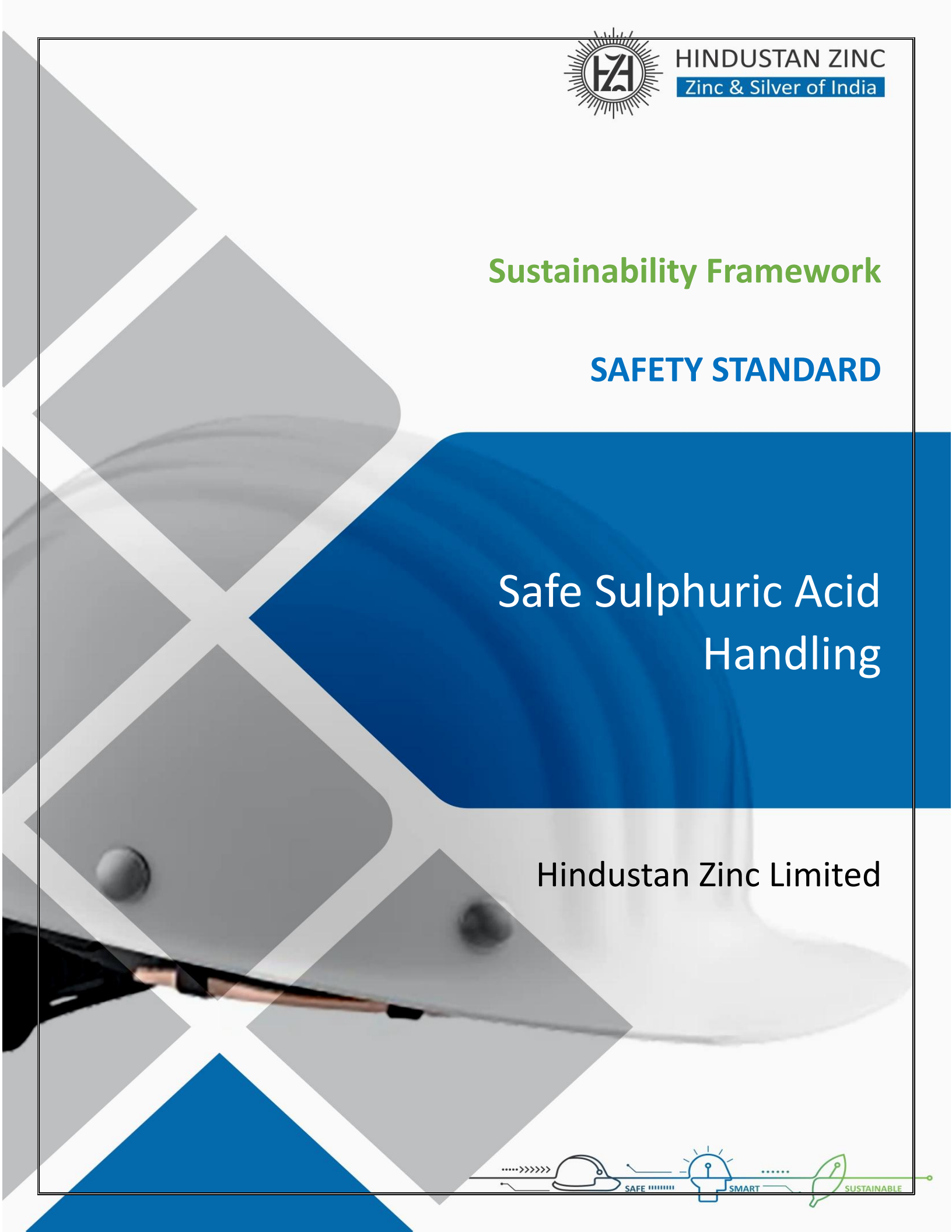
HINDUSTAN ZINC
Zinc & Silver of India

Sustainability Framework

SAFETY STANDARD

Safe Sulphuric Acid Handling

Hindustan Zinc Limited



Corporate Standard Rules & Procedures Sub-Committee	**Date**	**31-07-2025**
	Standard Document No.	HZL/CSRP/10
Safe Sulphuric Acid Handling	**Revision No.**	**01**

Document Control Details

	Issued by	Approved by
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Sign.		
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1. General

1.1. Purpose

HZL shall take all reasonable measures to protect both employees and the public from harm arising out of company operations involving sulphuric acid (H2S04).

This standard provides mandatory requirements and advisory guidance for the safe handling, storage, transport, inspection and maintenance of sulphuric acid. This standard was developed from the HZL
Engineering Standards, HZL Corporate EHS Standards, Process Safety Management standards, other industry standards, and HZL Acid community experts in the field.

It also provides the basis for audits of existing facilities to help ensure that minimum requirements (MR) are being followed.

1.2. Scope and Field of Application

Facilities covered by this standard include all HZL owned facilities, joint ventures, and facilities used in contract operations that manufacture, use, handle, or store sulphuric acid.

Sentences that include the words "Shall" and "Must" are highlighted in black to indicate that whatever is being described is a mandatory requirement (MR).

Personnel handling sulphuric acid must be familiar with the mandatory requirements found in this standard.

Both MR for existing facilities and the state-of-the-art (SOTA) design for new facilities are recognized. Unless designated SOTA, all requirements are MR.

All new facilities shall embody designs that are generally recognized as SOTA or designated SOTA. Alternatives to designated SOTA design for new facilities must obtain an authorized deviation from these standards.

Existing facilities must meet MR for continued operation. Local conditions and past experience shall determine the justification and timeline for achieving SOTA for existing facilities.

All repairs must meet MR. If the opportunity presents itself, then consideration should be given to SOTA upgrades.

All plants must also operate in accordance with all applicable laws and regulations, which are usually administered through state regulatory agencies.

1.3 Exclusions

The following items are not covered in this document:

1. In-process use of sulphuric acid
2. Manufacturing of sulphuric acid
3. Handling of mixtures of sulphuric acid with other substances
4. Handling of super-concentrated sulphuric acid solutions such as oleum

1.4 Acid community team: As on 31.07.2025

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2.0 Special Properties and General Hazard Information

2.1 General Properties of sulphuric acid

Sulphuric acid (H2S04, Molecular Weight 98.08) is a heavy, oily, strong, liquid mineral acid with a pH less than I and an acrid odour. It is completely soluble in water, and clear and colourless in pure form. Technical grades may be turbid and off-white in appearance. Grades below 100% have a very low vapour pressure of about 0.3 mm Hg at room temperature. Pure sulphuric acid does not have good warning properties, as it looks just like water and has no fumes. As a vapour, sulphuric acid is more than three times as dense as air.

Physical properties of technical grades of sulphuric acid are found in Table 1.

Strength	**sp. Gr.** @15.6 deg. C	**Density**	**Approximate** Freezing point (deg. C)	**Approximate** Boiling Point (deg, C)	**Viscosity at** 20 deg. C, cP	**Sp. Heat,** Cal/g deg
96%	1.843	15.4	— 14	308	23	0.36
98%	1.844	15.4	-2	327	25	0.35
99%	1.842	15.4	4	310	26	0.34
100%	1.839	15.3	11	274	28	O. 34

Table-1

The acid is highly corrosive to most metals; particularly at concentrations below 70% with evolution of hydrogen gas. In addition to attacking many metals, the acid in its concentrated form is a strong oxidizing agent and may cause ignition on contact with organic materials and such material as nitrates, carbides, chlorates, etc. It also reacts exothermally with water.

Concentrated sulphuric acid is a strongly acidic material that reacts rapidly with water, evolving considerable heat. When mixing or diluting sulphuric acid solutions, it is important to remember the following:

1. Always add acid to water to prevent or reduce boiling and spattering.
2. Dilute acid solutions slowly to minimize localized heat generation.
3. Provide good mixing to dissipate localized heat.
4. Provide cooling capabilities as required.

5. Make sure the equipment used for mixing and storage will tolerate the amount of heat generated and is compatible with the dilution range and final sulphuric acid solution.
6. In general, the weaker the sulphuric acid strength, the more corrosive it is to most metals.

2.2. Hazardous properties

Concentrated sulphuric acid is a strongly acidic material that reacts rapidly with water, evolving considerable heat. It can rapidly dehydrate body tissues and cause severe chemical and thermal burns. Inhalation of fumes or mists may cause nose, throat and delayed lung injury. Additional effects on inhalation include cough, difficulty in breathing and shortness of breath. Ingestion may cause corrosion of the gastrointestinal tract.

Contact of aqueous solutions of sulphuric acid with the skin and eyes may cause severe irritation or burns. Prolonged skin contact may cause corrosion with pain, ulceration, blisters or peeling of skin. Prolonged eye contact may cause corrosion with pain, redness or swelling. The more concentrated the solution, the faster the damage can occur.

