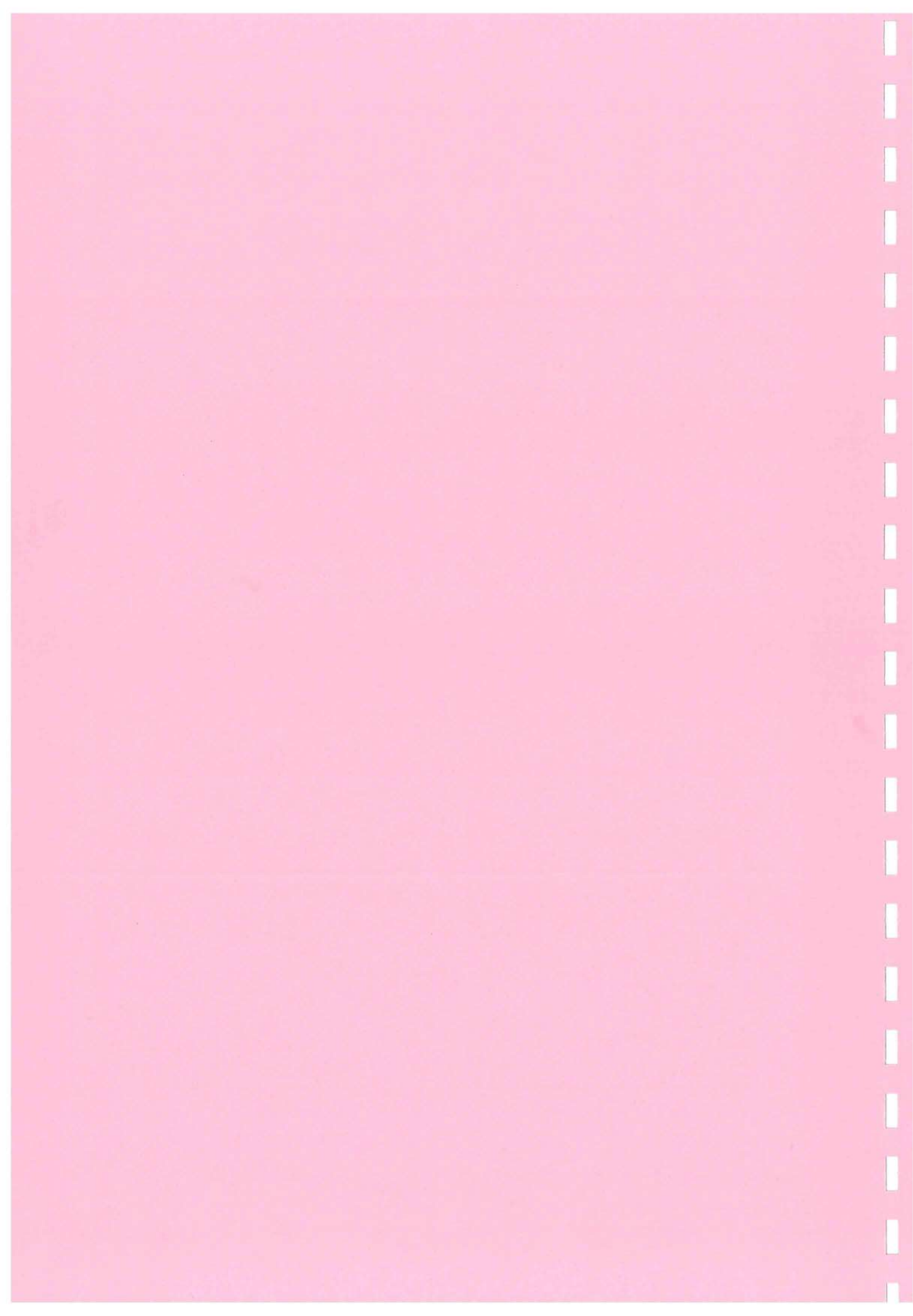


# RISK ASSESSMENT REPORT





SYMETRICS  
LIMITED

Client:

**FOCUS CONTAINER FREIGHT STATION**

Report:

**RISK ANALYSIS**

Revision:

**0**

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## **FOCUS CONTAINER FREIGHT STATION**

### **CONSTRUCTION OF A 15,000MT LIQUIFIED PETROLEUM GAS TERMINAL LOCATED IN KIPEVU LR. NO. MN/VI/3711, CHANGAMWE AREA, MOMBASA COUNTY**

PREPARED BY:	SYMETRICS LIMITED
ADDRESS:	GRAYLANDS IV INDUSTRIAL PARK, GODOWN NO. H06, ATHI RIVER, MOMBASA ROAD
DATE:	11 <sup>th</sup> MARCH 2025
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## LIST OF ABBREVIATIONS USED IN THE QUANTITATIVE RISK ANALYSIS

1	ROV	Remote Operated Valve
2	DOSHS	Directorate Directorate Of Occupational Safety And Health Services
3	TLF	Tank Lorry Filling Gantry
4	QRA	Quantitative Risk Analysis
5	LCS	Local Control Station
6	ALARP	As low as reasonably practicable
7	MCLS	Maximum Credible Loss Scenario
8	ELR	Environmental Lapse Rate
9	DALR	Dry Adiabatic Lapse Rate
10	UDM	Unified Dispersion Model
11	LFL	Lower Flammability Limit
12	UFL	Upper Flammability Limit
13	VCE	Vapour Cloud Explosion
14	F&EI	Fire and Explosion Index
15	MSDS	Material Safety Data Sheets
16	MSIHC	Manufacture, Storage and Import of Hazardous Chemicals
17	AIHA	American Industrial Hygiene Association
18	ERPG	Emergency Response Planning Guidelines
19	IDLH	Immediately Dangerous to Life or Health
20	STEL	Short Term Exposure Limit
21	LCLo	Lethal Concentration Low
22	TCLo	Toxic Concentration Low quantity
23	UDM	Unified Dispersion Model
24	FTA	Fault Tree Analysis
25	ETA	Event Tree Analysis
26	NDT	Non-Destructive Testing
27	MC	Maximum Credible Accident
28	UVCE	Unconfined Vapor Cloud Explosion
29	BLEVE	Boiling Liquid Expanding Vapor Explosion
30	ACGIH	American Conference of Governmental Industrial Hygienists

## 1.0 INTRODUCTION





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This Risk Analysis has been prepared for **FOCUS CONTAINER FREIGHT STATION** construction of a 15,000MT liquified petroleum gas terminal located in KIPEVU Ir. No. Mn/vi/3711, CHANGAMWE AREA, MOMBASA COUNTY.

Noticing the damage potential and the risk arising due to transportation, storage and handling of the flammable LPG, **SYMETRICS LIMITED** undertook the Risk Analysis for the LPG Plant and the finds are as follows in this report.

### 1.1 STUDY OBJECTIVES

The main objective QRA (Quantitative Risk Analysis) is to determine the potential risks of major disasters having damage potential to life and property and provide a scientific basis for decision makers to be satisfied about the safety levels of the facilities to be set up. This is achieved by the following:

1. Identification of hazards that could be realized from process plant.
2. Identify the potential failure scenarios that could occur within the facility.
3. To Assess, the potential risks associated with identified hazards to which the plant and its personal and community outside may be subjected. Consequences analysis of various hazards is carried out to determine the vulnerable zones for each probable accident scenario.
4. Evaluate the process hazards emanating from the identified potential accident scenarios.
5. Analyze the damage effects to the surroundings due to such accidents.
6. Conclusion and Recommendation to mitigate measures to reduce the hazard / risks.
7. To provide guidelines for the preparation of On-site response plan.

### 1.2 SCOPE OF STUDY

The scope of the QRA is given below:

1. Identification of Hazards (Fire/Explosion/Uncontrolled release of LPG/FIREBALL etc.)
2. Identification of maximum credible accident scenario using inputs from fault tree analysis, event tree analysis etc.
3. Frequency analysis. Evaluate the likelihoods of occurrence of possible events. Select worst case scenario.
4. Consequence modeling and analysis for the identified hazard covering impact on people and potential escalation.
5. Vapour cloud explosion scenario and unconfined vapour cloud explosion scenario due to uncontrolled leakage of LPG shall also be worked out.
6. Assessment of risk arising from the hazards and consideration of its tolerability to personnel, facility & environment. Assessment of risk to individual and /or societal and neighboring areas and contour mapping.
7. Damaged limits identification and quantification of the risk and contour mapping on the layout.
8. Determination of maximum over pressure and heat radiation effect which could act on the critical areas of the location.
9. Individual risk quantification and contour mapping.
10. Evaluation of risk against the acceptable risk limit.
11. Estimation of overall risk/risk quantification.
12. Prioritize and reduce risks. Risk documentation. Evaluate adequacy of risk reduction measures provided at location. Show whether risks have been made as 'As Low as Reasonably Practicable' (ALARP).
13. Risk reduction measures to prevent incidents, to control accidents.



