

Risk Assessment for Pipelines project

for

Coromandel International Limited

Vizag



Conducted by



Cholamandalam MS Risk Services Ltd.

(An ISO 9001:2008 Certified Company)

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LIST OF ABBREVIATIONS

ALARP :	As Low As Reasonably Practicable
ATM :	Atmospheric
BLEVE :	Boiling Liquid Expanding Vapor Explosion
CMSRSL :	Cholamandalam MS Risk Services Ltd
CPR 18E :	Commissie voor de Preventie van Rampem [Committee for Prevention of Disaster]
HAZOP :	Hazardous Operability
HSE UK :	Health and Safety Executive, UK
IS :	Indian Standard
IR :	Individual Risk
IDLH :	Immediately Dangerous to Life or Health
LOC :	Loss of Containment
LC50:	Lethal Concentration
QRA :	Quantitative Risk Assessment
SR :	Societal Risk
TLV:	Threshold Limit Value

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EXECUTIVE SUMMARY

Coromandel International Ltd (CIL) intended to conduct the Risk Assessment (QRA) study for their Pipelines project coming up in Visakhapatnam. Cholamandalam MS Risk Services Ltd. (CMSRSL), specialized in process safety studies was invited to carry out the Risk Assessment study. Accordingly, QRA study was carried out by CMSRS with the following objective,

- The consequence analysis of the worst case scenarios
- Individual and societal risk quantification and contour mapping.
- Evaluation of risk against the risk Acceptance Criteria.
- Suggest risk reduction and mitigation measures for prevention and control of accidents to reduce the Risk.

Risk Assessment was carried out at CMSRS office using the data collected from CIL. Following Loss of Containment Scenarios were identified to conduct the risk assessment:

Sulphuric Acid:

1. Leak / Rupture of H₂SO₄ storage tank
2. Leak / Rupture of H₂SO₄ ship unloading arm
3. Leak / Rupture of H₂SO₄ unloading pipeline header
4. Leak / Rupture of H₂SO₄ transfer pump suction line from st. tank
5. Leak / Rupture of H₂SO₄ transfer pump discharge line to CIL

Phosphoric Acid:

1. Leak / Rupture of H₃PO₄ tank truck
2. Leak / Rupture of H₃PO₄ ship unloading arm
3. Leak / Rupture of H₃PO₄ unloading pipeline header
4. Leak / Rupture of H₃PO₄ transfer pump suction line
5. Leak / Rupture of H₃PO₄ transfer pump discharge line
6. Leak / Rupture of H₃PO₄ tank truck loading arm

Consequence analysis was carried out using PHAST software and Risk Assessment calculations were carried out using PHAST Risk Micro v6.7 software. Software was used to model the LOC scenarios involving Sulphuric Acid. As Phosphoric acid is not expected to generate fumes upon on release, only qualitative risk assessment has been carried out in this report.

Based on the input conditions such as process parameters, meteorological conditions, etc., the risk posed by the Rupture of Phosphoric acid unloading and loading arms fall in Substantial Risk while Leak/Rupture of Tank truck falls in Moderate Risk level.

Based on the results of the sulphuric acid risk assessment, Individual risk ($4.80E-06$ per avg. Year) and Societal risk values for the facilities covered under the scope are observed to fall within ALARP (As Low As Reasonably Practicable) region.

It is recommended to adopt the following risk reduction measures in addition to the existing risk control measures to further reduce the risk level to Tolerable limits.

1. Maintenance schedule for the storage tank/pipelines to include painting once in 6 months, ultrasonic thickness testing once in a year and replacement if the size reduction is more than 20%.
2. Inspection and testing schedule to be evolved for the unloading/loading arm available for Sulphuric/Phosphoric Acid handling
3. Flooring and the walls inside Acid Storage tank farm dyke area to be provided with acid resistant tiles
4. Emergency eye & body shower is provided near the Acid storage tanks
5. Precautions that need to be taken while handling Sulphuric/Phosphoric acid are to be displayed in the Acid Storage tank farm area

If all the existing risk control measures along with proposed risk control measures recommended in this report are implemented, the risks levels are observe to fall within the acceptable limits.

CHAPTER 1- INTRODUCTION

1.1 INTRODUCTION

Coromandel International Ltd (CIL) intended to conduct the Risk Assessment (QRA) study for their Pipelines project coming up in Vizakapattinam. Cholamandalam MS Risk Services Ltd. (CMSRSL), specialized in process safety studies was invited to carry out the Risk Assessment study.

1.2 SCOPE & OBJECTIVE OF THE STUDY

The objective of this QRA study is:

- The consequence analysis of the worst case scenarios
- Individual and societal risk quantification and contour mapping.
- Evaluation of risk against the risk Acceptance Criteria.
- Suggest risk reduction and mitigation measures for prevention and control of accidents to reduce the Risk.

1.3 ABOUT THE CONSULTANTS

CMSRSL is a joint venture between the Murugappa Group and Mitsui Sumitomo Insurance Group of Japan. CMSRSL is an approved HSE consultant of Kuwait Oil Company. CMSRSL offers specialized and innovative risk management solutions to clients in India and rest of Asia. CMSRSL has carried out consultancy and training services to over 2500 units/locations of various organizations belonging to 32 industrial sectors including refineries and petrochemical units. In addition to industrial sector and service sector located in Kuwait, India, Hong Kong and Thailand, the Ministry of Environment and Forests, Government of India and insurance companies located in India, Sri Lanka and Singapore have been engaging the services of CMSRSL to carry out a number of risk Assessment and specialized safety studies. CMSRSL also carries out similar studies for companies like Kuwait Oil Company, located outside India. The team members have wide experience in risk management studies and have carried out studies for a number of industrial sectors including refineries located in India and rest of Asia.

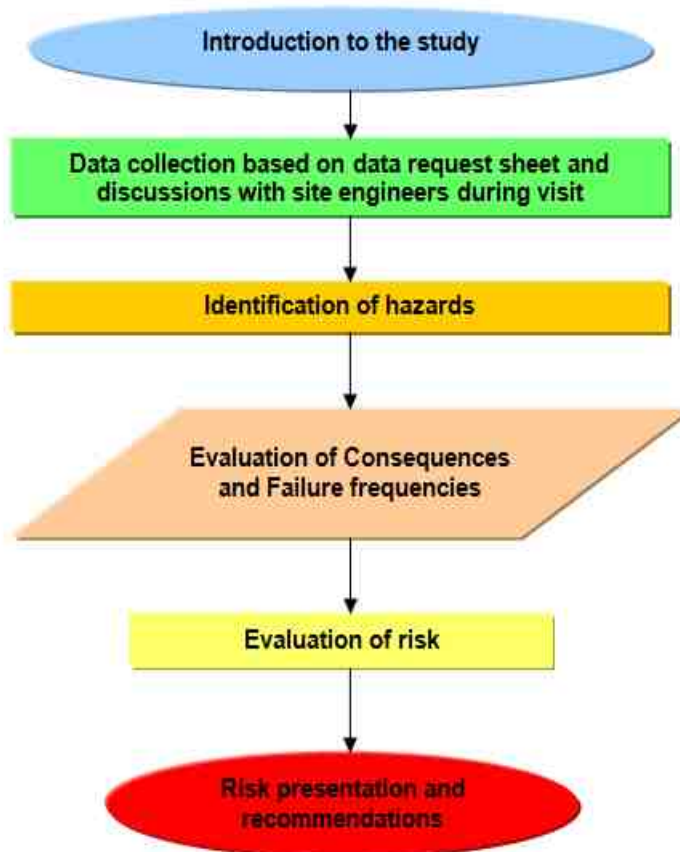
1.4 QRA METHODOLOGY

Detailed data request for risk Assessment study was submitted to the client before carrying out site visit to familiarize the site officials on the nature of information that would be collected during site visit. During site visit, CMSRS engineer had made a brief presentation to the site officials on the objective, scope, methodology and deliverables of the risk Assessment study. Subsequently, site visit was carried out for the entire facility to identify the potential hazard scenarios and to collect the necessary data for carrying out the risk assessment.

Risk Assessment calculations were carried out based on the collected data at CMSRS office using PHAST Risk Micro v6.7 software. Finally, risk reduction measures have been suggested based on the risk levels.

The above adopted methodology has been depicted in the form of flow chart below:

Overview of Risk Assessment Methodology



Immediately Dangerous to Life or Health (IDLH) is the criteria selected for damage estimation of toxic effects:

The OSHA regulation (1910.134(b)) defines the IDLH as "an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere.

As per Centre for Disease Control (CDC) and National institute for occupational safety and health (NIOSH):

H2SO4	<ul style="list-style-type: none"> • IDLH - 15 mg/m³. • LC50 – 13 mg/m³ • TLV – 1mg/m³
H3PO4	<ul style="list-style-type: none"> • IDLH - 1000 mg/m³. • TLV – 1mg/m³

Please refer **Appendix -1&2** for MSDS of H2SO4 and H3PO4 respectively

CHAPTER 2-FACILITY DESCRIPTION

2.1. FACILITY DESCRIPTION

M/s. Coromandel International Limited (herby referred as CIL), a Murugappa group company and India's second largest Phosphatic fertilizer player, is in the business segments of Fertilizers, Specialty Nutrients, Crop Protection and Retail. The company's manufacturing plant at Visakhapatnam Andhra Pradesh is involved in the manufacture of NP, NPK and water soluble fertilizers. The facility was largely expanded in the year 2007 from a production capacity of 8 lakh MTPA to the current production capacity of 12 lakh MTPA.

The raw materials required for the manufacturing of NP/NPK fertilisers include Ammonia, Potash, Urea, rock phosphate and sulphur. CIL is operating a dedicated jetty within the Visakhapatnam port limits which is leaded from Port Authorities. Ammonia is currently imported at the wharf and transferred to the plant through a dedicated pipe line. Similarly other raw materials like Potash, Urea and Sulfur, and Rock Phosphate are imported and transferred to the plant through trucks. Wharf is located 5 km away from plant premises and is connected through a dedicated road owned by CIL and built in with adequate infrastructure.

