3.1. Physical Plant Overview

A brewery is comprised of two distinct, but related systems. The brewhouse, of course, is where the beer is produced and it is accompanied by a traditional facility infrastructure, including heating, ventilation and air conditioning (HVAC). Both systems are supplied power and utilities; both require frequent maintenance. Restaurant facilities are not covered in this manual, but the same principals of operation and maintenance follow.

3.1.1. Brewhouse Systems

As outlined in section 1.4, brewhouses produce beer by a three step process: 1) extracting sugars from malted grains through the addition of warm water, 2) boiling of this sugar solution with the addition of hops, and 3) fermentation with yeast, which converts the boiled sugars into alcohol, carbon dioxide and volatile flavors, thus making beer.
The general safety concerns with brewing surround several principal safety issues:

- gas burners, steam boilers and hot surfaces
- hot liquids
- confined spaces
- pressurized systems
- slips, trips and falls
- conveyors, pinch points, and eye hazards (in the case of bottling operations)
- material handling and storage
- electrical safety

### 3.1.2 Utility Systems

The utilities required at a brewery will include electricity, water and wastewater, at a minimum. Natural gas, propane, fuel oil, or steam may also be used. The latter may be produced on site with a gas or oil-fueled boiler, or occasionally, may be piped into the brewery from a nearby source.

### 3.2 Housekeeping

There is a direct correlation between clutter in a brewery and the chance of an industrial accident. Transfer hoses left laying about, hand tools set on stairs, power cords running to portable equipment, unplacarded vessels, and unlabeled containers can lead to such incidents as slips, falls, electrocution, asphyxiation, and chemical burns, to name a few. A brewery with good housekeeping keeps equipment and tools in proper storage areas, maintains aisle space, cleans up spills on the floor immediately, posts warning notices in areas of defined hazards, and properly labels and stores hazardous chemicals.

Indeed, if an operation is inspected by a state or Federal OSHA representative, the appearance of the operation makes an immediate and subjective impression on the agent. Try as they may to be objective, inspectors are humans and they know on some level that a sloppy operation is much more likely to be the scene of an accident than an orderly one.

Common housekeeping issues in a brewery may include:

- spilled grain
- improperly stacked goods (e.g. kegs, bottles, grain, etc.)
- tools, power cords, and supplies left laying about
- hoses on the floor
- poor aisle space
- poorly organized inventory
- improperly stored chemical substances
- cluttered counter space, desks, lab benches
- ladders left where last used
- wetted surfaces (e.g. dripping hoses, unmaintained spills)
- improper signage (e.g. on tanks, exits, hot surfaces, etc.)
3.3. Slips, Trips and Falls

A major source of injuries in many wet manufacturing industries is what is known as slips, trips and falls (STFs).

Safety professionals usually speak of how slips and trips are incidents that may or may not result in a fall. While an individual may injure him or herself while correcting for a slip or trip (e.g. connective tissue sprain), it is usually the fall that creates the more serious injury (e.g. broken bones, head injuries, impaling, etc.). Numerous fall-related fatalities have been noted in OSHA records of brewery-related cases.

As with many safety issues, prevention is generally preferred to protection. For example, while it is prudent to have a railing on a brewhouse stairway to help protect against falls, it is more effective to prevent stairway falls by simply not having stairs in a brewhouse.

This prevention ideal is often not practical, since breweries must manage large quantities of water and grain without a large workforce. Also, in brewpubs, the brewhouse is often given a very small area, so that the number of revenue-generating tables can be maximized. In other words, gravity is used whenever possible and this means that brewhouse components are often stacked one over the other so that process fluids can be managed without sole reliance on pumps. Indeed, historic breweries had up to five or more stories, where the malting of grains was begun on the top floor and the finished beer distributed from the ground floor.