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### **1.3 OBJECTIVES, PHILOSOPHY AND METHODOLOGY**

#### **1.3.1. OBJECTIVES:**

The objective of this study is to identify potential physical hazards which could trigger losses causing events, such as fire and explosion and toxic gas cloud dispersion. Further objective of this study is to identify major accident scenarios, carry out consequence analysis, assess the associated risks, and suggest measures for risk reduction wherever warranted.

#### **1.3.2. PHILOSOPHY:**

Risk Assessment is a complex exercise and can be carried out to various depths. The depth of the study is determined by the definition of the study goals and study requirements.

Hazard identification is a key step in Risk Assessment. It is also important step in various safety studies and very many techniques are available for hazard identification depending on the depth and objective of the study. The most relevant to risk Assessment is review of release sources of hazardous chemicals. For the selected release source scenarios, depending upon the failure mode, causing loss of containment are developed.

#### **1.3.3. METHODOLOGY:**

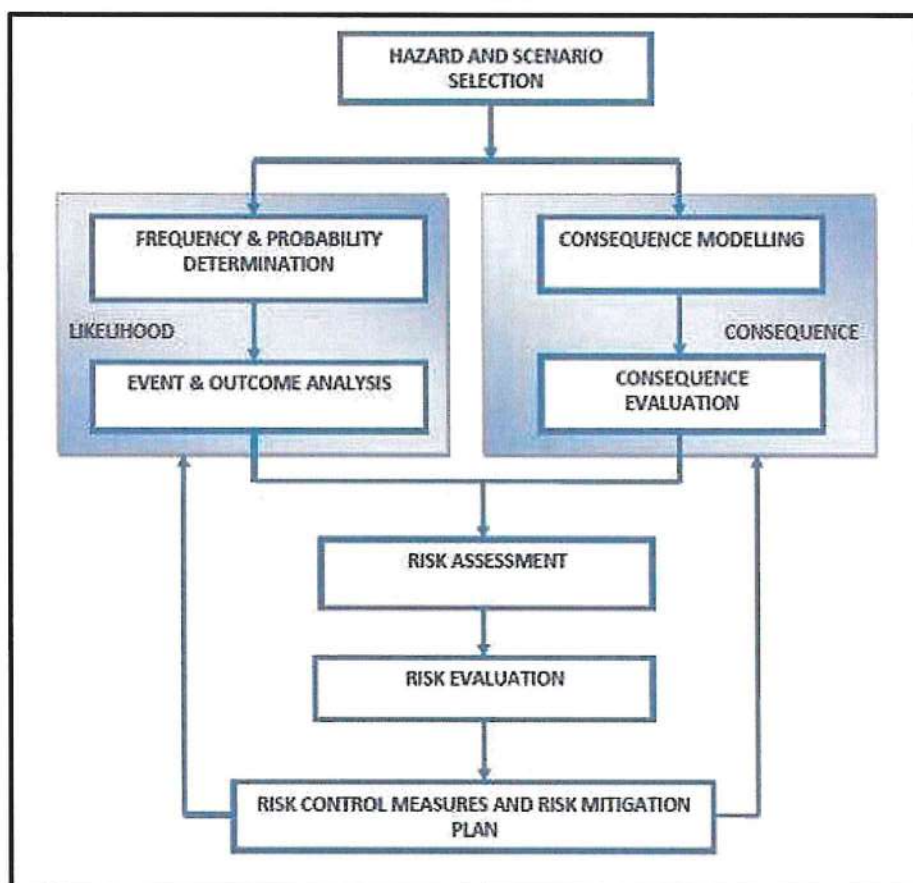
Risk Analysis techniques provide advanced quantitative means to supplement other hazard identification, analysis, assessment, control and management methods to identify the potential for such incidents and to evaluate control strategies. The methodology adopted for the QRA Study has been depicted in the Flow chart given below:





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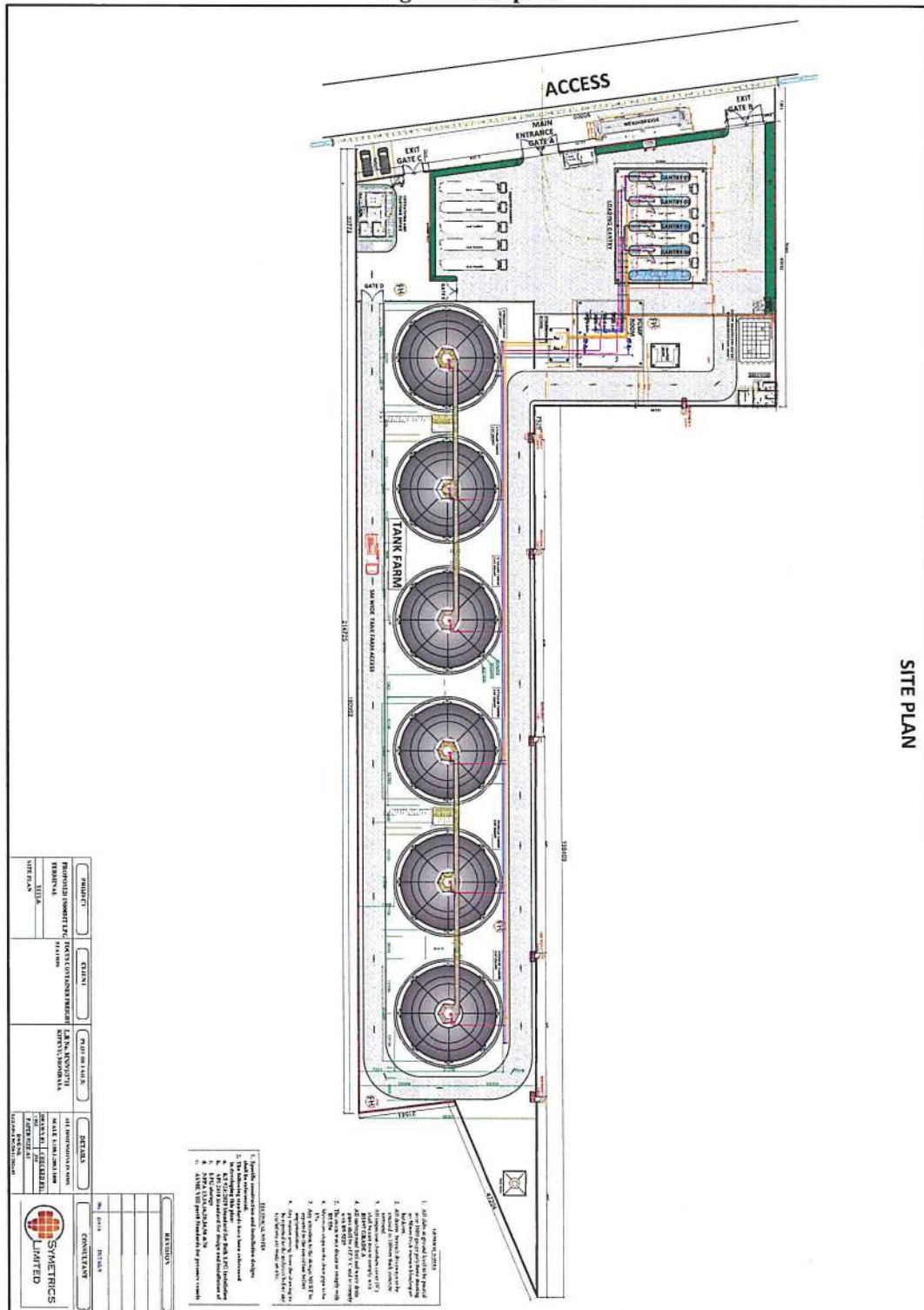
Fig 1.1: Methodology





