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Working with Hazardous Chemicals:
How Safety Showers Can Save Lives

A **chemical burn** occurs when skin tissue directly contacts a corrosive or caustic chemical. Though the victim will likely experience a burning sensation, the burn is not caused by heat. Both acids and bases may cause tissue damage. Severity varies dependent on the length of exposure. Bases tend to be harder to rinse off than acids and may require more flushing time.

Common industrial acids that may cause chemical burns include: sulfuric acid, muriatic acid, hydrofluoric acid, nitric acid and phosphoric acid. Common industrial bases or caustics that may cause chemical burns include: sodium hydroxide, potassium hydroxide, sodium hypochlorite, and ammonia.

https://ohsonline.com/Articles/2011/01/01/Putting-the-Lid-on-Chemical-Burns.aspx

Introduction: During a chemical emergency, easy access to safety showers is vital.

In 2013, as a maintenance technician at a California wastewater treatment facility attached a bypass line to a 10,500-gallon sodium hypochlorite tank, he heard a cracking noise. A valve and all the fittings attached had broken off the tank. It began spraying bleach, splashing on the worker. Immediately he ran toward the exit stairs and into the restroom in the nearby Chemical and Dewatering building. The technician needed to wash the chemicals off his body and rinse his eyes. Unfortunately, the restroom in this building did not have a safety shower or eye wash.

He rinsed off as well as he could in the restroom sink, but knew it wasn't enough to get all the chemicals off his body. He headed toward the lab, located in another building on the grounds, to use its safety shower station. Before he could make it to the building, pain overwhelmed him. Ripping off his shirt he screamed, "Help me, I feel like I'm on fire!"

Co-workers pulled him to the lab, helped him remove his additional clothing and activated the safety shower and eye wash unit. He showered until emergency medical services arrived on site to offer aid.

Doctors at a nearby hospital revealed the extent of his injuries. Chemical burns covered 22 percent of his total body surface area, including his hands, legs, and both corneas. He was transported to another medical center for advanced burn treatment.[1]

In cases of chemical splashes, the first 10 seconds following exposure is critical to minimize serious injury. This is especially true for industries where workers encounter hazardous chemicals or substances that may pose a safety risk. Emergency safety showers and eye/face wash equipment provide immediate relief to a person splashed by hazardous chemicals, fine dust, or metal shavings. In some cases, it can be the difference between life and death.

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OSHA's **Hazard Communication Standard** (HCS) (29 CFR 1910.1200(g)) was put into place to make sure workers are aware of the chemical and toxic substance hazards in their workplace. It requires chemical manufacturers to prepare labels and Safety Data Sheets (SDS) to inform of potential hazard information of each chemical. It also requires employers to communicate these hazards with their employees and provide appropriate safety training for handling and storing, as well as measures to protect themselves from accidents.

Section 4 on each SDS provides guidance for initial first aid measures when inhaled, ingested, or contacted with skin and eyes. Understanding these instructions play a vital role in choosing proper emergency safety equipment for different types of chemical hazards.

https://www.osha.gov/SLTC/hazardoustoxicsubstances/

Caustic Chemical Burns

The Occupational Safety and Health Association (OSHA) reports more than 43 million Americans are exposed to hazardous chemicals in the workplace each year.[2] The National Institute for Occupational Safety and Health (NIOSH) estimates over 13 million alone may be exposed to chemicals that are absorbed through their skin.[3] Chemical splashes cause an estimated 7 percent of all work-related eye injuries treated in U.S. emergency rooms. More than 60 percent of these injuries take place in the workplace.[4]

Most people are familiar with sodium hypochlorite (bleach). They recognize its chlorine smell. Water companies disinfect water with it. They add it to wastewater to remove harmful pathogens and bacteria that cause diseases like cholera, typhoid and others.[5]

Sodium hypochlorite is very corrosive. Upon contact, it will penetrate quickly into the skin, causing severe skin burns and eye damage, as well as respiratory system damage. Most Safety Data Sheets (SDS) recommend immediate rinsing of eyes if contacted, and removal of contaminated clothing followed by rinsing in a shower.

