**Safety Shower and Eyewash Systems – Best Practices**

**Purdue Process Safety and Assurance Center**

**(P2SAC)**

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# Executive Summary

This report is a summary of safety shower and eyewash system survey results and recommended best practices. CountryMark, SABIC and 3M participated in an effort to develop and conduct a survey of issues with the use of safety shower and eyewash units in refinery, chemical and manufacturing facilities. Eleven responses were received from: Tate & Lyle, Celanese, Cummins, 3M, Marathon, CountryMark, Corteva, American Chemistry Council, SABIC (Mount Vernon, IN), SABIC (Ottawa, IL), and QualEx. Survey questions were summarized in six categories: a. General; b. Water source; c. Corrosion; d. Maintenance, training, and management systems; e. Self-contained devices; f. Other issues or comments. Each category has a few related questions, and all the original input from companies is recorded in Chapter 3. Chapters 4 to 8 include analysis and best practices for each category.

Best practices can be summarized as follows, with further details in the report:

1. General: Provide highly visible signage such as wall signs, indicator lights, and painted trails to each station; Ensure the stations can be accessed within 10 seconds (55 ft or 16.8m) and there are no obstructions/partitions in the way; Install alarm systems such as audible alarms and warning lights for each station.
2. Water source: Maintain the water temperature between 16 ºC to 38 ºC; Install flushing units and filters; Activate the systems weekly to test the water quality; Consult authorities for local, state, and federal regulations about drainage and assess whether a system to treat the wastewater is warranted.
3. Corrosion: Select highly corrosion resistant materials such as PVC, PP, PVDF, or stainless steel for piping; Avoid using carbon steel or steel for piping.
4. Maintenance, training, and management systems: Test the systems as least on a monthly basis for function, water quality, temperature, buildup, flowrates, harmful bacteria and record the details; Train the employees on location and proper use of safety shower and eyewash systems and provide readily accessible operation, inspection, maintenance instructions; Include these systems as considerations in MOC and PSSR.
5. Self-contained devices: Provide sufficient self-contained devices in each unit; Add bacteriostatic additives to water supply.

# Chapter 1 Introduction

## 1.1 Scope

Safety shower and eyewash systems are essential equipment in facilities and laboratories that involve hazardous substances. These stations serve a significant role in preventing and mitigating the injuries of workers from inadvertent chemical releases. Therefore, setting up robust safety shower and eyewash stations is essential.

This report is based on standards related to the safety shower and eyewash systems, and surveys from chemical, refining and manufacturing companies. We learned how they build their stations in facilities, as well as how they operate, maintain, and assess them, and any issues. Finally, best practices are provided, since it is what people need and the most important conclusions we get from the analyses.

## 1.2 Importance

Installing safety shower and eyewash stations is necessary for plants with hazardous chemicals including liquids, gases, and solids. They can ensure that workers have chemicals promptly washed away from their bodies and eyes. By rinsing the skin and eyes, the substances can be removed or neutralized and hopefully have a relatively minor effect on one’s health. For workers subject to minor releases of less hazardous materials, use of the shower or washing their eyes can help prevent serious injuries. For people with serious injuries, this kind of treatment can often mitigate the long-term impact.

Companies should provide first aid stations to protect workers to the greatest extent. According to a report from the CDC (Centers for Disease Control and Prevention), more than 15,000 workers were injured in hazardous substance emergency events from 1999 to 2008. Among these, more than 10,000 were hurt by volatilization or aerosolized (vapor) or spills (liquid or solid). These numbers are concerning enough to alert people to attach significant importance to the methods of preventing such kinds of incidents and protecting health. [1]

# Chapter 2 Official Standards and Requirements

## 2.1 Overview

ANSI/ISEA Z358.1-2014, American National Standard for Emergency Eyewash and Shower Equipment is the most widely adopted and accepted standard currently in the United States. [2] This is an update of the 2009 version and was prepared by the Emergency Eyewash and Shower Group of the International Safety Equipment Association. It establishes the minimum performance and uses requirements for eyewash and shower equipment for the emergency treatment of the eyes or body of a person who has been exposed to hazardous materials. The International Plumbing Code (IPC), section 411, and Uniform Plumbing Code (UPC), section 416, requires the use of ANSI/ISEA Z358.1 compliant equipment whenever eyewash or shower equipment is needed. U.S. Department of Energy (DOE) health and safety regulations, 10 CFR 851, has stated “where this [injurious exposure of corrosive materials to the eyes or body] potential exists, there must be an emergency eyewash facility that meets ANSI standards.” The U.S. Navy and U.S. Air Force also requires the use of ANSI/ISEA Z358.1.

29 CFR 1910 *- Occupational Safety and Health Standards* also includes medical service and first aid regulations related to the safety shower and eyewash systems in 151 (c). [3] 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.” (CFR: Code of Federal Regulations)

EN 15154 *– Emergency Safety Showers* is the standard adopted in Europe. It has four parts that include: 1. Plumbed-in body showers for laboratories; 2. Plumbed-in eyewash units; 3. Non plumbed-in body showers; 4. Non plumbed-in eyewash units. [4] This standard was approved by the European Committee for Standardization (CEN), and it is a product specification, giving performance requirements for emergency safety body showers and eyewash units.

Canadian Centre for Occupational Health and Safety (CCOHS) posts fact sheets in question-and-answer format on their websites. [5] It includes dozens of questions and answers that are related to the safety shower and eyewash stations, and most of the content comes from ANSI/ISEA Z358.1-2014.

## 2.2 Recommended References

There are documents other than the standards noted above that are also used by institutions and companies, such as guidance published by the International Safety Equipment Association (ISEA), [6] The Institute of Chemical Engineers (IChemE), [7] and the N.C. Department of Labor (North Carolina) [8]. Some institutions and companies also create their internal guidance or compliance checklist and most of them are based on the official standards and implemented according to the actual situation.

We recommend companies refer to the official standards and also the guidance published by official institutions or associations. Here we provide a list of recommended references.

* ANSI/ISEA Z358.1-2014, *American National Standard for Emergency Eyewash and Shower Equipment*
* 29 CFR 1910 *- Occupational Safety and Health Standards*
* EN 15154 *– Emergency Safety Showers*
* Canadian Centre for Occupational Health and Safety (CCOHS) fact sheets
* ISEA, *Emergency Eyewash & Shower Equipment – Selection, Installation & Use Guide*
* IChemE, *IChemE Safety Centre Guidance - Sample University Laboratory Process Safety Management System*
* N.C. Department of Labor, *A Guide to Eyewash and Safety Shower Facilities*
* Internal guidance/checklist by companies/manufacturers based on official standards

# Chapter 3 Survey Result

## 3.1 Survey Information

On the basis of refinery, chemical and manufacturing companies’ experience with safety shower and eyewash systems, and the official standards, ANSI/ISEA Z358.1-2014, *etc*., we worked with SABIC, CountryMark, and 3M to conduct a survey of participating companies in this research project. The questions posed in a survey are listed below:

**Safety Showers & Eyewash Systems – SURVEY**

We would appreciate your response to this survey, coordinated by Purdue University and several companies to assess best practices.

1. How many safety showers & eyewash systems do you have per operating unit at your facility?
2. What factors do you consider in their number & placement (e.g., distance from hazard, number of personnel in area, risk from chemicals)?
3. Are their locations well marked with signage, floor markings, etc?
4. Do you train employees on their use & location (e.g., new employees, contractors)?
5. How are your safety showers & eyewash systems activated (e.g., without hands)?
6. Have you experienced corrosion problems in your safety shower/eyewash piping?
7. What material of construction do you use for safety shower/eyewash piping?
8. Do you use a ‘tempered’ water system to maintain a consistent warm temperature considering the potential impact on individuals?
9. Do you heat trace your safety shower piping to protect from freezing? If so, do you use anti-scalding devices?
10. Do you have issues with water quality and scale buildup? Do you use filters? Have you resolved any issues?
11. Do you have any ‘self-contained’ safety showers & eyewash systems (e.g., remote location without water supply)? Do you use antibacterial additives with these systems? If yes, is eyewash solution changed per manufacturer recommendations?
12. Do you have electronic indication or alarm that a safety shower / eye wash has been activated?
13. What manufacturer(s) do you use for safety shower/eye wash equipment?
14. How frequently do you test/inspect safety shower/eyewash systems?
15. What preventive maintenance protocol do you use for testing?
16. Is the safety shower / eyewash system a consideration in your plant Management of Change or PreStartup Safety Review process?
17. Is drainage from the system a consideration depending on the type of chemicals in that area of plant (e.g., HF)?
18. Do you have any other issues or comments on these systems?

## 3.2 Organized Survey Results

We received 11 company responses from the survey.:

* Tate & Lyle PLC
* Celanese Corporation
* Cummins
* 3M Company
* Marathon Refining – Robinson, IL
* CountryMark Cooperative Holding Corporation
* Corteva, Inc.
* American Chemistry Council, Inc.
* Saudi Basic Industries Corporation - Mount Vernon, IN
* Saudi Basic Industries Corporation - Ottawa, IL
* QualEx Inc.

By organizing the 18 questions in the survey, and reviewing all the results from companies, we summarized the information into six categories:

* General
* Water source
* Corrosion
* Maintenance, Training, and Management Systems
* Self-contained devices
* Other issues or comments

These categories provide a clear way to visual and analyze the results, both for subjective answers and numerical data.

