may require testing by the manufacturer after a ceriod of use or operation.

A Backup fall systems are good-ideas.:for any structure that is deep and can be considered a hazard to enter even if they have rungs- Especially, if the structure is old and the ladder rungs are not in the best of condition. The backup fall system can be a rope grab kit or a self-retracting lifeline, but must be connected to the "D" ring of the full body harness that the worker wears when entering the work saace- if the confined space contains a hazardous gas that cannot be effectively purged or reduced to an acceptable level, then some sort of breathing appartus will be required before the worker can be allowed to enter the space. Again, the existing conditions will determine what kind of breathing assistance/apparatus will be required.

For most conditions where the worker must enter, and remain for a time before he can complete his task, a 30 or 60 minute self-contained breathing appartus.(SCBA) would be required. While some are rated for fire fighting situations, there are others that are rated for industrial use- Both 5tyles have similar features and are acceptable under OSHA regulations. Keep in mind that the 30 or 60 minute air time cannot be fully used by the wearer. Usually, a 5 or 10 minute warning system permits the wearer to egress the space before the air runs out. There are also other SCRA units available that have more limited escape time from 5 to 15 minutes. These devices are not worn when entering, and are only used to permit an emergency exit from the space- in addition to these ddvices,. some manufacturers have limited use respirators that can be used by workers in atmospheres that contain hazardous Qasses,at low levels.

Regardless of how much and what kind of equipment you provide, it is useless if the employees are not trained and proficient with it. Training (mot just simply talking, but doing) is the most important part of any confined space entry program. It is also required as part of the OSHA regulations and can be used to certify the employees peeformance of various tasks that they will perform. There are many training programs available for this purpose as well as OSHA compliance and accident prevention manuals that can help you determine how to understand and meet the regulations.

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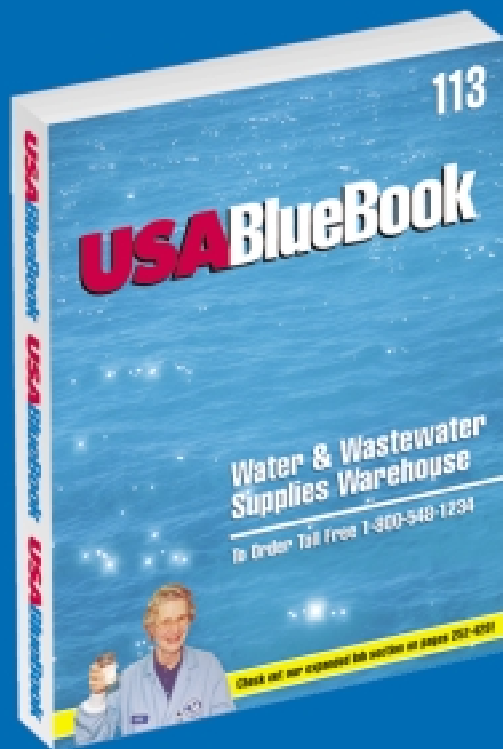

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