CHAPTER 2: OPERATOR SAFETY

SAFETY CONSIDERATIONS
Safety should be of great interest to anyone working in the wastewater profession. On any given day at work operators could be exposed to the following hazards:

- Excavation hazards
- Confined spaces
- Electrical and mechanical hazards
- Hazardous chemicals
- Noise
- Physical hazards
- Infectious materials
- Traffic hazards

This is not a short list! Operators need to be aware of potential injury in all activities they perform at work. The best person to prevent an injury from occurring is YOU. Being aware of potential danger, planning ahead for safety measures, and developing safe work habits can prevent many injuries.

Most injuries involve sprains, slips, falls and being struck by objects. These are all injuries that can be avoided. The number of years of experience an operator has affects how likely they are to be injured. As experience increases, workers are more likely to understand the hazards and prevent injuries. This makes it very important that workers with more experience look out for entry-level employees, who are the most vulnerable. Insistence on following safety rules is the responsibility of every employee, but entry-level employees follow the lead of their supervisors. If inexperienced employees are taught bad habits by their supervisor, it is the supervisor, not the employee, who is to blame.

OPERATOR SAFETY TRAINING PROGRAMS
On the job training (OJT) is a very valuable tool to not only upgrade operational skills, but also protect workers’ health. There is a great need to improve the safety training at many wastewater treatment systems. The desire for a safe workplace must start at the top of the organization. Without this support, safety efforts will be un-funded and ineffective. Some aspects of a good operator-training program are:

1. Develop written Standard Operating Procedures (SOPs) for routine duties or equipment operation and have regular training sessions over each SOP. This will not only point out safety aspects of the job, but will also be a way to train people in the most efficient way to work.
2. Have safety meetings for all workers at least once a month. Each supervisor should take turns presenting a meeting.
3. Form a safety committee to review accidents, inspect the facility for unsafe conditions, post warnings of suggest improvements to risky areas and enforce good work habits.
4. Have people learn CPR and First Aid skills. This can be done through the Red Cross, the American Heart Association, or maybe even your local fire department or ambulance service. These skills should be updated at least once every three years.

EXCAVATION HAZARDS
Accidents at the site of trenching and other excavation activities are still all too common. Almost anyone working in the field for more than just a few years can remember witnessing or at least being told about a real life excavation accident where workers were injured or killed. It does not matter how long of a time you will spend in a trench, if there is no adequate cave-in protection, you could be buried below tons of dirt. THERE IS USUALLY NO WARNING AND NO TIME TO ESCAPE.

It is strongly recommended that some type of adequate cave-in protection be provided when the trench is four (4) feet deep or more. OSHA REQUIREMENTS STATE THAT ADEQUATE PROTECTION IS ABSOLUTELY REQUIRED IF THE EXCAVATION IS FIVE (5) FEET OR MORE IN DEPTH. Methods of adequate protection include shoring, shielding and sloping.

Shoring is a complete framework of wood and/or metal that is designed to support the walls of the trench. Sheeting is the solid material placed directly against the side of the trench. Either wood sheets or metal plates might be used. Uprights are used to support the sheeting. They are usually placed vertically along the face of the trench wall. Spacing between the uprights varies depending upon the stability of the soil. Stringers are placed horizontally along the uprights. Trench Braces are attached to the stringers and run across the excavation. The trench braces must be adequate to support the weight of the wall to prevent a cave-in. Examples of different types of trench braces include solid wood or steel, screw jacks, or hydraulic jacks.
Shielding is accomplished by using a two-sided, braced steel box that is open on the top, bottom and ends (trench box). This trench box is pulled through the excavation as the trench is dug out in the front and filled in behind. Operators must remain within the box to be protected. If the trench is left open behind or in front of the box, the temptation will exist to wander outside of the trench box’s protection. Shielding does not actually prevent a cave-in the way shoring does because the space between the trench wall and the box are left open, allowing a cave-in to start. However, if a cave-in occurs, the workers inside the box will be protected from injury.

Sloping (or benching) is a practice that simply removes the trench wall itself. The angle of the slope required will depend on the stability and type of soil that the excavation site. An angle of 34 degrees (measured from the horizontal) is acceptable under all soil type and conditions. This requires a slope of 1 ½ ft across for every 1 ft vertical on both sides of the excavation. For example, a 5 ft deep trench would have to be sloped back 7.5 ft on each side under the least favorable soil stability conditions. For deep trenches, sloping will usually require more space than is available, so some other protective measure must be used (shoring or trench box).