### 3.2.1 General

General results include basic information of safety shower and eyewash systems.

Contents include: Company name, Manufacturer of safety shower and eyewash equipment, Number of systems per unit, Factors to consider in the number and placement, Signage and type, Ways to activate the equipment, Alarm systems, Ways of drainage, Employee training.

Answers are recorded in the tables below.

Table 3.1 General Results Part A

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Manufacturer | Signage | |
| Yes/No | Types |
| Tate & Lyle | We have probably one of every manufacturer that's ever existed in our plant. | Yes | They're brightly colored so they stand out in the background of other equipment. |
| Celanese | We select manufacturers that design safety shower / eye wash based on the ANSI Z358.1 requirement | Yes | / |
| Cummins | Honeywell | Some | Some marked with signage, most are not because of lack of space. Floor marking makes no sense because it would not be visible from distance. |
| 3M | It varies based on the age of the space. Global Industrial is primary. | Yes | Floor markings and green signs projecting from the wall or area above. |
| Marathon | Encon | Yes | Locations are well marked. The units are safety yellow to stand out. |
| CountryMark | Bradley | Yes | The systems are painted yellow. Safety showers/eye wash stations that are within buildings have signage on the exterior of building. As new systems are installed, they are equipped with a blue indicator light. |
| Corteva | Guardian and Bradley | Yes | Floor markings and wall signage |
| American Chemistry | Not sure | Generally, yes. | / |
| SABIC (Mount Vernon, IN) | B-L-S, Haws, Encon | Yes | We have a large yellow painted square on the floors, which outline the safety shower. Also, showers have paint “trails” which help individuals behind equipment find a safety shower more easily as well as blue lights. |
| SABIC (Ottawa, IL) | Various | Yes | Safety showers are marked but this could be improved as some locations are painted and have easier visibility. |
| QualEx | Haws, Encon, B-L-S | Yes | I believe they are typically painted in bright colors with a light above them to help locate. ANSI Z358.1 7.4.3 Are located in an area identified with a highly visible sign positioned so the sign shall be visible within the area served by the unit. The area around the unit shall be well-lit. |

Table 3.2 General Results Part B

|  |  |  |
| --- | --- | --- |
| Company | No. of systems per unit | Factors to consider in number and placement |
|  |
| Tate & Lyle | It really depends on the locations. Access to safety showers and eyewash stations (hereafter SS/ES) determines how many, as well as presence of hazards. If I had to guess at how many we have in our facility, it's in the hundreds total. | You want them where people are going to need them because of the hazards in that area. They also need to be accessed where people can get to them if they are partially incapacitated by material getting on them, so no climbing over pipes to get at a SS/ES. Number of personnel doesn't really have anything to do with SS/ES placement. You actually need to be more concerned with areas that are less populated because someone may be by themselves with no one around when they get contacted with material and they need to get to that SS/ES on their own. |  |
| Celanese | 20 on average per unit | ANSI Z358.1 is considered to define the Safety Showers & Eyewash location. Emergency showers are placed in an accessible location no more than 10 seconds to reach from the hazard. |  |
| Cummins | 60 bottles, 10 showers, 16 eyewash stations | Every lab, build area, hallways. 30 seconds or less to get to an eyewash or shower. |  |
| 3M | Roughly 500 | (1) presence of corrosive materials, (2) distance from hazard (10 sec maximum travel time). Doors, walls, partitions should not be in the path to the eyewash. |  |
| Marathon | Around 120 | Our spec calls for a minimum of 2 combination shower/ eyewashes per unit. We evaluate the risk based on hazardous materials present and the temperature of each. Typically, we have them spaced no more than 55 ft unimpeded from any location in the unit. |  |
| CountryMark | Typically, there are 1-2 safety showers/eye wash stations per operating unit. | The number and placement of safety showers/eye wash systems is dependent on the chemical hazards of the unit and the likelihood of exposure. |  |
| Corteva | About 320 safety shower/eyewash units which equivalates to 1 unit per laboratory space. | (1) Distance from hazardous materials and number of obstructions (doors) (2) 50 feet from work being conducted with hazardous materials (3) ANSI Z358.1 |  |
| American Chemistry | A relatively small plant has 17. | No more than 75 feet, and preferably 50 feet from areas where there is reasonable risk of exposure (filters, loading/offloading stations), and in a location where personnel would not have to climb stairs. |  |
| SABIC (Mount Vernon, IN) | 50-75 | In areas where toxic, corrosive, or flammable materials are processed, safety showers and eyewash facilities are accessible within 15 m travel distance from any point and require no more than 10 seconds to reach them. |  |
| SABIC (Ottawa, IL) | This varies per unit, 1 or 2 per floor (12 units) | Chemicals in the area and distance from potential hazard. |  |
| QualEx | We are an engineering firm and do not have showers in our office. However, we have designed several Safety Shower tempered loops for our clients. The number of showers/eyewash stations depends on the hazard locations in the area. A minimum of one shower/eyewash within 55 ft of a hazard is recommended per ANSI Z358.1. | Per ANSI Z385.1 it should take no longer than 10 seconds (~ 55 ft) from the hazard. There should be no stairs in the path from the hazard to the safety shower/eyewash. One step is acceptable. Doors are only acceptable in the path if the material is non-corrosive and it opens in the same direction of travel (limited to 1 door). We typically design the system to have two showers in operation at the same time. Some of our clients specify having three showers in operation at the same time. When designing a safety shower system, it is recommended to verify the shower requirement with the client. |  |

Table 3.3 General Results Part C

|  |  |  |
| --- | --- | --- |
| Company | Ways to activate plumbed-in devices | Alarm systems |
|  |
| Tate & Lyle | Mostly pull levers for the showers, and push levers for the eyewashes. | We may have a few electronic indicators here at the facility, but it's not common. |  |
| Celanese | There are activation variations, some showers are activated with a hand or foot, and for the eyewash, some are activated with the foot and other with the hand or elbow. | Not generally common in the units. |  |
| Cummins | Manually on all units | No |  |
| 3M | Hand-push activation for eyewash systems. Showers activated by pulling down on handle above the station. | No |  |
| Marathon | Activated by hand with a pull chord. | Yes, we have local alarms (audible and visual). |  |
| CountryMark | Safety Showers – Activated with a “pull handle”, Eye wash – Activated with lever mechanism. Note: Both are operational without the use of hands after activation | Safety Showers/Eye wash systems have electronic indication ability, although it is not activated. |  |
| Corteva | Human intervention/mechanical means to engage safety shower/eyewash. | Yes – connected to our Security system on site. |  |
| American Chemistry | Hands | Yes |  |
| SABIC (Mount Vernon, IN) | Safety showers have a “pull arm” that activates the shower portion and the eyewash has a “push lever” to activate the eye wash. | We have an alarm in the DCS when the safety shower handle is pulled. |  |
| SABIC (Ottawa, IL) | Push or pull handle activation | No |  |
| QualEx | From my experience most of the safety showers have a pull handle and the eyewashes have a push plate. | Depending on the unit the alarm may tell the specific shower that has been pulled (limit switch on individual valve) or it may just tell that a shower has been pulled in a unit. If it is a common alarm, it is often a flow switch on the common feed. Alarm devices are not currently required by ANSI Z358.1. |  |

### 3.2.2 Water Source

Water source results include issues related to water supply, temperature, and scale buildup.

Contents: Company name, Tempered water system, Freezing problem, Heat trace, Anti-scalding devices, Scale buildup, and Ways to drainage.

Table 3.4 Water Source Results Part A

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Tempered water system | | Freezing problem |
| Yes/No | Details |
| Tate & Lyle | Not a system | Pretty sure our potable water is just ambient temperature. | We still sometimes freeze and break this piping if the heat tracing isn't completely effective or it fails. |
| Celanese | No | / | / |
| Cummins | No | Have bottles or stations (eye saline) next to city water | / |
| 3M | Yes, indeed! | We follow ANSI/ISEA Z 358.1. | / |
| Marathon | Yes | We specify 60 – 100 deg F, but prefer 75 – 94 F. | The water piping is not permanently connected to the tempered water unit, so freeze protection is not a concern. |
| CountryMark | No | Water temperature is maintained with the use of electric/steam tracing | / |
| Corteva | Yes | Newer construction and remodels spaces receive tempered water. Original construction does not. | / |
| American Chemistry | Yes | In cold climates | / |
| SABIC (Mount Vernon, IN) | Yes | We use shell and tube heat exchanger that utilizes plant steam as the heating medium and keep the water at a consistent 85 F | / |
| SABIC (Ottawa, IL) | No | Water temperature is within the OSHA requirements for eye wash safety showers | / |
| QualEx | Tempered systems have been installed. | They units are installed to operate within the temperature and pressure limits of ANSI Z358.1. | / |

Table 3.5 Water Source Results Part B

|  |  |  |
| --- | --- | --- |
| Company | Heat trace | Anti-scalding devices |
|  |
| Tate & Lyle | We do heat trace some SS/ES piping with varied success. | No |  |
| Celanese | Yes, in the site locations impacted by low weather temperatures | / |  |
| Cummins | No, flush showers inside piping | No |  |
| 3M | No. It’s all indoors. | No |  |
| Marathon | No | The unit does have a scald protection valve. |  |
| CountryMark | Yes, all systems are protected from freezing by electric or steam tracing. | / |  |
| Corteva | One unit is heat traced but the remainder are not. | / |  |
| American Chemistry | Yes | Yes |  |
| SABIC (Mount Vernon, IN) | We heat trace our safety shower piping | No. In the future, we are looking at installing showers that have built in anti-scalding/anti-freezing valves. |  |
| SABIC (Ottawa, IL) | Outside units are heat traced with scalding protection | Yes |  |
| QualEx | If a tempered water system is not used and the flow is stagnant heat tracing is applied. If the loop is constantly flowing the loop piping is insulated and dead legs are heat traced. The individual showers are often bought assembled and often contain anti-freeze and anti-scald valves. | / |  |