Currently the phosphoric and sulfuric acid required for the plant are stored in leased storage tanks of private vendors (within the port premises but outside the facility) and transported to the plant through road tankers passing through public road. In order to avoid the risks associated with the transportation of toxic acids through the public roads, CIL has proposed to install storage tanks and associated facilities for the storage and handling of sulfuric acid and phosphoric acid in their own premises. Accordingly, the tanks will be installed at the existing wharf of CIL which was leased by Visakhapatnam Port trust. As a part of current proposal, necessary unloading facilities and transfer pipelines will be installed at all the existing three berths at the wharf. The stored phosphoric acid will be transferred to plant by road tankers through a dedicated road of CIL, while Sulfuric acid is pumped to the storage tanks in the plant through a dedicated line laid along the road.

CHAPTER 3 - INTRODUCTION TO QUANTITATIVE RISK ASSESSMENT

3.1 OVERVIEW OF RISK ASSESSMENT

Risk Assessment is proven valuable as a management tool in assessing the overall safety performance of the chemical process Industry. Although management systems such as engineering codes, checklists, and reviews by experienced engineers have provided substantial safety assurances, major incidents involving numerous casualties, injuries and significant damage can occur – as illustrated by recent world-scale catastrophes. Risk Assessment techniques provide advanced quantitative means to supplement other hazard identification, analysis, assessment, and control and management methods to identify the potential for such incidents and to evaluate control strategies.

The underlying basis of risk Assessment is simple in concept. It offers methods to answer the following four questions:

1. What can go wrong?
2. What are the causes?
3. What are the consequences?
4. How likely is it?

This study tries to quantify the risks to rank them accordingly based on their severity and probability. The report should be used to understand the significance of existing control measures and to follow the measures continuously. Wherever possible the additional risk control measures should be adopted to bring down the risk levels.

3.2 RISK CONCEPT

Risk in general is defined as a “measure of potential economic loss or human injury in terms of the probability of the loss or injury occurring and magnitude of the loss or injury if it occurs”. Risk thus comprises of two variables:

- Magnitude of consequences and;
- The probability of occurrence.

The results of risk Assessment are often reproduced as Individual and groups risks and are defined as below.

Individual Risk is the “probability of death occurring as a result of accidents at a plant, installation or a transport route expressed as a function of the distance from such an activity”. It is the frequency at which an individual or an individual within a group may be expected to sustain a given level of harm (typically death) from the realization of specific hazards. Such a risk actually exists only when a person is permanently at that spot (out of doors).

The exposure of an individual is related to:

- The likelihood of occurrence of an event involving a release;
- Ignition of hydrocarbon;
- The vulnerability of the person to the event;
- The proportion of time the person will be exposed to the event (which is termed 'occupancy' in the QRA terminology).

The second definition of risk involves the concept of the summation of risk from events involving many fatalities within specific population groups. This definition is focused on the risk to society rather than to a specific individual and is termed **Societal Risk**. In relation to the process operations we can identify specific groups of people who work on or live close to the installation; for example communities living or working close to the plant.

3.3 RISK ASSESSMENT PROCEDURE

Hazard identification and risk assessment involves a series of steps as follows:

Step 1: Identification of the Hazard

Hazard identification is a critical step in Risk Assessment. Many aids are available, including experience, engineering codes, checklists, detailed process knowledge, equipment failure experience, hazard index techniques, What-if Analysis, Hazard and Operability (HAZOP) Studies, Failure Mode and Effects Analysis (FMEA), and Preliminary Hazard Analysis (PHA). In this phase, all potential incidents are identified and tabulated. Site visit and study of operations and documents like drawings, process write-up etc are used for hazard identification.

Step 2: Assessment of the Risk

Consequence estimation is the methodology used to determine the potential for damage or injury from specific incidents. A single incident can have many distinct incident outcomes.

Likelihood assessment is the methodology used to estimate the frequency or probability of occurrence of an incident. Estimates may be obtained from historical incident data on failure frequencies, from failure sequence models, such as fault trees and event trees or both. In this study the historical data collected by **CPR18E – Committee for Prevention of Disasters, Netherlands (Edition: PGS 3, 2005)** is used as input to the event tree (where credits are given to various safety layers) to arrive at the final failure frequencies.

Risks arising from the hazards are evaluated for its tolerability to personnel, the facility and the environment. The acceptability of the estimated risk must then be judged based upon criteria appropriate to the particular situation.

Step 3: Elimination or Reduction of the Risk

This involves identifying opportunities to reduce the likelihood and/or consequence of an accident where deemed to be necessary.

Risk assessment combines the consequences and likelihood of all incident outcomes from all selected incidents to provide a measure of risk. The risk of all selected incidents are individually estimated and summed to give an overall measure of risk.

Risk-reduction measures include those to prevent incidents (i.e. reduce the likelihood of occurrence) to control incidents (i.e. limit the extent and duration of a hazardous event) and to mitigate the effects (i.e. reduce the consequences). Preventive measures, such as using inherently safer designs and ensuring asset integrity, should be used wherever practicable.

In many cases, the measures to control and mitigate hazards and risks are simple and obvious and involve modifications to conform to standard practice. The general hierarchy of risk reducing measures is:

- Prevention (by distance or design);
- Detection (E.g. Gas, Leak detection);
- Control (E.g. emergency shutdown and controlled depressurization);
- Mitigation (E.g. PPE);
- Emergency response (In case safety barriers fail).

3.4 SOFTWARE USED

PHAST v6.7 and PHAST Risk Micro v6.7

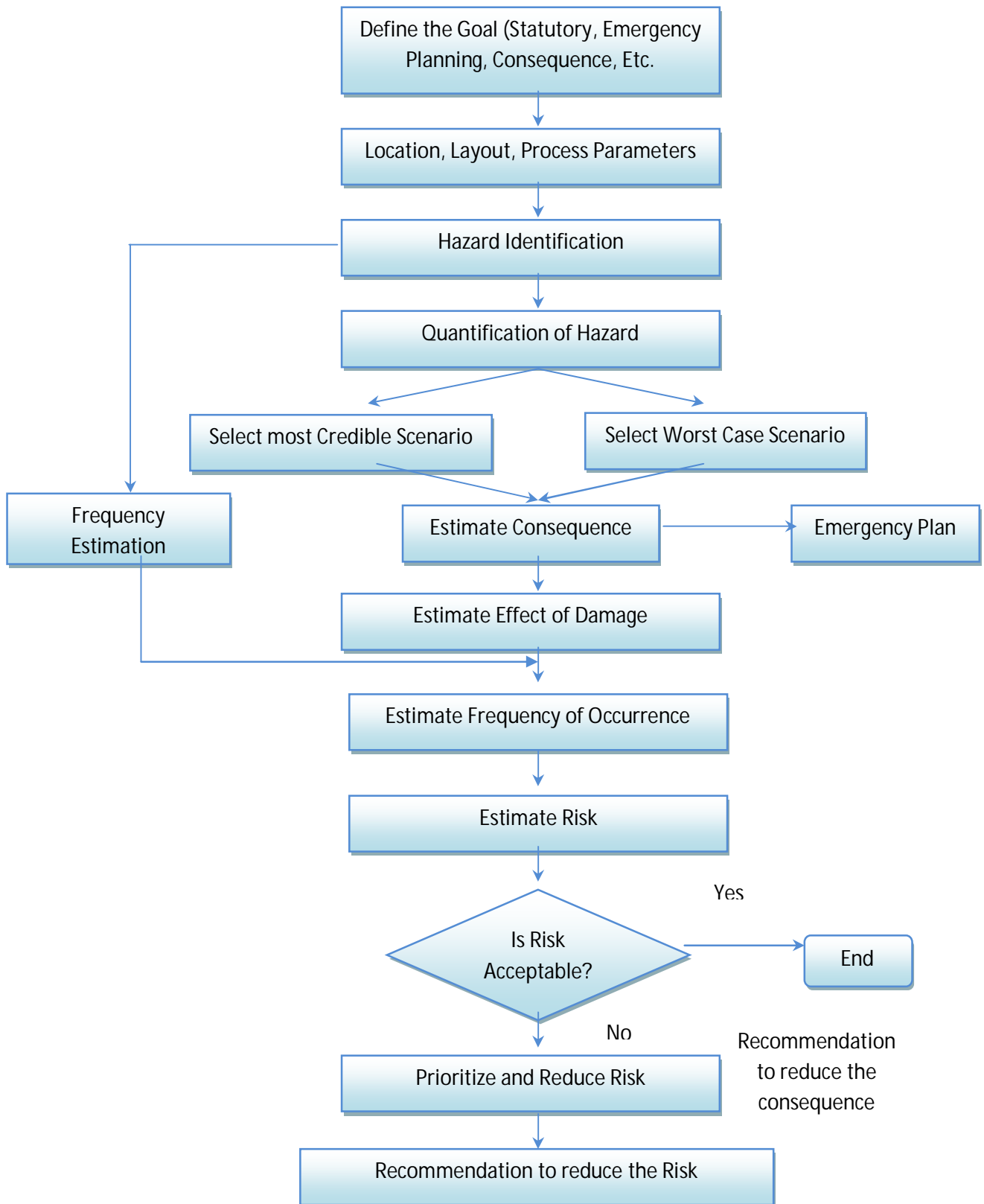
The software developed by DNV is used for risk assessment studies involving flammable and toxic hazards where individual and societal risks are also to be identified. It enables the user to assess the physical effects of accidental releases of toxic or flammable chemicals.

PHAST v6.7 is used for consequence calculations and PHAST Risk Micro v6.7 is used for risk calculations. It contains a series of up to date models that allow detailed modeling and quantitative assessment of release rate pool evaporation, atmospheric dispersion, vapor cloud explosion, combustion, heat radiation effects etc., The software is developed based on the hazard model given in **TNO Yellow Book** as the basis.

The software is developed based on the various incidents that had occurred over past 25 years. CMSRS has used the latest version of PHAST software for developing the consequences and risks for each model.

CHAPTER 4 - RISK ASSESSMENT METHODOLOGY

4.1 QRA METHODOLOGY



Risk Assessment Study will comprise of the following steps/ activities:

System Description -This step deals with defining the system under consideration.

Hazard Identification

This step deals with identification of possible hazards. The potential Loss of Containment scenarios has been considered for the following facilities:

- a) Storage tanks and
- b) Various critical inter unit pipelines

Consequence Analysis

Consequence assessment is conducted to understand the impact of identified scenarios in terms of Thermal radiation, Explosion and Toxic dispersion. Software model PHAST V 6.7 developed by DNV is used in this step.