3.3.1. Slips and Trips Analysis

Slips in a brewery context are thought to be most often caused by:

- change in surface friction (e.g. carpet transition to concrete)
- change in surface elevation (e.g. flat surface to ramped surface)
- wetted surfaces (e.g. water spilled on a smooth concrete surface)
- slippery agents (e.g. soap, caustic solution, or lubricants)
- poor work practices (e.g. hurrying down stairs, abrupt turns on the floor)
- inappropriate footwear
- distraction
- untrained and/or inebriated guests on a brewery tour

Trips, like slips, are related to both facility construction and human factors:

- change in surface elevation (e.g. transition from stairs to flat surface)
- presence of clutter (e.g. leaving hoses on the brewhouse floor)
- inappropriate footwear or excessively long pants
- distraction
The best avoidance of slips and trips is worker recognition of the potential for slips and trips. With this awareness, the worker can take steps (so to speak) to avoid slipping or tripping. This success, however, rests on the behavior and momentary state of mind of the individual. Workers must be adequately trained regarding the potential for STFs.

The other component of sound loss control is to examine the facility layout and construction of the brewery for risky circumstances. Generally, the brewer or safety inspector will evaluate the potential for STFs by ranking the following factors:

- are there changes in surface friction?
- are there changes in surface elevation?
- how slick are surfaces that become wetted?
- do stairs and elevated platforms have textured surfaces?
- do floors have adequate drains?
- what footwear are brewery workers wearing?
- do hoses lay in the footpaths of brewery workers?
- are hoses and pumps stored out of the way when not in use?
- are there clear and apparent aisle spaces?
- are there adequate railings on stairways, elevated platforms, etc.?
- what are the policies related to brewery tours during brewing operations?
- what policies encompass worker sobriety during brewing operations?
- does it appear that the brewery is adequately staffed for its size?
- if there are high storage locations, how are goods accessed?
- are there established worker training programs that include STF avoidance?

3.4. Pressurized Gas Systems

Breweries commonly rely on pressured systems two areas: for carbonation of the beer and for delivery of natural gas as fuel for heating kettles and other vessels. Steam, used in heating on some systems, and glycol chiller lines are dealt with in 3.5, below.

3.4.1. Carbonation and Dispensing Gases

Among the highest number of anecdotal injury reports in breweries come from the production and use of carbon dioxide (CO₂) in the brewery. This brewer must be knowledgeable of the various hazards associated with pressurized systems and recognize the safety features which are in use or absent during the operations. The five principal hazards are:

- overpressurization of tanks leading to catastrophic rupture
- asphyxiation of workers due to CO₂ (may occur inside or outside of vessels)
- unsecured cylinders and pressurized lines
- frostbite injuries from CO₂
- projectile motion of system components when removed under pressure

Let's look at each of these very different hazards one at a time.

**Tank Overpressurization.** Without certain design features and safe work practices in place, overpressurized tanks can rupture violently and have been the cause of several reported deaths in this country. Fermentation and conditioning tanks are designed to operate at fairly low pressures, from about 0.9 to 1.1 atmospheres. Atmospheric air pressure is around 14.7 pounds per square inch (psi). Finished beer, which is cold and
being kept in a lagering tank, conditioning tank or bright beer tank, will be kept at about 13 psi of CO$_2$ pressure. While this sounds like the beer is kept under a slight vacuum, it is actually slightly pressurized, due to the fact that the beer has CO$_2$ dissolved in it.

Engineering a fermentation vessel which would be able to contain the pressures produced during fermentation would be very expensive due to the thickness of steel required. Thus, engineering controls are used instead. Controlling overpressurization of tanks is typically accomplished by pressure relief valves, or PRVs (photo left), and rupture disks, RDs, (second from left). The PRV is a cleanable, reusable device which is typically spring loaded to release excess pressure at a predetermined pressure, often 15 psi. The PRV looks like a small stainless capsule and it is will be located on the top, outside of the tank. PRVs can and should be tested frequently, for they are not one time use like RDs.

The rupture disk is a pan shaped object that is inserted between pipe flanges. Typical rupture disks will break though if the either unacceptable pressure or vacuum is encountered. Many tanks are protected with both PRVs and rupture disks.

Other steps that are taken to avoid tank failure are the periodic checking and recording of tank pressures (photo third from left as shown by a pressure arm manifold), use of two dial pressure regulators (photo right), regular inspection of PRVs and RDs, and brewery worker training.