The International Agency for Research on Cancer (IARC) has classified "strong inorganic acid mists containing sulphuric acid" as a Category 1 carcinogen, a substance that is "carcinogenic to humans." This classification is for inorganic acid mists only.

The U.S. Department of Labor has ruled that an employee's exposure to sulphuric acid mists in any 8hour work shift of a 40-hour week must not exceed a time-weighted average (TWA) of 1 mg/m3 (29 CFR 1910.1000 Air
Contaminants). The American Conference of Governmental Industrial Hygienists
(ACGIH) recommends a TWA exposure limit of 0.2 mg/m3 as a Thoracic fraction. The Acceptable Exposure Limit (AEL) is a TWA limit of 0.5 mg/m3 for 8-to-12-hour work shifts. For 15 minutes of exposure, the AEL is a TWA limit of 1.5 mg/m3. Note: where governmentally imposed occupational exposure limits are lower than the AEL, such limits shall take precedence.

3. First Aid and Medical Treatment

3.1 General

Heat is released on contact with water, and the material may dehydrate tissue. Destruction of tissue results from direct chemical reaction with the tissue, thermal burns, and dehydration of the tissue.

Overexposure of eyes or skin to sulphuric acid could result in eye corrosion, with corneal or conjunctival ulceration, or skin burns or ulceration. Ingestion may cause severe burns to the mucous membranes of the mouth and oesophagus. Repeated or prolonged contact with mists may cause eye irritation with discomfort, tearing or blurring of vision, or skin irritation with discomfort or rash.

When inhaled, the compound may cause irritation of the upper respiratory passages or erosion of dental surfaces. High inhalation exposures may lead to temporary lung irritation or damage and pneumonitis with cough, discomfort, difficulty in breathing, or shortness of breath. Pulmonary edema (fluid accumulation in the lungs) may occur, progressing to severe shortness of breath, cyanosis (bluish discoloration of the skin), and loss of consciousness. Modest initial symptoms may be followed by more severe symptoms within several hours, requiring prompt medical attention. Gross overexposure may be fatal.

All personnel who handle sulphuric acid must be adequately trained and drilled in first-aid procedures for handling sulphuric acid burns and other exposure.
The basic rules for safely handling sulphuric acid are as follows:

- Always avoid direct personal contact with sulphuric acid
- Always wear the required protective equipment
- Always ensure the immediate availability of an adequate water supply
- Always avoid ignition sources

3.2. First Aid

Rapidly removing exposed personnel from the contaminated area and removing the sulphuric acid from the skin and eyes is of primary importance. First aid must be started immediately in all cases of contact with sulphuric acid in any form.

3.2.1. Inhalation

Immediately remove the victim to an uncontaminated atmosphere. Call a physician. Check the patient's breathing and pulse. Remove all tight clothing and cover individual with a blanket. Check for other injuries. Keep the victim warm and at rest.

If the patient is not breathing, give him or her artificial respiration. Administer oxygen (6 lpm) as soon as possible. Oxygen must only be administered by a person who has been trained to do so.

3.2.2. Skin Contact

Immediately flush the exposed area with large quantities of water after contact or suspected contact. Flush the skin thoroughly with water for at least fifteen (15) minutes. Completely remove all contaminated personal protective equipment (PPE), clothing, and shoes while in the shower. Call for medical help while flushing the skin. Wash the affected area with clean white terry towels that have been dipped in clean ice water. Continue applying the towels until a doctor or other qualified medical person determines it should be stopped. If the injured person is transported to a hospital or other emergency facility, continue applying the cold wet towels.

Avoid freezing the burned area.

Caution: If the burn is to a large area of the body, the first-aid responder must be aware that the victim may go into shock. Indications of shock are the patient becoming pale, cold and clammy, or lightheaded. If the patient goes into shock, stop the ice water treatment and immediately raise his or her feet.

Further help can be obtained by simultaneously washing the exposed areas with soap for approximately 15 minutes.

Diphoterine@ solution is an emergency rinsing solution for splashes of chemical products. Its rapid use in case of contact between the skin or eye and a chemical product is intended to quickly eliminate the residual chemical product on the skin or in the eye. This makes it possible to limit the extent of the burns and lesions caused. Diphoterine@ facilitates secondary treatment of the burn injuries by restricting the extent and severity of the lesions. Diphoterine@ solution is not a treatment for confirmed

chemical lesions. It is an emergency rinsing solution for eye or skin splashes of chemical products.

3.2.3. Eye Contact

Check for contact lenses and if individual is wearing them, remove them immediately.

Wash out eyes with large amounts of water or an isotonic eye wash for at least 15 minutes. If pain is still present, continue the washing out for an additional 15 minutes. During the washing, spread apart the eyelids as much as possible to ensure contact of the water or eye wash with all the surfaces of the eyes and lids.

Rinsing with DIPHOTERINE@ solution as soon as possible helps. Eyewashes must be installed in a place close enough to the potential splash hazard that they can be triggered in the first minute following an accident.

Send individual to a doctor, preferably an eye specialist, as soon as the washing out has been completed.

3.2.4. Ingestion

Do not induce vomiting or administer a strong base or bicarbonate to neutralize the acid.

Remove individual quickly from the contaminated area to one which is quiet and well-ventilated for protection and comfort.

Remove tight clothing as soon as possible and cover individual with a blanket. Place individual in a lying down position with his legs elevated. If individual is vomiting, lower his head and if lying down, turn him on his left side to prevent inhaling the vomit into his lungs. Remove individual to a medical facility as soon as possible for more complete treatment.

3.3. Medical Supplies for Field and Site Medical Office

3.3.1 Background

These guidelines help ensure that certain procedures, medications, and equipment are available for use both in the field and in medical facilities to facilitate proper treatment.

3.3.2. Field

Safety showers and eyewashes (minimum 15-minute water supply) should be located in areas with high potential for exposure.

The area must have a bucket, clean ice, drinking quality water, and clean (preferably sterile) white terry cloth towels available. The terry cloth towels must be prewashed to remove the sizing. They should also be packaged in a self-sealing container or bag.

It is recommended that an emergency kit be kept in a designated, readily accessible, and centrally located area (i.e., a control room or shift supervisor's office) if the site does not have ready access to a medical facility. The kit must contain, as a minimum, the following supplies:

1. 99 percent USP oxygen cylinder with regulator and mask capable of 6 to 8 lpm
2. Blanket
3. Clean white terry cloth towels stored in self-sealing bags (prewashed to remove the sizing)
4. Eye patches and DIPHOTERINE@ eyewash
5. Checklist of contents (inventory)
6. Set of instructions and procedures for first aid and medical treatment
7. Phone numbers of site medical personnel and emergency information number
8. MSDS

The kit is intended to be used to initiate first aid treatment and accompany the patient in the ambulance if the injured has to be transported to an off-site treatment centre.

The kit must be kept sealed, and the integrity of the seal must be checked monthly. A full inventory of the contents should be made annually.

3.4. Training

3.4.1 Objective

The objective is to help ensure that all sites handling sulphuric acid have an adequate number of people trained to provide first aid and that the local hospital or trauma centre has adequate information and training to provide the treatment prescribed by HZL for personnel exposed to sulphuric acid.

Medical treatment procedures include the recommended treatment and evaluation criteria to be used by the attending physician or medical professional.

In order to help ensure that the proper first aid and medical treatment are provided to the exposed or injured persons, each site must develop, and conduct training programs aimed at on- and off-site rescue teams and the plant's medical and off-site medical support facilities. These training programs must be prepared by knowledgeable persons, and training must be conducted on a annual basis to help ensure personnel remain competent in the techniques that they are expected to use. The recommended minimum frequencies for rescue team training and for off-site medical support facilities are annual. However, depending on the turnover of personnel within the off-site facilities, it may be appropriate to increase this frequency.

3.4.2 Rescue Team On-Site Personnel Training

This training must be given to the site rescue team or whoever would be expected, including truckdrivers, to assist the injured so that first aid could be initiated immediately. This training must be hands on. Participants must be trained, as appropriate, on the following:

1. Decontamination of exposed employees
2. How and when to irrigate the eyes with the sterile saline solution
3. How and when to administer oxygen
4. Records of the personnel trained, and date of training must be kept by the site.

3.4.3 Plant Medical and Off-Site Support Facilities Training

Annually, site personnel must confirm that first aid and medical treatment—with emphasis on medical criteria can be adequately addressed by local doctors, nurses, physician assistants, paramedics, and ambulance attendants that may be called on to provide their services to personnel exposed to sulphuric acid.