But, imagine a situation in which a worker spills a caustic agent like bleach and suffers immediate chemical burns. He follows procedure and rushes to the nearest emergency shower to activate it, but the water pressure is low. This insufficient water flow takes more time to wash the bleach off his body, increasing the severity of his burns and damage to his skin.

Now imagine the same situation occurs in an area with extremely cold ambient temperatures. The same worker rushes to the nearest safety shower as trained, only to realize the water temperature is less than 40˚F (5˚C). Despite the painful burns, his body reacts naturally to the temperature. He automatically jumps out of the frigid stream, leaving chemical residue on his skin. This residual chemical can still cause tissue damage. Even if he had stayed in the shower, flushing with water less than 60˚F (16˚C) can cause hypothermia. He potentially traded one severe health issue for another.

Safety shower technology that guarantees adequate water supply pressure and flow, as well as temperature, would prevent such situations from occurring. The ideal safety shower solution

will provide a steady flow of tepid water – 60 to 100˚F (16 to 38˚C) for at least 15 minutes. Using the wrong shower design or badly maintained equipment can lead to an experience where emergency safety showers fail to provide relief at the time it is most needed.

Regulators have developed standards for emergency safety shower and eye/face wash equipment that aim to prevent incidents like these.

Standards for Emergency Safety Shower and Eye Washes

OSHA 29 CFR 1910.151(c) addresses the need for facilities to enable workers to flush themselves of corrosive materials via safety showers and eye wash stations. It states:

> "Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use."

Other standards address specific industries and the hazards associated with them. Facilities with open tanks must have an emergency safety shower (or an alternative) within easy reach. This covers dipping and coating applications, as well. The pulp and paper industry must provide facilities to counteract lime or acid burns.

However, OSHA requirements do not specify details about their functionality or location. Instead, OSHA refers companies to ANSI/ISEA Z358.1-2014. The American National Standards Institute (ANSI) adopted this standard to protect workers from eye injuries caused by caustic and corrosive substances.

ANSI/ISEA Z358.1-2014 is the most comprehensive and widely used standard for safety showers and eye/face wash equipment. It provides guidance for the design, installation, maintenance and inspection of this equipment. The standard lists minimum requirements for location, operation, flow rate and temperature.

Location

As mentioned, the first few seconds after a hazardous chemical splash are the most critical. The longer the chemical substance remains on the skin, the more damaging it is.

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A 2005 **OSHA accident report** from a large chemical corporation illustrates why emergency equipment must be on the same level as the potential hazard. An employee climbed a ladder to a mezzanine to gain access to the top of a large mixing tank. He made a mistake when pouring caustic beads into the solution, which caused a violent reaction and doused him in the corrosive solution. There was an emergency eyewash station on the mezzanine, but the safety showers were located on the main floor. He feared climbing down the ladder in his current state. A co-worker finally reached him and helped him into a shower, but the delay exacerbated his injuries. He suffered second and third degree burns to 30 percent of his body, affecting his face, arms, stomach and legs.

https://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=201505302

Safety showers must be within a 10 second reach (or approximately 55 feet away) of a person from where an incident occurs. Ten seconds is about the same amount of time it takes to tie your shoelaces or to fold a t-shirt. And since the average male's walking stride length is 30 inches[6], 55 feet equates to about 22 steps.

ANSI does allow a single step into an enclosure to access emergency safety equipment. But, it's best for the injured person if the station is located on the same level as the potential hazard. Under no circumstances should an injured person have to navigate multiple stairs. In case of impaired vision, the path to the emergency equipment must be simple and unobstructed. Place stations in a prominent position with clear markings and lighting.

Operation

Emergency safety shower stations must be accessible and easy-to-operate, even with impaired vision. Safety showers and eye wash valves should be designed so the flushing flow remains on without the use of the operator's hands. The control valve must go from 'off' to 'on' in one second or less.