Considering the nature of material handled **only toxic dispersion model is considered for the study.**

Impact Assessments

This step deals with calculating the impacts of potential toxic hazards associated with the scenarios. Software model PHAST RISK Micro V 6.7, developed by DNV, will be used to calculate the impacts of toxic hazards. It enables the user to assess the physical effects of accidental releases of toxic chemicals.

Frequency Analysis

This step deals with determining how often – in terms of frequency per year – toxic hazards can likely to occur. The likelihood of occurrence of the identified hazardous scenarios is assessed by reviewing historical industry accident data.

In this study the historical data available in international renowned databases will be used. The same are listed below:

1. Reference Manual Bevi Risk Assessments version 3.2, Netherlands
2. CPR 18E – Committee for Prevention of Disasters, Netherlands

Risk Calculation

This step involves calculating risk considering both severity of the consequences of an identified hazard and the probability of its occurrence.

$$\text{Risk} = \text{Likelihood of Occurrences} \times \text{Severity of Consequences}$$

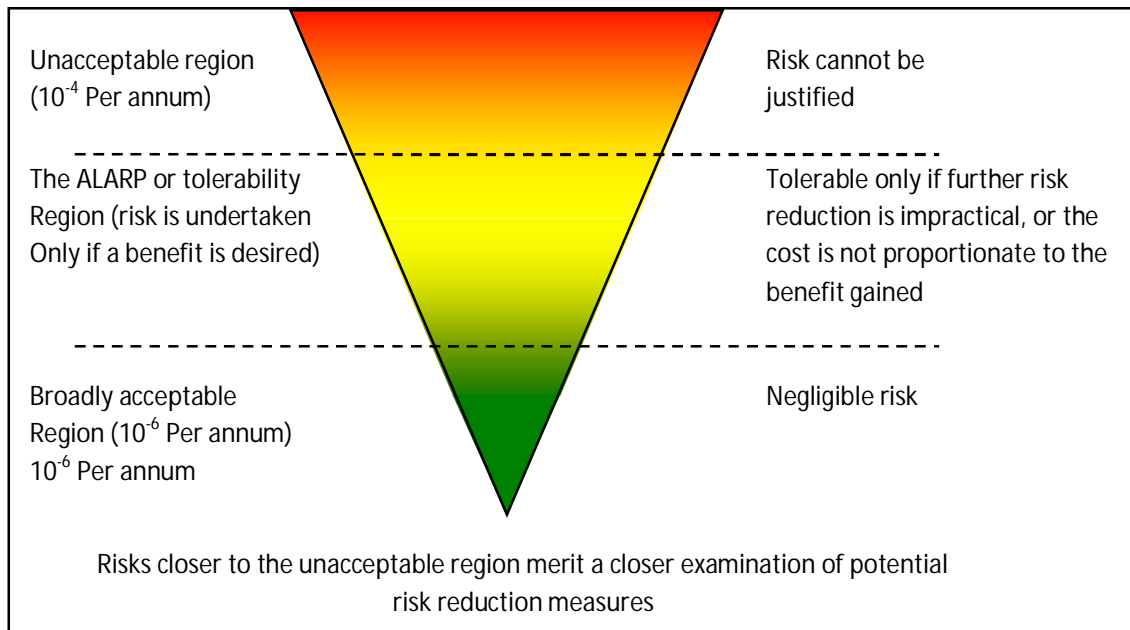
Risk will be calculated using software PHAST RISK Micro V 6.7 by DNV. This software will receive input from the Frequency Analysis and Impact Assessment Tasks. Risk is measured in various ways and presented numerically and graphically.

Risk Assessment

This step deals with comparing the calculated risk with the standard values. For this project UK HSE risk acceptance criteria will be followed which is as below:

Authority and Application	Maximum Tolerable Risk (Per Year)	Negligible Risk (Per Year)
VROM, The Netherlands (New)	1.0E-06	1.0E-08
VROM, The Netherlands (existing)	1.0E-05	1.0E-08
HSE, UK (existing hazardous industry)	1.0E-04	1.0E-06
HSE, UK (New nuclear power station)	1.0E-05	1.0E-06
HSE, UK (Substance transport)	1.0E-04	1.0E-06
HSE, UK (New housing near plants)	3 x 1.0E-06	3 x 1.0E-07
Hong Kong Government (New plants)	1.0E-05	Not used

HSE, UK for existing hazardous industry highlighted in the above table is used for the study.



Note: People inside industry will have 10 times higher Risk than Social people

Risk Tolerable

Risk mitigation is a decision making process based on the comparison of the risk calculated and predefined risk criteria. This comparative analysis would results in outcomes:

- The risk is below as low as reasonably practicable (ALARP) level, then the risk is tolerable and no further actions are required,
- The risk falls in the ALARP region, which requires efforts to reduce further, (it would not be economically feasible to reduce the risk further), and
- The risk is above the ALARP region, which requires design modifications to reduce the risk to, at minimum, to the ALARP region.

Findings

This step deals with reporting the findings of QRA study. If the risk calculated is not tolerable, the final report will provide specific technical recommendations to bring down the risk level or if the risk calculated is in ALARP zone, recommendations will be provided to further bring down the risk level.

Presentation of risk results

In the present study, risks to people are expressed in two complementary forms:

- Individual Risk – the risk experienced by an individual person.
- Societal Risk – the risk experienced by the whole group of people exposed to the hazard.

The individual risk and societal risks are calculated based on the consequence, base event frequency, ignition probability, population density in the area, weather conditions etc.

4.2. IDENTIFICATION OF HAZARDS & RELEASE SCENARIOS

A technique commonly used to generate an incident list is to consider potential leaks and major releases from fractures of all storage tanks, process pipelines and associated facilities. The containment is defined as one or several devices, any parts which are permanently in open contact with one another, and which are intended to contain one or multiple substances. A Loss of Containment is one that will not lead to the release of significant quantities of hazardous substance from other containment systems.

The following data were collected to envisage scenarios:

- Composition of materials stored in storage tanks/flowing through pipeline;
- Inventory of materials stored in storage tanks/tank trucks;
- Flow rate of materials passing through pipelines;
- Storage tanks/pipeline conditions (phase, temperature, pressure);
- Connecting piping and piping dimensions.

Accidental release of toxic liquids/gases can result in severe consequences. Major accident hazards arise upon the release of toxic liquids/gases and their dispersion into the atmosphere. Sulphuric Acid and Phosphoric Acid will not undergo any phase change upon release to the atmosphere. Due to its affinity

towards water, Sulphuric acid will absorb the moisture present in the atmosphere and start generating fumes. Sulphuric Acid is heavier than air and hence, fumes of sulphuric acid fumes tend to get accumulated near the ground.

4.3 FACTORS FOR IDENTIFICATION OF HAZARDS

In any installation, main hazard arises due to loss of containment during handling of toxic chemicals. To formulate a structured approach for identification of hazards, an understanding of contributory factors is essential.

Inventory

Inventory analysis is commonly used in understanding the relative hazards and short listing of release scenarios. Inventory plays an important role in regard to the potential hazard. Larger the inventory of a vessel or a system, larger is the quantity of potential release. A practice commonly used to generate an incident list is to consider potential leaks and major releases from fractures of pipelines and vessels/tanks containing sizable inventories.

Operating parameters

Potential vapor release for the same material depends significantly on the operating conditions. This operating range is enough to release a large amount of vapor in case of a leak/rupture, therefore the storage tank/pipeline leaks and ruptures need to be considered in the risk Assessment calculations.

Range of incidents

Both the complexity of study and the number of incident outcome cases are affected by the range of initiating events and incidents covered. This not only reflects the inclusion of accidents and/or non-accident-initiated events, but also the size of those events. For instance studies may evaluate one or more of the following:

- Catastrophic failure of tank trucks
- Large hole (large continuous release)
- Small hole (continuous release)
- Leaks at fittings or valves (small continuous release)

In general, quantitative studies do not include very small continuous releases or short duration small releases if past experience or preliminary consequence modeling shows that such releases do not contribute to the overall risk levels.

Selection of initiating events and incidents

The selection of initiating events and incidents should take into account the goals or objectives of the study and the data requirements. The data requirements increase significantly when non-accident – initiated events are included and when the number of release size increase. While the potential range of release sizes is tremendous, groupings are both appropriate and necessitated by data restrictions. The main reasons for

including release sizes other than the catastrophic rupture are to reduce the conservatism in an analysis and to better understand the relative contributions to risk of small versus large releases.

As per **Reference Manual Bevi Risk assessment version 3.2**, only the Loss of Containment (LOC) which is basically the release scenarios contributing to individual and/or societal risk are included in the QRA. LOC scenarios for the installation are included only if the following conditions are fulfilled:

- Frequency of occurrence is equal to or greater than 10^{-9} ; and
- Lethal damage (1% probability) occurs outside the establishment's boundary or the transport route.

There may be number of accidents that may occur quite frequently, but due to proper control measures or fewer quantities of chemicals released, they are controlled effectively. A few examples are a leak from a gasket, pump or valve, release of a chemical from a vent or relief valve. These accidents generally are controlled before they escalate by using control systems and monitoring devices.

QRA is carried out by identifying the hazards, using both installation specific and industry standard data to estimate the likelihood of hazardous events and using mathematical models to calculate the consequences (in terms of toxic effects etc.) of the scenarios.

4.4 CONSEQUENCE ASSESSMENT

Accidental release of acids can result in severe consequences. Acids will generate fumes, which will disperse in air and can cause detrimental impact to life and property.

The consequences caused by exposure to acid fumes are a function of:

- The toxic concentration [ppm];
- The exposure duration [sec];
- Type of exposure (Inhalation, direct contact etc.,)
- The protection of the skin tissue (clothed or naked body).