Other Excavation Requirements
Certain soil conditions can increase the chances of a cave-in. These conditions include low cohesion, high moisture content, freezing conditions, or a recent excavation at the same site. Other factors to be considered are the depth of the trench, the soil weight, the weight of nearby equipment, and vibration from equipment or traffic. The spoil (dirt removed from the excavation) must be placed at least two feet back from the excavation and should be placed on one side of the trench only.

A ladder or other means of egress is required in the excavation if it is four or more feet deep. Ladders must be placed so that there is one available every 25 feet and they must extend at least three feet above the excavation wall.

Before an excavation begins, OSHA standards require that the location of underground utility lines that may be encountered while digging be identified. In New Mexico, a free service known as New Mexico One Call is available for utility line location prior to excavation work. In Albuquerque, the phone number is 260-1990. For all other cities, towns, villages and outlying areas, call 1-800-321-2537. 48 hours notice is required, (not including weekends or holidays).

OSHA standards also require that a competent person inspect, on a daily basis, excavations and the adjacent areas for possible cave-ins, failures of protective systems and equipment, hazardous atmospheres, or other hazardous conditions.

**CONFINED SPACE HAZARDS**
A confined space is defined as a space that has any one of the following characteristics:

- **Limited openings for entry and exit.** This could mean a small opening, such as a manhole or could mean that a ladder, hoist or other device is needed to enter or exit a space.
- **Unfavorable natural ventilation.** Deadly gasses can accumulate or oxygen can be displaced.
- **Not designed for continuous worker occupancy.** Most confined spaces are entered for inspection, maintenance, repair, cleanup, or some similar task. They are not designed for routine entry or long-term occupancy.

**ACCORDING TO OSHA STANDARDS, EACH ENTRY INTO A CONFINED SPACE REQUIRES A CONFINED SPACE ENTRY PERMIT.** The confined space entry permit is “an authorization and approval in writing that specifies the location and type of work to be done, certifies that all existing hazards have been evaluated by the qualified person, and that necessary protective measures have been taken to ensure the safety of each worker”. The permit is renewed any time the space is left and re-entered, even if for a break or lunch, or to go get a tool. The **qualified person** is a person designated in writing as capable (by education and/or specialized training) of anticipating, recognizing and evaluating employee exposure to hazardous substances or other unsafe conditions in a confined space. This person must be capable of specifying necessary control and/or protective action to ensure worker safety.

**ACCORDING TO OSHA STANDARDS, ENTRY INTO A CONFINED SPACE IS NOT PERMITTED WITHOUT**
**CONFINED SPACE ENTRY PERMIT**

<table>
<thead>
<tr>
<th>Date:</th>
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Location of Space or Vessel:

Purpose of Entering Space or Vessel:

<table>
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<tr>
<th>Persons Performing Work:</th>
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<tr>
<td>System Employees</td>
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<table>
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<tr>
<td>Employee Qualified?</td>
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<td></td>
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<tr>
<td>Safety Observer?</td>
<td></td>
<td></td>
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<tr>
<td>Space/Vessel Clean?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space/Vessel's Atmosphere Safe for Entry?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Periodic/Continuous Monitoring Required?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lines to Space Blanked or Disconnected?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lock-out Devices?</td>
<td></td>
<td></td>
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<tr>
<td>Safety Lights?</td>
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<td></td>
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<tr>
<td>Communication Devices?</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Belt/Harness/Lifeline?</td>
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<td></td>
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<tr>
<td>Breathing Apparatus?</td>
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<td></td>
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<tr>
<td>Warning Signs?</td>
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<td></td>
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<tr>
<td>Protective Gear?</td>
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<td></td>
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<tr>
<td>Fire Equipment?</td>
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<td></td>
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<tr>
<td>Forced-Air Ventilation?</td>
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<td></td>
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<tr>
<td>Rescue Gear on Hand?</td>
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</tbody>
</table>

Misc. Equipment:

Name of Safety Observer:

Misc. Precautions:

Issued by:

Supervisor or Supt. Date

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Figure 2.2 - Confined Space Entry Permit
STAND-BY RESCUE EQUIPMENT AND A STAND-BY SAFETY PERSON. An approved safety harness is required so that an injured worker can be pulled out of the confined space. If the space is entered vertically, a hoist designed for lifting people is required. The job of the stand-by safety person is to remain on the outside of the space and be in constant contact (visual or speech) with the worker inside. The stand-by person should have no other duties but to observe the worker inside and to notify the appropriate people in case of emergency. Stand-by personnel should not enter a confined space until help arrives, and then only with proper protective equipment. Over 50% of confined space fatalities are attributable to rescue attempts by other workers. Rescuers must be trained and follow established emergency procedures. An unplanned rescue, such as when someone instinctively rushes in to help a downed co-worker, can easily result in a double fatality. REMEMBER: AN UNPLANNED RESCUE WILL PROBABLY BE YOUR LAST.