Flow Rate

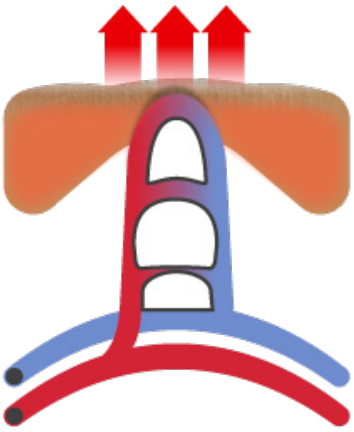
Emergency showers must deliver a water flow of at least 20 U.S. gallons (76 liters) per minute for 15 minutes. This provides enough time to remove contaminated clothing and rinse thoroughly. If the flow rate is too low, hazardous chemicals may not be completely washed off the skin leading to ongoing chemical burns.

Water flow from emergency showers is much greater than the standard home shower head, which averages 2 to 3 gallons per minute of flow. The dangers of hazardous chemicals vary by each chemical's specific properties. But, a deluge of water is generally required to wash them away.

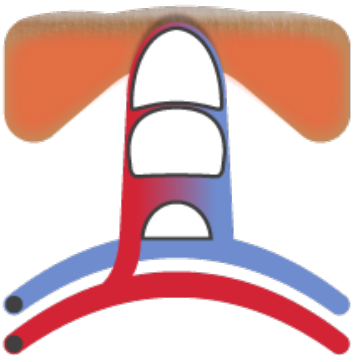
Eye/face wash equipment must deliver at least 3 U.S. gallons (11.4 liters) per minute for 15 minutes to ensure a complete decontamination. An eyewash station should operate at a flow of 0.4 GPM for the same duration.

Temperature

ANSI did not establish parameters for "tepid water" until 2009. The standard requires safety shower and emergency eye/face



When the human body encounters extremely hot temperatures, capillaries near the skin surface dilate to lose heat to the environment.



When the human body encounters extremely cold temperatures, capillaries near the surface of the skin constrict to conserve heat.

wash equipment to deliver tepid water in the range of 60 to 100˚F (16 to 38˚C).

Adhering to these parameters can be the difference between life and death. The human body strives to maintain a steady internal temperature within a normal range of 89 to 100˚F (32 to 38˚C). When the body encounters water temperature significantly (10˚F or more) above or below its core temperature, it instinctively reacts.

A higher temperature water may scald the injured person, adding temperature burns to their chemical injury. Blood vessels close to the surface of the body dilate to allow more blood flow in the area. This process removes heat from the skin and prevents the core temperature from rising too high. It also directs blood away from vital internal organs and causes cardiovascular strain. Hotter water may also cause skin to absorb more of the hazardous chemicals.

The opposite actions occur when the body experiences extreme cold. Lower temperatures can lead to hypothermia or thermal shock. Water conducts heat away from the body much quicker than air does. Blood vessels near the surface contract to limit the blood flow and prevent the loss of body heat. Internal blood vessels dilate to compensate, causing the heart to work harder to keep up.

People are also less likely to remove contaminated clothing and PPE if the water is too cold. Clothes containing chemical residue will prolong exposure and exacerbate burns if not removed.

Whether the water is scalding or freezing, the natural human reaction is to withdraw from the temperature extreme to protect the body. But, ANSI recommends at least 15 minutes of shower time to completely rinse away most hazardous chemicals. The only way to ensure this length of time is to control the water temperature in the tepid range.

Challenges of Remote Locations

From oil refineries to manufacturing plants, there are many situations in which industrial operations must occupy large areas due to the complex combination of processes and the high volumes produced. Expansions to existing facilities to take advantage of economies of scale increase the site footprint even more. Remote sections of a plant can be miles away from utility

supplies. Some areas may suffer from low water pressure and supply, while others may not be connected to a utilities network at all.

Challenges of Extreme Ambient Temperatures

Oil and gas fields or petrochemical facilities need to be close to their raw material supply. Many of these sites operate in extreme conditions— like the freezing cold Arctic region or the intense heat of Texas in the summer. The extreme ambient temperatures make it difficult to supply water in the tepid range.

Challenges of Plant Expansions

Over the years of their life, production facilities require expansions and modifications to keep pace with production needs and product changes. Each time this happens, demand rises on their central utility systems. In some cases, plants reach the capacity of their potable water supply. Adding another emergency shower becomes even more challenging. Additionally, the shower may not perform to the ANSI standard.