Overpressurization can also occur when hot cleaning solutions are recirculated through a closed tank. The cleaning solution, even though it may be only a few gallons, will transfer its heat to the air in the tank and the resulting pressure can permanently distort or even rupture the tank. Underpressurization can be caused by withdrawing product from the tank without allowing CO$_2$ or air to come in on top of the beer.

Worker Asphyxiation. Carbon dioxide asphyxiation is another cause of serious injury and death in the brewery. The two principal locations for CO$_2$ buildup are inside of fermenters and in poorly ventilated rooms where fermentation is taking place.

CO$_2$ is a colorless gas which sinks to low areas in the absence of high air turbulence. The signs of CO$_2$ overexposure include gasping for fresh air, burning nostrils, headache, dizziness, fatigue, loss of consciousness, convulsions and death. One reported case involved the dispensing of CO$_2$ from a tank truck into the brewery’s CO$_2$ system which was located in a depressed loading dock area. The transfer fittings leaked causing an accumulation of the gas where the worker was located. He was overexposed to CO$_2$, but survived.

Avoidance of asphyxiation in tanks is discussed in detail in Permit Spaces (section 4.3).
Unsecured Cylinders and Pressurized Lines. Cylinders of any type of gas pose a physical injury hazard if they are ruptured. This rupture can take place fairly easily if the cylinder drops onto its valve stem. If the stem is damaged, a two hundred pound cylinder can rocket through a work area like a torpedo, breaking through walls, machinery and killing people.

Because of poor labeling practices, it may be unclear whether a cylinder is empty or full. Moving of cylinders must take place with the regulator removed and the protective steel cap screwed on. For these reasons, cylinders must be secured to a fixed object (leg of a fermenter or to a wall) with chain or nylon webbing (photo left).

Pressurized lines that convey high pressure gases to points around the brewery should be secured and out of the way from being dislocated.

Frostbite Injuries from CO₂. Rapidly escaping gas under pressure expands, and as it does so, it requires heat. The heat is drawn from the fittings the expanding gas is being passed through. This thermodynamic property of expanding gases causes fittings to become so very cold, such that momentary skin contact can cause frostbite (tissue death by cold). In the moist climate of a brewery, these fittings will usually form a layer of frost or snow that can indicate their frigid temperature. Personal protective equipment (thick gloves) and engineering controls (insulated valve handles) are the common solutions to this hazard.

Projectile Motion. Hoses, valves, tank manway doors, heat exchanger connections, and filtering systems, can and will instigate projectile motion if not operated in way to reduce internal pressures. Something as simple as a hose removed from a tank of product which has the valve open can cause the hose to fly out towards the brewery worker and cause contusions, head injury, or a fall. One worker had his face caved-in when he was hit with the lid of a diatomaceous earth filter after failing to bleed the internal pressure created during filtering operations. Many brewers have been covered with hot water, hot wort, or beer because of pressurized systems or the hydraulic forces that a large tank of liquid possesses. The best avoidance to these types of injuries is workplace notices, worker training, and manually operated bleed off valves.

3.4.2. Natural Gas

Natural gas is a common fuel for heating in breweries. Kettles may be heated with a direct flame or with steam which has been heated by a gas flame. Natural gas has odorizing chemicals added to it (usually, methyl mercaptan) to help leaks be recognized by smell. Natural gas has no smell with it.

The principal hazards associated with gas are its extreme flammability and its mobility. Natural gas leaks can travel a great distance to a source of ignition, flashing back rapidly to the source of the release.
3.4.3. Liquefied Petroleum Gas (LPG)

Occasionally, a brewery will use LPG or propane to heat their system. The practices and hazards for working with LPG are essentially the same as with natural gas.

3.5. Steam and Coolants

3.5.1. Steam Plant and Steam Lines

Many breweries today generate their own steam for use in heating the hot liquor tank and the kettle. Almost all breweries using steam use low pressure steam. High pressure steam requires much more rigorous operation and maintenance and poses a higher risk for injury. The demands for steam at a brewery are not typically high enough to require a high pressure boiler.