Table 3.6 Water Source Results Part C

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Experienced scale buildup | | |
| Yes/No | Filters | Prevention/Solution/Resolution |
| Tate & Lyle | No | We use local filters on the eyewashes to prevent scale from getting in people's eyes. | / |
| Celanese | May not | / | Periodic flushing is used to prevent obstruction |
| Cummins | No | / | Flush units as needed |
| 3M | Water quality not an issue. | / | Scale is removed by flushing showers and eyewashes on weekly basis. Annual PM includes flowrate, temperature, time measurements. |
| Marathon | Not typically | Yes, there are inline filters included in the tempered water skid unit. | The tempered water units are drained and chemically treated on a regular schedule. Yes, there are inline filters included in the tempered water skid unit. Water is changed every 6 months. |
| CountryMark | No known water quality of scale buildup issues | No | / |
| Corteva | Yes | Eyewash screens are used | Weekly and monthly tests of the systems help with this issue. |
| American Chemistry | Not that we’ve seen | I don’t think we usually have filters. | / |
| SABIC (Mount Vernon, IN) | Yes, we have issues with water having a brown hazy color most likely from rust/corrosion. When we do replace sections of our piping, there is a significant buildup of scale in the pipes. This is most likely from the hard “city water” we use and keep recirculating through our system. | / | We are looking into better flush plans where we can send higher velocity water through the system to remove the scale on an annual PM. |
| SABIC (Ottawa, IL) | Does not seem to be a scale build up issue | / | Safety showers and eye wash units inspected weekly |
| QualEx | Water quality and scale buildup is a major issue with the city water at some clients. | Filters have been installed and plug up at regular intervals. | From my understanding the water quality and scaling has not been resolved |

Table 3.7 Water Source Results Part D

|  |  |
| --- | --- |
| Company | Handling drainage |
|  |
| Tate & Lyle | We have an onsite waste treatment plant, so most of the places that have SS/ES and hazardous chemicals have drains that lead to waste treatment. |  |
| Celanese | Depend on types of chemicals. Drainage use to go to the chemical sewers. |  |
| Cummins | There may be |  |
| 3M | Depends on the type of chemicals |  |
| Marathon | The tempered water units are drained and chemically treated on a regular schedule. Water that would be routinely drained from the Tempered Water Skid would go to the Oily Water Sewer for treatment. |  |
| CountryMark | All runoff water either runs to a drain or downhill away from potential affected personnel. |  |
| Corteva | No drainage is in the immediate area of safety showers/eyewashes. |  |
| American Chemistry | Not really |  |
| SABIC (Mount Vernon, IN) | We do not have any specific drains for the safety showers, just run off areas. |  |
| SABIC (Ottawa, IL) | Drainage is considered with flow directed to nearest area drain |  |
| QualEx | In the appendix of ANSI Z358.1 (Information only not part of standard) it says that consideration should be given to the proper disposal of the waste flushing fluids. This includes the consideration of drainage. |  |

### 3.2.3 Corrosion

Corrosion results include issues related to corrosion of the equipment, and piping materials.

Contents: Company name, Corrosion issues, Piping materials.

Table 3.8 Corrosion Results Part A

|  |  |  |
| --- | --- | --- |
| Company | Experienced corrosion | |
| Yes/No | Problem details/Preventive methods |
| Tate & Lyle | Not that I know of, but I wouldn't surprise me if we did. | / |
| Celanese | No | We preferably select non or low corrosive materials for the safety shower/eyewash pipelines. The safety shower/eyewash are periodically flushed |
| Cummins | Yes | / |
| 3M | No | / |
| Marathon | No | Over the last several years, we have installed Tempered Water Enclosure units that are a combination shower & eyewash. Each contains a 400-gallon reservoir to store enough water for 20 gpm flush for 15 minutes. These units are not hard piped to the water supply piping. |
| CountryMark | No known corrosion issues. | / |
| Corteva | Yes | We experience issues with a result of orange water, but larger issue lies with mineral deposits in the units. |
| American Chemistry | Not to our knowledge | / |
| SABIC (Mount Vernon, IN) | Yes | We have had to replace large sections of piping that eventually cannot handle the pressure of the system and leak. Also, piping that has been cut open reveals thinning of the pipe wall. |
| SABIC (Ottawa, IL) | Does not seem to be an issue at this time. | / |
| QualEx | Yes | One client has experienced significant corrosion in galvanized steel piping. |

Table 3.9 Corrosion Results Part B

|  |  |
| --- | --- |
| Company | Piping material |
|  |
| Tate & Lyle | A combination of carbon steel and plastic piping for SS/ES. Plastic is better so you don't get rust flakes in the water, but plastic is brittle and easily damaged, so there are a lot of carbon steel lines to SS/ES here too. |  |
| Celanese | Galvanized carbon steel or stainless-steel pipelines. We try to use low corrosive material to prevent damage. |  |
| Cummins | Steel pipe |  |
| 3M | Stainless steel. |  |
| Marathon | Although not connected to the shower units, we try to have potable water within 50 LF of the safety shower location. We would run a hose to the tempered water skid. If the installation requires new potable water piping, we would use a 304/304L dual certification piping. Internal piping on the safety shower is galvanized. |  |
| CountryMark | Galvanized Steel |  |
| Corteva | Copper, galvanized steel, stainless steel and PVC |  |
| American Chemistry | 304L stainless steel |  |
| SABIC (Mount Vernon, IN) | Carbon Steel and Galvanized Steel (currently). Pursuing options of 304L/316L stainless |  |
| SABIC (Ottawa, IL) | Metal pipe. |  |
| QualEx | Stainless Steel Piping is preferred but not required. ANSI Z358.1 states that the units be constructed of materials that will not corrode in the presence of the flushing fluid. |  |

### 3.2.4 Maintenance, Training, and Management Systems

Maintenance, training, and management results include issues related to frequency of test, preventive maintenance protocol, and consideration of MOC & PSSR.

Contents: Company name, Frequency of Test, Employee Training, Preventive Maintenance Protocol, consideration of Management of Change & PreStartup Safety Review.

Table 3.10 Maintenance, Training, and Management Systems Results Part A

|  |  |  |
| --- | --- | --- |
| Company | Frequency of test | Preventive maintenance protocol |
|  |
| Tate & Lyle | Before you do work in the area, you test them to make sure they work. We also test each of them monthly. | I don't think we have much in the way of a testing protocol. |  |
| Celanese | If it is related to current work, safety shower/eyewash are inspected before the work initiates and on a daily basis. In other cases, the safety shower/eyewash are tested/inspected monthly. | We use ANSI Z358.1 protocol for testing |  |
| Cummins | Monthly | Check + Test monthly |  |
| 3M | Scale is removed by flushing showers and eyewashes on weekly basis. Annual PM includes flowrate, temperature, time measurements. | We follow ANSI/ISEA Z 358.1 |  |
| Marathon | Operations inspects the showers on weekly RADAR rounds. They are to check the water temperature, pressure on the air supply tanks, ensure the unit has power. Water is replaced every 6 months and every 12 months the heating element is pulled and inspected. | The tempered water units are drained and chemically treated on a regular schedule. Yes, there are inline filters included in the tempered water skid unit. Water is changed every 6 months. |  |
| CountryMark | Systems are activated and inspected on a monthly basis. | Showers/Eye washes are inspected for cracks and then the system is flushed. |  |
| Corteva | Monthly by site personnel and weekly by researchers. | We follow internal Corteva protocol. |  |
| American Chemistry | Some weekly, some monthly. OSHA says at least monthly (8 CCR 5162(e)) | Flush each shower until control room gets the alarm. |  |
| SABIC (Mount Vernon, IN) | Weekly on Sunday nights | We have our operators put in work notifications if there are issues with the safety showers. |  |
| SABIC (Ottawa, IL) | Weekly | N/A, outside of weekly inspection/testing |  |
| QualEx | Showers should be activated weekly to verify operation and ensure flushing fluid is available. Showers shall be inspected annually. | Weekly testing of equipment. |  |

Table 3.11 Maintenance, Training, and Management Systems Results Part B

|  |  |  |
| --- | --- | --- |
| Company | Employee Training | |
| Yes/No | Details |
| Tate & Lyle | Yes | When we're doing work, we have places on our work permits where we note where the nearest SS/ES is and the permit issuer goes over that with whoever is doing the work. |
| Celanese | Yes | Part of the new hire orientation and periodically as part of the safety permit training |
| Cummins | Yes | ERTS are trained at one location as needed |
| 3M | Yes | Annually for employees. Yes, for contractors on every-third-year basis. |
| Marathon | Yes | Use of showers is reviewed in the site training program. The locations are reviewed in the unit specific training. |
| CountryMark | Yes | Employees/Contractors are trained on the location of safety showers, not operation. |
| Corteva | Yes | Self-pace electronic training as well as hands-on training is leveraged at the site |
| American Chemistry | Yes | / |
| SABIC (Mount Vernon, IN) | Yes | During initial unit orientation, individuals are shown how to operate the safety showers/eye wash’s properly. Also, contractors are shown where to find safety showers in their area during permitted jobs. |
| SABIC (Ottawa, IL) | Yes | Training is part of the new employee orientation; locations are part of the area training responsibility when personnel are placed in work areas. |
| QualEx | Yes | The clients often will show you locations during the unit specific training. |