A primary off-site support facility must be selected so that patients are sent to that facility. The training should include visiting the facility and determining whether adequate supplies are available and that personnel are familiar with and support HZL's medical treatment procedures.

4. Facilities

The acid plant and loading area pumps and storage tanks will always be barricaded off, and entry to these areas will be restricted to only trained and authorized personnel.

4.1 Minimum Inventory Concept

During process conception, development, improvement, or normal operation, consideration must be given to minimizing the inventory of sulphuric acid, consistent with meeting the needs of the business and achieving sound risk-management practices.

4.1.1 Design Guidance

Two general approaches to risk management are a quantitative risk assessment and a qualitative risk assessment. Before designing any inventory containing equipment, a risk assessment should be made.

4.1.2 Standard Operating Conditions

In addition to minimizing the size of process and storage vessels, operating personnel must keep in-plant levels within standard operating conditions. These conditions should be set at a minimum. On-site storage of full tankers must also be kept to a minimum. Sulphuric acid suppliers should have an understanding of user requirements to maintain a good balance between supply and business needs.

Sulphuric acid tankers must be loaded only as needed to meet shipping requirements.

4.2. Materials of Construction

Selection of materials of construction for sulphuric acid is very complex because the relationships between operating temperature, velocity, and concentration are so interrelated. Any subtle changes in any of these parameters may have a very dramatic effect on the corrosion resistance of the material. For applications and process changes beyond normal operating parameters and new installations, consult a sulphuric acid materials specialist.

4.2.1 Metals for sulphuric acid service

Sulphuric acid attacks cast iron, brass, bronze, and most other non-ferrous metals. Mild steel (low carbon steel) and stainless steel are resistant to corrosion and are recommended for storage systems and piping. Sandvik alloy steel piping suitable for the specified sulphuric acid concentration is strongly recommended.
Mild steel is generally satisfactory for storage and handling of the concentrated technical grades of sulphuric acid (93 to 99%) sulphuric acid, since the acid reacts with iron and the sulphate salt forms protective layer over the steel preventing further reaction.

Metal loss increases as the acid strength decreases below 98% sulphuric acid. Sulphuric acid less than approximately 68% strength should be stored in phenolic-lined tanks or chemical lead-lined tanks. Strengths of sulphuric acid between approximately 79% and 93% and between 99% and 101.5% are much more corrosive to steel, especially when the acid is hot. Because of this, these strengths should be stored in steel only when the temperature is kept below 24^0C and moist air is excluded from the tank.

77% sulphuric acid is usually regarded as the practical lower limit at which sulphuric acid can be stored at ambient temperatures in unprotected carbon steel tanks. Above 77% mild steel is recommended as long as temperatures stay below 37^0C.
Even with these limitations, allowance should be made for high corrosion rates to the tank wall.

4.2.2 Nonmetals for sulphuric acid Service

Teflon@ (TFE, FEP, and PFA) is the preferred non-metallic material for use in sulphuric acid service. (Do not mix types of Teflon@.)

Polyvinylidene fluoride (PVDF) can be used for liners for pipes and equipment. However, free sulphur trioxide (S03) will attack PVDF. Therefore, 98% sulphuric acid should be considered the absolute maximum concentration to be handled by PVDF. Other circumstances where free S03 may be present should be avoided.

Baked phenolic coatings can be used as lining to minimize iron pickup and corrosion in tanks storing 93% sulphuric acid. The life of this type of coating is severely limited in 98% to 99% service. Phenolic coatings should never be exposed to alkaline neutralizations because alkali attacks phenolic coatings even in dilute concentrations.

Other non-metals may be suitable at some concentrations and temperatures if properly formulated. Non-metallic materials other than Teflon@ should be tested and specified in consultation with a sulphuric acid materials specialist. Teflon@ in general can be used at temperatures up to 120^0C. At higher temperatures, permeation can be a problem, and a sulphuric acid materials expert should be consulted.

4.3. Isolation

Each site must review its process and study historical failure data to identify areas where releases might be expected to occur and to determine the corresponding need for EBVs.

Caution: Good engineering judgment should be used when designing the number and cost of valves.

4.3.1 Manual EBV Locations and Operation

EBVs must be located as close to and on both sides of the critical operation to be isolated.

Piping and accesses should be laid out to help ensure that personnel have a direct route of access to the valve without having to pass within 25 ft of the potential leak area.

If the location is within 75 ft of the potential leak area, the valve should be located at grade or on a platform no more than 15 ft above grade. Access to the platform should be by stairway.

Valves must not be located near a sump or catch basin that collects drainage from a potential leak and prevents ready access to the valve.

Valves 8 in. and under must be directly accessible and positioned within normal reach for operation.

Valves 8 in. or smaller may be manually operated and fitted with extension spindles, angle drives, and so forth, to fulfil the criteria of operability from grade or platform. Use of chain wheels for this service is not permitted.

It is strongly recommended that valves larger than 10 in. be motor operated. Controls, electrical cables, motor operator, diaphragm valve operator, piston, and pilot on piston-operated valves must be protected from fire or acid, if exposure to fire or acid is reasonably possible. Only stainless-steel instrument tubing and fittings must be used in this service.

4.3.2 Automatic Emergency Block Valve Locations and Operation

Automatic EBVs must be located on loading and unloading lines, storage tank discharge, places deemed necessary by process hazards analysis (PHA) or other studies, and wherever manual EBVs are not adequate.

Guidelines for locating and operating automatic EBVs are as follows:

a. EBVs must be located as close to and on both sides of the critical operation to be isolated.
b. There must be at least one remote field shutoff of EBVs. It is recommended that it be positioned at least 40 ft from the potential leak area. Prevailing wind direction should be considered when locating the switch. There must also be a remote shutoff switch with visual indication in the control room.
c. The shutoff switch must be identified with a suitable tag or label. Shutoff switches should be mounted at a convenient elevation of 4 to 5 ft.
d. For remotely operated EBVs installed in pump piping systems, the valve control station should be located no less than 40 ft from the pump and, if possible, within sight of the valve.
e. If automatic EBVs are installed around pumps, the shutoff switch shall also shut down the pump.

4.3.3 Remote Equipment Shutoff

Locations of local and remote switches to shutoff equipment (i.e., pumps) need to be identified and labelled appropriately.

4.3.4 Function Testing

All EBVs—manual or automatic—must be function-tested annually or during major shutdowns if shutdown frequency is more than a year. The test results must be documented and retained on file for the life of the equipment.

4.4 De-Inventory

All sites handling sulphuric acid must have procedures and facilities to de-inventory storage, and process equipment on short notice when an emergency arises. This capability is important in minimizing the length of time the incident continues. It, in turn, minimizes adverse publicity, aids in return to normal operations, and provides increased operating flexibility.

4.4.1 De-Inventory Requirements

All tanks and process vessels (of more than 4 metric tonne capacity) must be able to be de-inventoried.

Note: Equipment kept on site for de-inventory purposes must be maintained to meet transportation or fixed storage standards.

Items to be considered include the following:

1. Size of each vessel
2. Normal and peak inventory for the storage system
3. Empty tanks, tankers, and process equipment available for receiving the de inventoried material or that can be made available fairly quickly.
4. Neutralization facilities available and their capability
5. Facilities required to achieve the DE inventory (i.e., pumps and tanker loading facilities)

4.4.2 Design Criteria

De-inventory facilities shall be designed to fit the needs of each site, but as a general rule, de-inventory equipment must meet the same specifications as the process equipment.

To minimize de-inventory time consideration should be given to installing additional pumps, valves, instruments, and jumper lines to supplement use of existing equipment. Equipment

used for this purpose must be function-tested and leak-checked at least annually. Process feeds and energy sources must be designed for rapid, orderly shutoff during an emergency.

4.4.3 Procedures

All sites must have written procedures covering anticipated de-inventory scenarios. They must include enough detail to allow de-inventory to be accomplished quickly and thoroughly.

De-inventory procedures should consider including an approximate timeline, to give management an idea of the length of time required for de-inventory.

4.4.4 Training

Operating personnel must receive adequate training in order to facilitate orderly deinventory when necessary. Field training must be conducted at least annually.

4.5 Instruments

Instrumentation in sulphuric acid service must be very dependable due to the hazardous nature of the materials. This section provides information useful for applying instrumentation to sulphuric acid facilities.

Instrumentation must be capable of handling sulphuric acid over a wide range of temperature, pressure, and concentration levels.

OEMs should be made aware of the grade of sulphuric acid for which service is intended before initial procurement of instruments and valves.

4.5.1 Overview

All temperature, flow and pressure instruments, as well as control valves must meet applicable specifications, including original equipment manufacturer specifications.