Modern steam boilers are generally double walled, meaning that they are designed to be resistant to explosion. Even so, boilers are typically built into a specially designed room which provides an added measure of safety.

The principal hazard with steam is of course, direct contact with the steam. Steam has a higher thermal content than boiling water and will cause serious burns with even the smallest of exposures.

3.5.2. Coolant Systems

Most commonly, smaller breweries use a coolant system containing a glycol product to keep fermenters and conditioning tanks cool. Other coolants include ammonia and freon. The former is thermodynamically superior to glycols, but is poisonous. The latter is very expensive due to surcharges related to freon’s role in the environment as an ozone depleting chemical.

The principal hazard with glycol coolant is that it is moderately toxic (ingestion) and it is slippery. Spilled coolant on the brewery floor has resulted in slip/trip/fall injuries. Coming in direct contact with chilled coolant for short periods of time probably does not represent a serious hazard, as it is neither cold enough to freeze a person, nor skin absorptive enough to cause a chemical exposure.

What is most critical with refrigerant systems is that the heat exchanger (chiller) and associated plumbing systems are well maintained and functional. Maintenance records should be kept on the chiller and temperature controllers should be installed on all jacketed tanks.

From a product loss liability standpoint, failure of the coolant system has caused product to be ruined. This results in a claim being made against the insurance policy to recover the lost income.
3.6. Pumps, Valves, Hoses and Fittings

3.6.1. Pumps and Vacuums

Pumps, and sometimes vacuums, are commonly encountered in breweries. Because of the wet environment in brewing, there is a potential for electrocution if staff do not use properly configured and grounded equipment. Other potential hazards with pumps include a lack of mechanical guarding on rotating shafts and the creation of vacuum or back pressure by improper valve configuration running to or from the pump or component.

The inspector should look particularly at mobile pumps, which are typically a multipurpose pump mounted aboard a low cart on casters or mounted on a hand truck. Inspect for proper mechanical guarding and especially for a three-prong power supply. Such pumps may or may not have hoses attached at the time of inspection and are usually fitted with quick disconnect fittings. Housekeeping of these pumps is important, as they tend to clutter the work area and may lead to STF injuries (refer to section 3.3).

With fixed system pumps, which are integral to a certain operation in the brewing process (i.e. they are bolted down), inspect for proper wiring, which typically is encased in metal or plastic conduit and which will have a control switch located on a panel or controlled by software.

Another brewhouse component which is sometimes seen as a portable system is a filter. The filters most commonly encountered are diatomaceous earth (DE) filters. These may look like a stout cylinder (similar to a swimming pool filter) or as a series of square or rectangular plates that are mounted inside a metal framework (so called, plate and frame filters). Filters are operated under pressure, with high pressure being exerted on the influent side of the filter with lower pressure filtered solutions exiting as effluent. There are known brewery injuries related to workers disassembling filters while still under residual pressure, and getting hit it the head/face with the components as a result. (refer to section 3.4.1., Projectile Motion, above).

3.6.2. Valves

Valves control the flow of fluids through the brewhouse plumbing. The most common type of valve is the ball-lever valve. Its outward appearance is of a small bulge in the line with a metal or plastic lever. Such valves come in a variety of configurations and are usually on-off, but they may be multipositioned.

The brewer should observe valves in the brewhouse and note any that are artificially kept open or closed (such as with a piece of wire, for example), as well as any which are leaking. Leaks can be a sign of overpressurization of lines and/or poor quality of materials. Continual leaks can lead to STF hazards, as well (refer to section 3.3).

When uncoupling hoses, the brewer should always look at least twice at the configuration of valves to make sure he/she does not release a fitting with hot wort, hot water, or pressure behind it.
3.7. Walking and Working Surfaces

OSHA regulates housekeeping in 29 CFR § 1910.22 and in other standards, as needed. Aisles must be kept clear, and the extent possible, dry. If material handling equipment is used, there must be room to maneuver the device. Some common considerations for working surfaces include:

- marking of aisles
- aisles are free of clutter / materials are properly stored
- stairs, ladders, and platforms are free from clutter
- items stored on shelving is secure and safe
- spills are cleanup immediately

3.8. Fall Guarding

3.8.1. Railings on Stairs, Ladders, and Elevated Platforms

There are numerous reported injuries in the brewing industry and allied fields which have involved a fall from a height. For the most part these could have been avoided with proper railings.