Table 3.12 Maintenance, Training, and Management Systems Results Part C

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Consideration | | |
| Management of Change | PreStartup Safety Review | Details |
| Tate & Lyle | ✔️ | ✔️ | / |
| Celanese | ✔️ | ✔️ | / |
| Cummins | ✔️ | ✔️ | We would consider the risk present in that area, chemicals used or stored in the area, where existing eyewash or showers are already |
| 3M | ✔️ | / | It’s a line item in site’s MOC form. |
| Marathon | ✔️ | ✔️ | / |
| CountryMark | / | ✔️ | This is part of our PSSR process. |
| Corteva | ✔️ | ✔️ | / |
| American Chemistry | ✔️ | ✔️ | / |
| SABIC (Mount Vernon, IN) | ✔️ | / | One of our questions in the MOC process in the safety system is does this change “Affect existing safety equipment (e.g. safety showers, safety stations, PPE, machine guarding) or require additional safety equipment?” |
| SABIC (Ottawa, IL) | ✔️ | ✔️ | Would be if a new safety shower is added or removed. |
| QualEx | / | / | / |

### 3.2.5 Self-contained Devices

Contents: Company name, Have this kind of device or not, Use bacteriostatic additives or not, Change of eyewash solutions.

Table 3.13 Self-contained Devices Results

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Have or not | Bacteriostatic additives | Change of eyewash solutions |
| Tate & Lyle | Previous employer has, not sure what they do here | Previous: we'd make sure to use fresh antibacterial additives each time | At my previous employer, we had portable eyewashes that we would empty after use and refill before staging |
| Celanese | This is not a common solution in our units | Under the manufacturer recommendations | Under the manufacturer recommendations |
| Cummins | Yes, eye saline stations are self-contained and change per manufacturer recommendations | No | Change every 2 years |
| 3M | No | / | / |
| Marathon | Yes | Yes | Yes, water in the reservoir is drained, replaced, and treated every 6 months. |
| CountryMark | Yes. There is 1 self-contained unit | No | / |
| Corteva | Yes, eyewash bottles are used in designated locations predominately in Operations and Maintenance areas | / | Bottles are changed based on manufacturer recommendations. |
| American Chemistry | We have some eyewash bottles | / | During audits have found that they’re not always changed out as recommended. |
| SABIC (Mount Vernon, IN) | We have “self-contained” safety shower/eye wash systems, but these are generally only for temporary use. | They do not have antibacterial additives with these systems to my knowledge. | / |
| SABIC (Ottawa, IL) | Yes, there are remote locations and antibacterial additive is used when unit is placed in service. Currently we don’t have program to verify or track when this is changed out. | Yes | / |
| QualEx | I have not worked with these before. However, a potential concern would be bacterial buildup due to stagnant water. | / | The water should be changed on a regular basis to prevent the buildup of bacteria. Per ANSI Z358.1 the water should be visually checked weekly to determine if it needs to be replaced. |

### 3.2.6 Other Issues and Comments

This part includes the additional information that companies provided at the end of the survey. It can be issues, comments, or recommendations.

Table 3.14 Comments

|  |  |
| --- | --- |
| Company | Details |
| Tate & Lyle | / |
| Celanese | Important to consider spare parts as a selection of the safety shower/eyewash systems. Also, a challenge to install shower curtains. |
| Cummins | / |
| 3M | We use an electronic barcode system to track weekly and annual inspection/PM completions. |
| Marathon | In the last 6 - 7 years, Marathon has implemented an extensive program to upgrade the safety shower & eyewash equipment to go above and beyond complying with the requirements in OSHA and 29CFR1910.151. |
| CountryMark | / |
| Corteva | / |
| American Chemistry | / |
| SABIC (Mount Vernon, IN) | Interested in the material of construction from other companies. |
| SABIC (Ottawa, IL) | No |
| QualEx | ANSI Z358.1 is an informative reference that touches on many aspects of the safety shower system. For tempered water systems the quality of the steam should be considered. From the International Plumbing Code 2006, if the heating media is not potable than the heat exchanger should be double walled to minimize risk of contamination. |

# Chapter 4 General Result Analysis

## 4.1 Result Summary

General questions in the survey are about the basic information of the safety shower and eyewash stations in a company, and any issues. As the tables shown above, three tables were created to record the general results, which include:

Table 3.1 Part A: Manufacturer; Signage

Table 3.2 Part B: Number and placement of systems

Table 3.3 Part C: Ways to activate plumbed-in devices; Alarm systems

The numerical and subjective analysis will be performed in this chapter as well as the best practices recommended based on the survey results.

## 4.2 Part A: Manufacturer; Signage

### 4.2.1 Part A Result Analysis

Fig. 4.1 shows the percentage of the use of manufacturers from the 11 survey responses from companies. From the graph, the most popular brand among the 11 companies is Encon (3/11, representing 3 of 11 companies), a safety and protective equipment manufacturer. Unfortunately, 5/11 of the responses did not include a manufacturer. Then Haws, B-L-S, and Bradley (2/11) are also used by some companies. Honeywell and Guardian are used by 1/11 of responses. Several companies have more than one manufacturer. These numbers can be used for reference only, since the number of survey participants is small.

![Chart, bar chart

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Fig. 4.1 Manufacturer

From Part A table, all 11 companies have signage for their safety shower and eyewash stations, and this can be very important when an employee is seeking a station. Different companies have various signage, which is shown in Fig. 4.2. From the graph, 4/11 of companies have safety shower and eyewash stations in bright colors which stands out from the background. 3/11 of companies have wall signs around the stations and floor markings on the ground that help to highlight the area of the stations. 2/11 of companies install indicator lights on the equipment that shows the location of the stations. 1/11 of companies paint a trail that can direct workers to the stations and have a sign on the building that includes safety shower and eyewash stations.

![Chart, bar chart

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Fig. 4.2 Signage

### 4.2.2 What’s in official standards

* ANSI/ISEA Z358.1-2014 [2]

**4.5.3** “Be located in an area identified with a highly visible sign positioned so the sign shall be visible within the area served by the emergency shower. The area around the emergency shower shall be well lit.”

* EN15154 [4]

**9** “In addition, a safety sign in accordance with *ISO 3864-1* [9] displayable near the shower shall be supplied with each emergency body shower.”

* CCOHS Fact Sheets [5]

“The location of each emergency shower or eyewash station should be identified with a highly visible sign. The sign should be in the form of a symbol that does not require workers to have language skills to understand it. The location should be well lit.”

“Be located where workers can easily see them - preferably in a normal traffic pattern.”

### 4.2.3 Best Practices

The goal of the signage is to direct workers to the stations. ANSI standards recommend a highly visible sign and the area well lit. As for the types of signage, companies can design the best ones for their particular facility. From Fig. 4.2, all the companies have good methods of signage, but according to the details they provide, some companies may not have signage for all of their stations, or some types are not highly visible. While 3/11 of companies use floor markings this has limitations since it can’t be seen from a distance. While manufacturers typically use brightly colored systems to aid with locating, additional signage may be needed depending on specific plant site, congestion, etc.

Based on the requirements of official standards and the analysis of details that companies provide, we recommend:

* Provide highly visible signage for every safety shower & eyewash in the facility;
* Position wall signs and indicator lights around every station in the facility;
* Painted trails are recommended if applicable;
* Train the employees who work in this area on how to get to the nearest station;

## 4.3 Part B: Number and Placement of systems

### 4.3.1 Part B Results Analysis

The number of systems per unit may vary due to different scale of facilities, and some responses weren’t clear as to whether the number was for a single unit or multiple. We assume that for numbers over 100, they are the total numbers; while for relatively small numbers, they are for one unit or laboratory area. From the data, about half of the companies have less than 100 stations per unit/in total, and others have over 100 stations per unit/in total.

Fig. 4.3 shows the factors considered when designing the number and location of the safety shower and eyewash stations. “Distance from hazards” is mentioned by 8/11 of companies and “Hazards of substances” is mentioned by 7/11 of companies. They all emphasize that the stations should be quickly accessed within seconds by injured workers, and areas involving highly hazardous substances may have more stations. “No obstructions/partitions” was mentioned by 6/11 of companies and this is also important because if people encounter obstructions, it will increase the time to get to the station. “Areas with less personnel” (1/11), mentioned by Tate & Lyle is also a good point. They emphasize this factor because they notice that at the location where there are fewer people, they need to get to the stations without help from others when contacting hazardous materials. “Likelihood of exposure” (1/11) can be a good factor to consider that can avoid waste of resources and provide the equipment to the most needed areas.

![Chart, bar chart

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Fig. 4.3 Factors to consider in number and placement

### 4.3.2 What’s in official standards

* ANSI/ISEA Z358.1-2014 [2]

**4.5.2** “Be in accessible locations that require no more than 10 seconds to reach. The emergency shower shall be located on the same level as the hazard and the path of travel shall be free of obstructions that may inhibit its immediate use. (See Appendix B5)”

**Appendix B5 Placement of Emergency Eyewash and Shower Equipment**

“Emergency eyewash and shower equipment should be available for immediate use, but in no instance should it take an individual longer than 10 seconds to reach the nearest facility.”