4.5.2 Maintenance

Instrumentation and valving must be routinely maintained to be safely operated. A Preventive Maintenance schedule must be followed.

Materials of construction, instrument ranges, gasket types, and other relevant information must be documented. Methods to help ensure that proper materials are used when repairing equipment are required.

4.6 Alarms and Interlocks

Alarms must provide both audio and visual warnings to alert operating personnel that the process or equipment limits are being approached. They must appear on a control room panel or other device where someone is in attendance.

1. Safety interlock circuits must be kept simple and be composed of reliable parts. They must be fail-safe and separate from the control system and control valve.
2. Documentation for alarms and interlocks must be available (i.e., field loop and electrical books, piping and instrument diagrams (P&ID), maintenance management system databases, and logic diagrams). The documentation must be sufficiently complete to allow trained personnel to understand, maintain, and operate the system. All documentation must be kept up—to-date. Each interlock and alarm must be suitably identified, and a list of their set points must be kept in the operating area readily available to personnel.
3. All changes to the set points must be approved and recorded according to the site procedure for design changes.
4. Each site must establish and maintain documented procedures according to the HZL Engineering Standard for functionally testing all safety interlocks and their alarms.
5. The site must have a system, including appropriate approvals and authorizations, to help ensure that safety is not compromised if an interlock is taken out of service.

4.7 Storage

i. At ambient temperatures, sulphuric acid can be stored in mild steel or 304/304L or 316/ 316L SS storage tanks. Low carbon grades of stainless steel are generally preferred but not required. No nozzles shall be installed in the floor of vertical storage tanks.

ii. Design calculations must be retained for all vessels. The minimum shell thickness and corrosion allowances should be identified and checked periodically.

iii. Vessels with base wall thickness measurements below the recommended base wall thickness shall have a fitness for service analysis performed.

iv. Tanks must include a redundant independent high liquid-level alarm to guard against overflow.

v. Personnel accessing the top of the storage tank should obtain a permit before proceeding with the activity.

4.7.1 Vents

Air vents are necessary on sulphuric acid tanks to allow normal breathing with temperature changes, to handle surges of air from compressed air unloading, and to prevent the accumulation of highly flammable and potentially explosive hydrogen gas which has evolved by the reaction of the acid with the metal tank.

The vent/breather line should be flush with the inner surface at the highest point of the tank to dissipate any hydrogen evolved. This vent/breather can be equipped with a gooseneck bend or point straight up and be protected with a cover to prevent entrance of rainwater.

Because the hydrogen gas evolved in the tank will also be carried off by the vent, open lights and smoking should be excluded from this area.

Iron sulphate can build up in the vent line over a period of time. Periodic documented inspection of the vent/breather line for blockage is required to prevent tank collapse during acid transfer.

A silica gel pot must be included in the vent/breather line to help prevent entry of atmospheric moisture into the tank. The pot should be checked at least once a year to ensure the continued suitability of the silica gel for service.

4.7.2 Secondary Containment

Common containment for bulk sulphuric acid should be through concrete diking completely covered with an acid-resistant coating, as concrete will react with the sulphuric acid.

4.7.3 Painting

Storage tanks should be cleaned, prepared and painted on the outside with a suitable acid-resisting coating system. The paint needs to be inspected on an annual basis by a competent person and any damage needs to be rectified in a timely manner.

4.7.4 Cleaning and inspection

Tank cleaning is typically required every 5 years to remove accumulated iron sulphate. A bottom outlet expedites this occasional cleaning. To minimize corrosion, the tank should be filled with strong acid as soon after washing as practical.

Storage tanks should be thickness-tested at least every year.

4.8. Piping

Piping systems should be simple with a minimum number of joints, bends, and elevation changes. This section lists guidelines for piping systems.

- Use of butt-welded fittings is recommended because the weld quality can be checked by x-ray.
- Socket-welded fittings shall not be used.
- Screwed connections are not allowed in sulphuric acid piping, except for instrument fit-up where flanged connections are impossible to be obtained.
- Flange guards should be installed around flanges to guard against unexpected releases.
- All-welded schedule 80 black steel pipe with forged welding fittings and series 15 welding-neck or slip on weld flanges are commonly used in sulphuric acid service.
- Since iron sulphate forms during sulphuric acid storage, care must be taken to avoid clogging pipelines. Generally, pipe larger than one inch in diameter is necessary. Also, as the pipe diameter is enlarged, acid velocity is reduced, and corrosion rates are substantially lower.
- Low spots must be minimized. There must be provisions made for draining low spots and venting high spots.
- Lines should be kept full of acid to minimize corrosion and excessive sulphation. Venting of acid lines is suggested to avoid pressure build-up and possible rupture from hydrogen gas or thermal expansion. Highly flammable hydrogen gas is generated by the action of sulphuric acid on metal pipes. The valves at each end of a line should not be closed unless there is a vent, preferably back to the vented storage tank. This will prevent hydrogen gas from accumulating in the line.
- It is occasionally necessary to empty acid lines for maintenance purposes, so the lines should have sufficient pitch to permit complete draining. If nitrogen is available, it may be used to facilitate pipe drainage.
- Sulphuric acid pipes should not be blown with air unless absolutely necessary. If air blowing is necessary, dry air should be used to minimize corrosion.
- Lines may be flushed with nitrogen after maintenance or repairs to avoid condensation of moisture in the lines which could lead to increased corrosion.

4.8.1 Protection against mechanical damage

Where pipelines run adjacent to roadways or cross over roadways, they must be protected from vehicles according to HZL Engineering Standard for guardrails and for posts.

4.8.2 Pipe Marking

Sulphuric acid piping in pipe alleys and pipe bridges must be identified by either color-coding or by marking with the word sulphuric acid. It is particularly important to mark at roadways, major elevation changes, and locations where sulphuric acid piping enters or leaves an operating area.

4.9 Chemical Transfer Hoses

Hoses must be adequately supported to help ensure that they are not stretched, kinked, bent, strained, or allowed to sag, possibly trapping pockets of product. When they are stored, hoses must be vented to the atmosphere or a scrubber.

Hoses and their made-up connections must be leak tested with nitrogen or dry air at operating pressure before each use. Loading and unloading hoses must be discarded after one year of service.

Hydrostatic testing of hoses after the initial test by the manufacturer is not recommended. However, if they are tested, they must not be dried with hot air or nitrogen above the design temperature of the hose. Hoses must be tagged, and inspection information recorded in the maintenance records.

4.10 Pumps

Commonly used pumps are centrifugal, vertical submersible, and sealless canned motor or magnetic drive. The type used depends on the acid concentration, temperature and the service application. Horizontal centrifugal pumps or heavy duty vertical, submerged, centrifugal pumps are typically used for most sulphuric acid pumping requirements.

4.10.1 Centrifugal pumps

A self-priming magnetic-drive centrifugal pump is preferred over the positive displacement type. A sealless magnetic-drive centrifugal pump is usually recommended for handling acids of strength from 77% to 100% sulphuric acid.

In transfer service of ambient temperature 93% acid from storage tanks, Alloy 20 horizontal centrifugal pumps are commonly used with packing or mechanical seals.

In general, horizontal pumps should be self-priming with 50% excess head, and volume characteristics to compensate for the relatively high viscosity of the acid that may be encountered at low temperatures. Special alloys have been developed by pump manufacturers for sulphuric acid handling. The pump should be constructed of suitable materials.

CAUTION: Packing of asbestos or Teflon types can allow some leakage which could cause acid spray in the vicinity of the horizontal pump. For this reason, mechanical seals of Alloy 20 or higher alloy construction are usually employed to minimize this type of problem.

4.10.2 Vertical submersible pumps

In sulphuric acid producing plants, heavy duty vertical, submerged pumps are typically used for hot acid service. These pumps have heavy walled section, iron alloy castings with Lewmet internal parts. The primary advantages of vertical, submerged pumps over horizontal pumps is the inherent safety in their being submerged and fact that there is no stuffing box leakage.

When a submerged pump is used, it should be mounted in a manhole so the entire pump assembly may be easily removed. To ensure protection of the top bearing from acid, vertical submerged pumps should be constructed with the top bearing above the packing gland and external to the tank.

4.10.1 Gaskets and packings

Viton@B (for sulphuric acid <100%) or solid TEFLON@ TFE are recommended for flange gaskets.

Valve packing should be of TEFLON@ fluorocarbon resin; pump packing should be of braided TEFLON@

Alternatively, on pumps, an outside mechanical seal or a double mechanical seal can be used.

Ring gaskets for use with sulphuric acid are generally made from either 1/16-inch sheets of tetrafluoroethylene or chlorotrifluoroethylene. These materials are particularly recommended for service with hot acid. (450^0 F max.)