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Fig 1.2: Site plan







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**TOPOGRAPHICAL VIEW**



**TOPOGRAPHICAL VIEW**





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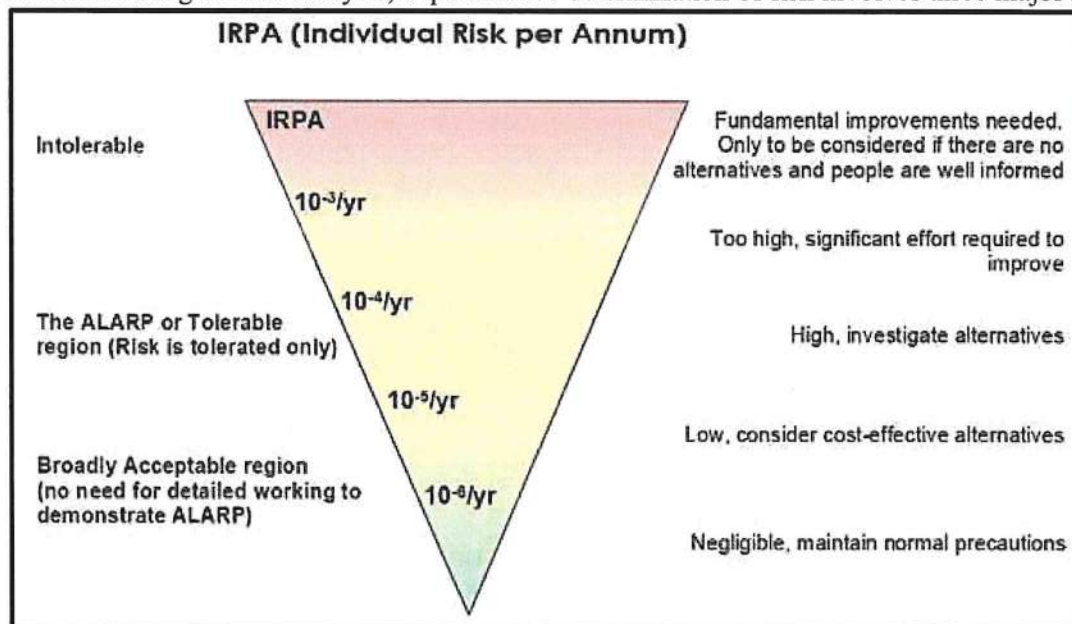
#### 1.4 RISK ANALYSIS AND RISK ASSESSMENT.

The basic procedure in a risk analysis shall be as follows:

- Identify potential failures or incidents (including frequency)
- Calculate the quantity of material that may be released in each failure, estimate the probability of such occurrences.
- Evaluate the consequences of such occurrences based on scenarios such as most probable and worst case events.
- The combination of consequences and probability will allow the hazards to be ranked in a logical fashion to indicate the zones of important risk. Criteria should then be established by which the quantified level of risk may be considered acceptable to all parties concerned.
- After assessing the risk "maximum tolerable criterion" must be defined and above which the risk shall be regarded as intolerable. Whatever be the benefit level must be reduced below this level.
- The risk should also be made "as low as reasonably practicable" (ALARP) and least impacting the neighborhood.

Fig 1.3:

While conducting the risk analysis, a quantitative determination of risk involves three major steps:



#### 1.5 QUANTITATIVE RISK ASSESSMENT

QRA study for, Focus Container Freight Station has been carried out based on the provided report.

The study has been carried out in accordance with the International codes of practices

The full terms of potential hazardous scenarios and consequence events associated with the installation and operation was considered in the analysis.

Based on the operations to be carried at the plant, the Risk Analysis, affected distances and the damage of property and population from the identified scenarios considering the Maximum Credible Loss Scenario (MCLS) & Worst case scenario.

Maximum credible loss scenarios have been worked based on the inbuilt safety systems and protection measures to be provided for the operation of the facility.



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We have assumed Maximum credible loss scenario (MCLS) i.e. Nozzle failure and Worst case Scenario i.e. catastrophic rupture

Similarly, maximum inventory at the time of failure is assumed.

### **1.6 USE OF QRA RESULTS:**

The techniques used for risk prediction within the QRA have inherent uncertainties associated with them due to the necessary simplifications required. In addition, QRA incorporates a certain amount of subjective engineering judgment and the results are subject to levels of uncertainty. For this reason, the results should not be used as the sole basis for decision making and should not drive deviations from sound engineering practice. The results should be used as a tool to aid engineering judgment and, if used in this way, can provide valuable information during the decision making process.

The QRA results are dependent on the assumptions made in the calculations, which are clearly documented throughout the following sections of this report. Conservative assumptions have been used, which helps to remove the requirement for detailed analysis of the uncertainty.

The results show the significant contributions to the overall risk and indicate where worthwhile gains may be achieved if further enhancement of safety is deemed necessary.

### **1.7 WEATHER CATEGORY**

One of the most important characteristics of atmosphere is its stability. Stability of atmosphere is its tendency to resist vertical motion or to suppress existing turbulence. This tendency directly influences the ability of atmosphere to disperse pollutants emitted into it from the facilities. In most dispersion scenarios, the relevant atmospheric layer is that nearest to the ground, varying in thickness from a few meters to a few thousand meters. Turbulence induced by buoyancy forces in the atmosphere is closely related to the vertical temperature gradient.

Temperature normally decreases with increasing height in the atmosphere. The rate at which the temperature of air decreases with height is called Environmental Lapse Rate (ELR). It will vary from time to time and from place to place. The atmosphere is said to be stable, neutral or unstable according to ELR is less than, equal to or greater than Dry Adiabatic Lapse Rate (DALR), which is a constant value of 0.98°C/100 meters. Pas-quill stability parameter, based on Pas-quill – Gifford categorization, is such a meteorological parameter, which describes the stability of atmosphere, i.e., the degree of convective turbulence. Pas-quill has defined six stability classes ranging from 'A' (extremely unstable) to 'F' (moderately stable). Wind speeds, intensity of solar radiation (daytime insolation) and nighttime sky cover have been identified as prime factors defining these stability categories.

When the atmosphere is unstable and wind speeds are moderate or high or gusty, rapid dispersion of pollutants will occur. Under these conditions, pollutant concentrations in air will be moderate or low and the material will be dispersed rapidly. When the atmosphere is stable and wind speed is low, dispersion of material will be limited and pollutant concentration in air will be high. In general, worst dispersion conditions (i.e. contributing to greater hazard distances) occur during low wind speed and very stable weather conditions.

### **1.8 METHODOLOGY ADOPTED FOR CONSEQUENCE ANALYSIS**

Consequences of loss of containment can lead to hazardous situation in any industry handling potentially hazardous materials. Following factors govern the severity of consequence of the loss of containment.

- a) Intrinsic properties; flammability, instability and toxicity.
- b) Dispersive energy; pressure, temperature and state of matter.
- c) Quantity present
- d) Environmental factors; topography and weather.





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Consequence analysis and calculations are effectively performed by computer software using models validated over a number of applications.

PHAST contains data for a large number of chemicals and allows definition of mixtures of any of these chemicals in the required proportion. The calculations involve following steps for each modeled failure case:

- Run discharge calculations based on physical conditions and leak size.
- Model first stage of release (for each weather category).
- Determine vapor release rate by flashing of liquid and pool evaporation rate.
- Dispersion modeling taking into account weather conditions.
- In case of flammable release, calculate size of effect zone for fire and explosion.

## 1.9 HAZARDS OF MATERIALS

### DEFINITIONS

The release of flammable gas or liquid can lead to different types of fire or explosion scenarios. These depend on the material released, mechanism of release, temperature and pressure of the material and the point of ignition. Types of flammable effects are as follows:

**FLASH FIRE:** It occurs when a vapor cloud of flammable material burns. The cloud is typically ignited on the edge and burns towards the release point. The duration of flash fire is very short (seconds), but it may continue as jet fire if the release continues. The overpressures generated by the combustion are not considered significant in terms of damage potential to persons, equipment or structures.

The major hazard from flash fire is direct flame impingement. Typically, the burn zone is defined as the area the vapor cloud covers out to half of the LFL. This definition provides a conservative estimate, allowing for fluctuations in modeling. Even where the concentration may be above the UFL, turbulent induced combustion mixes the material with air and results in flash fire.