“There are several factors that might influence the location of emergency facilities. It is recognized that the average person covers a distance of approximately 55 ft. (16.8 m) in 10 seconds when walking at a normal pace. The physical and emotional state of a potential victim (visually impaired, with some level of discomfort/pain, and possibly in a state of panic) should be considered along with the likelihood of personnel in the immediate area to assist. The installer should also consider other potential hazards that may be adjacent to the path of travel that might cause further injury. A single step up into an enclosure where the equipment can be accessed is not considered to be an obstruction. Additionally, installers should allow for adequate overhead clearance to accommodate the presence of cabinets over counter- or faucet- mounted emergency eyewashes, so as not to create an additional hazard that could be encountered when using the device.”

“A door is considered to be an obstruction. Where the hazard is not corrosive, one intervening door can be present so long as it opens in the same direction of travel as the person attempting to reach the emergency eyewash and shower equipment and the door is equipped with a closing mechanism that cannot be locked to impede access to the equipment.”

* EN 15154 [4]

**5.2 Free space**

“The free space between the centre line of the shower head and the nearest obstruction (wall, vertical supply tube or similar) shall be a circle with a minimum radius of 400 mm.”

“Only the valve control element and/or the eyewash station and/or the hand held shower o n a combination shower shall project into this space by a maximum of 200 mm. Other parts or components shall not project into this space.”

* CCOHS Fact Sheets [5]

“To be effective, the equipment has to be accessible. ANSI recommends that a person be able to reach the equipment in no more than 10 seconds. In practical terms, consider that the person who needs the equipment will be injured, and may not have use of their vision. ANSI notes that the average person can walk 16 to 17 metres (55 feet) in 10 seconds, but this does not account for the physical and emotional state of the person in an emergency.”

“As such, the "10 second" rule may be modified depending on the potential effect of the chemical. Where a highly corrosive chemical is used, an emergency shower and eyewash station may be required to be closer to the workstation. Check with a professional with knowledge in this area. These units should be installed in such a way that they do not become contaminated from corrosive chemicals used nearby.”

“Other recommendations include that the emergency shower or eyewash station should:

* be located as close to the hazard as possible,
* not be separated by a partition from the hazardous work area,
* be on an unobstructed path between the workstation and the hazard (workers should not have to pass through doorways or weave through machinery or other obstacles to reach them),
* be located where workers can easily see them - preferably in a normal traffic pattern,
* be on the same floor as the hazard (no stairs to travel between the workstation and the emergency equipment),
* be located near an emergency exit where possible so that any responding emergency response personnel can reach the person easily,
* be located in an area where further contamination will not occur,
* provide a drainage system for the excess water (remember that the water may be considered a hazardous waste and special regulations may apply),
* not come into contact with any electrical equipment that may become a hazard when wet,
* be protected from freezing when installing emergency equipment outdoors.”

“Work areas and operations that may require these devices include:

* Battery charging areas
* Laboratories
* Spraying operations
* High dust areas
* Dipping operations
* Hazardous substances dispensing areas”

### 4.3.3 Best Practices

The goal is to let people get to the station promptly without delay. ANSI standards and CCOHS fact sheets both provide detailed requirements and recommendations for the position of the safety shower and eyewash stations and the factors to consider when designing it. According to the survey results, companies are aware of the important factors to consider that are mentioned in the standards. We recommend companies review the standards to ensure the best positions of stations.

Based on the requirements of standards and the analysis of details that companies provide, we recommend:

* Ensure the stations can be accessed within 10 seconds. (55 ft or 16.8 m, same floor)
* Resolve any obstructions/partitions (including doors) on the way to the stations.
* Allow for adequate overhead clearance so as not to create an additional hazard that could be encountered when using the device.
* An appropriate, professionals should be contacted for advice on the proper distances.
* Ensure the stations are near the hazards but are situated in such a manner that exposure to the splash hazard or other hazards (e.g., exposed electrical conductors) does not occur while using the eyewash.
* If possible, consider the access of responding emergency response personnel to the injured individual.

## 4.4 Part C: Activation and Alarm Systems

### 4.4.1 Part C Result Analysis

According to the results, all equipment will be activated by human intervention/mechanical means. For example, they will have pull/push levers, pull handles, pull chords, push plates, and “pull arms” for workers to use. CountryMark states that their devices are operational without the use of hands after activation, and this is exactly what ANSI standards recommend.

Fig. 4.4 shows that ~45% (5/11) of companies have an alarm system on their equipment, while others (~55%, 6/11) do not have alarm systems or they are not common in the units. Installing alarm systems connected to the safety shower and eyewash stations, however, is recommended by ANSI standards.

![Chart, pie chart

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Fig. 4.4 Alarm Systems

### 4.4.2 What’s in official standards

* ANSI/ISEA Z358.1-2014 [2]

**4.1.5** “Emergency showers shall be designed, manufactured and installed in such a manner that, once activated, they can be used without requiring the use of the operator’s hands.”

**4.2** “Manual or automatic actuators shall be easy to locate and readily accessible to the user. Valve actuators shall be located not more than 173.3 cm (69 in.) above the level on which the user stands.”

**5.3.2 (3)** “Activate the unit and verify that it can be activated in one second or less and that it stays activated.”

**Appendix B4 Alarm Devices**

“In addition to the equipment identification required by ANSI/ISEA Z358.12014, users may also want to use audible alarms or warning lights to indicate that the unit is in operation. These are particularly important in remote areas. Many companies connect valves electrically to warning lights or buzzers in central dispatch areas to alert the appropriate authorities when the unit is in use.”

* EN 15154 [4]

**6 Valve**

“For manual operation, the valve shall be opened in a single operation by turning or moving a valve actuator to maximum 90° or maximum 200 mm stroke. The maximum force for the operation shall be 100 N or the maximum torque 7 Nm. By using this force/torque, the valve shall be fully open within 1 s.”

“Also for automatic operation, the valve shall be fully open within 1 s.”

“The valve shall not close automatically once it has been opened. The direction of operating the valve actuator shall be clearly visible and unmistakable.”

“The valve actuator shall be large enough to be easily located and operated by the user even when wearing protective gloves, with a maximum size in accordance with EN 420. The valve actuator shall be positioned between floor level and a maximum of 1 750 mm above that level.”

* CCOHS Fact Sheets [5]

“The shower should also be designed so that it can be activated in less than 1 second, and it remains operational without the operator's hand on the valve (or lever, handle, etc.). This valve should not be more than 173.3 cm (69 inches) in height. If enclosures are used, ensure that there is an unobstructed area of 86.4 cm (34 inches) in diameter.”

“With an eye wash station, the user should be able to open their eyelids with their hands and still have their eyes in the liquid. In the case of the eye/face wash, the user should have enough room to allow the eyelids to be held open with the hands while the eyes and face are still in the stream. As with the shower, the unit should also be designed so that it can be activated in less than 1 second, and it remains operational without the operator's hand on the valve (or lever, handle, etc.) with the valve being located in an easily located place. Since the nozzles to eyewash stations typically need to be protected from airborne contaminants, the units are to be designed such that the removal of these covers should not require a separate motion by the user when the unit is activated.”

“The installation of an audible or visual alarm can alert other workers when the emergency shower or eyewash station is being used. An alarm is especially important if only one worker happens to be working in that area. A person may need help in getting to the eyewash if temporarily blinded. Some companies connect valves electrically to warning lights or buzzers in central areas.”

### 4.4.3 Best practices

The goal is to ensure the continued use of the devices in an emergency circumstance and alert other workers when a device is activated. From the results, only one company mentions that their devices will be used without requiring the use of the operator’s hands once activated, and the answers from other companies are not clear about this feature. Additionally, only less than half of the companies have an alarm system connected to the stations. Therefore, companies should pay more attention to this point. ANSI standards, EN 15154, and CCOHS all have clear recommendations about this.

Based on the requirements of standards and the analysis of details that companies provide, we recommend:

* Select safety shower and eyewash equipment that is easy to activate and do not need additional operations once activated.
* Install alarm systems on every station of safety shower and eyewash equipment that can alert other workers when one device is activated. (audible alarms or warning lights)

# Chapter 5 Water Source Result Analysis

## 5.1 Result Summary

Water source questions in the survey are about the issues related to water, such as temperature, scale buildup, and drainage. As the tables shown above, four tables are created to record the general results, which include:

Table 3.4 Part A: Tempered water system; Freezing problems

Table 3.5 Part B: Heat tracing; Anti-scalding devices

Table 3.6 Part C: Scale buildup

Table 3.7 Part D: Drainage

The numerical and subjective analysis will be performed in this chapter as well as the best practices recommended based on the survey results.

## 5.2 Part A&B: Water Temperature

### 5.2.1 Part A&B Results Analysis

From Table 3.4, 6/11 (~55%) of companies have a tempered water system that ensures the temperature of the water supply meets the ANSI standards. Some companies provide details of how they maintain the water temperature: CountryMark uses electric/steam tracing; SABIC uses a shell and tube heat exchanger that utilizes plant steam as the heating medium, *etc*. Others state that they follow the ANSI/OSHA standards when designing this system. Of the companies that do not have a tempered water system, most of them do have methods to maintain the water temperature, though they do not define it as a “system”.