Consult manufacturers for specific grades and style numbers.

5. Mechanical Integrity/Quality Assurance

5.1. Mechanical Integrity/Quality Assurance

Mechanical Integrity and Quality Assurance focuses on helping to ensure that the facilities system integrity to contain hazardous substances is maintained throughout the life of the process to prevent premature failure and to help ensure the operability of systems. Follow the guidelines as set forth in the HZL MIQA Standard for compliance.

5.2. Corrosion Monitoring

Periodic inspection and testing for pressure vessels, low-pressure vessels, and piping shall be done by a competent person in accordance with HZL MIQA Procedures. The following sections discuss inspection requirements.

5.2.1 Isometric Drawings

Up-to-date isometric drawings or sketches (not necessarily dimensional) of all sulphuric acid piping and equipment must be provided so that test data can be easily correlated to equipment in the plant. All testing points must be identified on the isometric drawings. A representative number of areas susceptible to accelerated attack, such as the following, must be included.

- Elbows and flanges where turbulent flow can remove the protective corrosion coating.
- Heat-affected zones adjacent to welds.
- Areas immediately down-stream of flanges affected by turbulent flow.

5.2.2 Non-destructive Test Methods

Test methods more sophisticated than thickness measurements, depending on specific use, may be required in areas where there is expected spot corrosion, blisters, cracks, or erosion (e.g., P-scan, shear wave, and wet fluorescent magnetic particle).

5.2.3 Wall Thickness

Baseline wall thickness for all test locations must be obtained and stored for easy comparison to later inspection data. Corrosion allowance must be included on the drawings to enable corrosion monitoring personnel to determine problem areas.

5.2.4 Test Results

Test results must be reviewed by a competent person, be documented, and a system must be instituted for repair or replacement at minimum wall thickness measurements.

The minimum thickness (T-min) that would require changing or repairing a piece of piping shall be determined by calculation and not just by using the corrosion allowance. The calculation of minimum wall thickness must use the appropriate design considerations applicable for that pressure vessel, component, or pipe, and include consideration of pressure, temperature, allowable design stress for the material, and support spacing for pipe. A Fitness for Service evaluation can be made for selected thin areas, not subject to general thinning.

The documentation of the inspection or test must include the date, the name of the person performing the test or inspection, the identity of the equipment on which it was performed, a description of the test or inspection, and the results.

5.2.5 Inspection Schedule

An inspection schedule must be provided to help ensure that piping and equipment are inspected and tested. The inspection frequency shall be based on deterioration expected as a result of operating conditions and previous inspection history and data. For equipment used in new processes in which there is no experience, the maximum time between inspections and tests for equipment shall be one year. After the inspection history is developed, the inspection frequency may be changed based on historical data.

The testing frequency may be revised as necessary based on test results or a change in operating conditions that might induce higher or lower corrosion rates. A corrosion expert recommended by the HZL acid community must make this determination.

5.2.6 Visual Inspection

Piping, flanges, flange guards, bolts, valves, and piping supports shall be visually inspected every month.

Observations must be documented, and replacements made as required. Sample visual inspection

Equipment	Visual Inspection requirement
Tank	Examine the tank's external surface from the ground upwards for: 1. Evidence of leaks 2. Shell distortion 3. Signs of settlement 4. Corrosion In addition, check condition of: 1. Tank foundation 2. Paint coatings 3. Insulation systems 4. Appurtenances 5. Dyke surfaces (thoroughness of acid-proof covering) 6. Dyke integrity Document observations for follow-u b an API 653 certified inspector
Piping and Valves	1. Check for misalignment, vibration, and leakage. 2. Check for corrosion product build-up and other debris for follow-up. 3. Check that weep holes in reinforcing plates are open to provide visual evidence of leakage. 4. Check for presence of intact flange guards. 5. Check for short-bolting and visible material of construction mismatches (e.g. mild steel in contact with stainless steel
Pipe supports	Check for: l. Cracked or broken hangers, 2. "Bottoming out" of spring supports. 3. Support shoes displaced from support members. Check vertical support dummy legs to confirm that they have not filled with water Check Horizontal support dummy legs to guard against slight displacements from horizontal.
Bellows expansion joints	Check for: 1. Unusual deformations 2. Misalignment 3. Excessive angular rotation

	4. Displacements that max exceed design

5.2.7 Training

Personnel assigned to corrosion monitoring shall be trained and must be certified in non-destructive testing methods.

5.3 Lifting Heavy Equipment

Lifting heavy equipment over pipe bridges, vessels, or other equipment containing sulphuric acid should be avoided whenever possible. If it is necessary to make this type of lift, it should be made in accordance with site guidelines.

5.4 Repairs

5.4.1 General

A proper clean-up and Lock-Out/Tag-Out procedure must be followed before equipment is isolated.

5.4.2 Equipment Decontamination

Sulphuric acid must be removed from equipment as thoroughly as possible during the cleaning and clearing process before the first break is made.

Every attempt must be made to wash the equipment with water or steam until all acid residue is eliminated before it is sent to the shop or off-site.

If complete decontamination cannot be confirmed, PPE must be worn while the equipment is being disassembled.

6. Procedures

6.1. General

Each site handling sulphuric acid must have written operating, maintenance, and emergency procedures in place. All procedures must be specific and contain sufficient detail to perform the job and help ensure personnel safety as directed by the HZL SHE Standard.

Procedures must be readily available in a location convenient to all personnel for reference and retraining purposes. They must be reviewed for adequacy at least every three years in accordance with SHE Standard or when changes are made. Procedures must be maintained to help ensure that invalid or obsolete procedures are promptly removed from all points of use. It is suggested that procedures be made electronically. There must be a mechanism in place to help ensure that all necessary personnel are informed of pertinent changes in procedures.

6.1.1 Emergency Procedures

Emergency procedures must be in place to respond to potential incidents and to protect employees and the public according to the HZL SHE Standard.

6.1.2 Line Openings Procedures (First Breaks)

Procedures shall contain measures to help ensure that all systems containing sulphuric acid are purged, cleared, vented, and isolated. Every energy source shall be locked and tagged, the hazards eliminated, and at atmospheric pressure or below before making the first line opening. The potentially affected area must be cleared of unprotected personnel. PPE requirements must be included. If a piece of equipment is to be worked on while the system is under pressure, it must be isolated by a double block-and-bleed valving arrangement or by a valve and blind flange.

If in the course of the job, conditions affecting safety, health, or the environment change or differ from the expected scenario, the job must be stopped, re-evaluated and a new plan developed.

Similar precautions must be taken at re-assemble step to help ensure that the system is clear and safe.

6.1.3 Job Cycle Checks or Proficiency Audits

Job cycle checks or proficiency audits are effective methods of auditing procedures for operations, mechanical, and laboratory, thus helping to ensure that all people are trained on procedures in accordance with the company's SHE Standard.

6.2. Training

Site or unit management shall be responsible for developing and maintaining an adequate number of well trained, knowledgeable, and committed employees for assignment in areas where sulphuric acid is handled.
They must be trained according to the HZL SHE Standard.
Before non-HZL personnel are permitted on a site handling sulphuric acid, they must receive appropriate safety training to protect themselves and those with whom they work.

6.3. PPE

This section defines the various job risk categories, the minimum mandatory PPE required for each category, standby requirements, and the recommended care of PPE.

6.3.1 PPE Limitations

PPE is considered to be the last line of defence against the hazards associated with hazardous chemical environments. Since PPE cannot replace good planning and judgment, the limitations of PPE must be recognized.
If PPEs currently used at plant sites are not approved for acid service by OEM, they must be removed from service immediately. The HZL acid community must be consulted before sites order or use any PPE not on the listing of acceptable PPE.

6.3.2 Protective Equipment Selection Methodology

- In deciding which PPE should be used for jobs involving sulphuric acid, the following procedure is recommended:
- Identify the job risk category.
- Identify unique situations that requires additional PPE
- Select appropriate PPE material and vendor.

All parties doing the job must agree to the above before starting the job. For sulphuric acid service, PPE must possess the following characteristics:

- Be composed of materials that have low, relative permeation rates and breakthrough times of at least 45 minutes
- Be composed of materials that have good chemical and physical degradation resistance.
- Be constructed by vendors without the presence of imperfections at seams, zippers, and other parts of the PPE.
- Be sufficiently flexible and ergonomic (based on field use and testing) so as not to unduly impede a worker carrying out the job at hand.
- Provide good resistance to abrasion and tearing.

Before any task involving sulphuric acid is started, all parties involved with the job must agree to the PPE that safeguards against the cumulative dangers of the task.
The standby person must use the same PPE as that used by the person doing the job.