**JET FIRE:** Escaping jet of LPG from pressure vessels/piping, if ignited, cause a jet flame. The jet flame direction and tilt depend on prevailing wind direction and velocity. Jet flames are characterized as high-pressure release of gas from limited openings (e.g. due to small leak in a vessel or broken drain valve).

A fireball is an intense spherical fire resulting from a sudden release of pressurized liquid or gas that is immediately ignited.

**FIREBALL:** A combination of fire and explosion, sometimes referred as fireball, occurs with an intense radiant heat emission in a relatively short time interval along with generation of heavy pressure waves and flying fragments of the vessel. As implied by the term, the phenomenon can occur within a vessel or tank in which a liquefied gas is kept at a temperature above its atmospheric boiling point.

If a pressure vessel fails as a result of a weakening of its structure the contents are instantaneously released from the vessel as a turbulent mixture of liquid and vapor, expanding rapidly and dispersing in air as a cloud.

When this cloud is ignited, a fireball occurs, causing enormous heat radiation intensity within a few seconds. This heat intensity is sufficient to cause severe skin burns and deaths at several hundred meters from the vessel, depending on the quantity of the gas involved.

A fireball therefore be caused by a physical impact on a vessel, for example from a traffic accident with a road tanker or a derailment of, or it can be caused by fire impinging upon or engulfing a vessel and thus weakening its structure.





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Explosions are characterized by a shock-wave, which can cause damage to buildings, breaking windows and ejecting missiles over distances of several hundred meters. The injuries and damages are in the first place caused by the shock-wave of the explosion itself. People are blown over or knocked down and buried under collapsed buildings or injured by flying fragments.

The effects of the shock wave depend on factors like characteristics of the chemical, quantity of the chemical in the vapor cloud etc. The peak pressures in an explosion, therefore, vary between slight over-pressure and a few hundred kilopascals (KPa).

Pressure of the shock-wave decreases rapidly with the increase in distance from the source of the explosion.

### CONFINED AND UNCONFINED VAPOR-CLOUD EXPLOSIONS:

Confined explosions are those that occur within some sort of containment such as vessel or pipe work. Explosions in buildings also come under this category.

Explosions that occur in the open air are referred to as unconfined explosions and produce peak pressures of only a few KPa. The peak pressures of confined explosions are generally higher and may reach hundreds of KPa.

All the examples given are vapor cloud explosions, which in some cases, lead to detonation due to the confinement of the gas cloud. It is difficult to strictly distinguish between a fire and an explosion. Quite often a fire follows an explosion and the casualties are caused by both phenomena.

### 1.10 FIRE AND EXPLOSION INDEX (F & EI)

F & EI is a rapid ranking method for identifying the degree of hazard. In preliminary hazard analysis LPG are considered to have fire & Explosion hazards. The application of F & EI would help to make a quick assessment of the nature and quantification of the hazard in these areas. However, this does not provide precise information.

Material factor (MF) of the material concerned, the General Process hazards and Special Process Hazards associated with the product are taken into consideration while computing, using standard procedure of awarding penalties based on storage, handling & operating parameters.

As regards the storage area is concerned the major potential hazard rests with the contents of LPG. In addition F & EI for complete storage area has been evaluated.

### 1.11 DOW F & EI HAZARD CLASSIFICATION

The F & EI calculation is used for estimating the damage that would probably result from an accident in the plant. The following is the listing of F & EI values versus a description of the degree of hazard that gives some relative idea of the severity of the F & EI.

#### Computations & Evaluation of Fire Explosion Index:

The degree of hazard potential is identified based on the numerical value of FEI as per following criteria:

#### DEGREE OF HAZARD FOR F & EI

F&EI Range	Degree of Hazard
1-60	Light
61-96	Moderate
97-127	Intermediate
128-158	Heavy



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### 1.12 FEI & TI Methodology:

In order to estimate FEI & TI, approach given in "Major Hazard Control" (An ILO Publication) has been referred. Dow's Fire & Explosion Index (FEI) is a product of Material factor (MF) and hazard factor (HF) while MF represents the flammability and reactivity of the substances, the hazard factor (HF), is itself a product of General Process Hazards (GPH) and Special Process Hazards (SPH).

#### (A) Selection of Pertinent Storage or Process Unit

For the purpose of FEI & TI calculations, a Process Unit is defined as any unit or pipeline under consideration for the purpose of estimating FEI & TI. Hence, all the process units, storage tanks and units handling hazardous chemicals etc. can be termed as process units.

However, only pertinent process units that could have an impact from the loss prevention standpoint need to be evaluated.

The selection of pertinent process / storage units is based on the following factors:

1. Energy potential of the chemical/chemicals in the unit for flammable & reactive
2. hazards, represented by Material Factor (MF) Inventory/quantity of hazardous material in the process unit
3. Operating temperature and pressure

#### (B) Determination of Material Factor (MF)

MF is a measure of intrinsic rate of potential energy release from fire or explosion produced by combustion or any other chemical reaction. Hazard potential of a chemical has been represented by flowing three Indices

Index	Indicates
Nh (for health)	Toxic hazard potential
Nf (for flammability)	Fire hazard potential
Nr (for reactivity)	Explosion/Reactive hazard potential

Values of Nh, Nf & Nr ranges from 0 to 4, depending on their hazard potential.

Significance of Nf, Nh & Nr values has been defined, while MF is calculated based on Nf & Nr.

#### (C) Computation of General Process Hazard Factor (GPH)

Operations or processing conditions which contribute to a significant enhancement of potential for fire and explosion have been identified. Accordingly numerical values of penalties are to be allocated. Sum of these penalties would be GPH for the unit.

The penalties include:

1. Exothermic and endothermic reaction,
2. Handling and transfer of chemicals,
3. Enclosed or indoor process units & accessibility of equipment and facilities with respect to drainage or spill control

#### (D) Computation of Special Process Hazard Factor (SPH)

SPH includes the factors that are specific to the process unit, under consideration:

1. Process temperature
2. Low pressure





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3. Operation in or near flammable range
4. Operating pressure
5. Low temperature
6. Quantity of flammable or toxic material
7. Corrosion and erosion
8. Leakage, joints and packing

**(E) Classification of Hazard Categories**

By comparing the indices FEI and TI, the unit in consideration is classified into one of the following three categories based on their hazard potential.

Category	FEI	TI
Light	< 65	< 6
Moderate	65 to 95	6 to 10
Severe	> 95	> 10

#### 1.14 LPG-LIQUEFIED PETROLEUM GAS:

##### PROPERTIES

Commercial LPG marketed in KENYA consists of Butane and Propane. They are in vapor form at ambient temperature and they are condensed to liquid state by application of moderate pressure and simultaneous reduction in temperature.

##### I. PROPERTIES OF LPG:

- A. COLOR:** Like air, LP gas is colour less, therefore it cannot be seen. However, when liquid LPG leaks from a container, it vaporizes immediately. This produces a cooling of surrounding air and may cause water vapor in the air to condense, freeze and become visible.
- B. ODOUR:** LPG is basically odour less. Hence, it is distinctly odorized by adding Mercaptan Sulphur to give warning in case of leakage. It can be smelt sufficiently before it becomes dangerous enough to catch fire.
- C. TASTE:** LPG vapour is tasteless and non-toxic. Therefore, presence of LPG vapours in atmosphere cannot be sensed by taste.

##### II. PHYSICAL & CHEMICAL PROPERTIES:

###### A. DENSITY OF LIQUID:

It is defined as mass per unit volume of substance at a given temperature (grams/cm<sup>3</sup>). Density of liquid at 15 degree C grade (Water=1) is 0.542 i.e. half as heavy as water i.e. in all 1 litre capacity container we can store 1kg of water whereas we can store 0.542 kg of LPG only.

###### B. DENSITY OF VAPOUR:

It is defined as mass of a substance occupying a unit volume at a stated temperature and pressure (kg/m<sup>3</sup>). LPG vapour is 1.5 to 2 times volume at a stated temperature and pressure (kg/m<sup>3</sup>). LPG vapour is 1.5 to 2 times heavier than air. As a result of this property, any leakage LPG tends to settle down at the lower most



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important that floor level ventilation's should be provided to disperse leaking gas to prevent accumulation of gas. The volume of gas at 15 degree C, 760 mm Hg is 0.44 litres/gr.

**C. COEFFICIENT OF VOLUMETRIC EXPANSION:**

It is defined as change in volume per unit of liquid for each degree of temperature change. The coefficient of volumetric expansion of LPG is about 100 times that of the steel. Hence, any LPG container must be filled to a certain volume of liquid in order to leave sufficient space for LPG expansion in case of temperature rise.