THE ATMOSPHERE OF A CONFINED SPACE MUST BE CHECKED PRIOR TO EVERY ENTRY. Three potentially dangerous atmospheric conditions can exist in confined spaces. These are:

1. **Oxygen deprivation.** Some gasses are heavier than air and so will fill up a confined space, which forces oxygen out. The oxygen concentration must not fall below 19.5% at any time.

2. **Explosive conditions.** Many gasses are explosive when present in certain ratios with oxygen. These ratios are defined by the upper explosive limit (UEL) and the lower explosive limit (LEL). The specific gravity of a gas indicates its weight as compared to air. Gasses such as hydrogen sulfide and chlorine collect at the bottom of confined spaces because they are heavier than air (high specific gravity). Gasses like methane collect on the top, because they are lighter than air (low specific gravity).

3. **Toxic conditions.** Some gasses are poisonous. A worker can be injured or killed by the poisonous effect.

The sense of smell is not a reliable check of the atmosphere within a confined space. Many gasses, such as hydrogen sulfide, rapidly paralyze the sense of smell. Other dangerous gasses have no smell at all. THE ATMOSPHERE OF A CONFINED SPACE MUST BE CHECKED WITH RELIABLE, CALIBRATED INSTRUMENTS PRIOR TO EVERY ENTRY. Because gasses could exist at any area throughout the confined space, checks must be made of the TOP, MIDDLE AND BOTTOM. Detectors often rely on oxygen levels to determine explosive conditions, so testing of atmospheric hazards should always be done in the order of oxygen deficiency, explosive conditions and then toxic conditions. Always calibrate the detectors before opening the confined space. Atmospheric testing should continue while the confined space is occupied. If any hazardous condition is detected, no entry into the confined space is permitted until the condition has been made safe.

ENTRY INTO A CONFINED SPACE IS NEVER PERMITTED UNTIL THE SPACE HAS BEEN PROPERLY VENTILATED USING A SPECIALLY DESIGNED . These blowers force all the air out of the confined space, replacing it with good air from outside. Forced air ventilation is a crucial practice that must continue as long as the space is occupied, even if no atmospheric hazard is detected. Atmospheric testing should never be performed instead of forced air ventilation, or vice versa. Because some of the gasses in confined spaces can be combustible, the forced air blowers used for ventilation must be specifically designed to be intrinsically safe. This means the blower itself will not create a spark and set off an explosion. Caution must be used to prevent the forced air blower intake from drawing in dangerous gasses, such as the exhaust from an idling work truck.

<table>
<thead>
<tr>
<th>Name of Gas</th>
<th>Chemical Formula</th>
<th>Specific Gravity (Air=1.00)</th>
<th>Explosive Range (% in air)</th>
<th>Common Properties</th>
<th>Physical Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>CH₄</td>
<td>0.55</td>
<td>5.0%</td>
<td>15.0%</td>
<td>Colorless, Tasteless, Flammable, Explosive</td>
</tr>
<tr>
<td>Hydrogen Sulfide</td>
<td>H₂S</td>
<td>1.19</td>
<td>4.3%</td>
<td>46.0%</td>
<td>Rotten-egg odor, Colorless, Flammable, Explosive, Poisonous</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>CO₂</td>
<td>1.53</td>
<td>Not flammable</td>
<td></td>
<td>Colorless, Tasteless, Odorless, 10% can’t be endured formorethan 10 min., Acts on nerves of respiration</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Cl₂</td>
<td>2.5</td>
<td>Not flammable</td>
<td>Not explosive</td>
<td>Greenishyellow, Strong odor, Highly corrosive</td>
</tr>
</tbody>
</table>

Table 2.1 - Dangerous Gasses in Wastewater Treatment Plants and Collection Systems
Finally, all equipment should be kept at least two feet from an overhead opening to a confined space (like a manhole or wetwell). Personal protective equipment (PPE), such as hardhats, coveralls, gloves and eye protection should be worn by all those inside. Only non-sparking tools and lamps should be used. Obviously, no one should be allowed to smoke anywhere near the entrance to a confined space.