There are different ways to represent the toxic concentration e.g. IDLH, STEL, TLV etc.,

4.5 ASSUMPTIONS MADE FOR THE STUDY

4.5.1 Scenarios

As per CPR 18E - Guidelines for Quantitative Risk Assessment, developed by the Committee for the Prevention of Disasters, Netherlands, for each of scenario two leak sizes i.e., hole sizes are considered for analysis,

For Pipelines

- Leak – Leak size 10% of the pipeline diameter
- Rupture – Actual diameter of the Pipe

For storage tanks,

- Leak – Leak size 10 mm
- Catastrophic Rupture

The following table present the potential initiating events and credible accident scenarios identified and quantitatively (Sulphuric Acid) /qualitatively (Phosphoric Acid) analysed:

Table 1 – List of Hazardous Scenario Identified for Sulphuric Acid

S No	Scenario	Leak Size	Inventory (MT) / Flow rate (m3/h)	Pressure (Kg/cm2 g)	Temp (° C)
(A) Storage tanks & tank trucks					
1.	H2SO4 storage tank	10	12,500	Atm	Ambient
		CR	12,500	Atm	Ambient
2.	H2SO4 storage tank	10	10,000	Atm	Ambient
		CR	10,000	Atm	Ambient
(B) Pipelines					
3.	H2SO4 ship unloading arm	0.1ID	250	5	Ambient
		FBR	250	5	Ambient
4.	H2SO4 unloading pipeline header	0.1ID	250	5	Ambient
		FBR	250	5	Ambient
5.	H2SO4 transfer pump suction line from st. tank	0.1ID	60	5	Ambient
		FBR	60	5	Ambient
6.	H2SO4 transfer pump discharge line to CIL	0.1ID	60	5	Ambient
		FBR	60	5	Ambient

Table 2 – List of Hazardous Scenario Identified for Phosphoric Acid

S No	Scenario	Leak Size	Inventory (MT) / Flow rate (m3/h)	Pressure (Kg/cm2 g)	Temp (° C)
(C) Storage tanks & tank trucks					
1.	H3PO4 tank truck	10	20	Atm	Ambient
		CR	20	Atm	Ambient
(D) Pipelines					
2.	H3PO4 ship unloading arm	0.1ID	300	5	Ambient
		FBR	300	5	Ambient
3.	H3PO4 unloading pipeline header	0.1ID	300	5	Ambient
		FBR	300	5	Ambient
4.	H3PO4 transfer pump suction line	0.1ID	75	5	Ambient
		FBR	75	5	Ambient
5.	H3PO4 transfer pump discharge line	0.1ID	75	5	Ambient
		FBR	75	5	Ambient
6.	H3PO4 tank truck loading arm	0.1ID	75	5	Ambient
		FBR	75	5	Ambient

Legend: CR- Catastrophic rupture, **FBR-** Full bore Rupture, **0.1ID** – 10% of internal dia.

As H3PO4 will not generate fumes upon on release, only qualitative risk assessment has been carried out in this report. Dispersion of H2SO4 upon release is modelled.

4.5.2 Metrological Data

Ambient Temperature: 30 deg C

Humidity: 70%

Solar Radiation: 0.5 kW/ m²

Table-3 Wind speed and stability class considered for the study

Wind Speed (m/s)	Stability Class	Description
1.5	F	This is typical of during night time with low wind speed.
5	D	This is typical of day time situation, with moderate wind fluctuations

Wind probabilities are taken from climatologically tables of observatories in India 1971-2000.

4.5.3 Failure Frequencies

For this study the failure data is taken from CPR 18E – Guidelines for Quantitative Risk Assessment, developed by the Committee for the Prevention of Disasters, Netherlands.

Internal domino effects are not explicitly covered in QRA. An internal domino needs to be considered only in case of a situation in which the failure of one component clearly leads to the failure of another component. In Such cases contents of the biggest vessel / tank needs to be taken for Instantaneous failure.

4.5.4 Immediate Ignition Probability

In this study, as **H2SO4 & H3PO4 are non- flammable, probability of delayed ignition is “zero”.**

4.5.5 Explosion Probability

The probability of ignition of a free gas cloud is zero. **No explosion and flash fire scenarios are envisaged in this study.**

4.5.6 Population Data

Population within the tank farm area: 10

For offsite population, population density of 384 per sq.km is considered as per 2011 census details.

4.5.7 Blocking systems

The blocking systems are used to limit the released quantity following a LOC. A blocking system consists of a detection system (ex; gas detection, hydrocarbon detection, etc) combined with shut-off valves. The shut-off valves can be closed automatically or manually. Blocking systems are further classified into Automatic, semi-automatic & non-automated (Manual) system.

For this study Non-automated blocking system is considered for all pipelines and storage tanks.

CHAPTER 5 - CONCEQUENCE ANALYSIS

5.1 Consequence Analysis:

Inventory Used for the Risk Assessment study is as below.

Table 4– Inventory Details – Sulphuric Acid

S No	Scenario	Leak Size	Inventory (MT, m3/h)
(A) Storage tanks			
1.	H2SO4 storage tank	10	1250
		CR	12500
(B) Pipelines			
2.	H2SO4 ship unloading arm	0.1ID	250
		FBR	250
3.	H2SO4 unloading pipeline header	0.1ID	250
		FBR	250
4.	H2SO4 transfer pump suction line from st. tank	0.1ID	60
		FBR	60
5.	H2SO4 transfer pump discharge line to CIL	0.1ID	60
		FBR	60

Legend: CR- Catastrophic rupture, FBR- Full bore Rupture, 0.1ID – 10% of internal dia.

PHAST software uses UDM (Unified Dispersion Model) to determine the concentration levels of acid fumes during a leak of Sulphuric Acid and subsequent dispersion. UDM is an integrated model with set of inbuilt equations to determine the dispersion results. Following are calculated to derive the dispersion results.

- Discharge data: release rate, drop diameter etc.,
- Jet dispersion: entrainment, trajectories (Particularly to touch down)
- Thermodynamics: Droplet evaporation, droplet trajectories, rainout
- Pool data: spreading, evaporation etc.,
- Heavy gas dispersion
- Possible plume lift off
- Passive dispersion

Quantity of acid fume that would be involved in dispersion depend on the thermodynamic properties which in turn depends on factors such as evaporation rate, ambient pressure, temperature, wind stability, direction etc. Hence, entire quantity of sulphuric acid indicated in the inventory column of Table-4 would not be involved in dispersion. Only a part of it would disperse.

Table 5 – Inventory Details –Phosphoric Acid

S. No	Scenario	Quantity of Acid released
1	H3PO4 tank truck	20 MT
2	H3PO4 ship unloading arm	5.03m3
3	H3PO4 unloading pipeline header	46.50m3
4	H3PO4 transfer pump suction line	6.73m3
5	H3PO4 transfer pump discharge line	2.89m3
6	H3PO4 tank truck loading arm	0.09m3

Consequence Results for Toxic dispersion of Sulphuric Acid:

Table 6 – Consequence Distances for toxic dispersion

S.No	Scenarios	Distance to concentration (m)	
		2F Weather Condition	6D Weather Condition
Storage tanks			
1	Leak of H2SO4 storage tank	6.66	6.59
2	CR of H2SO4 storage tank	Not envisaged	Not Envisaged
Pipelines			
3	Leak of H2SO4 ship unloading arm	6.89	6.71
4	FBR of H2SO4 ship unloading arm	11.88	11.86
5	Leak of H2SO4 unloading pipeline header	2.86	2.79
6	FBR of H2SO4 unloading pipeline header	11.89	11.87
7	Leak of H2SO4 transfer pump suction line from st. tank	2.08	2.06
8	FBR of H2SO4 transfer pump suction line from st. tank	6.97	6.88
9	Leak of H2SO4 transfer pump discharge line to CIL	0.36	0.34
10	FBR of H2SO4 transfer pump discharge line to CIL	5.74	5.99

Analysis of Results

Storage Tanks

Catastrophic Rupture of Sulphuric Acid tank is not envisaged and hence, modelling for this scenario was not considered. However, the failure frequency for the storage tank failure is being considered along with the inventory to estimate the risk levels.

Pipelines

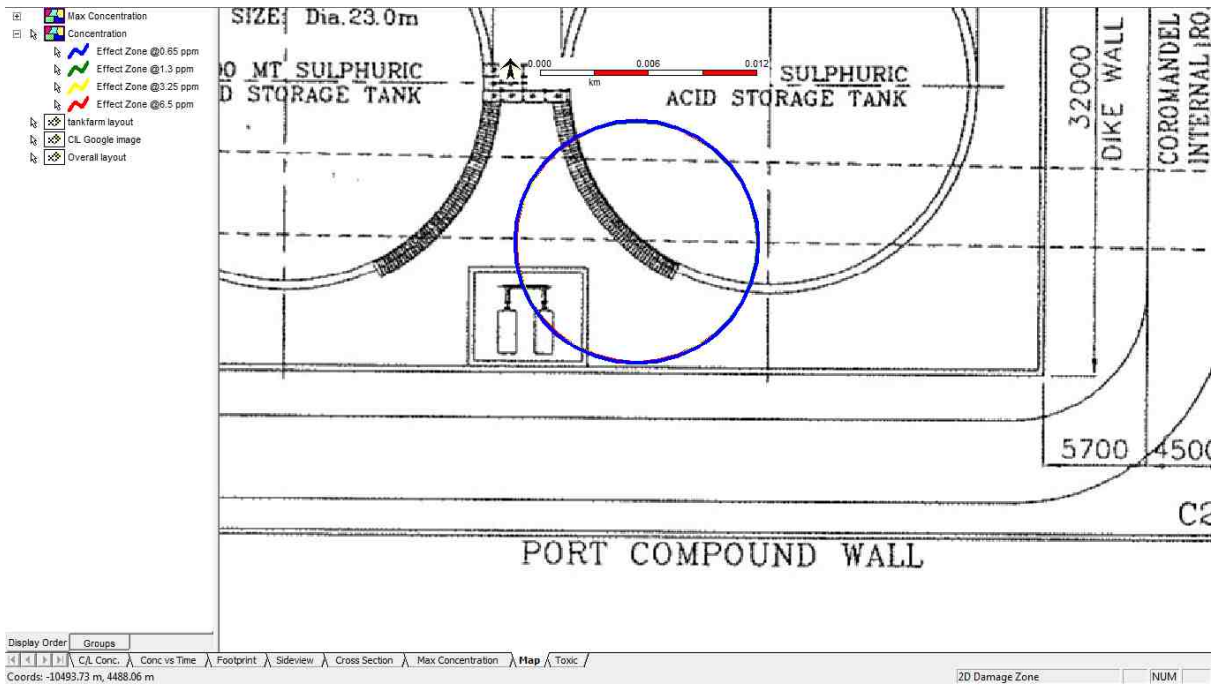
In case of Rupture of unloading pipeline header, the IDLH concentration is present up to a maximum downwind distance of 11.89m at 1.5F weather condition.