**D. MELTING/FREEZING POINT:**

The lowest temperature at which liquid assumes the solid state is known as melting point i.e. 187degrees C for propane and 137 degree C for Butane.

**E. CRITICAL TEMPERATURE:**

It is defined as the highest temperature at which a substance exists as liquid irrespective of pressure applied i.e. 97 degree C for propane and 152 degree C for Butane.

**F. CRITICAL PRESSURE:**

The minimum pressure required to obtain the substance in liquid form at a critical temperature is called critical pressure. That is 43 kg/Sq.cm for Propane and 39 kg/Sq.cm for Butane

**G. BOILING TEMPERATURE:**

The temperature at which vapor pressure of a liquid becomes equal to the external pressure is called the boiling temperature. The boiling point of LPG presently marketed is very nearly zero degree C or sub zero temperature. Therefore, this product cannot be used at places where the ambient temperature is near/or sub-zero.

**H. VAPOUR PRESSURE:**

The vapour pressure of liquid at a give a temperature is defined as the equilibrium, pressure developed at that temperature in a closed container containing the liquid and its vapour only. The point of equilibrium is reached when the rate of escape of molecules for liquid = the rate of return to the liquid.

**I. LATENT HEAT OF VAPOURIZATION OF LIQUID:**

It is defined as the heat needed at a particular temperature to change a unit mass of liquid to vapour without change in temperature. At zero degree C it is 90 KCAL/kg for propane, 92 KCAL/kg for Butane.

**J. SPECIFIC HEAT:**

It is defined as quantity of heat requested to raise unit mass of substance through unit temperature interval. It is 0.57 KCAL/kg at 0 degree C for Butane.

**K. FLAMABILITY RANGE:**

The minimum and maximum percentage of fuel gas in air in which the mixture can be ignited are termed as lower/upper limits of flammability. The range is 1.8% to 9%.

**L. IGNITION TEMPERATURE:**

The minimum temperature of the spark/flame/heated material required for burning of combustible mixture i.e. 410 degrees C to 580 degrees C.

**M. CALORIFIC VALUE:**

It is defined as amount of heat produced by complete combustion of unit mass of the fuel. It is about 11400 KCAL/kg for LPG.





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**N. THEORETICAL FLAME TEMPERATURE:**

In air-2000 degree C and in oxygen 2850 degree C.

**O. VOLUME OF GAS PRODUCED ON VAPORIZATION:**

One volume of liquid LPG produces 250 volumes of gas at a normal temperature and pressure. Therefore, large quantity of gas can be compactly stored and transported in liquid form.

**P. VISCOSITY:**

Liquid LPG has a low viscosity and can leak in situations in which water may not. It is a poor lubricant and leaks are therefore likely to occur at seals (on pumps).

**Q. AUTO REFRIGERATION:**

Refers the phenomena which occurs when the pressure is rapidly released from a vessel containing liquid LPG. Any evidence of frosting on outside of the vessel is an indication that auto refrigeration is occurring

### **1.15 LIQUEFIED PETROLEUM GAS (LPG):**

#### **INFERENCES**

1. Liquefied petroleum gas in general use is commercial butane and commercial propane. These hydrocarbons exist in gaseous state at normal temperatures and pressure but can be liquefied under moderate pressure. If the pressure is subsequently released, the hydrocarbons will again gasify.
2. LPG is colorless and its density in liquefied form is approximately half of that of water. If LPG is spilt on water, it will float on the surface before vaporizing. The liquid has approximately 1/250th of the gas volume.
3. The gas or vapor is at least 1.5 times denser than air and does not disperse very easily. It will tend to sink to the lowest possible level and may accumulate in cellars, pits, drains or other depressions depending on wind velocity and atmospheric stability.
4. LPG forms flammable mixtures with air in volumetric concentrations of between 2% & 10% (approximately). It can, therefore, be a fire & explosion hazard if stored or used un-safely. There have been incidents in which escapes of LPG have been ignited, resulting in serious fires. If LPG escapes into a confined space and is ignited, an explosion could result. If a LPG vessel is involved in a fire, it may overheat and rupture violently giving an intensely hot fireball and may project pieces of the vessel over considerable distance.
5. Vapor/air mixture arising from leakage or other causes may be ignited at some distance from the point of escape and the flame may travel back to source. This phenomenon is called as "Back Fire".
6. At very high concentrations, when mixed with air, LPG vapor is anesthetic and subsequently an asphyxiant by diluting or decreasing the available oxygen.
7. LPG can cause cold burns to the skin owing to its rapid vaporization and consequent lowering of temperature. Vaporization of LPG can also cool equipment to the extent that it may be cold enough to cause cold burns. Protective clothing such as gloves and goggles should be worn if this cooling is likely to occur.
8. LPG is normally odorized before distribution so that it has a characteristic smell, which can easily be recognized. This enables detection by smell of the gas at concentrations down to one fifth of the lower limit of flammability. Significant leaks may also be detected by hissing sound or by icing in the area of the leak. Small leaks may be detected by applying the suspect areas with a detergent/water mixture where bubbles will form at the leak. On no account should a flame or other source of ignition be used to detect a leak. To sense leakage of LPG portable type as well as panel mounted detectors are used.
9. A vessel, which has held LPG and is nominally empty may still contain LPG in vapor form and be potentially dangerous. In this state the internal pressure is approximately atmospheric and, if a valve is leaking or left opens, air can diffuse into the vessel and thus a flammable mixture may be formed.





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The extent of the consequences arising from a LPG depends on the quantity of LPG present, mode of containment, and external factors like location, density of population etc. In many cases realization of hazard and its potential also depend on prevailing meteorological conditions and availability of ignition source. Thus the most serious consequences would arise from a large inventory of LPG surrounded by a densely populated area. LPG requires interaction with air or oxygen for its hazard to be realized.

Under certain circumstances the vapor/gas when mixed with air may be explosive especially in confined spaces. However, if LPG is present within flammability limits, the cloud may explode in the open air also. Following methods of hazard identification have been employed in this study: Characterization of major hazardous units based on Manufacture, Storage and Import of Hazardous Chemicals Rules

### 1.16 HAZARDS ASSOCIATED WITH TOXIC MATERIALS

It is necessary to specify suitable concentration of the toxic substance under study to form the end-point for consequence calculations. The considerations for specifying the end-points for the hazardous material involved in the failure scenario are described in the following paragraphs. American Industrial Hygiene Association (AIHA) has issued Emergency Response Planning Guidelines (ERPG) for many chemicals.

**ERPG-1** is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour.

**ERPG-2** is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms, which could impair an individual's ability to take protective action.

**ERPG-3** is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

Toxic limit values as Immediately Dangerous to Life or Health (IDLH) concentrations are issued by US National Institute for Occupational Safety and Health (NIOSH). An IDLH level represents the maximum airborne concentration of a substance to which a healthy male worker can be exposed as long as 30 minutes and still be able to escape without loss of life or irreversible organ system damage. IDLH values also take into consideration acute toxic reactions such as severe eye irritation, which could prevent escape. IDLH values are used in selection of breathing apparatus.

**TLV:** Threshold Limit Value – is the permitted level of exposure for a given period on a weighted average basis (usually 8 hrs for 5 days in a week).

**STEL:** A Short Term Exposure Limit (STEL) is defined by ACGIH as the concentration to which workers can be exposed continuously for a short period of time without suffering from:

- Irritation
- Chronic or irreversible tissue damage
- Narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency.

It is permitted Short Time Exposure Limit usually for a 15-minute exposure.





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### 1.17 DAMAGE CRITERIA

Damage estimates due to thermal radiations and overpressure have been arrived at by taking in to consideration the published literature on the subject. The consequences can then be visualized by the superimposing the damage effects zones on the proposed plan site and identifying the elements within the project site as well as in the neighboring environment, which might be adversely affected, should one or more hazards materialize in real life.

#### 1.17.1 THERMAL DAMAGE

The effect of thermal radiation on people is mainly a function of intensity of radiation and exposure time. The effect is expressed in terms of the probability of death and different degrees of burn. The following tables give the effect of various levels of heat flux.