**Electrical and Mechanical Hazards**

Wastewater treatment plant and collection system operations involve the use and maintenance of a variety of electrical and mechanical equipment. Injuries often result during maintenance activities due to equipment accidentally being started, pumps not being properly isolated and electrical supplies not being completely shut off. The OSHA mandated program known as **Lock-Out/Tag-Out** is designed to prevent these causes of injury. According to OSHA law, all equipment that could unexpectedly start-up or release stored energy must be locked out and tagged out to protect against accidental injury to personnel. Some of the most common forms of stored energy are electrical and hydraulic energy. Whenever it is necessary to work on a piece of equipment or machinery, the following procedure shall be adhered to:

1. Notify all affected employees that the system will be locked-out/tagged-out for maintenance. Ensure that the maintenance employee(s) understands the type and magnitude of the stored energy that the equipment utilizes.
2. If the equipment is operating, shut it down by the normal stopping procedures.
3. Operate the switch, valve, or other energy isolating devices so that the equipment is isolated from its energy source. Stored energy, such as that in springs, elevated machine members, rotating flywheels, water or sludge under pressure, air, gas and steam must be dissipated or restrained by methods such as repositioning, blocking, or bleeding down.
4. Lock-out devices shall be placed on electrical controls (circuit breakers) and on valves to prevent their operation. Each employee that is working on the equipment should have their own individually keyed lock on the lock-out devices and equipment controls should display prominent tags to warn other employees.
5. It is mandatory that the locked out valve or disconnect be tried to make sure that it cannot be opened or turned on. In addition, the machine controls themselves shall be tried to make certain the energy is “off”. Return the operating controls to the neutral or off position after testing them.
6. The equipment is now locked-out and tagged-out and maintenance can begin.

7. After the maintenance work on the equipment is complete, all tools have been removed, equipment guards have been reinstalled, and employees are in the clear, remove all lock-out/tag-out devices. The equipment can now be restored to operation following normal procedures.

**Hazardous Chemicals**

Hazardous chemicals are used throughout wastewater treatment plants and in collection systems. Treatment plant laboratories use a variety of acids, bases and other potentially dangerous compounds. Operators could be exposed to various forms of chlorine, sulfur compounds, fuels and oils and even herbicides and insecticides. Employers are required to provide information to employees regarding the hazards associated with chemicals under OSHA’s Hazard Communication Standard. These rules are designed to help minimize injuries caused by chemical over-exposure and misuse.

A MATERIAL SAFETY DATA SHEET (MSDS) FOR EVERY HAZARDOUS CHEMICAL THAT IS USED OR PRODUCED IN A WASTEWATER TREATMENT SYSTEM MUST BE READILY AVAILABLE TO ALL OPERATORS. The MSDS is a reliable reference (usually provided by the manufacturer) for the type of hazards the chemical presents and what to do in the event of an emergency. All operators should be familiar with the information on the MSDS through training provided by the employer and through personal study.

Safely handling the chemicals that are used at a treatment plant is the operator’s responsibility. However, treatment plant managers should develop a coordinated response to an emergency situation, which includes local law enforcement and firefighters. If a situation develops that is beyond the emergency response plan’s scope, Chemtrec will provide immediate advice for those at the scene of an emergency and then quickly alert experts whose products are involved for more detailed assistance and appropriate follow-up. CHEMTREC CAN BE REACHED TOLL-FREE AT 1-800-424-9300.

**Noise**

Noise is a hazard that is often overlooked. Prolonged exposure to high noise levels (85 decibels or higher) can lead to permanent hearing loss. Excessive noise can come from motors, blowers, pumps, chlorine ejectors, power tools, lawn mowers and irate supervisors. Noise levels throughout the plant should be periodically checked using a standard sound level meter. In general, if you have to
shout or cannot hear someone talking to you in a normal tone of voice, the noise level is excessive. Employer provided hearing protection, such as ear-plugs or muffs, are required if the noise source cannot be eliminated. Employees shall not be exposed to noise exceeding the duration/decibel levels shown in the following table.