Stairways and fixed ladders are required to have adequate railings. Usually this means a railing with two parallel bars, one at hand height and one lower, the latter to prohibit one from falling under the railing. Elevated platforms are common in breweries, and these too require railings.

3.8.2. Closures on Open Vessels

Open vessels, such as kettles, whirlpools, and grants, need to have adequate closures on them to prevent elevated workers from falling into the vessel. Brewhouses can be engineering to make it difficult for the brewer to be directly above the tank, but many are designed without this consideration.

3.9. Platforms

Platforms need to be sturdy, rigid, and should possess good footing. Typically footing is enhanced with ‘diamond plate’ or ‘expanded steel.’ Both of these feature raised portions of a steel floor which provides tread and improves the drainage of liquids that may collect. Railings, discussed above, are also essential. Clutter stacked on platforms is a common housekeeping problem that may exacerbate the chances of an injury.

3.10. Fixed Industrial Stairs

Breweries are most commonly multilevel systems. This may be to conserve space or reduce transfer distances of grain or fluids. Consequently, most breweries have stairs that allow access to the other levels. These fixed industrial stairs, however, are often very steep and essentially constitute fixed ladders. The treads of these stairs can be slippery when wet, and often, there may be protruding components that can create a risk of head or hand injuries.

In settings like this, handrails and suitable treads are required for safe passage on fixed industrial stairs.
3.11. **Portable Wooden Ladders**

Portable ladders are a common sight in breweries and represent the potential for serious injury. OSHA regulates portable wooden ladders under 29 CFR § 1910.25, and portable metal ladders under 1910.26. Additionally, ANSI has developed standards for portable ladders of both types.

Perhaps the most dangerous use for portable ladders is to lean them against tall tanks to gain access to fitting near the top. This is, unfortunately, a common sight in breweries. The surfaces of these tanks are round and slick. Additionally, placing the feet of the ladder on wet and/or uneven flooring makes this act particularly dangerous.

3.12. **Mills, Mixers, Grinders, and Augers**

3.12.1. **Grain Mills and Augers**

The grain mill is a device which cracks open the malt kernels prior to the adding the malt to hot water. (The addition of cracked malt grains to water is called ‘mashing in’ or ‘doughing in.’) A few breweries purchase their malt already milled, but most prefer to do this process at the brewery.

Most grain mills are roller mills. That is, parallel knurled steel rollers rotate towards each other, causing the grain to fall between them and be crushed. The gap between the rollers is adjustable. Typically there is a hopper which allows grain to feed into the roller assembly. The hopper is filled either by hand (emptying sacks of grain into the hopper), by auger or conveyor (which brings the malt from elsewhere to the mill), or by direct feeding from a silo (usually positioned directly over the mill). Roller mills may have one, two, or even three pairs of rollers. Mills present a substantial and real threat for worker injury, such as with insertion of fingers into the hopper and entrainment of hair or clothing.

Augers are long pipes with a grain moving device inside them. This device may take the form of a screw conveyor, a cable or chain with plastic carriers, or may be pneumatic. Typically what one sees is an auger used to move crushed malt from the mill to the mash tun (where the hot water is added to instigate starch conversion).

Both mills and screw augers require motors, and both usually have belt driven pulleys. The inspector should be mindful that these systems must have adequate guarding, such that clothing, hair, and fingers cannot enter into the works. The hopper of the grain mill will usually sit atop a box-like structure. Inside this box are the bearings for the rollers and the drive belts and pulleys that spin the rollers. There is typically a front panel that limits access to the bearing and pulleys. Operating the mill without this panel is very unsafe. Additionally, the mill hopper must have a barrier bar in the base of the hopper cone to prevent accidental entry of the fingers into the top of the mill.