**Table 1.1: Damage Due To Incident Radiation Intensity**

Incident Radiation intensity (KW/m <sup>2</sup> )	Type of damage
37.5	Sufficient to cause damage to process equipment
25.0	Minimum energy required to ignite wood, at infinitely long exposure (non piloted)
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing etc.
4.0 – 5.0	Sufficient to cause pain to personnel if unable to reach cover within 20 seconds, however blistering of skin (first degree burns) is likely
1.6	Will cause no discomfort to long exposure
0.7	Equivalent to solar radiation

**Table.1.2: Damage Effects of Blast Overpressure**

Blast Overpressure, psi	Damage Level
5.0	Major structural damage (assumed fatal to people inside building or within other structures)
3.0	Oil storage tank failure
2.5	Eardrum rupture
2.0	Repairable damage. Pressure vessels intact; light structures collapse
1.0	Window breakage, possibly causing some injuries

### 1.18 SELECTED FAILURE CASES

Earlier, it was the practice to select a particular item in a unit as failure scenario, e.g. rupture of reactor outlet pipe. Such selection is normally subjective on following parameters:

- Properties of material namely Toxic or Flammable.



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- The likely severity of consequence in the event of accidental release based on inventory, operated pressure & operated temperature.
- The probability of failure of various equipments such as valves, flanges, pipe, pressure vessels etc. used in the plant.

The scenarios are considered to be confined to those equipment failures which involve the leakage of flammable or toxic products, of which the frequency of occurrence and the severity of the consequences have been taken into consideration and which may have a low probability of early detection.

Taking this factor into consideration, a list of selected failure cases was prepared based on process knowledge, inventory, engineering judgment, and experience, past incidents associated with such facilities and considering the general mechanisms for loss of containment. Cases have been identified for the consequence analysis.

Consequence analysis and calculations are effectively performed by computer software using models validated over a number of applications.

### 1.19 EFFECT OF RELEASE

When hazardous material is released to atmosphere due to any reason, a vapor cloud is formed. Direct cloud formation occurs when a gaseous or flashing liquid escapes to the atmosphere. Release of hydrocarbons and toxic compounds to atmosphere may usually lead to the following:

- a) Dispersion of hydrocarbon vapor with wind till it reaches its lower flammability limit (LFL) or finds a source of ignition before reaching LFL, which will result in a flash fire or explosion.
- b) Spillage of liquid hydrocarbons will result in a pool of liquid, which will evaporate taking heat from the surface, forming a flammable atmosphere above it. Ignition of this pool will result in pool fire causing thermal radiation hazards.
- c) Lighter hydrocarbon vapor or Hydrogen disperses rapidly in the downwind direction, being lighter than air. But comparatively heavier hydrocarbon vapor cloud like that of LPG, propane will travel downwind along the ground. If it encounters an ignition source before it is dispersed below the LFL, explosion of an unconfined vapor cloud will generate blast waves of different intensities.
- d) A fireball occurs when a vessel containing a highly volatile liquid (e.g. LPG, Propylene etc) fails and the released large mass of vapor cloud gets ignited immediately. It has damage potential due to high intensity of radiation and generation of the overpressure waves, causing large-scale damage to nearby equipment and structures.
- e) Catastrophic failure of tanks/ pressurized vessels, rotary equipment and valves etc. can result in equipment fragments flying and hitting other equipment of the plant.
- f) Release of toxic compounds results in the toxic vapour cloud traveling over long distances, affecting a large area, before it gets sufficiently diluted to harmless concentration in the atmosphere.
- g) The material is in two phases inside the containment - liquid & vapor. Depending on the location of the leak liquid or vapor will be released from the containment. If vapor is released a vapor





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cloud will form by the mixing of the vapor and air. The size of the vapor cloud will depend on the rate of release, wind speed; wind direction & atmospheric stability will determine the dispersion and movement of the vapor cloud.

- h) If liquid is released there will be some flashing as the boiling point of liquid is below the ambient temperature. The vapor formed by immediate flashing will behave as vapors release. The liquid will fall on the ground forming a pool. There will be vaporization from the pool due to the heat gained from the atmosphere & ground. There will be dispersion and movement of vapor cloud formed by evaporation of liquid.
- i) The behavior of material released by loss of containment depends on the following factors:
1. Physical properties of the material.
  2. Conditions of material in containment (pressure and temperature).
  3. Phase of material released (liquid or gas).
  4. Inventory of material released.
  5. Weather parameters (temperature, humidity, wind speed, atmospheric stability).
  6. Material with boiling point below ambient condition.

## 1.20 CONSEQUENCE ANALYSIS

### 1.20.1 INTRODUCTION

Consequence analysis quantifies vulnerable zone for a conceived incident and once the vulnerable zone is identified for an incident measures can be proposed to eliminate damage to plant and potential injury to personnel. For consequence analysis both units chosen for hazards analysis are considered.

#### The following likely scenarios considered for hazard analysis

- Rupture of one of the nozzle/pipe
- Bursting/catastrophic rupture of a tank
- Road tanker fire

The consequence analysis is carried out to determine the extent of spread(dispersion) by accidental release which may lead to jet fire, pool fire, tank fire resulting into generating heat radiation, overpressures, explosions etc. In order to form an opinion on potentially serious hazardous situations and their consequences, consequence analysis of potential failure scenarios is conducted.

It is qualitative analysis of hazards due to various failure scenarios.

In consequence analysis, each failure case is considered in isolation and damage effects predicted, without taking into the account of the secondary events or failures it may cause, leading to a major disastrous situation.

The results of consequence analysis are useful in developing disaster management plan and in developing a sense of awareness among operating and maintenance personnel. It also gives the operating personnel and population living in its vicinity, an understanding of the hazard they are posed to.



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### 1.20.2 EVENT TREE ANALYSIS TO DEFINE OUTCOME OF RELEASE

Different outcomes of a leakage or catastrophic failure are possible depending on if and when ignition occurs and the consequences thereupon. ETA considers various possibilities such as immediate or delayed ignition for the different outcomes to occur. From ETA, following incident outcomes and the pathways are identified:

1. Fireball due to immediate ignition of an instantaneous escape of LPG from any MSV or road tanker.
2. Flare or Jet fire due to immediate ignition of a continuous release of LPG from any MSV or any LPG handling unit and escalating into a fireball due to flame impingement or over heating.
3. Delayed ignition of a vapor cloud formed due to continuous release of LPG from any MSV or any LPG handling unit resulting in 'back fire' and escalation of the event in to a fireball.
4. Confined or Unconfined VCE due to delayed ignition of a vapor cloud formed due to continuous or an instantaneous release of LPG from any MSV or any LPG handling unit.

ETA diagrams for various modes of failures of storage vessels for pressurized liquefied gas, i.e. LPG has also been developed for conditions such as overfilling, over-pressure and remote incidents like missile, lightening or bomb attack and earth quake. The resultant rupture of vessels or leak incidents has been identified. The outcomes of such accidents are also been identified in ETA. These are depicted in for Pressurized Liquefied gases. Scenarios pertaining to over-pressure and overfilling are most credible.

### 1.20.3 FAULT TREE ANALYSIS TO EXPLORE PROPENSITY FOR OCCURRENCE OF THE TOP EVENT

In a system such as LPG Import Terminal it is important to analyze the possible mechanisms of failure and to perform probabilistic analysis for the expected rate of such failures.

A technique like Fault Tree Analysis (FTA) can suitably be used for this purpose.

Any system represented by a fault tree has components that operate in series or parallel, with the contribution of the two being most frequent.

These components are studied for their failure and the possible causes are linked together through logical gates.

Thus a complete network is formed using logical gates for different causes and consequences. This network represents a system for which propensity towards top event is examined.

To construct a fault tree the catastrophic failure of interest is designated as the "top event".

Tracing backward, exactly opposite to the forward approach followed in

Event Tree Analysis (ETA), all failures that could lead to the top event are found. Then all failures leading to each of those events are identified. The word 'event' means conditions, which are deviations from the normal or planned state of operation of a system. The evaluation of fault tree may be qualitative or quantitative or both depending on the scope of analysis and requirement. The aim of fault tree evaluation is to determine whether an acceptable level of safety has been incorporated in the design of the system or not. Suitable design improvements to minimize the probability of occurrence of top event are found out. The system safety is upgraded by evaluating the critical events that significantly contribute to the top event and the measures provided to cope with such eventualities. Qualitative evaluation of fault tree involves critical inspection of the fault tree and arriving at minimal cut sets to determine most likely set of events leading to top event. Whereas the quantitative evaluation results in identification of weakness inherent in the system design by numerically evaluating the importance of basic events and cut sets in fault tree and





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thereby to determine the propensity of occurrence of the top event. A Boolean expression for the top event in terms of basic events, and the failure rate of individual basic events is required to perform quantitative evaluation.