Apart from IDLH, 5%, 10%, 25%, 50% of Lethal Concentration (LC) and TLV for H₂SO₄ dispersion are analyzed and the results are tabulated below:

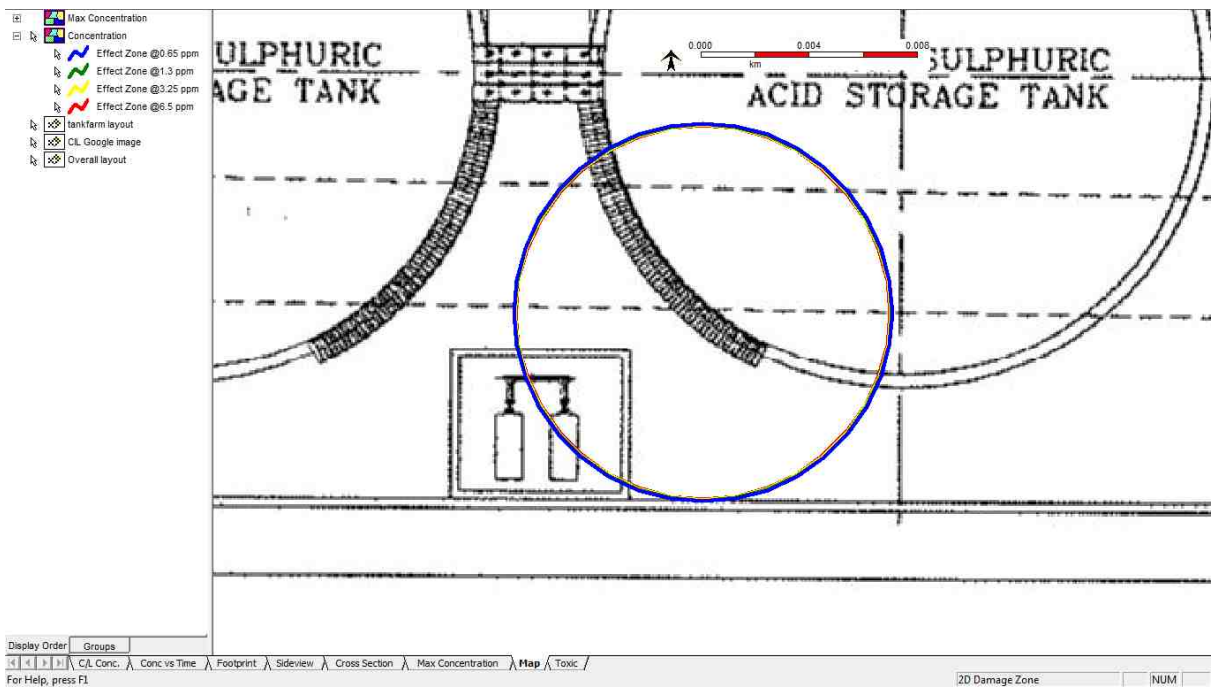
H ₂ SO ₄ Concentration (ppm)	Distance (m)	
	1.5F weather condition	5D weather condition
0.65 (5% of LC50)	6.60194	6.66897
1 (TLV)	6.60187	6.66897
1.3(10% of LC50)	6.60180	6.66897
3.25(25% of LC50)	6.60137	6.66895
6.5(50% of LC50)	6.60065	6.66891
13(LC50)	6.59922	6.66884

Dispersion contours:

1.5F weather condition



5D weather condition



CHAPTER 6 - FREQUENCY ANALYSIS

6.1 Failure Frequencies

For this study the failure data is taken from CPR 18E – Guidelines for Quantitative Risk Assessment, developed by the Committee for the Prevention of Disasters, Netherlands.

Internal domino effects are not explicitly covered in QRA. An internal domino needs to be considered only in case of a situation in which the failure of one component clearly leads to the failure of another component. In Such cases contents of the biggest vessel / tank needs to be taken for Instantaneous failure.

Table 7– Failure Frequency

S No	Scenario	Leak Size	Failure Frequency (per year)
(A) Storage tanks			
1.	H2SO4 storage tank	10	1.00E-04
		CR	5.00E-06
(B) Various critical inter unit pipelines			
2.	H2SO4 ship unloading arm	0.1ID	8.64E-01
		FBR	8.64E-02
3.	H2SO4 unloading pipeline header	0.1ID	2.25E-04
		FBR	4.50E-05
4.	H2SO4 transfer pump suction line from st. tank	0.1ID	7.00E-05
		FBR	1.40E-05
5.	H2SO4 transfer pump discharge line to CIL	0.1ID	5.00E-04
		FBR	1.00E-04

Legend: CR- Catastrophic rupture, FBR- Full bore Rupture, 0.1ID – 10% of internal dia.

CHAPTER 7 - QUALITATIVE ANALYSIS OF PHOSPHORIC ACID SCENARIO

7.1 QUALITATIVE ANALYSIS OF PHOSPHORIC ACID SCENARIO

In Risk Analysis studies contributions from low frequency - high outcome effect as well as high frequency - low outcome events are distinguished; the objective of the study is emergency planning, hence only holistic & conservative assumptions are used for obvious reasons. Hence though the outcomes may look pessimistic, the planning for emergency concept should be borne in mind whilst interpreting the results.

The LOC scenarios were evaluated as per HSE-UK standards.

Table 8- Loss of Containment scenarios

S. No	Scenario	Quantity of Acid released
1	H3PO4 tank truck	20 MT
2	H3PO4 ship unloading arm	5.03m3
3	H3PO4 unloading pipeline header	46.50m3
4	H3PO4 transfer pump suction line	6.73m3
5	H3PO4 transfer pump discharge line	2.89m3
6	H3PO4 tank truck loading arm	0.09m3

While estimating the consequences the safety devices and risk control measures adopted were not taken into account. The base frequency taken for the scenario also gives no credit for risk control

The environmental damage scenarios are evaluated based on the following factor

Harm

Three categories of harm are taken into consideration.

- Slightly Harmful: Harm that is of a temporary nature.
- Harmful: Harm that result in permanent minor disability.
- Extremely Harmful: Premature death or permanent major disability.

The frequency estimation or likelihood of an event occurrence is estimated based on the Likelihood scale given below.

Likelihood

The three categories of Likelihood that harm can occur are taken into consideration.

- Highly unlikely- A freak combination of factors would be required for an incident to occur.
- Unlikely- A rare combination of factors would require for an incident to occur.
- Likely- Not certain to happen but an accidental factor may result in an incident.

The overall hazard evaluation is carried out based on the hazard evaluation matrix given below.

Table 9- Hazard Evaluation Significance Matrix

		Potential severity of harm		
		Slightly Harmful 1	Harmful 2	Extremely Harmful 3
Likelihood of harm occurring	Highly unlikely 1	Trivial 1	Tolerable 2	Moderate 3
	Unlikely 2	Tolerable 2	Moderate 4	Substantial 6
	Likely 3	Moderate 3	Substantial 6	Intolerable 9

The hazard evaluation matrix for the above scenarios is developed based on the judgment of the risk assessment expert.

Table 10- Hazard Evaluation Matrix for LOC scenarios

S. No	Scenario	Consequence	Potential Severity of harm	Like hood of harm Occurring	Risk Level
1	Leak/Rupture of H3PO4 tank truck	Spillage of Phos acid material and environmental damage	Harmful	Unlikely	Moderate
2	Leak/Rupture of H3PO4 ship unloading arm	Spillage of Phos acid material and environmental damage	Harmful	Likely	Substantial
3	Leak/Rupture of H3PO4 unloading pipeline header	Spillage of Phos acid material and environmental damage	Slightly Harmful	Unlikely	Tolerable
4	Leak/Rupture of H3PO4 transfer pump suction line	Spillage of Phos acid material and environmental damage	Slightly Harmful	Unlikely	Tolerable
5	Leak/Rupture of H3PO4 transfer pump discharge line	Spillage of Phos acid material and environmental damage	Slightly Harmful	Unlikely	Tolerable

S. No	Scenario	Consequence	Potential Severity of harm	Like hood of harm Occurring	Risk Level
6	Leak/Rupture of H3PO4 tank truck loading arm	Spillage of Phos acid material and environmental damage	Harmful	Likely	Substantial

Analysis:

Based on the input conditions such as process parameters, Climatological condition, etc., the risk posed by the Rupture of Phosphoric acid unloading and loading arms fall in Substantial Risk while Leak/Rupture of Tank truck falls in Moderate Risk level.

It is recommended to follow the risk reduction measures proposed in Section 8.3 of this report in addition to the existing risk control measures followed to further reduce the risk level to Tolerable.

CHAPTER 8 - RISK ASSESSMENT

8.1 RISK ASSESSMENT

Individual Risk and Societal Risk:

The Individual Risk per annum (IRPA) measure expresses the risk exposure to any Individual who is continuously present in a particular area for the whole year. The risk exposure is calculated for all relevant hazards and summed to give the overall risks for area of the installation.