From Table 3.5, 8/11 (~73%) of companies heat trace their piping of safety shower and eyewash systems. Of these 8 companies, 4/8 (50%) of them heat trace the piping of part of the stations under specific conditions, such as outside stations, locations at low weather temperatures, and stations with stagnant flow. The other 4 companies heat trace all the piping, using electricity or steam. Only one company has a freezing problem because sometimes the heat tracing is not effective or it fails to work. 4/11 (~36%) of companies have anti-scalding devices (valves) according to Table 3.5.

### 5.2.2 What’s in official standards

* ANSI/ISEA Z358.1-2014 [2]

**Definition:**

“Tepid: A flushing fluid temperature conducive to promoting a minimum 15-minute irrigation period. A suitable range is 16 - 38º C (60 -100º F).”

**4.5.5** “Where the possibility of freezing conditions exists, the emergency shower shall be protected from freezing or freeze protected equipment shall be installed.”

**4.5.6** “Deliver tepid flushing fluid. In circumstances where chemical reaction is accelerated by flushing fluid temperature, a facilities safety/health advisor should be consulted for the optimum temperature for each application.”

**4.5.7 (5)** “Using a temperature gauge or other means, determine that the flushing fluid is tepid.”

**Appendix B6 Delivered Flushing Fluid Temperature**

“Continuous and timely irrigation of affected tissues for the recommended irrigation period are the principal factors in providing first aid. Providing flushing fluid at temperatures conducive to use for the recommended irrigation period is considered an integral part of providing suitable facilities. Medical recommendations suggest a flushing fluid at tepid temperatures be delivered to affected chemically injured tissue. Temperatures in excess of 38°C (100°F) have proven to be harmful to the eyes and can enhance chemical interaction with the skin and eye tissue. Consideration should be given to the impact of isolated ambient temperature changes. Colder ambient temperature might require an enclosure for added protection. Warmer ambient temperature might require a reevaluation of the water temperature.”

“While cold flushing fluid temperatures provide immediate cooling after chemical contact, prolonged exposure to cold fluids affect the ability to maintain adequate body temperature and can result in the premature cessation of first aid treatment. Recent information indicates that a temperature of 16°C (60°F) is suitable for the lower parameter for tepid flushing fluid without causing hypothermia to the equipment user.”

* EN 15154 [4]

**Annex A Water Temperature**

“Medical recommendations suggest water at tepid temperatures be delivered to affected chemically injured t issue. Temperatures in an excess of 37 ºC have proven to be harmful to the eyes and can enhance chemical interaction with the eyes and skin.”

“Recent information indicates that a temperature of 15 ºC is suitable for the lower parameter for tepid water without causing hypothermia to the equipment user.”

**NA.2 System Design**

“Where supplementary heating of the cistern is installed to combat risks to the users of thermal shock induced by drenching with water, the heating arrangement should be designed to ensure that the temperature does not exceed the maximum advised for legionella control in cold water systems.”

Legionella: A genus of pathogenic Gram-negative bacteria that includes the species L. pneumophila, causing legionellosis (all illnesses caused by Legionella) including a pneumonia-type illness called Legionnaires' disease and a mild flu-like illness called Pontiac fever.

* CCOHS Fact Sheets [5]

The 2014 ANSI standard recommends that the water should be "tepid" and defines this temperature as being between 16-38°C (60-100°F). Temperatures higher than 38°C (100°F) are harmful to the eyes and can enhance chemical interaction with the skin and eyes. Long flushing times with cold water (less than 16°C (60°F)) can cause hypothermia and may result in not rinsing or showering for the full recommended time (ANSI 2014). With thermal burns (injuries to the skin), the American Heart Association (2010) noted that water temperatures of 15-25°C (59-77°F) help to cool the burn and that "cooling reduces pain, edema, and depth of injury". (However, do not apply ice directly to the skin.)

Remember that any chemical splash should be rinsed for a minimum of 15 minutes but rinsing time can be up to 60 minutes. The temperature of the water should be one that can be tolerated for the required length of time. Water that is too cold or too hot will inhibit workers from rinsing or showering as long as they should.

Install anti-scalding devices (temperature control valve or thermostatic tempering valve), constant flow meters, and other devices that will help maintain a constant temperature and flow rate. For cold or outdoor locations, emergency showers with heated plumbing are available. In hot climates, outdoor emergency showers should also have a tempering valve so that workers are not exposed to water that is too hot.

### 5.2.3 Best Practices

The goal of using a tempered water system is to provide a comfortable relief for workers who are exposed to hazardous chemicals. Water neither too cold (<16 °C or 60 °F) or too hot (>38 °C or 100 °F) can be harmful to the eyes and can enhance chemical interaction with the skin and eyes. For outdoor stations, heat tracing the pipelines are necessary for cold climates, and installing anti-scalding devices are necessary for hot climates. From the survey results, most of the companies have a tempered water system or adopt ways to maintain the water temperature. However, the water temperatures in the safety shower and eyewash stations of some companies are at ambient temperatures, and they do not have devices that can maintain the temperature between the recommended range.

Based on the requirements of standards and the analysis of details that companies provide, we recommend:

* Install tempered water system for every safety shower and eyewash stations to maintain the water temperature between 16 °C to 38 °C.
* For outdoor stations in cold climates, heat trace the piping and install an enclosure.
* For outdoor stations in hot climates, install anti-scalding devices (temperature control valve or thermostatic tempering valve), and other devices that will help maintain a constant temperature.

## 5.3 Part C: Scale Buildup

### 5.3.1 Part C Result Analysis

3/11 (~27%) of companies have experienced scale buildup in their safety shower and eyewash systems. 4/11 (~36%) of companies have filters in the systems. For most of the companies that do not have scale buildup issues, they do have some means for prevention. For example, some companies use flush units to wash away the buildup; and others perform inspections on a monthly or weekly basis to check and remove the buildup. This issue does not seem common, and companies have proper ways to prevent it.

### 5.3.2 What’s in official standards

* ANSI/ISEA Z358.1-2014 [2]

**Appendix B7 Weekly Activation for Plumbed Emergency Eyewash and Shower Equipment**

“The intent of the weekly activation to be conducted on plumbed emergency eyewash and shower

equipment is to ensure that there is a flushing fluid supply at the head of the device and to clear the supply line of any sediment buildup that could prevent fluid from being delivered to the head of the device and minimize microbial contamination due to stagnant water. The duration of this test is dependent on the volume of water contained in the unit itself and all sections of pipework that do not form part of a constant circulation system (also known as “dead leg” portions). Water in these sections is stagnant until a flow is activated by opening a valve. The goal is to flush out stagnant water in the dead leg completely. Where mixing valves are used, both the hot water and cold water supplies to the valve must be considered.”

* EN 15154 [4]

**NA.5 Routine testing of water quality**

“Routine testing of the water quality within the emergency shower, eyebath and eye/facewash

equipment is required to ensure there is no build-up of harmful bacteria. Test records should include details of water quality and temperature (and disinfectant if it is applied in the building). If necessary, following the test, the unit should be thoroughly cleaned and chlorinated/disinfected. Records should include details of water quality, both pre-clean and post-clean. These records should be kept for a minimum period of seven years.”

**A.2 Filter**

“To avoid a build-up of water-borne contaminants, the water supply pipe can be fitted with a fine mesh filter.”

* CCOHS Fact Sheets [5]

“A weekly activation will help make sure that there is flushing fluid available as well as clear the supply line of sediments and minimize microbial contamination caused by 'still' or sitting water. This person should keep a signed, dated record. The ANSI standard also recommends a complete inspection on an annual (yearly) basis.”

### 5.3.3 Best Practices

The goal of installing flushing units and filters is to prevent scale buildup and the existence of stagnant water in the safety shower and eyewash stations. According to the survey, companies that use this kind of device can effectively wash away the buildup and keep the stations clean. Routine testing of water quality and weekly activation will also help to ensure there are no sediments and contamination within the stations.

Based on the requirements of standards and the analysis of details that companies provide, we recommend:

* Installing flushing units that remove buildup and ensure water quality.
* Fine mesh filters are strongly recommended especially for the eyewash units.
* Perform weekly activation of the safety shower and eyewash units to ensure there is no sediment and buildup of contaminants.
* Test the systems regularly and keep a record of water quality and temperature.

## 5.4 Part D: Drainage

### 5.4.1 Part D Result Analysis

Companies use various methods to handle drainage from the safety shower and eyewash system. However, more than half of the companies surveyed do not have special treatment for drainage. According to the results, Tate & Lyle has an onsite treatment plant, and Celanese and Marathon deliver the drainage to a chemical sewer. It seems that developing a system to treat the drainage is necessary because wastewater that comes from the safety shower and eyewash stations usually has hazardous chemicals that are harmful to both humans and the environment.

### 5.4.2 What’s in official standards

* ANSI/ISEA Z358.1-2014 [2]

**Appendix A3 Waste Disposal**

“Consideration should be given to the proper disposal of waste flushing fluids from operating emergency eyewash and shower equipment. Freezing temperatures, drainage, elevated showers and pollutants are some, but not all, of the considerations. Consult authorities for assistance with applicable local, state and federal regulations.”

* EN 15154 [4]

**NA. 2 System Design**

**3.** “The cistern should be fitted with a separate drain valve at the lowest point to facilitate complete drainage of the unit, the flushing out of sediments and the cleaning/disinfection of chemical residues;”

* CCOHS Fact Sheets [5]

“Provide a drainage system for the excess water (remember that the water may be considered a hazardous waste and special regulations may apply).”