Since inferences from failure rate data have been found very subjective, conclusions from the fault tree are to be utilized more for improving system reliability. The cut sets give a clear understanding of most of the failure modes of the system under consideration.

#### SAFETY MEASURES PROVIDED & SAFE PRACTICES FOLLOWED:

Perceiving the hazardous scenario of occurrence of fireball or VCE various safety measures are provided. In addition to the safety measures following safe practices are followed:

1. Non-Destructive Testing (NDT) for the LPG MSVs
2. Ultra-sonic test for testing effect corrosion
3. Regular training to plant personnel
4. Plant safety review through Safety Check List by Safety Office

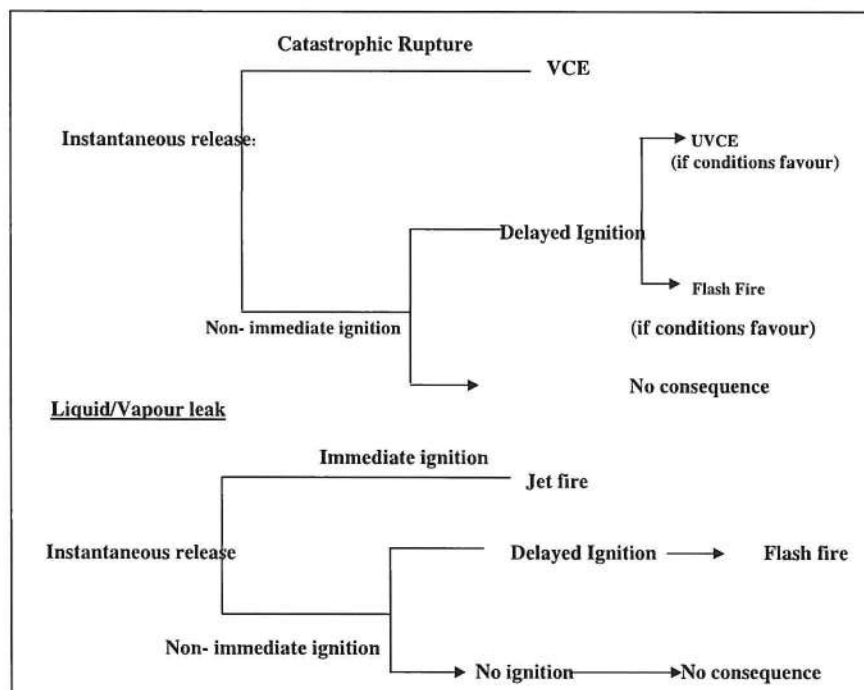
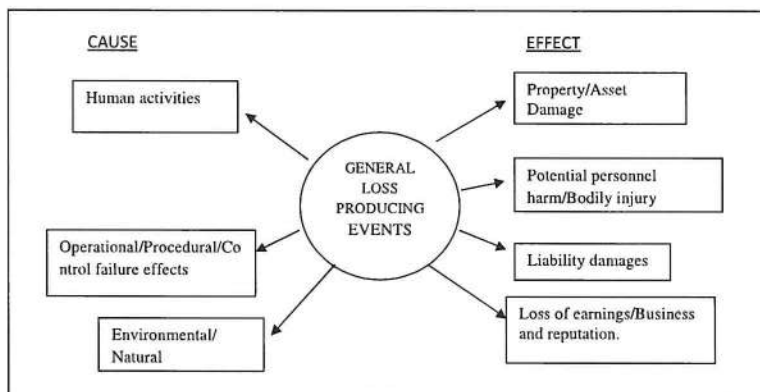


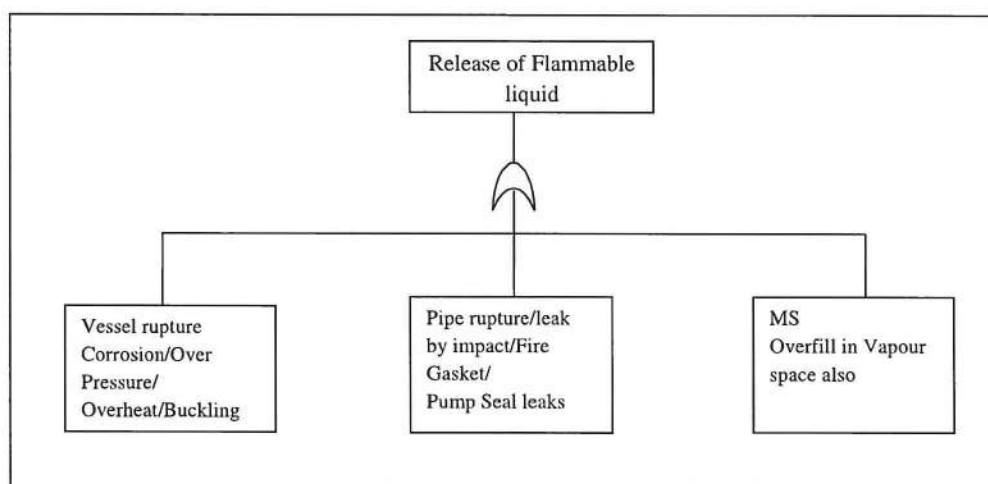
Fig 1.8 Event Tree Analysis for Rupture & Leak scenarios



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**Fig 1.9 Event Analysis**



**Fig 1.10 Release of flammable liquid**





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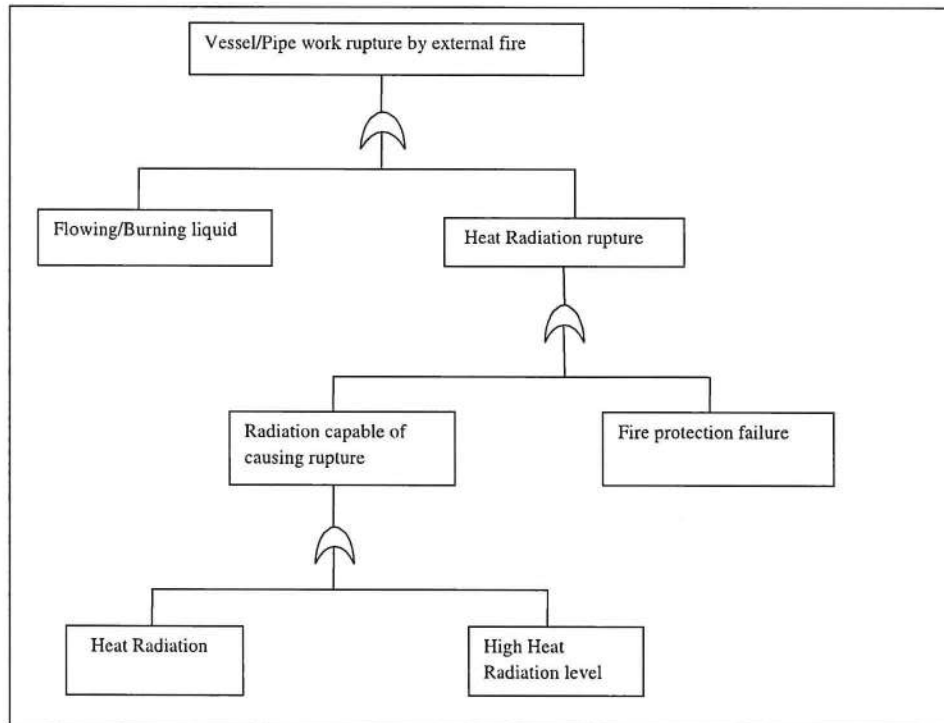