**Table 2.2**

<table>
<thead>
<tr>
<th>Duration: Hours Per Day</th>
<th>Sound Level: dBA Slow Response</th>
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<tbody>
<tr>
<td>8</td>
<td>90</td>
</tr>
<tr>
<td>6</td>
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<tr>
<td>1½</td>
<td>102</td>
</tr>
<tr>
<td>1</td>
<td>105</td>
</tr>
<tr>
<td>½</td>
<td>110</td>
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<tr>
<td>¼</td>
<td>115</td>
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The OSHA Blood Bourne Pathogen Standard is a law that is designed to limit worker’s exposure to two specific pathogens; Human Immune-deficiency Virus (HIV) and the virus responsible for Hepatitis B. The Blood Bourne Pathogen Standard is mainly applicable to workers in the health profession that could have direct exposure to blood or other bodily fluids and syringes that are infected with these viruses. However, because blood and other bodily fluids, along with syringes and other sharps could be present in wastewater, the Blood Bourne Pathogen Standard is applicable to many wastewater workers.

The Blood Bourne Pathogen Standard requires employers to prepare a “written exposure control plan” and make it available to employees. The exposure control plan must contain the following elements, (at minimum), to meet the standard with regard to wastewater workers:

- An exposure determination must be made for each job classification that identifies task for which exposure could be expected.
- “Universal precautions” must be taken. This means that all blood and body fluids, and the surfaces they contact, are assumed to be infected at all times.
- Engineering and work practice controls must be implemented. If employee exposure can be eliminated or minimized by engineering controls or a change in procedures, they must be instituted.
- Training on disease transmission and symptoms must be provided to employees.
- Vaccinations for Hepatitis B shall be made available to all exposed employees at no-cost.
- Personal protective equipment, (i.e. rubber gloves, overalls, goggles), must be provided at no-cost to employees with the potential for exposure. This includes laundering of contaminated clothing and PPE.
- In the event of exposure, (like being cut while in a manhole or stuck with a needle while cleaning a barscreen), employers are required to provide no-cost medical evaluations to the exposed employee. This medical evaluation includes testing for HIV and Hepatitis B infection and follow-up medical assessments.

Studies have shown that the survival of the HIV virus in sewer systems is very low, but the Hepatitis B virus can persist for long periods. Some situations greatly increase the risk of exposure, such as working in a manhole that receives wastewater directly from a clinic or hospital. In these situations, a very high level of precaution needs to be taken (this starts with identifying the situation). However, adequate precautions must be taken in all situations where exposure to infectious agents is a possibility.
In addition to wearing the appropriate PPE, personal hygiene is one of the most effective precautions that wastewater workers can take. Examples of appropriate hygiene measures that should be taken by wastewater workers include:

- Wash hands and face with soap and warm water after finishing any task that involves potential exposure to infectious agents. For example, after cleaning a barscreen, entering a manhole, operating a rodding machine, hosing down an aeration basin or collecting laboratory samples.
- Wash hands with soap and warm water or hand sanitizer before smoking, eating or going home to your family.
- Leave work clothes at work, including work boots and launder them at work. If this is not possible, wash work clothes separately from household laundry and leave your work boots outside of your home.
- Cover all open wounds with bandages while at work.

Additionally, wastewater workers should maintain all of the immunizations and boosters recommended by their doctor. Immunizations and boosters are typically provided free of charge by county health services.

Traffic Hazards
Understanding traffic safety and traffic control is essential for wastewater collection system operators, both to protect themselves and to protect the public. Some of the things that can be done to prevent injuries caused by traffic hazards include:

- Do not work during rush hour traffic if avoidable.
- Place warning signs or flagmen 500 feet ahead of the work zone.
- Always wear bright colored/reflective safety vests to make yourself and your co-workers highly visible.
- Place a barrier between the workers and traffic, such as a truck or an excavation spoils pile. The general rule is the bigger, the better.

Personal Responsibility for Safety
It is important to remember that we are each responsible for our own safety and for the safety of our co-workers. Don’t treat safety issues as unimportant or boring. The life you save may be your own.

References
Office of Water Programs, California State University, Sacramento, *Operation of Wastewater Collections Systems*, Volume 1, 5th ed., Chapter 4, 7
OSHA Confined Space Entry Standard
OSHA Lock Out/ Tag Out Standard
OSHA Hazard Communications Standard
OSHA Personal Protective Equipment Standard
OSHA Blood-borne Pathogen Standard