6.3.3 PPE

The following personal protective equipment (PPE) are used when working in the barricaded acid plant area.

- Personnel have an increased probability of acid exposure in this area. However, they are not expected to be exposed to immediately dangerous to life and health (IDLH) conditions.
- To provide protection for a high-risk exposure to sulphuric acid, the following PPE is required:
- Head Protection: helmet
- Eye Protection: chemical splash goggles
- Hand Protection: acid-resistant gloves
- Body Protection: acid-proof suit
- Foot Protection: acid-resistant boots with pant legs over boots

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6.3.4. PPE Illustrations

Figure I Fully encapsulated Suit

Figure 2 Acid-resistant suit

Figure 3 Butyl glove

Maximum-risk activities involve responding to emergencies related to sulphuric acid and environments contaminated with unconfined sulphuric acid liquid or S03 vapor. Maximum risk situations are classified as potentially IDLH. The following are examples of this job type:

- Emergencies involving equipment failure (e.g., valve packing, pump seal, or gasket blowout), emergency patching, or plugging.
- Activities where there is evidence of fuming or S03 involvement.
- Transport Emergency Response operations
- Personnel rescues

- A high level of protection is required, where it is necessary to enter areas having a high sulphuric acid mist concentration, or where there is a liquid acid mist spray. The following PPE is required:
- Eye Protection: full face mask
- Respiratory: NIOSH approved respiratory protection
- Body Protection: acid-resistant, fully encapsulated suit (Fabric must pass a 45 min breakthrough ASTM F 739 chemical permeation test for 93% Sulphuric Acid)
- Foot Protection: acid-resistant boots with pant legs over boots
- Fully encapsulated suits, like other protective clothing, should be considered a "last line-of-defence." The limitations of the suits must be recognized. Under no circumstances should personnel enter a situation where they may be sprayed with a stream of liquid sulphuric acid or step into puddles of liquid sulphuric acid. The totally encapsulated chemical protective suit with SCBA PPE must be considered the MR for this job category. Standby and backup personnel with the same PPE must also be available as dictated by the situation. NIOSH-Approved Escape Respirators

Manufacturer	Model	Flow (min)	Rated time	Pressure (psi)	Refill weight (1b)
North	855	70 to 80	5	3000	8
Polyurethane hood rated for use as low as —18 ^{0}C (O^{O}F). Aluminium cylinder, 2-year warranty. Claims to have muffler to reduce air flow noise to less than 8 decibels.					
MSA Custom air V	484353	60 to 70	5	3000	7.3
Wrapped urethane hood, operating temperatures —18 to —54^{0}C (0 to —130^{0}F), composite cylinder.					
Respirator	L565HF	60 to 70	5	3000	8-1/2
System Inc.	L566HF	60 to 70	5	3000	8-1/2
Lifeair	L507HF	60 to 70	7	3000	8-1/2
3-year warranty. Hood is PVC and material is thinner around neck for softness. Only difference between 505 and 507 is a larger volume cylinder flow rate and pressure relief valve in 507.					
Draeger Max	4052250 (waist mount)	70	5	3000	6.25

ERMA	4052226 (chest mount)	70 (70)	5 (10)	3000 (2216)	6.25 (15.5)
Teflon@/Nomex@ hood with Teflon window. Muffler incorporated into diffuser to reduce air flow noise in hood.					
Scott Skat-pak	900105-01	60 to 70	5	3000	9.2
Aluminium cylinder, polyurethane hood.					
ISI ELSA	5XF	60—70	5	3000	10.25
	7XF	55-60	7	3000	10.25
PVC or polyurethane (for low temperature flexibility) hood rated down to —7 ^{o}c (—20^{0}F), aluminium cylinder					

Working in partially or fully encapsulated suits for long periods of time in warm climates may produce heat stress for the wearer. Provisions should be made to provide rest periods and/or use of devices for heat removal, such as ice vests or cooling air. Standby and backup personnel should be specified for these jobs. Standby or backup personnel provide prompt response to a job situation where something unexpected has occurred.

When an area is declared acid-free, the PPE requirements may be reviewed based on the job safety analysis and permits issued and applied until the system is re-energized or repressurized.

6.3.5 Care of PPE

Contaminated PPE must not be worn or carried beyond the operating area. After exposure to sulphuric acid, each item must be thoroughly washed before reuse. Each item should be washed and removed according to a written sequential procedure to avoid possible acid contact with any part of the body.

Decontamination procedures should be established for all personnel before removing the acid-suits. decontamination brushes available for cleaning bottom of boots, etc.

An example of such a procedure follows:

1. Stand under a safety shower for at least five minutes after use to rinse acids from the suit. Thoroughly wash down all outer garments below the neck with water. This includes gloves, boots, aprons, coveralls, jackets, and trousers.
2. Remove hard hat, hood, mask, or face shield while gloves are still on. Thoroughly wash these items with water and wash gloves again.
3. Remove apron or coveralls, jacket and trousers, boots and gloves, in that order.
4. Wash hands with water. If a half face respirator was worn, remove eye goggles last and wash them.

6.3.6 PPE Inspection

PPE Must be,

- Visually inspected before each use by the user.
- Inspected on schedule with the manufacturer's recommendations.
- Whenever equipment is found to be damaged beyond repair it must be washed, destroyed, and discarded.

6.3.7 PPE Storage

Protective equipment must be stored in an area that is clean and, preferably, has a moderate temperature. Suits and hoods must be stored following the manufacturer's recommended practices.

7. Transportation

7.1. General

Each location shipping sulphuric acids shares the responsibility with carriers for its safe transportation in accordance with all applicable regulations. The shipper must include transportation in the site process hazards management system.
Transportation of sulphuric acid must be considered to be an extension of the manufacturing process and receive the same care to help ensure that all necessary measures are taken to protect employees, the public, and the environment from harm.

7.2. Classification

The US DOT hazard classification for sulphuric acid is Class 8 (corrosive) Packing Group II. Its UN number is 1830.

7.3. Regulations

Transport regulations covering hazard communications, marking, labelling, and packaging are subject to periodic revision, and therefore, persons responsible for transportation must keep abreast of the regulations. Carriers should be audited periodically to help ensure that they are adapting to regulatory changes.

7.4. Carrier Selection

Special care must be used in selecting carriers for shipping sulphuric acid. Sourcing procedure must be followed. Carrier safety surveys must be made where HZL is the shipper of record. Safe delivery of purchased sulphuric acid shall be the primary consideration in supplier selection. Inbound materials where HZL is the shipper of record shall be handled consistent with HZL manufactured products. Tankers, once hired, should be regularly inspected and certified for continued suitability of service — a fitness certificate to this effect should be obtained.

Specially trained drivers are used for transporting sulphuric acids via highways in cargo tanks and portable containers. National and limited access highways are to be used to the maximum extent practical.

Each vehicle supplied by a carrier must come certified for a pre-specified filling capacity.

7.5 Transportation incident response

In the event of a transportation incident involving sulphuric acid, the carrier should notify HZL. If HZL is the shipper, the unit is responsible for helping to ensure an appropriate response. The unit may request a response from a regional HZL response team. It is important to keep in mind that the sulphuric acid dispatching unit has overall responsibility for managing the response to an emergency even though other sites may be requested to respond.

7.6 Equipment Preparation for Shipment

Each shipping point must help ensure that the transportation equipment, including empty returns, is secure for safe transportation and meets all regulatory requirements. A pre-shipment checklist, covering items (i.e., placards, product tags, stencilling, equipment condition, and others) shall be prepared for each shipment to help ensure safe transportation and containment of the contents. The shipping point shall maintain copies of the pre-shipment checklist for three years.

7.7 Loading Limits

National highway weight limits must not be exceeded. The recommended maximum gross weight for trucks is 80,000 lbs (36 tonnes) but could vary depending on weight limits of the route traveled and weight distribution over the axles.

7.8 Bill of Lading

A bill of lading that is properly executed and accompanied with an MSDS shall be issued to the carrier for each shipment. An MSDS must be provided to the carrier at least once a year.

7.9 Tanker Seals

A 3/32—in. minimum diameter steel cable seal must be applied to the protective housing cover of each full and empty acid tanker before shipping.

7.10 Placards

Appropriate sulphuric acid corrosive placards (labels for portable tanks) must be placed in the placard holders on both sides and ends of a tank truck. Placards may be placed on the front of the truck cab in lieu of the front of the tank.

7.11 Tanker Driver Qualifications

Drivers for sulphuric acid tanker must undergo a formalized selection, testing, training, and certification program before being allowed to transport sulphuric acid.
Each driver that meets the training requirements is issued a driver's identification card to carry in his or her possession. The shipping plant issues cards annually. Each driver has a TREM card/an emergency response guidebook in his or her possession.