Temperature Controlled Showers

Temperature controlled showers meet the ANSI standard of tepid water supply. If the water is too hot, chillers produce a cold-water stream. If the water is too cold, heaters produce a hot-water stream. Thermostatic valves mix hot and cold water to achieve a tepid supply temperature. But, because it is a mechanical device capable of failing, the valve must be designed for emergency safety showers and eye washes. This way, it will bypass to cold water if not functioning properly, to prevent severe scalding.

There are also chemical properties to consider. When it vaporizes, liquid anhydrous ammonia, a common chemical in fertilizer plants, pulls heat out of skin tissue. With a temperature of minus 28˚F (minus 33˚C), it causes instant frostbite. Often, clothing will freeze to the skin. Contact with ammonia requires flushing the area with water for at least 15 minutes, at a temperature between 77 and 95˚ F (25 to 30˚ C). A temperature-controlled emergency shower allows the affected area to thaw out so clothing can be safely removed.[7]

Tepid Water Loop Systems

Tepid water loop systems offer an inexpensive method to supply water to a network of showers and eye/face wash equipment at the same time. A centralized temperature control system keeps the supply water in the tepid range.

The water flows through all the equipment on the network, ensuring tepid water is available upon activation. Power options for loop systems include electrical, electric and steam, or electric and air pressure.

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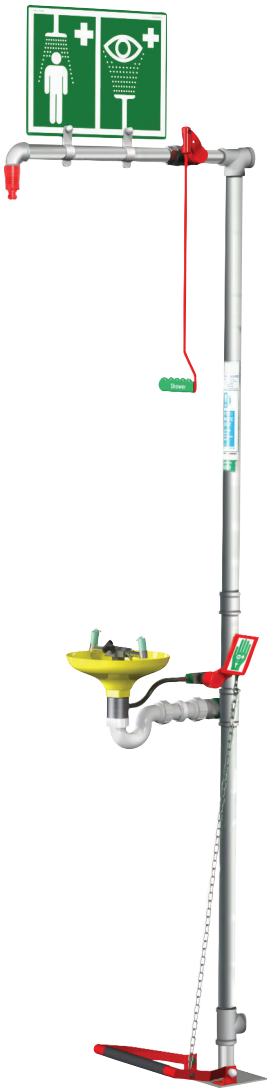

SD18G75G – Floor Mounted Outdoor Self-Draining Safety Shower

Self-Draining Showers

The southwestern United States and similar climates experience sweltering summer temperatures. Providing adequate outdoor emergency safety showers is challenging. Water in standing pipes can rise to temperatures of 122˚F (50˚C) due to solar radiation. If activated under these conditions, the shower will give a deluge of hot water.

Self-draining showers offer a suitable solution. They prevent the build-up of hot water in the supply pipes to the shower head. The water will not scald the injured person despite the extreme ambient temperatures.

Freeze-Protected Showers

Freezing climates also present challenges. Water freezes in the pipes rendering the showers inoperable in an emergency. Trace tape heating and insulation prevent freezing and ensure a positive flow of water when the shower is activated.

Heated cubicles create a safe environment where the atmospheric temperature is freezing. A specialized design of fiberglass panels and double doors use space heaters to control the cubicle temperature. This polar shower solution protects an injured person from the elements until help arrives.

Emergency Tank Showers

Even in remote areas, emergency safety shower technology must meet the ANSI standard. This means overcoming the challenge of unreliable or unavailable water supplies. Gravity-fed emergency tanks showers with an integrated supply tank of 317 to 528 gallons (1200 to 2000 liters) provide enough water for a 15-minute shower at the minimum required rate. Low-pressure shower roses give a flow pattern that covers a person completely.

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Emergency tanks have temperature control systems appropriate to the natural environment. Tank insulation may be enough indoors or in moderate climates. More extreme conditions may require immersion heaters or chillers are. Where cold nights follow hot days, chillers operate during the day. Heaters switch on at night to ensure a tepid water supply at any time.

Wireless monitoring systems alert personnel to safety shower activations. Early response to assist a person in distress can make the difference between minor injuries and more serious consequences.