### 5.4.3 Best Practices

The goal of a drainage system is to ensure the wastewater is safe to enter the environment. Wastewater coming from safety shower and eyewash systems can contain hazardous chemicals washed away from the bodies and eyes, and it can be harmful without treatment.

Based on the requirements of standards and the analysis of details that companies provided, we recommend:

* Develop a drainage system to treat the wastewater coming from the safety shower and eyewash systems.
* Water treatment depending on the type of chemicals potentially involved is recommended.
* Consult authorities for assistance with applicable local, state and federal regulations about the criteria for drainage.

# Chapter 6 Corrosion Results Analysis

## 6.1 Result Summary

Corrosion questions in the survey are about the issues related to the experiences of corrosion of the piping materials. As the tables shown above, two tables are created to record the general results, which include:

Table 3.8 Part A: Experience of corrosion

Table 3.9 Part B: Piping materials

The numerical and subjective analysis will be performed in this chapter as well as the best practices recommended based on the survey results.

## 6.2 Results Analysis

4/11 (~36%) of companies have experienced corrosion problems in the piping of their safety shower and eyewash systems. Corteva experienced issues resulting in orange water, and mineral deposits in the units are more severe. One of QualEx’s clients has experienced significant corrosion in galvanized steel piping. 2/11 (~18%) of companies adopted some methods to prevent or handle this issue. Celanese selects non or low corrosive materials for pipes, and periodically flushes the units. SABIC (Mount Vernon, IN) had replaced large sections of piping that eventually cannot handle the pressure of the system and thus leak. Also, the piping that had been cut open reveals a thinning of the pipe wall.

7/11 of companies mention that they use stainless steel for their piping, while 5/11 companies use galvanized steel for their piping. These two materials are the most popular ones among all the choices. Plastic, carbon steel, and metal (e.g., copper) are also used by one or two companies. According to Tate & Lyle, plastic is better with no rust flakes in the water, but it is brittle and easily damaged. Stainless steel and galvanized steel are acknowledged to be the low corrosive options.

![Chart, bar chart

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Fig. 6.1 Piping Materials

## 6.3 What’s in official standards

* ANSI/ISEA Z358.1-2014 [2]

**5.1.5** “Eyewashes shall be constructed of materials that will not corrode in the presence of the flushing fluid.”

**5.2** “The valve shall be resistant to corrosion.”

## 6.4 Best Practices

The goal of using non or low corrosive piping materials is to prevent the pipelines from corrosion, make the equipment more durable, and ensure there are fewer contaminants in the water supply. There are no specific materials mentioned in any standards, but according to Fig. 6.2 below (from a reference providing specific piping recommendations), seeing the row with property “Corrosion”, PVC (Polyvinylchloride), PP (Polypropylene), and PVDF (Polyvinylidene fluoride) have a rating of “5” that means the highest non-corrosive materials. These materials have the advantage of being very resistant to most forms of corrosion. Also, stainless steel (SS, rating “4”) is widely considered to be resistant to corrosion. This is true in many circumstances, but not all. Anaerobic and chloride corrosion can affect SS. Copper has a rating of “3”. Galvanized steel only has a rating of “2”. Galvanized steel pipe has all the advantages of steel pipe, plus improved corrosion resistance in most environments. Galvanizing works almost perfectly in applications where it is wetted and dried, but it can fail in environments with high sodium (e.g., softened water that started out very hard) because the sodium makes the adherent oxide film detach and react more like steel pipe where the oxide flakes off. Steel (carbon steel) has a rating of only “1” which is the lowest corrosive resistance.

Table

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Fig. 6.2 Application and pipe material rating [11]

Based on the requirements of standards and the analysis of details that companies provided, we recommend:

* Select highly corrosion resistant materials such as PVC, PP, PVDF or stainless steel as the priority choice for piping.
* Avoid using carbon steel (steel) for piping materials.
* Note that these recommendations are based on preventing corrosion, and that the ranking would differ from an overall ‘Total’ perspective (and importance one places on flammability and UV resistance, for example), although stainless steel is clearly the preferred option. Please refer to Fig. 6.2 and Reference [11] for more details on choosing piping materials.

# Chapter 7 Maintenance, Training, and Management Systems Results Analysis

## 7.1 Results Summary

Maintenance, training, and management systems questions in the survey are about the issues related to testing, training, and management considerations. As per the tables shown above, three tables are created to record the general results, which include:

Table 3.10 Part A: Maintenance

Table 3.11 Part B: Employee training

Table 3.12 Part C: Management systems

The numerical and subjective analysis will be performed in this chapter, as well as the best practices recommended based on the survey results.

## 7.2 Part A: Maintenance

### 7.2.1 Part A Results Analysis

6/11 (~55%) of companies have their systems inspected monthly, and 5/11 (~45%) of companies weekly. Tate & Lyle and Celanese test them every time before employees work in the area. 3M tests the flowrates, temperature, and time measurements annually. Marathon checks the heating element annually. Corteva tests the systems used by researchers weekly, and monthly for sites used by operating personnel.

Most companies will check and test the systems regularly. 2/11 (~18%) companies use ANSI standards as their preventive maintenance protocol. One company does not have a protocol, but it does the checking and testing work.

### 7.2.2 What’s in official standards

* ANSI/ISEA Z358.1-2014 [2]

**4.6.2** “Plumbed emergency showers shall be activated weekly for a period long enough to verify operation and ensure that flushing fluid is available. (See Appendix B7)”

**4.6.5** “All emergency showers shall be inspected annually to assure conformance with Section 4.5 requirements of this standard.”

**Appendix B7 Weekly Activation for Plumbed Emergency Eyewash and Shower Equipment**

“The intent of the weekly activation to be conducted on plumbed emergency eyewash and shower

equipment is to ensure that there is a flushing fluid supply at the head of the device and to clear the supply line of any sediment buildup that could prevent fluid from being delivered to the head of the device and minimize microbial contamination due to stagnant water. The duration of this test is dependent on the volume of water contained in the unit itself and all sections of pipework that do not form part of a constant circulation system (also known as “dead leg” portions). Water in these sections is stagnant until a flow is activated by opening a valve. The goal is to flush out stagnant water in the dead leg completely. Where mixing valves are used, both the hot water and cold water supplies to the valve must be considered.”

* EN 15154 [4]

**NA.5 Routine testing of water quality**

“Routine testing of the water quality within the emergency shower, eyebath and eye/facewash

equipment is required to ensure there is no build-up of harmful bacteria. Test records should include details of water quality and temperature (and disinfectant if it is applied in the building). If necessary, following the test, the unit should be thoroughly cleaned and chlorinated/disinfected. Records should include details of water quality, both pre-clean and post-clean. These records should be kept for a minimum period of seven years.”

“Regardless of monitoring results, storage tanks supplying safety showers should be cleaned at least annually in accordance with Health and Safety Commission L8 – Legionnaire’s disease. The control of legionella bacteria in water systems. Approved code of practice and guidance [11].”

“Regardless of the minimum requirements for tank cleaning safety, showers represent a heightened risk of microbiologic regrowth and associated risks from legionella and pseudomonas bacteria to traumatized users of the facility. Therefore, depending on the results of testing at least quarterly, tank cleaning/checking should be considered unless substantial turnover of water in the storage cisterns can be assured. Persistent results (three consecutive) in excess of the prescribed quality criteria defined in NA.3 indicate that cleaning of the cistern is required.”

**NA.6 Maintenance of emergency shower**

“This type of equipment should be maintained in an efficient state, in effective working order and

in good repair. All emergency shower, eyebath and eye/facewash equipment should be serviced and cleaned at least once every six months. Servicing records should be kept for a minimum of five years.”

**NA.7 Recording test data and maintenance schedule**

“Recommended flushing instructions and periods should be individually indicated on each separate emergency shower, eyebath and eye/facewash unit. Details of flushing should be recorded and records kept for a minimum of seven years.”

* CCOHS Fact Sheets [5]

“One person in the work area should be designated responsible for inspecting and operating (activating) the emergency shower, eyewash station, combination units, and drench hoses weekly. A weekly activation will help make sure that there is flushing fluid available as well as clear the supply line of sediments and minimize microbial contamination caused by 'still' or sitting water. This person should keep a signed, dated record. The ANSI standard also recommends a complete inspection on an annual (yearly) basis.”

“Preventive maintenance inspections should check for such problems as valve leakage, clogged openings and lines, and adequacy of the fluid volume. A work record of these inspections should be kept. Replacement parts should be kept on hand to prevent the system from becoming non-functional. If the system breaks down for any reason, the workers in the area should be properly warned and protected.”

“Personal eyewash equipment should be inspected and maintained according to the manufacturer's instructions and at least annually for overall operation.”

### 7.2.3 Best Practices

The goal of testing the safety shower and eyewash systems regularly is to ensure their operability. The water supply should meet the requirements (sufficient flowrate, comfortable temperature, clean, *etc.*), and there should be no sediment and contaminants in the water. Records of testing should be kept, too. According to the survey results, a detailed and uniform testing standard is missing, so companies have adopted various ways to handle this.

Based on the requirements of standards and the analysis of details that companies provided, we recommend:

* Activate the safety shower and eyewash systems weekly to ensure adequate flushing fluid supply and no sediment.
* Test the systems at least on a monthly basis of the function, water quality, temperature, buildup, flowrates, and harmful bacteria. Record the details of each test.
* Clean the tanks that supply the water annually, if applicable.
* Problems arising during testing, such as valve leakage, clogged openings and lines, and adequacy of the fluid volume should be solved as soon as possible, considering alternate options for personnel in the meantime.