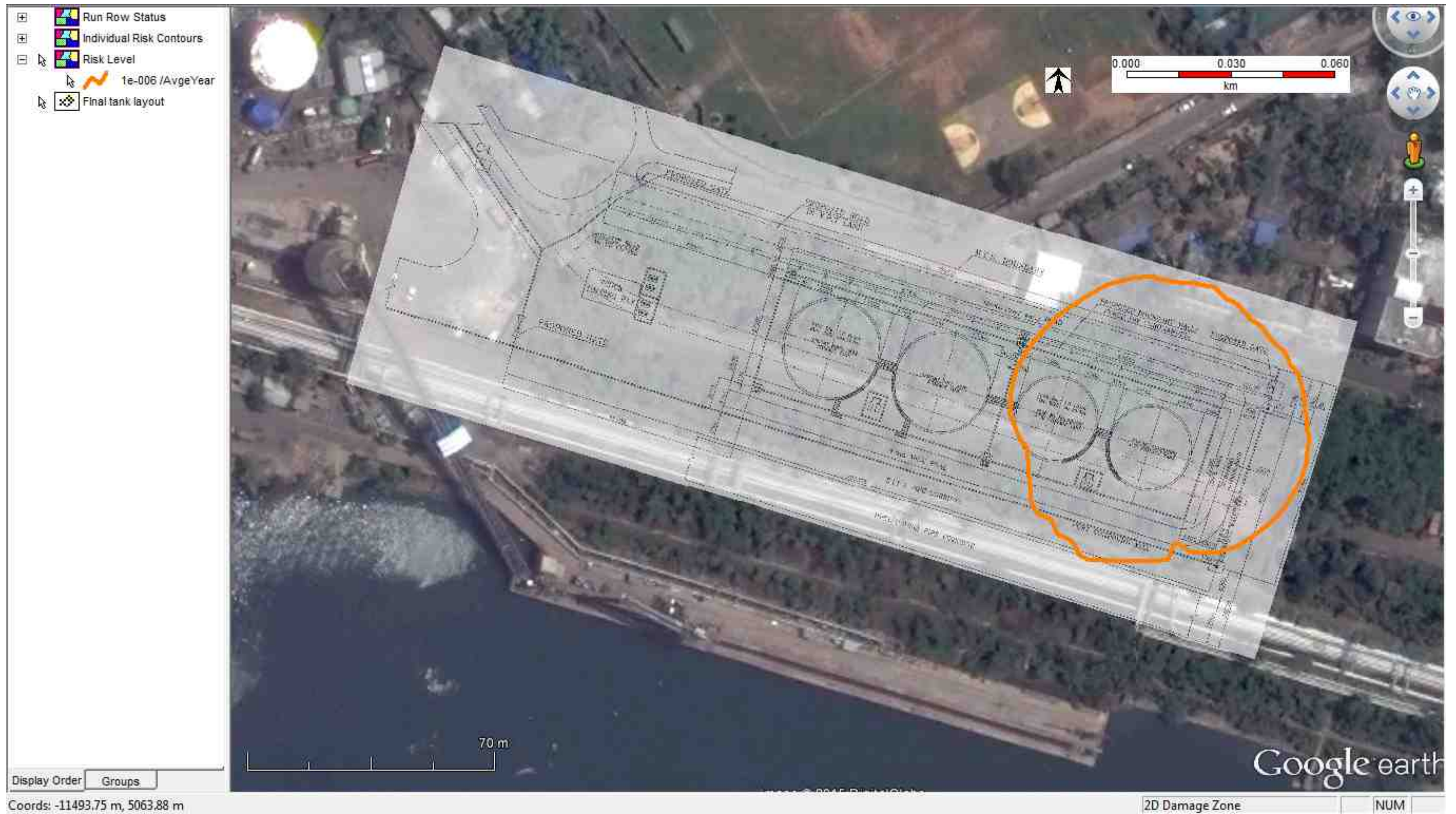
The individual & societal risks are presented in the form of IR contour & F- N Curve respectively as below.

Individual risk value: 4.80E-06 per avg. year

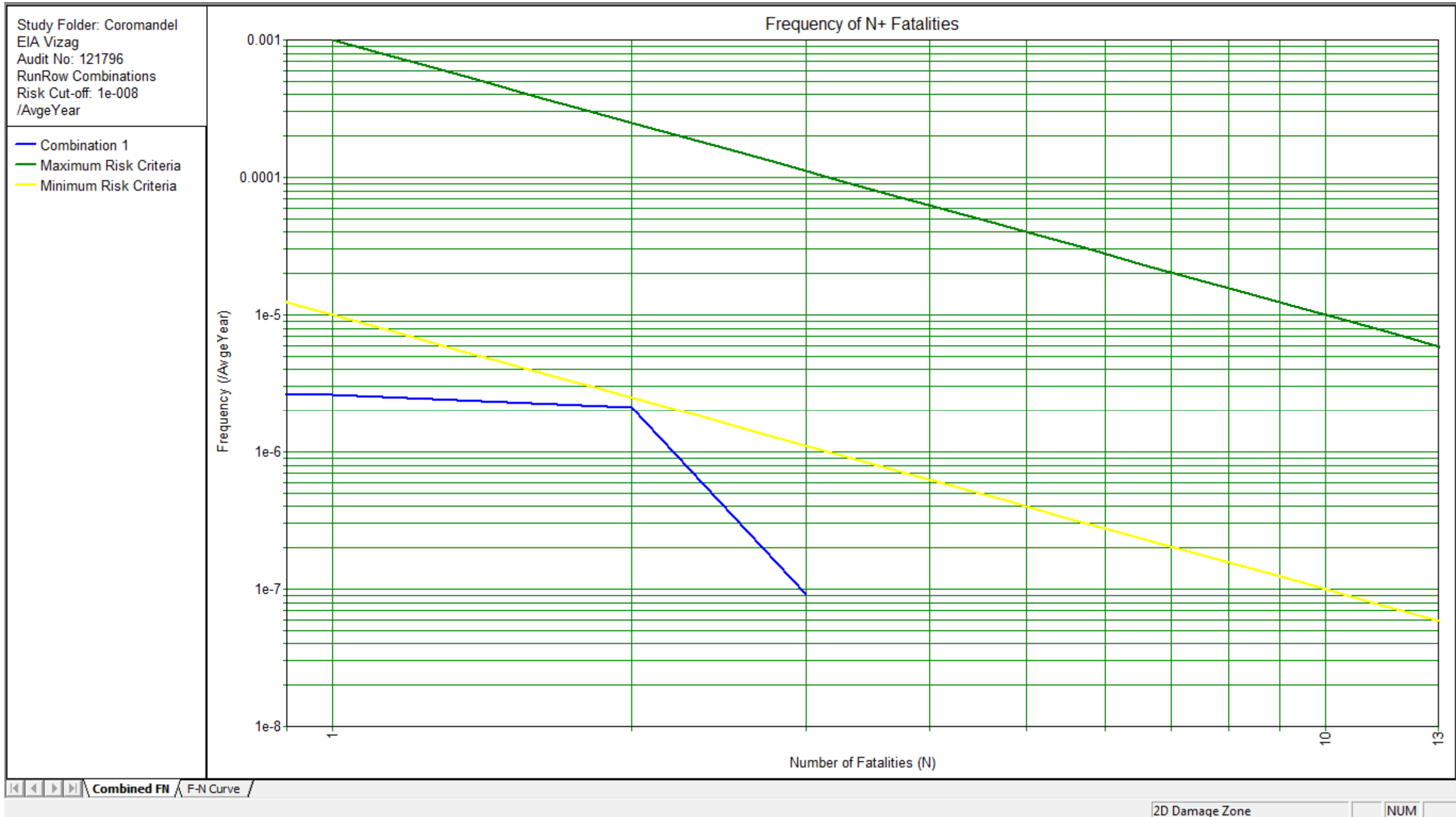
Societal risk value: FN Curve provided

As per UK HSE guidelines, IR & SR of this facility fall under ALARP (As Low As Reasonably Practicable) region.

IR: 4.80E-06 per avg. year



SR: 4.80E-06 per avg. Year



8.2 EXISTING RISK REDUCTION MEASURES

1. MOC of Sulphuric Acid and Phosphoric Acid tanks are selected based on the material compatibility.
2. Proposed tank farm facility is equipped with following control systems and mechanisms as given below:
 - Level control system
 - Radar gauge with alarm
 - Closed roof tanks with vapour control system
 - High-High level alarm on tankers to trigger the manual control of the feed pump
 - Dyke spill control sump
 - Acid absorbing materials such as calcium carbonate and bicarbonate are stored at the tank farm area.
 - Spill collection system is made available at the wharf area to avoid any spill into marine environment.
3. Existing Disaster Management Plan (DMP) for the wharf area is upgraded for the tank farm proposal.
4. Dedicated road for transportation of H₃PO₄ by trucks

8.3 PROPOSED RISK CONTROL MEASURES

1. Maintenance schedule for the storage tank/pipelines to include painting once in 6 months, ultrasonic thickness testing once in a year and replacement if the size reduction is more than 20%.
2. Inspection and testing schedule to be evolved for the unloading/loading arm available for Sulphuric/Phosphoric Acid handling
3. Flooring and the walls inside Acid Storage tank farm dyke area to be provided with acid resistant tiles
4. Emergency eye & body shower is provided near the Acid storage tanks
5. Precautions that need to be taken while handling Sulphuric/Phosphoric acid are to be displayed in the Acid Storage tank farm area

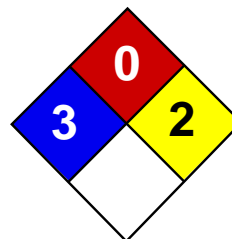
8.4 CONCLUSION

If all the existing risk control measures along with proposed risk control measures recommended in this report are implemented, the risks levels are observe to fall within the acceptable limits.

CHAPTER 9 – REFERENCES

9.1 REFERENCE

- IS 15656:2006: Hazard identification and risk analysis - Code of Practice
- Guidelines for Quantitative Risk Assessment CPR 18E (Purple book), Committee for the Prevention of Disasters, Netherlands (Edition: PGS 3, 2005)
- Reference manual Bevi risk assessments version 3.2
- Guidelines for Hazard Evaluation Procedures - Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York, 1992.
- Indian Standard IS:4262 – 2002- Sulfuric Acid - Code of Safety



Health	3
Fire	0
Reactivity	2
Personal Protection	

Material Safety Data Sheet

Sulfuric acid MSDS

Section 1: Chemical Product and Company Identification

Product Name: Sulfuric acid

Catalog Codes: SLS2539, SLS1741, SLS3166, SLS2371, SLS3793

CAS#: 7664-93-9

RTECS: WS5600000

TSCA: TSCA 8(b) inventory: Sulfuric acid

CI#: Not applicable.

Synonym: Oil of Vitriol; Sulfuric Acid

Chemical Name: Hydrogen sulfate

Chemical Formula: H₂-SO₄

Contact Information:

Sciencelab.com, Inc.