The Tengiz oilfield in Kazakhstan is in one of the harshest environments in the world. Temperatures range from minus 49˚ F to 113˚ F (minus 45˚ C to 45˚ C), making it very difficult to supply potable water in the tepid range. Hughes Safety provided Tengiz with Polar Emergency Tank Showers. The additional benefit of an enclosed cubicle means that the casualty remains in a safe and comfortable environment until help arrives.

The popular Immersion Heated 2000L Emergency Tank Shower is suitable when low ambient temperatures make it impractical to use a standalone safety shower. With a tank capacity of 528 gallons (2000 liters), it provides a tepid water flow of 20 gallons (76 liters) per minute for the shower and 3 gallons per minute for the eyewash for 15 minutes. Heaters and dual thermostats ensure water temperature remains in the tepid range by using immersion heaters and chiller units for both hot and cold climates.

Mobile/Portable Emergency Safety Equipment

At many construction sites, electricity is unreliable or non-existent. The nature of work on these sites also requires the ability to move showers from one part of the site to another. But these challenges affect other industries as well. What happens when industrial sites take emergency safety showers out of service for maintenance or servicing? They need a temporary alternative available should an incident occur during this outage.

Mobile or portable emergency safety showers offer a viable option. Self-contained units come with water tanks of varying sizes. Smaller models provide a 20-gallon per minute flow for 1.5 minutes, while larger models supply more than 15-minutes of flow. The pressurized tanks do not need electrical connections of pumps to supply water to the shower head.

Remote locations often have poor road infrastructure or changing environmental conditions. Choose mobile safety showers that can move as required, or even tow behind a vehicle. In locations with low ambient temperatures, insulated tanks or immersion heaters are available.

Keeping Emergency Safety Equipment Reliable

Once the right emergency safety shower and eye/face wash equipment is selected, it must be kept in reliable operating condition for use in the case of chemical splashes.

Maintenance and Servicing

Maintenance and servicing tasks keep safety showers and eye/face wash equipment dependable. The ANSI standard requires a weekly flow test of plumbed safety showers and eye washes, as well as an annual service. Rust particles can build up in the water supply pipes and lodge in the shower valve. This causes temporary blockages or a restriction in flow. Both can be potentially disastrous for an injured person.

Activating showers once a week keeps the water flowing and releases blockages. Establishing a maintenance cycle to clean filters prevents rust build-up. Regular inspections of trace tape, heating, and insulation are also vital. A break in insulation of a small section of pipe can leave it vulnerable to freezing.

Wireless Technology

Technological advances are helping to improve maintenance and servicing of emergency equipment. Wireless monitoring systems measure and report the water level in a tank shower system. Early detection of water leaks allows companies to take swift corrective actions. These systems also alert co-workers that a safety shower was activated, improving first responder awareness. All these actions help keep safety shower equipment operable for emergency situations.

Conclusion

A chemical splash or burn in the workplace is dangerous. But, choosing the wrong emergency safety shower solution or failing to provide the proper maintenance can be just as detrimental to employees. Understanding ANSI and applying it to the unique conditions of your industrial site can contribute to safe working environments. The proper emergency safety equipment is a vital step for your operations on the path to safety and success.

[1] OSHA Accident: 202510129 – Employee is Chemically Burned with Sodium Hypochlorite. https://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=202510129

[2] Business & Legal Resources (BLR). https://safety.blr.com/training/workplace-safety-training-powerpoints/hazardous-substances-and-materials/hazard-communication/Hazcom-and-GHS-What-Employees-Need-to-Know-ppt/

[3] NIOSH: Skin Exposures & Effects. https://www.cdc.gov/niosh/topics/skin/

[4] Ophthalmologic Approach to Chemical Burns. https://emedicine.medscape.com/article/1215950-overview

[5] The Complete Chemical Storage Guide for Wastewater Treatment – White Paper, Poly Processing Tanks. https://tanks.polyprocessing.com/hubfs/wastewater-white-paper-v2-digital_2.pdf

[6] The Average Walking Stride Length. https://livehealthy.chron.com/average-walking-stride-length-7494.html

[7] First Aid Information. https://www.mda.state.mn.us/first-aid-information-anhydrous-ammonia-exposure

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