## 7.3 Part B: Employee Training

### 7.3.1 Part B Result Analysis

From Table 3.4, all the companies train their employees or contractors on the use of safety shower and eyewash systems and where they can find the stations. However, the means and content of the training vary. In the detailed results, most of the companies note that they have such training, or the frequency, and some simple ways of handling the training. Among the answers with the training content, most of the companies just show the workers the location of the stations, but not both the locations and operation of the equipment.

### 7.3.2 What’s in official standards

* ANSI/ISEA Z358.1-2014 [2]

**4.6.1** “Manufacturers shall provide operation, inspection and maintenance instructions with

emergency shower equipment. Instructions shall be readily accessible to maintenance and training personnel.”

**4.6.4** “Employees who may be exposed to hazardous materials shall be instructed in the

location and proper use of emergency showers.”

* EN 15154 [4]

**NA.4.2 Training**

All employees who may be exposed to potentially hazardous materials should be trained in the use of emergency showers, eyebaths and eye/facewash equipment. Employees should also be made aware of the exact location of all emergency showers, eyebaths and eye/facewash equipment, and be able to record details on a flushing record.

* CCOHS Fact Sheets [5]

All workers require instruction in the proper use and location of emergency showers or eyewash stations before any emergencies occur. It should never be assumed that workers are already aware of the proper procedures. Written instructions should be made available to all workers and posted beside the emergency shower and eyewash station. Part of the instructional process should include a "hands-on" drill on how to find equipment.

The wearing of contact lenses can be dangerous because chemicals can become trapped under a contact lens. Any delays caused by removing contact lenses in order to rinse eyes could result in injury. Training should include instruction in contact lens removal.

### 7.3.3 Best Practices

The goal of training is to let employees know the location of the safety shower and eyewash stations and the ways to operate them in an emergency. The results of training will indicate how useful the stations are. The stations will be useless if employees cannot find or use them. The survey results show that all the companies train their employees about this, but how they train and what they train about vary. One should create a standard that includes all the contents that should be included in training.

Based on the requirements of standards and the analysis of details that companies provide, we recommend:

* Operation, inspection, and maintenance instructions should be readily accessible to all employees.
* Training should include the location and the proper use of safety shower and eyewash units.
* The details on a flushing record should be made by employees.
* Training should include instruction in contact lens removal, as appropriate.

## 7.4 Part C: Management Systems

### 7.4.1 Part C Results Analysis

9/11 (~82%) of companies consider safety shower and eyewash systems in their Management of Change (MOC). 8/11 (~73%) of companies consider it in PreStartup Safety Reviews (PSSR). Cummins states that they would consider the risk present in that area, chemicals used or stored in that area, where existing eyewash or showers are already. SABIC (Mount Vernon, IN) states that one of their MOC questions addresses this via, does this change “Affect existing safety equipment (e.g. safety showers, safety stations, PPE, machine guarding) or require additional safety equipment?”

### 7.4.2 What’s in official standards

There are no specific requirements in official standards that requires one to consider safety shower and eyewash systems in MOC or PreStartup Review.

### 7.4.3 Best Practices

Management of Change (MOC) is a formalized process for addressing temporary or permanent changes to operations. The goal of this approach is to safeguard workers from potential harm. The PreStartup Safety Review (PSSR) is a safety review conducted prior to startup (commissioning) of a new or modified processing/manufacturing plant or facility to ensure that installations meet the original design or operating intent, to catch and re-assess any potential hazard due to changes during the detailed engineering and construction phase of a project. However, there are no requirements. Companies should consider safety shower and eyewash systems in their MOC and PSSR processes, to provide a safeguard, and ensure the installation meets the official standards.

Thus, we recommend:

* Add the consideration of safety shower and eyewash systems into MOC and PSSR.
* A (separate) checklist is recommended for operation and installation procedures.
* Records should be kept for every change.

# Chapter 8 Self-contained Devices

## 8.1 Results Summary

Self-contained device questions in the survey are about the use of portable eyewash bottles. As per the tables shown above, one tables are created to record the general results, which include:

Table 3.13 Self-contained devices results

The numerical and subjective analysis will be performed in this chapter as well as the best practice recommended based on the survey results.

## 8.2 Result Analysis

7/11 (~64%) of companies have self-contained eyewash devices, but only 2/11 (~18%) of companies use bacteriostatic additives in the water supply. Some companies state that they follow the recommendation of manufacturers. We searched for some brands and found that most manufacturers provide a choice of purchasing bacteriostatic additives, but it is optional.

The period of changing the water in eyewash bottles varies among companies surveyed. Most of the companies cannot change the water as the recommendation of the manufacturer or the official standards.

## 8.3 What’s in official standards

* ANSI/ISEA Z358.1-2014 [2]

**8.1.1.1** “Personal wash units shall have the capacity to deliver immediate flushing fluid

without being injurious to the user. Personal wash units do not meet the criteria of plumbed or

self-contained eyewash equipment.”

**8.1.1.2** “In circumstances where chemical reaction is accelerated by flushing fluid temperature, a facilities safety/health advisor should be consulted for the optimum temperature for each application. (See Appendix B6)”

**8.1.2** “Personal wash units shall be protected from freezing and shall not be exposed to ambient temperatures exceeding 38 º C (100 º F).”

**8.1.3.2** “All personal wash units shall be inspected and maintained in accordance with manufacturer’s instructions and shall meet applicable regulatory requirements.”

**Appendix A1 Personal Wash Units**

“The first seconds following an eye injury are often critical to keeping eye injury to a minimum. A personal wash unit may be kept in the immediate vicinity of employees working in a potentially hazardous area. The main purpose of these units is to supply immediate flushing. With this accomplished, the injured individual should then proceed to a plumbed or self-contained eyewash and flush the eyes for the required 15-minute period.”

* EN 15154 [4]

**4.2.1 General**

“The rinsing fluid shall be non-toxic and safe for the user during the entire shelf life of the product. The rinsing fluid shall be water or solutions.”

**4.2.2 Water**

“If water is used in eyewash units, it shall be potable water or water of a similar quality, wherein germ multiplication is prevented.”

**4.2.3 Solutions**

“If saline solutions, buffered solutions or other solutions are used in eyewash units, the solutions shall be sterile according to EN 556-1 [13] or EN 556-2 [14].”

* CCOHS Fact Sheets [5]

**Self-contained Eye/Face Washes**

“Install and maintain according to the manufacturer's instructions. Similar requirements apply as with the plumbed units regarding the unit's ability to provide flushing liquid for at least 15 minutes, accessible access, and to deliver tepid flushing fluid.”

**Personal Wash Stations**

“Designed to deliver flushing fluid immediately, personal wash stations can be used while transporting the person to the permanent eyewash station or medical facility. These stations do not replace the requirement to have a 15 minute-supply eyewash station. The expiry date of the fluid should be printed permanently on the unit.”

**Portable, Self-Contained Eyewash Stations**

“Portable, self-contained eyewash stations have a limited amount of fluid. As a result, maintenance is critical to ensure that units are fully charged at all times.”

“These eyewash stations also require ongoing maintenance of the flushing solution. The agents used to control bacterial growth are effective for certain limited periods of time. Also, small amoebae capable of causing serious eye infections have been found in portable and stationary eyewash stations. Consequently, it is important to monitor the shelf life of the solution and replace the solution when it has expired.”

**Eyewash Bottles**

“Eyewash bottles or personal eyewash units supplement plumbed and self-contained stations, but in no way can replace them. They are portable and permit immediate flushing of contaminants or small particles. However, eyewash bottles are very difficult for the user to handle, especially when alone and when both eyes have been exposed. (e.g., holding the eyelids open while handling the unit is awkward). Also, one bottle cannot flush both eyes simultaneously. Since the fluid supply lasts for only a short period of time, the bottle may not able to wash the eyes sufficiently.”

“The main purpose of such a unit is to supply immediate flushing. Once accomplished, the user should proceed to a self-contained or plumbed eyewash and flush for the required flushing/ rinsing period.”

## 8.4 Best Practices

The goal of having self-contained devices is designed and intended to supply immediate primary flushing. It allows continued flushing on the way to medical care.

Based on the requirements of standards and the analysis of details that companies provide, we recommend:

* Provide enough and easily accessible self-contained devices in each unit.
* Add bacteriostatic additives as per manufacturer.
* Train employees on operating self-contained devices.
* Change the water in the bottle as manufacturers recommend.

# References

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[3] 29 CFR 1910 - *Occupational Safety and Health Standards*

[4] EN 15154 *– Emergency Safety Showers*

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<https://www.ccohs.ca/oshanswers/safety_haz/emer_showers.html>

[6] ISEA, *Emergency Eyewash& Shower Equipment – Selection, Installation& Use Guide*

[7] IChemE, *IChemE Safety Centre Guidance - Sample University Laboratory Process Safety Management System*

[8] N.C. Department of Labor, *A Guide to Eyewash and Safety Shower Facilities*

[9] ISO 3864-1, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs in workplaces and public areas*

[10] EN 420, *Protective gloves — General requirements and test methods*

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[14] EN 556-2, *Sterilization of medical devices. Requirements for medical devices to be designated "STERILE".* Part 2: Requirements for aseptically processed medical devices