An additional hazard common to mills and augers is caused by the hard nature of malt. It might be surprising that something like grain can abrade something as hard as steel, but malt mills, auger screws, and mash tun rake arms are well known to become extremely sharp with use. Indeed, malt mills often have a series of magnets installed just above the rollers for the purpose of scavenging up sharp wisps of metal created during milling.
3.12.2. Mixers and Stirrers

There are extensive rules in OSHA pertaining to the guarding of machines, as well as for lockout/tagout (a means of avoiding injury by securing energy sources that could injure the worker).

Motions may be described as rotating, reciprocating, and transverse. Likewise, the action of the device may include cutting, punching, shearing, bending, or deforming. In the context of brewing the two most common machine actions are: 1) malt milling, and 2) grist stirring. Both involve rotating energy with shearing action.

OSHA describes the general requirements for all machines in 29 CFR § 1910.212. All machines must have in-place guards to prevent the worker from contacting the mechanisms. In a malt mill, pulleys and belts usually transfer the energy from an electric motor to the grain rollers. These belts must be guarded, the belts must be in good condition, and the hopper must have a guard to prevent one's hand from going into the rollers in what is known as an in-going nip point. Mash tun stirrers (rakes) will normally have an electric motor above the tun which turns the rake arms. Accessing the grain bed while the arm is rotating is possible on many systems, and constitutes a serious potential hazard. The automatic lockout (interlock) system developed by some manufacturers is usually a user-specified addition. Due to additional cost, most breweries don’t have these interlocks installed at the time of purchase.

3.13. Electrical Systems

Electrical systems are widespread in any brewery context. The basic principals of prevention and protection apply here as well. Preventative strategies include: preventative maintenance of wiring, use of professional electricians for installation, and adherence to the Uniform Electrical Code. Protective strategies principally include the use of ground fault interrupters. Electrical sparks, either high current arcs or low current static sparks, can also be the source of ignition for grain dust explosions in the grain storage or milling areas.

3.13.1. General Electrical Safety

The hazard potential of electricity is described in two ways, current and voltage. Voltage is the volume of electrons flowing through circuit, while current, measured in amperes, can be defined as the flow rate of those electrons. Either can cause a fatality.

High voltage – high current combinations are the most dangerous. Power panels and transformers can present this sort of hazard. Low voltage – high current combinations can be fatal as well. A forklift battery array may only have 24 volts, but can possess a life-threatening current over 60 amps.

High voltage – low current combinations are generally less threatening form the standpoint of electrocution, but this situations can result in static electric discharge which may trigger a grain dust explosion of ignite flammable vapors, should they be present.
The best means to avoid electrocution are safe work practices. They do not rely on specific tools or equipment. For instance, keeping a safe distance from an electrical hazard is better than putting on thick rubber gloves and attempting to touch it. This is not to say that equipment can’t help. Insulation, guarding, grounding, and ground fault circuit interrupters are all effective in reducing the chance of electrocution.

3.13.2. Ground Fault Interrupters

Ground fault interrupters, often called GFIs or GFCIs, are devices which detect a ground fault and immediately turn off the power to the circuit. Ground faults, if left undetected, can result in electrocution of the employee or an electrical fire. Most often, GFIs are built into an outlet box or power strip.

3.14. Powered Industrial Trucks

Powered industrial trucks are power-propelled, mobile devices used for transporting, lifting, and stacking materials. Forklifts are the most well known of the powered industrial trucks. These devices allow large quantities/weights of materials to be easily loaded, moved and stacked.

3.14.1. Pallet Jacks

Though not technically a powered industrial truck, the pallet jack is a very common material handling tool. Safe work practices that go with pallet jacks are: 1) never ride them, 2) do not proceed too quickly with moving a load, as the momentum created can be difficult to stop, 3) practice turning, loading and unloading prior to use.

3.14.2. Forklifts

OSHA specifically states that all operators of forklifts must be trained by individuals with specific knowledge and experience. Training must include both formal instruction and hands-on practical aspects. The standard specifically lists content requirements for the training.