7.12 Tanker or Portable Tank Storage, On-Site

If tankers, or portable tanks are to be stored on an HZL site before they are shipped, they must be stored in a safe area.

7.13 Tanker or Portable Tank Storage, Off-Site

Storing loaded sulphuric acid tankers, or portable tanks in unsecured areas off the site is not permitted for producing sites.

7.14 Route Studies

Routing safety surveys must be conducted where HZL is the shipper of record. The route analysis should avoid areas of bad track or roadway and high-population areas (where possible). The route selected should try to minimize the distance. The route surveys must be conducted every five years for existing customer and be documented by the distribution coordinator. For new customers the route study should be done prior to the first delivery.

7.15 Loading Tankers and ISO Tanks

Each site handling sulphuric acid must follow the written loading and unloading procedures in place. All procedures must be specific and contain sufficient detail to perform the job and help ensure personnel safety. All procedures must be reviewed and/or updated every three years.

ISO Tanks should be treated the same as tankers.

Moving joints and swivel joints in the loading platform/arm should be inspected regularly.

7.15.1 Operator Attendance

The operator must be in attendance during loading and unloading. The operator must maintain clear visibility (either personally or by CCTV camera) of the operation during loading and unloading. He or she must have ready access to valve controls, emergency switches, and other parts that control loading and unloading. The attendance requirement may be satisfied, in some cases, if the operation can be monitored by closed-circuit monitoring cameras and controls (e.g., emergency switches or valve controls) are immediately available to mitigate an emergency situation.

7.15.2 Tanker positioning

The tanker or ISO tank to be loaded must be positioned and secured at the appropriate loading spot in accordance with plant procedures. The tanker must be spotted on a level surface capable of supporting the entire weight of the vehicle and secured in accordance with plant procedures. The procedures must include the following:

- Chock the wheels of the tanker or ISO tank trailer.
- Verify that the engine is off, brakes set, the key removed from the ignition, and key is in possession of the loader.

7.15.3 Access to Loading Area

Access to the area during loading and unloading by personnel not involved with the operation must be prevented. Ropes, barricades, signs or warning lights or flashers may be used to warn people during the loading or unloading operation.
Truck drivers must be forbidden from entering the loading area when loading is in progress and until given permission to do so by the loading operator.

7.15.4 Checklists

The use of preliminary, loading and unloading, and pre- and post-loading or unloading checklists shall be required. The person completing the checklist must initial each line item. The MR for the checklists are in the following sections.

7.16 Preliminary Inspection Checklist

- Compare the bill of lading with the carriers.
- Determine the amount to be loaded and verify that the weighbridge has cleared it for capacity
- Verify safety shower and eyewash fountain are operable.
- Inspect tanker in accordance with inspection sheet.
- Verify placards are correct and legible.

7.17 Preloading Checklist

- Visually inspect load and vent hoses for defects (i.e., bulges, abrasions, tears, or signs of leakage).
- Inspect rupture disk and relief valve assembly for damage or leakage.
- Open then close telltale on rupture disk housing. If fuming or damage to assembly is observed, do not load and notify supervision.
- Remove gauge cap, raise to full load level, and then lower until magnet catches.
- After assurance that vent and load valves are closed, remove the valve caps or flanges, inspect gaskets and faces, and install the load and vent line hoses.
- Ensure that an earthing clamp is in place and connected to the body of the tanker

7.18 Loading Checklist

- Check trailer tank pressure. If more than 5 psig, vent through vent line.
- Open the load and vent valves and load trailer to the desired level.
- The loader must be in attendance during loading, or the operation observed via closed circuit monitoring cameras. There must be good communication between the Central Control Room (CCR) and the field person via radio or a passive public address (PA) system.
- Shut off loading pump.
- Drain the load and vent hoses for a short time.
- Close process load and vent valves and walk the hoses to the tanker.
- Relieve pressure on the tanker and then close the load and vent valves on the tanker.
- Employ fumeless disconnect system for hose disconnects.
- Cap trailer valve fittings.
- Close and pin the crash cover.
- Confirm that the proper placards are in place.
- Remove chocks, barricade ropes, and return the tanker to the driver.

7.19 Instrumentation

This section includes the minimum instrumentation requirements to help ensure safe loading and unloading of sulphuric acid tank trailers. This protection consists of automatic valves or actuators, switches, pushbuttons, and proper interlock logic to prevent unexpected release of sulphuric acid to the environment and injuries to personnel.

Emergency Shutdown Buttons—Emergency shutdown buttons must be located where the loader or unloader Is stationed, at the bottom of the platform stairs, and at a strategically located spot at least 100 ft from the platform. They must close the following:

- Valve on the hose
- The pump
- Any other designated valve in the line

Motion Detectors—A motion detector is recommended at each spot on the trailer to detect horizontal movement of the trailer and activate an emergency shutdown of the AEBVs and the loading (or unloading) pump.

Closed-Circuit Monitoring Cameras Closed-circuit monitoring cameras are recommended to view the loading and unloading areas for leaks.

7.20 Sampling

Each site handling sulphuric acid must follow the written sampling procedures in place. All procedures must be specific and contain sufficient detail to perform the job, including identification of sample points, sample container specifications and PPE requirements, to ensure personnel safety. All procedures must be reviewed and/or updated every three years.

Testing of samples under lab-hoods is recommended. Performance tests of the lab-hood should be conducted at least annually.

8. Emergency Response

Each site handling sulphuric acid must have dedicated emergency response facilities and procedures for on- and off-site and transportation emergencies according to the HZL SHE Standard. The emergency response plan should be clear, concise, well-organized, and easy to use (including indices, diagrams, and charts). It must be reviewed annually to help ensure that it reflects current needs and conditions. Each site handling sulphuric acid must be prepared to make emergency repairs to equipment. Sites that manufacture sulphuric acid must be familiar with the HZL Transportation Emergency Response Procedure (TERP). The manufacturing or shipping site has the primary responsibility for mitigating a transportation incident. This overall responsibility may not be delegated. However, a site may call on other HZL sites with adequate training and equipment to assist in a transportation emergency. HZL sites must minimize off-site exposure from sulphuric acid operations through effective use of technical and economic resources in evaluating the risks and making improvements where needed. In addition, sites shall have emergency procedures and response teams trained to respond to an off-site emergency according to HZL SHE Standard. Sites shall also provide leadership in establishing and promoting appropriate community organizations to respond to chemical emergencies. Sites can enter into mutual aid agreements with other organizations with the necessary expertise in sulphuric acid that might be in a position to support.

- All residues from spills that have been mitigated must be neutralized before leaving the site or transferred to a waste disposal contractor.
- Training on how to address leaks must be given to the emergency responders annually and such training documented.

CLZS Incident Recommendation

Sr. No.	Incident Date	Recommendation
1	CLZS — Sulphuric tank collapse	SOP to be prepared for reviewing the SOL at reduce thickness and all tank to be reassessed
2		CCTV monitoring in all Acid storage tanks/dykes/loading & unloading areas
3		Explore to Design all existing tanks with an auto drain provision to unload/drain acid in dyke during emergency scenario
4		The height of the dyke wall to be increased in consultation with the designer to avoid splash of acid outside the dyke & also sheet to be provide above the dyke wall up to the defined SOL of a tank.
5		Plant should be interlocked with tank level (In no case SOL exceeded) and acid feed should stop in case SOL is approached
6		Remote control operated field isolation valve (away from the influence of acid leakage) to be installed to facilitate loading, unloading, dump in the dyke & equalization of the tank
7		Residual Life Assessment (RLA) & Fitness for service (FFS) to be carried out after either every 5 year or based on the RLA report recommendation from the vendor & corrective action to be taken accordingly.
8		Safe level of acid in tanks to be established through calculations for all acid storage tanks and regular review to be done basis thickness deterioration /change.
9		Motorized Valves shall be provided in both acid inlet & outlet for remote operation and interlocked with level HH to cut off the acid inlet to tank. Alarm must be provided both audio and visual once's the SOL is approached

10		In case of Emergency, available tankers & nearby acid tank shall be loaded irrespective of Turbid acid or clear acid to tackle emergency.
11		All online work on sulphuric acid storage - Policy to be framed for involvement of Fire and safety team
12		Acid Storage control cabin and driver rest room to be moved away from storage tanks.
13		Carry out PHA /HAZOP of all acids Storage tanks (mandatory requirement to carry out PHA post-accident)

6. Management systems

10.1. Revisions

The Acid Handling standard shall be revised, as necessary, so it shall continue to help ensure safe operation and handling of sulphuric acid. Revisions to the standard shall be in accordance with the HZL SHE Standard.