14025 Smith Rd.

Houston, Texas 77396

US Sales: **1-800-901-7247**

International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:

1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Sulfuric acid	7664-93-9	95 - 98

Toxicological Data on Ingredients: Sulfuric acid: ORAL (LD50): Acute: 2140 mg/kg [Rat.]. VAPOR (LC50): Acute: 510 mg/m 2 hours [Rat]. 320 mg/m 2 hours [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects:

Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, of inhalation. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:

CARCINOGENIC EFFECTS: Classified 1 (Proven for human.) by IARC, + (Proven.) by OSHA. Classified A2 (Suspected for human.) by ACGIH. **MUTAGENIC EFFECTS:** Not available. **TERATOGENIC EFFECTS:** Not available. **DEVELOPMENTAL TOXICITY:** Not available. The substance may be toxic to kidneys, lungs, heart, cardiovascular system, upper respiratory tract, eyes, teeth. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged

contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

Eye Contact:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:

Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. **WARNING:** It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion:

Products of combustion are not available since material is non-flammable. However, products of decomposition include fumes of oxides of sulfur. Will react with water or steam to produce toxic and corrosive fumes. Reacts with carbonates to generate carbon dioxide gas. Reacts with cyanides and sulfides to form poisonous hydrogen cyanide and hydrogen sulfide respectively.

Fire Hazards in Presence of Various Substances: Combustible materials

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available. Slightly explosive in presence of oxidizing materials.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:

Metal acetylides (Monocesium and Monorubidium), and carbides ignite with concentrated sulfuric acid. White Phosphorous + boiling Sulfuric acid or its vapor ignites on contact. May ignite other combustible materials. May cause fire when sulfuric acid is mixed with Cyclopentadiene, cyclopentanone oxime, nitroaryl amines, hexalithium disilicide, phosphorous (III) oxide, and oxidizing agents such as chlorates, halogens, permanganates.

Special Remarks on Explosion Hazards:

Mixtures of sulfuric acid and any of the following can explode: p-nitrotoluene, pentasilver trihydroxydiaminophosphate, perchlorates, alcohols with strong hydrogen peroxide, ammonium tetraperoxychromate, mercuric nitrite, potassium chlorate, potassium permanganate with potassium chloride, carbides, nitro compounds, nitrates, carbides, phosphorous, iodides, picrates, fulminates, dienes, alcohols (when heated) Nitramide decomposes explosively on contact with concentrated sulfuric acid. 1,3,5-Trinitrosohexahydro-1,3,5-triazine + sulfuric acid causes explosive decomposition.

Section 6: Accidental Release Measures**Small Spill:**

Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill:

Corrosive liquid. Poisonous liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage**Precautions:**

Keep locked up.. Keep container dry. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, combustible materials, organic materials, metals, acids, alkalis, moisture. May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package.

Storage:

Hygroscopic. Reacts violently with water. Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 23°C (73.4°F).

Section 8: Exposure Controls/Personal Protection**Engineering Controls:**

Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:

Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:

Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:

TWA: 1 STEL: 3 (mg/m³) [Australia] Inhalation TWA: 1 (mg/m³) from OSHA (PEL) [United States] Inhalation TWA: 1 STEL: 3 (mg/m³) from ACGIH (TLV) [United States] [1999] Inhalation TWA: 1 (mg/m³) from NIOSH [United States] Inhalation TWA: 1 (mg/m³) [United Kingdom (UK)] Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid. (Thick oily liquid.)

Odor: Odorless, but has a choking odor when hot.

Taste: Marked acid taste. (Strong.)

Molecular Weight: 98.08 g/mole

Color: Colorless.

pH (1% soln/water): Acidic.

Boiling Point:

270°C (518°F) - 340 deg. C Decomposes at 340 deg. C

Melting Point: -35°C (-31°F) to 10.36 deg. C (93% to 100% purity)

Critical Temperature: Not available.

Specific Gravity: 1.84 (Water = 1)

Vapor Pressure: Not available.

Vapor Density: 3.4 (Air = 1)

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility:

Easily soluble in cold water. Sulfuric is soluble in water with liberation of much heat. Soluble in ethyl alcohol.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability:

Conditions to Avoid: Incompatible materials, excess heat, combustible material materials, organic materials, exposure to moist air or water, oxidizers, amines, bases. Always add the acid to water, never the reverse.

Incompatibility with various substances:

Reactive with oxidizing agents, reducing agents, combustible materials, organic materials, metals, acids, alkalis, moisture.

Corrosivity:

Extremely corrosive in presence of aluminum, of copper, of stainless steel(316). Highly corrosive in presence of stainless steel(304). Non-corrosive in presence of glass.

Special Remarks on Reactivity:

Hygroscopic. Strong oxidizer. Reacts violently with water and alcohol especially when water is added to the product. Incompatible (can react explosively or dangerously) with the following: ACETIC ACID, ACRYLIC ACID, AMMONIUM HYDROXIDE, CRESOL, CUMENE, DICHLOROETHYL ETHER, ETHYLENE CYANOHYDRIN, ETHYLENEIMINE, NITRIC ACID, 2-NITROPROPANE, PROPYLENE OXIDE, SULFOLANE, VINYLIDENE CHLORIDE, DIETHYLENE GLYCOL MONOMETHYL ETHER, ETHYL ACETATE, ETHYLENE CYANOHYDRIN, ETHYLENE GLYCOL MONOETHYL ETHER ACETATE, GLYOXAL, METHYL ETHYL KETONE, dehydrating agents, organic materials, moisture (water), Acetic anhydride, Acetone, cyanohydrin, Acetone+nitric acid, Acetone + potassium dichromate, Acetonitrile, Acrolein, Acrylonitrile, Acrylonitrile +water, Alcohols + hydrogen peroxide, ally compounds such as Allyl alcohol, and Allyl Chloride, 2-Aminoethanol, Ammonium hydroxide, Ammonium triperchromate, Aniline, Bromate + metals, Bromine pentafluoride, n-Butyraldehyde, Carbides, Cesium acetylene carbide, Chlorates, Cyclopentanone oxime, chlorinates, Chlorates + metals, Chlorine trifluoride, Chlorosulfonic acid, 2-cyano-4-nitrobenzenediazonium hydrogen sulfate, Cuprous nitride, p-chloronitrobenzene, 1,5-Dinitronaphthlene +

sulfur, Diisobutylene, p-dimethylaminobenzaldehyde, 1,3-Diazidobenzene, Dimethylbenzylcarbinol + hydrogen peroxide, Epichlorohydrin, Ethyl alcohol + hydrogen peroxide, Ethylene diamine, Ethylene glycol and other glycols, , Ethylenimine, Fulminates, hydrogen peroxide, Hydrochloric acid, Hydrofluoric acid, Iodine heptafluoride, Indane + nitric acid, Iron, Isoprene, Lithium silicide, Mercuric nitride, Mesityl oxide, Mercury nitride, Metals (powdered), Nitromethane, Nitric acid + glycerides, p-Nitrotoluene, Pentasilver trihydroxydiaminophosphate, Perchlorates, Perchloric acid, Permanganates + benzene, 1-Phenyl-2-methylpropyl alcohol + hydrogen peroxide, Phosphorus, Phosphorus isocyanate, Picrates, Potassium tert-butoxide, Potassium chlorate, Potassium Permanganate and other permanganates, halogens, amines, Potassium Permanganate + Potassium chloride, Potassium Permanganate + water, Propiolactone (beta)-, Pyridine, Rubidium acetelyene carbide, Silver permanganate, Sodium, Sodium carbonate, sodium hydroxide, Steel, styrene monomer, toluene + nitric acid, Vinyl acetate, Thallium (I) azidodithiocarbonate, Zinc chlorate, Zinc Iodide, azides, carbonates, cyanides, sulfides, sulfites, alkali hydrides, carboxylic acid anhydrides, nitriles, olefinic organics, aqueous acids, cyclopentadiene, cyano-alcohols, metal acetylides, Hydrogen gas is generated by the action of the acid on most metals (i.e. lead, copper, tin, zinc, aluminum, etc.). Concentrated sulfuric acid oxidizes, dehydrates, or sulfonates most organic compounds.

Special Remarks on Corrosivity:

Non-corrosive to lead and mild steel, but dilute acid attacks most metals. Attacks many metals releasing hydrogen. Minor corrosive effect on bronze. No corrosion data on brass or zinc.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:

WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE. Acute oral toxicity (LD50): 2140 mg/kg [Rat.]. Acute toxicity of the vapor (LC50): 320 mg/m³ 2 hours [Mouse].

Chronic Effects on Humans:

CARCINOGENIC EFFECTS: Classified 1 (Proven for human.) by IARC, + (Proven.) by OSHA. Classified A2 (Suspected for human.) by ACGIH. May cause damage to the following organs: kidneys, lungs, heart, cardiovascular system, upper respiratory tract, eyes, teeth.

Other Toxic Effects on Humans:

Extremely hazardous in case of inhalation (lung corrosive). Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (corrosive), of ingestion, .

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:

Mutagenicity: Cytogenetic Analysis: Hamster, ovary = 4mmol/L Reproductive effects: May cause adverse reproductive effects based on animal data. Developmental abnormalities (musculoskeletal) in rabbits at a dose of 20 mg/m³ for 7 hrs.(RTECS) Teratogenicity: neither embryotoxic, fetotoxic, nor teratogenic in mice or rabbits at inhaled doses producing some maternal toxicity

Special Remarks on other Toxic Effects on Humans:

Acute Potential Health Effects: Skin: Causes severe skin irritation and burns. Continued contact can cause tissue necrosis. Eye: Causes severe eye irritation and burns. May cause irreversible eye injury. Ingestion: Harmful if swallowed. May cause permanent damage to the digestive tract. Causes gastrointestinal tract burns. May cause perforation of the stomach, GI bleeding, edema of the glottis, necrosis and scarring, and sudden circulatory collapse(similar to acute inhalation). It may also cause systemic toxicity with acidosis. Inhalation: May cause severe irritation of the respiratory tract and mucous membranes with sore throat, coughing, shortness of breath, and delayed lung edema. Causes chemical burns to the respiratory tract. Inhalation may be fatal as a result of spasm, inflammation, edema of the larynx and bronchi, chemical pneumonitis, and pulmonary edema. Cause corrosive action on mucous membranes. May affect cardiovascular system (hypotension, depressed cardiac output, bradycardia). Circulatory collapse with clammy skin, weak and rapid pulse, shallow respiration, and scanty urine may follow. Circulatory shock is often the immediate cause of death. May also affect teeth(changes in teeth and supporting structures - erosion, discoloration). Chronic Potential Health Effects: Inhalation: Prolonged or repeated inhalation may affect behavior (muscle contraction or spasticity), urinary system (kidney damage), and cardiovascular system, heart (ischemic heart lesions), and respiratory system/lungs(pulmonary edema, lung damage), teeth (dental discoloration, erosion). Skin: Prolonged or repeated skin contact may cause dermatitis, an allergic skin reaction.