OSHA also has requirements for material handling. Bags must be stacked in interlocking rows and drums and barrels must be stacked symmetrically. A formal training program should include, at a minimum: proper lifting technique, avoiding strains, hazard recognition, and the use of appropriate tools such as steps, handles, and wheels.

3.15. Head, Eye, and Foot Protection

3.15.1. Head Protection

Hard hats are occasionally seen in the context of a brewery, especially where there are many low pipes or fittings. OSHA, however, describes the hardhat as a protective device against falling objects. Sometimes a lesser protective hat is used called a bump cap. Hard hat standards are found in 29 CFR § 1910.135 and they directly reference the ANSI Z89.1 standard.
3.15.2. **Eye Protection**

Eye and face protection requirements are given in 29 CFR § 1910.133 in OSHA. As with head and foot protection, the standard references current ANSI test methodology.

A hazard assessment is first, followed by equipment selection and training on proper use. Over 100,000 eye injuries occur each year, and the vast majority of these (over 90%) could have been prevented with safety glasses. For brewers, safety glasses must be impact resistant and have side shields.

3.15.3. **Foot Protection**

In 29 CFR § 1910.136, OSHA describes the requirements for foot protection. Foot protection is required where there is a risk of falling or rolling objects, foot piercing, or electrical hazards. In ANSI Z41, the minimum requirements for approved footwear are described. In essence, one must have a steel toe and steel shank boot.

In brewing, boots such as these are often fused with chemical protection as well. Brewer's boots should be full length (to below the knee) and have both chemical and physical hazard resistance.

3.16. **Lockout/Tagout Program**

Lockout/tagout is a system of locking power supplies to equipment so that such equipment cannot be turned on while an individual is working it. When speaking of lockout, one means any device used to control the potentially hazardous energy. Typically this might be a padlock placed on a power supply panel, a lock on a gate valve, or the removal of a key linkage in a drive shaft.

Tagout is similar to lockout, except that a single use tag or other prominent warning device is placed on the system. Quite often these tags are attached with a plastic zip tie or similar fastener.

3.16.1. **Written Program**

OSHA specifies a written program be developed. Four major areas contained in the written program: 1) when to use a certain lockout procedure, 2) procedural steps for implementing a shut down and lockout, 3) specific rules for the removal of locks and tags, and 4) assurances that the lockout and tagout devices are effective.

3.16.2. **Training**

OSHA specifies that lockout/tagout training be conducted by an authorized employee. Employees must be shown when to use lockout/tagout devices, when, if ever, they are to remove them, and be described the limitations of such devices.
3.17. **Signage**

3.17.1. **Exit Signs**

The facility will be required (under local fire code, in most cases) to place exit signs, clearly visible, at all means of egress. OSHA also has legally enforceable standards with specific dimensions and wording in 29 CFR § 1910.37(q). Please find a link to further details on this standard in the Table of Contents.

3.17.2. **Warning and Advisement Signs**

OSHA has classified signs into three classes: 1) danger signs, 2) caution signs, and 3) safety instruction signs. In each case there is a signal word which is designed to get the viewer's attention. Signs must be placed in such a way as to alert employees in time to avert the hazard. Signs must be placed obviously and in an unobstructed manner. Signs are not to be placed on moving objects. Signs which may have to be viewed under low light conditions must be lit or be reflective.

3.17.3. **Piping Signage**

ANSI standard A13.1 describes how pipes can be labeled to adequately show their contents. The legend, as it is called, will show an arrow in the direction(s) of the flow and the name of the substance in the pipe. The label should be close to valves or other controls.

3.18. **Brewery Tours Physical Safety Concerns**

Breweries are generally interesting places and conducting tours through the brewing operation is quite common. However, this activity introduces some new hazards to the workplace. First and most importantly, the customers on a brewery tour are not employees and are rarely schooled in industrial safety. This means that they may not appreciate the hazards of slippery surfaces. They may not understand the seriousness of wearing eye protection or not touching surfaces in the brewery.

Any brewery that is conducting tours needs to establish a written program for these tours. The head brewer or owner will typically describe what the tour entails, specifically where the tour goes, about how long it will last, and so forth. The staff who may conduct tours will be trained according to this program.