a. **Review**

The standard shall be reviewed not later than two years from the date of the last review. A review can be initiated should the need arise following a new insight or a major incident. The acid community head is responsible for initiating the review.

b. **Control and Location**

Corporate SHE is responsible for updating and maintaining this standard. The official copy of the Acid
Handling Standard shall be maintained in the Zing Portal HZL.

c. **Audit requirement**

Compliance with the requirements of this standard should be audited at least annually by each unit where the standard applies.

d. **Deviations**

Deviations from this standard must be authorized using the process described below. A deviation shall be requested and authorized before implementing the alternative procedure unless compliance with a provision of this standard presents an imminent hazard. In such cases, an alternative practice may be applied until a deviation is authorized or denied. A deviation shall only be authorized where a safety analysis of the alternative procedure is conducted and supports the conclusion that the alternative procedure is at least as safe as the procedure specified in the standard for which a deviation is requested.

i. Process for Requesting a Deviation

The following steps must be followed to request a deviation:

1. The deviation must be requested by the plant manager or unit manager for the covered process.
2. A thorough safety analysis of the proposed alternative procedure must be conducted and the findings documented. The findings must support the plant's/unit's conclusion that the alternative procedure provides safety equivalent to or better than the Acid Handling standard. The deviation request must include
   a. An Acid Handling standard deviation authorization form, completed except for approval and authorization signatures.
   b. The Acid Handling standard title and paragraph from which the deviation is requested.
   c. A statement explaining why a deviation from the existing Acid Handling standard is requested.
   d. A description of the proposed alternative procedure to be used in lieu of the Acid Handling standard procedure,

including any precautions to be taken to help ensure the safety of the proposed procedure.

e. A summary of the proposed procedure's safety analysis and an explanation of why it provides equal or greater safety than compliance with the Acid Handling standard.

3. The deviation request shall be submitted to the unit head who will consult the
Chief HSE and the acid community head to assess the deviation.

ii . Approval and Authorization

Requested deviations shall only go into effect after they are approved by the Unit Head after due consultation with the Chief HSE and the acid community head to assess the deviation. It may also be appropriate to consult with other experts (e.g. original equipment manufacturer, metallurgical engineer).

iii Deviation Form

A standard deviation authorization form must be completed, approved, and authorized for all deviations. It must be either maintained in a secure electronic format or retained on file by the unit manager of the Acid
Handling area. A copy must be sent to the Acid Community Head.

iv. Annual Review

The acid community shall review each active, authorized deviation annually to determine whether to maintain, close, or revise the deviation or to revise the Acid Handling standard to accommodate the alternative procedure.

v. Closing Deviations

Whenever a deviation is no longer required, an Acid Handling standard deviation closing form must be completed. Closure of deviations must be approved by the acid team and the Chief HSE and authorized by the Corporate Safety Council.

e. Management of Change

Corporate Standard Rules & Procedures Sub-Committee	**Date**	**31-07-2025**
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Management of each plant site or unit handling sulphuric acid shall develop and implement a structured and disciplined system to manage changes in equipment and procedures relating to the handling of sulphuric acid in accordance with the HZL SHE Standard.

i. **Communication**

The operating area management must help ensure that all changes are conveyed to those affected.

ii. **Management of Change—Personnel**

People are the one essential ingredient common to all elements of process safety management (PSM). Personnel at all levels must possess minimum levels of knowledge and experience to help ensure processes can be operated safely. Changes in personnel assignments can have a major impact on process safety. Management of Change—Personnel must be performed in accordance with the HZL SHE Standard and site guidelines.

11. ANNEXURES

a. Acid Handling standard Deviation Authorization Form

Deviation No. Sulphuric acid_____

Deviation effective from:_____ To:

Corporate Standard Rules & Procedures Sub-Committee	**Date**	**31-07-2025**
	Standard Document No.	HZL/CSRP/10
Safe Sulphuric Acid Handling	**Revision No.**	**01**

Plant site: <NAME> Area:

Section title: Paragraph no.:

sulphuric acid standard provision for which deviation is requested (precise wording):

Description of deviation:

Remarks (including temporary controls in place):

Statements explaining the rationale for the deviation (Attach additional sheet if necessary)

Requested by: Date:
(Plant Manager)

Reviewed by: Date:
(Acid Community Head)

Reviewed by: Date:
(Chief HSE)

Approved by: Date:
(Unit Head)

b. Sulphuric acid standard Deviation Closing Form

Deviation No. Sulphuric acid

Deviation closing date:

Plant site: <NAME> Area:

Paragraph no.:

Corporate Standard Rules & Procedures Sub-Committee	**Date**	**31-07-2025**
	Standard Document No.	HZL/CSRP/10
Safe Sulphuric Acid Handling	**Revision No.**	**01**

Section title:_____

Sulphuric acid standard provision to which deviation applied:_____

Description of deviation:_____

Statement explaining the rationale for closing:_____

Remarks:_____

Requested by:_____ Date: _____
(Plant Manager)

Reviewed by:_____Date:_____
(Acid Community Head)

Reviewed by: _____ Date: _____
(Chief HSE)

Approved by:_____Date: _____
(Unit Head)

10.3. Interactions between chemicals

Chemical Name	ALUMINUMSULFATE,SOLID	CALCIUMHYDROXIDE	CHLORINE	FUELOIL,[DIESEL]	HYDRAZINE,ANHYDROUS	HYDROCHLORICACID,SOLUTION	MERCURICCHLORIDE	MERCUROUSCHLORIDE	MORPHOLINE	SODIUMCARBONATE	SODIUM CHLORIDE	SODIUMHYDROXIDE,SOLID	SODIUMHYPOCHLORITE	SODIUMPHOSPHATE,TRIBASIC	SODIUMSILICATE	SULFURDIOXIDE	SULFURTRIOXIDE	SULFURICACID	VANADIUMPENTOXIDE	ZINCDUST	ZINCOXIDE	ZINCSULFIDE
ALUMINUM SULFATE, SOLID	X																					
CALCIUM HYDROXIDE	N	X																				
CHLORINE	N	N	X																			
FUEL OIL, [DIESEL]	Y	Y	N	X																		
HYDRAZINE, ANHYDROUS	N	N	N	Y	X																	
HYDROCHLORIC ACID, SOLUTION	C	N	N	Y	N	X																
MERCURIC CHLORIDE	C	N	N	Y	N	C	X															
MERCUROUS CHLORIDE	C	C	N	Y	N	N	C	X														
MORPHOLINE	C	Y	N	Y	N	N	C	C	X													
SODIUM CARBONATE	N	Y	N	Y	C	N	N	Y	Y	X												
SODIUM CHLORIDE	Y	Y	N	Y	N	N	Y	Y	C	Y	X											
SODIUM HYDROXIDE, SOLID	N	Y	N	Y	N	N	N	C	Y	Y	Y	X										
SODIUM HYPOCHLORITE	N	N	N	N	N	N	N	N	N	N	N	N	X									

SODIUM PHOSPHATE, TRIBASIC	N	Y	N	Y	N	N	N	C	Y	Y	C	C	N	X							
SODIUM SILICATE	N	Y	N	Y	N	N	N	C	Y	Y	C	C	N	Y	X						
SULFUR DIOXIDE	C	N	N	Y	N	C	N	N	N	N	N	N	N	N	N	X					
SULFUR TRIOXIDE	C	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	X				
SULFURIC ACID	C	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	C	X			
VANADIUM PENTOXIDE	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	X		
ZINC DUST	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	X	
ZINC OXIDE	N	Y	N	Y	N	N	N	C	Y	Y	C	C	N	Y	Y	N	N	N	N	N	X
ZINC SULFIDE	N	Y	N	Y	N	N	N	N	N	Y	C	N	N	Y	Y	N	N	N	N	N	Y

10.4.HAZCHEM Codes

NFPA	Hazard	Value	Description

	Health	3	Can cause serious or permanent injury.
	Flammability	0	Will not burn under typical fire conditions.
	Instability	2	Readily undergoes violent chemical changes at elevated temperatures and pressures.
	Special	~~W~~	Reacts violently or explosively with water.

10.5. References

- Sulphuric acid MSDS
- PT packages of Acid handling units
- Standard for Chemical Handling and Storage
- API 510 for periodic inspection and testing for pressure vessels
- API 570 for visual inspection of piping, flanges, flange guards, bolts, valves, and piping supports
- API 620 for periodic inspection and testing of low-pressure vessels
- API 653 for recommended tank inspection methods and frequencies
- Sandvik corrosion tables: https://www.materials.sandvik/en-in/materials-center/corrosiontables/sulphuric-acid/
- HZL Safety Standard Audit Procedure - HZL/Aarohan/Audit Procedure/01/171B