Section 12: Ecological Information

Ecotoxicity: Ecotoxicity in water (LC50): 49 mg/l 48 hours [bluegill/sunfish].

BOD5 and COD: Not available.

Products of Biodegradation:

Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Sulfuric acid may be placed in sealed container or absorbed in vermiculite, dry sand, earth, or a similar material. It may also be diluted and neutralized. Be sure to consult with local or regional authorities (waste regulators) prior to any disposal. Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

Identification: : Sulfuric acid UNNA: 1830 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:

Illinois toxic substances disclosure to employee act: Sulfuric acid New York release reporting list: Sulfuric acid Rhode Island RTK hazardous substances: Sulfuric acid Pennsylvania RTK: Sulfuric acid Minnesota: Sulfuric acid Massachusetts RTK: Sulfuric acid New Jersey: Sulfuric acid California Director's List of Hazardous Substances (8 CCR 339): Sulfuric acid Tennessee RTK: Sulfuric acid TSCA 8(b) inventory: Sulfuric acid SARA 302/304/311/312 extremely hazardous substances: Sulfuric acid SARA 313 toxic chemical notification and release reporting: Sulfuric acid CERCLA: Hazardous substances.: Sulfuric acid: 1000 lbs. (453.6 kg)

Other Regulations:

OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):

CLASS D-1A: Material causing immediate and serious toxic effects (VERY TOXIC). CLASS E: Corrosive liquid.

DSCL (EEC):

R35- Causes severe burns. S2- Keep out of the reach of children. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S30- Never add water to this product. S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 2

Personal Protection:**National Fire Protection Association (U.S.A.):****Health:** 3**Flammability:** 0**Reactivity:** 2**Specific hazard:****Protective Equipment:**

Gloves. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Face shield.

Section 16: Other Information**References:**

-Material safety data sheet emitted by: la Commission de la Santé et de la Sécurité du Travail du Québec. -The Sigma-Aldrich Library of Chemical Safety Data, Edition II. -Hawley, G.G.. The Condensed Chemical Dictionary, 11e ed., New York N.Y., Van Nostrand Reinold, 1987.

Other Special Considerations: Not available.**Created:** 10/09/2005 11:58 PM**Last Updated:** 05/21/2013 12:00 PM

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SAFETY DATA SHEET

PHOSPHORIC ACID 30%

1 IDENTIFICATION OF THE SUBSTANCE AND OF THE COMPANY

Identification of the Substance: Orthophosphoric Acid

Synonyms: PHOSA30

Company Identification:
MURPHY & SON LTD.

ALPINE STREET
OLD BASFORD
NOTTINGHAM
NG6 0HQ
ENGLAND

TEL: + 44 (0)115 978 5494

FAX: + 44 (0)115 942 4431

Emergency Contact

TEL: + 44 (0)1332 830736

2 COMPOSITION/INFORMATION ON SUBSTANCE

Chemical Composition: Orthophosphoric acid in aqueous solution

CAS No.: 7664 - 38 - 2

Classification: C

Risk Phrases: R34 - Causes burns

3 HAZARD IDENTIFICATION CORROSIVE

Attacks metals to produce extremely flammable gas (hydrogen). Reacts as a strong acid with many chemicals and materials

Eye contact: May cause severe damage

Skin contact: Material will cause chemical burns

Inhalation: Causes damage to tissue of the respiratory tract if inhaled as a fine mist or aerosol

Ingestion: May cause burns to mouth, throat and digestive tract

Other Information: May cause localised adverse environmental impact due to pH

4 FIRST AID MEASURES

Eye contact: Flush eyes with copious quantities of water for at least 15 minutes. OBTAIN MEDICAL ATTENTION

Skin contact: Wash affected area with copious quantities of water for at least 15 minutes. Remove all contaminated clothing and wash before re-use. Obtain medical attention if irritation or redness persists

Inhalation: Remove from exposure. In severe cases OBTAIN MEDICAL ATTENTION

Ingestion: Wash out mouth with water provided person is conscious. Keep warm and at rest. OBTAIN MEDICAL ATTENTION

5 FIRE FIGHTING MEASURES

This product is a non-flammable liquid

Suitable Extinguishing Media: Water, dry chemical or carbon dioxide, dependent upon surrounding fire conditions

Unsuitable Extinguishing Media: None

Special Exposure Hazards: Acid mists may be produced in fires

Special Protective Equipment: Wear gloves, goggles, rubber boots and overalls if contact with the product is possible

6 ACCIDENTAL RELEASE MEASURES

Personal Precautions: Evacuate the area and warn others in the vicinity of the danger. Wear full protective clothing - overalls, goggles, gloves, and boots

Environmental Precautions: Prevent spillages from entering drains, streams, watercourses etc. If unavoidable warn the local Water Authority immediately

Methods for Cleaning Up: Do not touch spilled material. Contain in sand or earth. Spillage may be carefully neutralised with hydrated lime or soda ash. Shovel into marked container for safe disposal. After material pick-up is complete wash affected area well with plenty of water

7 HANDLING & STORAGE

Handling Precautions:	This material should be used only by trained personnel wearing safety goggles, chemically resistant gloves, boots and overalls. A safety shower/source of running water and eye bath should be available
Storage:	This is a food grade product – protect from contamination. Store in dedicated food grade areas. Store away from strong bases, oxidising and reducing agents. Protect from extremes of cold. Storage temperatures should be kept below 50°C. Will react with metal containers with liberation of hydrogen(a flammable gas). Suitable storage containers are: - certain stainless steels, certain plastics. Because of its corrosive nature, extreme care should be exercised in the choice of materials for pumps, gaskets and lines

8 EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Limits:	Short Term Exposure Limit (STEL):	2 mg/m ³ (15 mins)
Personal Protection:	Engineering controls to prevent or control exposure is preferred. Methods include process or personnel enclosure, mechanical ventilation (dilution and local exhaust), and control of process conditions	
Respiratory Protection:	Not required for normal work procedures. If misting occurs use an appropriate respirator for acid gases/mists	
Hand Protection:	Wear PVC gloves with gauntlets	
Eye Protection:	Wear full face visor	
Skin Protection:	Wear acid-resistant protective clothing with rubber boots. This substance attacks cotton and wool fabrics	
Other Protective Measures:	An eyewash and safety shower should be nearby	

9 PHYSICAL & CHEMICAL PROPERTIES

Appearance:	Colourless Liquid
Odour:	Odourless
pH:	< 2 at 1% w/w in water
Boiling Point:	135°C
Melting Point:	-18°C
Flash Point:	Not applicable
Flammability:	Non Flammable
Autoflammability:	Not applicable
Explosive Properties:	None
Oxidising Properties:	None
Relative Density:	Typically 1.180 – 1.220
Solubility:	Miscible with water in all proportions

10 STABILITY & REACTIVITY

Stability:	Stable at ambient temperatures
Conditions to Avoid:	Store away from incompatible materials
Materials to Avoid:	Contact with metals may cause formation of flammable and explosive hydrogen gas. Contact with bases will liberate heat. Poisonous gases will be released from materials containing sulphur, chlorine, cyanide or carbide
Hazardous Decomposition Products:	Above 300°C toxic gases and vapours dependent upon reactions. May liberate phosphorus oxide

11 TOXICOLOGICAL INFORMATION

Toxicological Data:	LD ₅₀ Oral (Rat) 1530 mg/kg LD ₅₀ Dermal (Rabbit) 2740 mg/kg
Effects of exposure:	
Eye contact:	This material is corrosive to the skin
Skin contact:	May cause severe damage to eyes
Carcinogenicity:	This material is not considered to be a carcinogen
Mutagenicity:	This material is not considered to be a mutagen
Reproductive Effects:	None identified

12 ECOLOGICAL INFORMATION

Environmental Effect:	May cause localised adverse environmental impact due to high pH
Ecotoxicity Value:	LC ₅₀ (Fish), (96hr) 100 -1000 mg/litre EC ₅₀ Sludge 270mg/litre
Persistence & Degradability:	Orthophosphate is a plant nutrient and may also precipitate heavy metals
Bioaccumulative Potential:	Product is inorganic; Log Pow inappropriate

13 DISPOSAL CONSIDERATIONS

Disposal of Product:	Neutralised acid slurry can be buried in an approved landfill. Do not wash into drains. This material is classified as a "special waste" under COPA (Special Waste) regulations 1980 and must be disposed of in accordance with those regulations
Disposal of Packaging:	Empty containers may contain hazardous residues. Labels should not be removed from containers until they have been cleaned. Containers should be cleaned by appropriate methods and then reused or disposed of by landfill or incineration as appropriate. Where practical, containers should be reused or recycled

14 TRANSPORT INFORMATION

UN No.:	1805
ADR/RID Classification:	8, 17(c)
Packing Group:	III
CDG - CPL Classification:	Corrosive



15 REGULATORY INFORMATION

Classification:	CORROSIVE
Hazard Pictogram:	C
Risk Phrases:	R34 - Causes burns
Safety Phrases:	S26 - In case of contact with eyes rinse immediately with plenty of water and seek medical advice S45 - In case of accident or if you feel unwell, seek medical advice immediately (show label where possible) S1/2 - Keep locked up and out of the reach of children
EEC No.	231 - 633 - 2



National Legislation:

The Control of Substances Hazardous to Health Regulations 1999
EH40 Occupational Exposure Limits
Chemicals (Hazard Information and Packaging for Supply) (Amendment) Regulations 1996 (CHIP 96) Amended 1998
Carriage of Dangerous Goods by Road and Rail (Classification, Packaging and Labelling) Regulations 1996
Carriage of Dangerous Goods by Road Regulations 1996

16 OTHER INFORMATION

Recommended Uses:	Customers should ensure that the product is entirely suitable for their own purpose
Further Information:	Advice and literature on the properties, storage and handling of this product are available on request
EEC Directive:	The above information complies with the Directive 93/112/EEC

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