Fig 1.11 Vessel/pipe work rupture by external fire

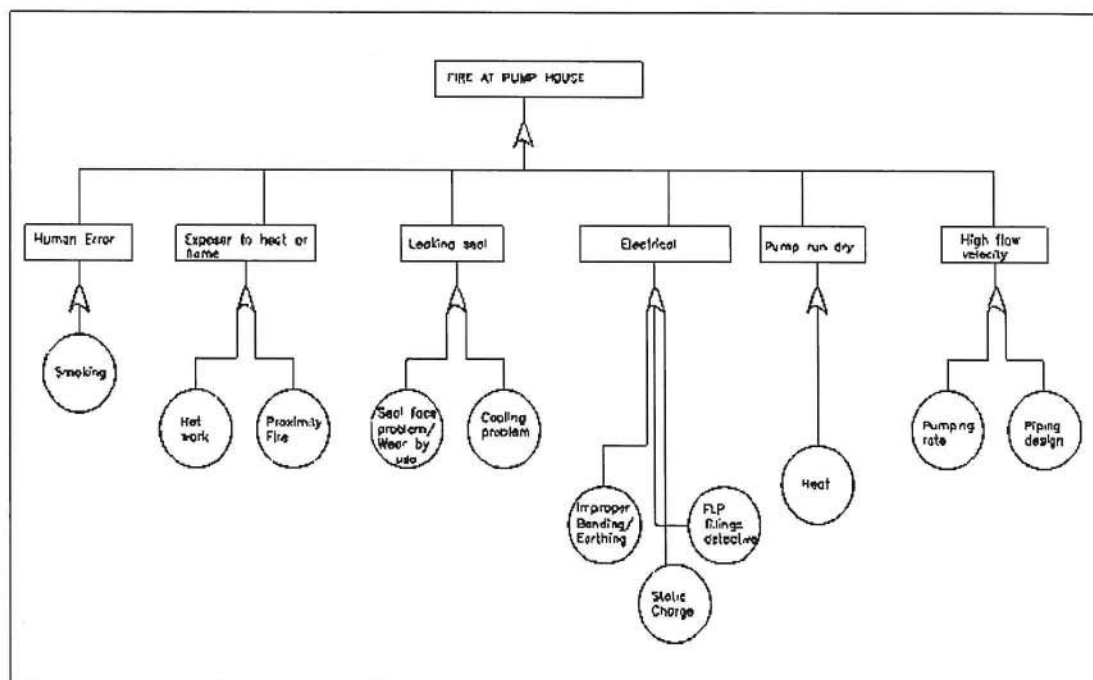


Fig 1.12 Fire at Pump House



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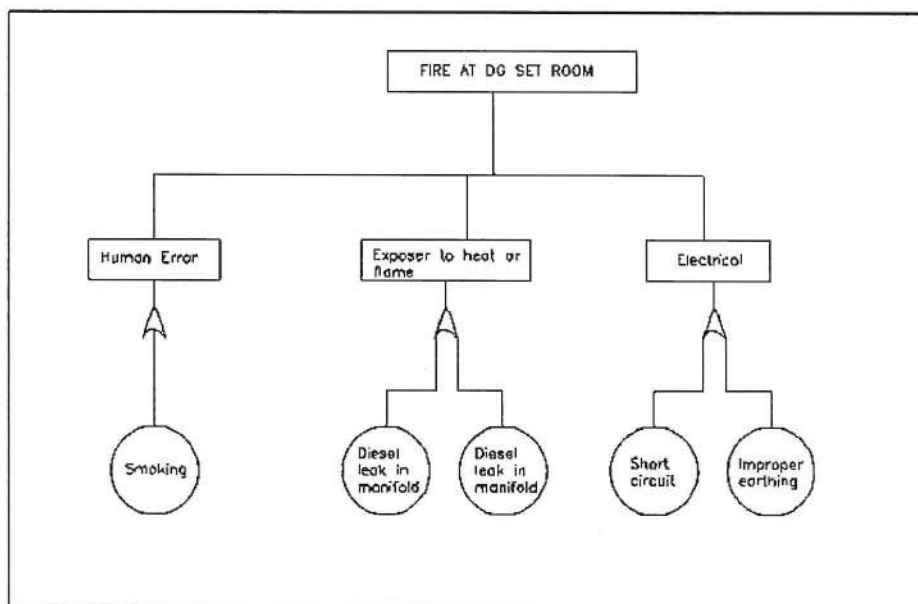


Fig 1.13 Fire at DG Set Room

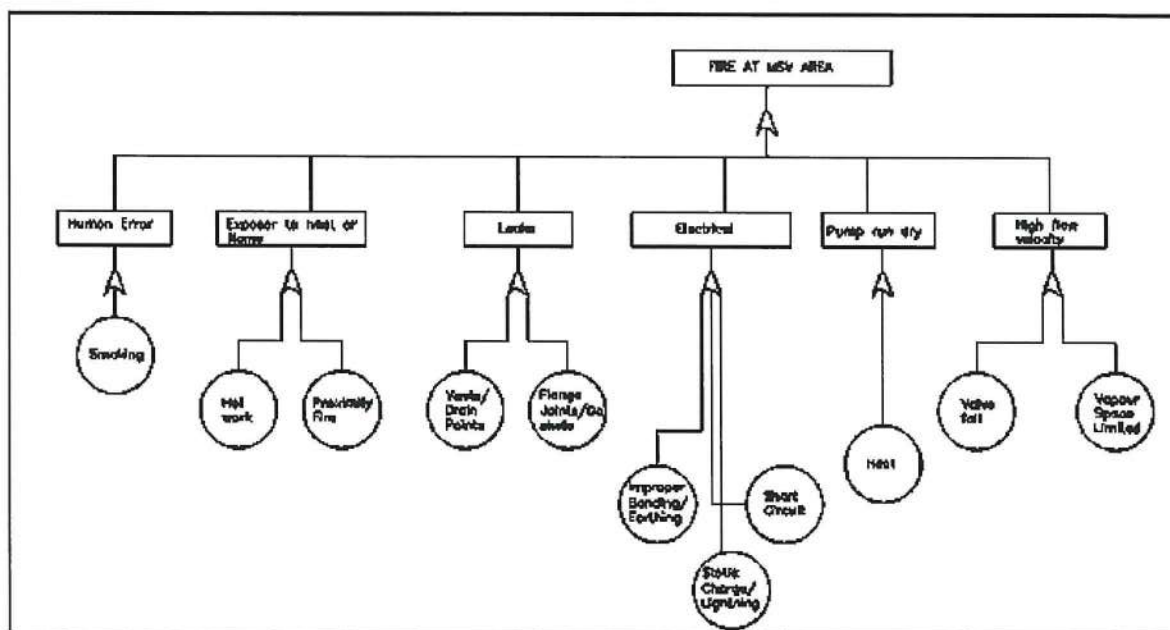


Fig 1.14 Fire at MSV area





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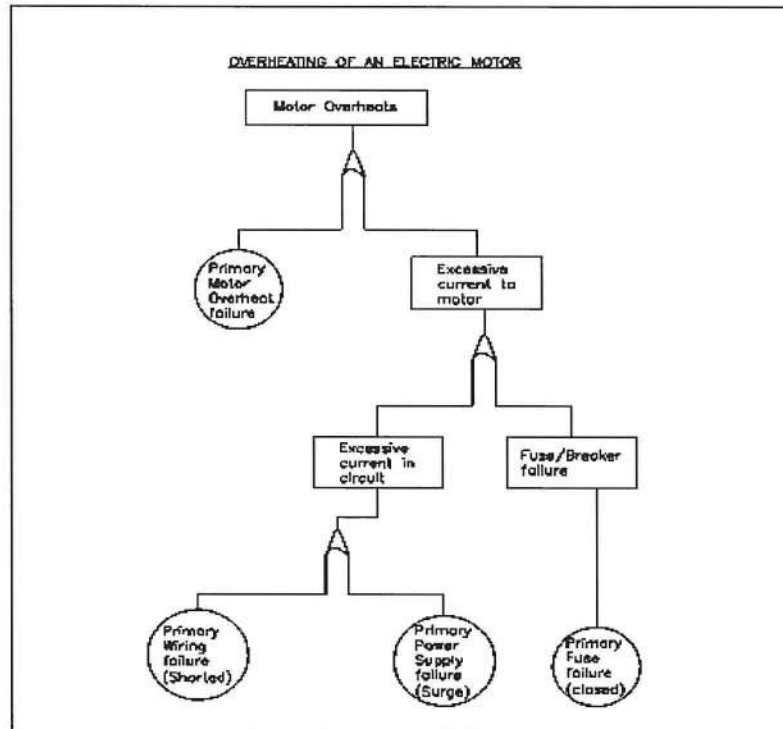


Fig 1.15 Overheating of an electric motor



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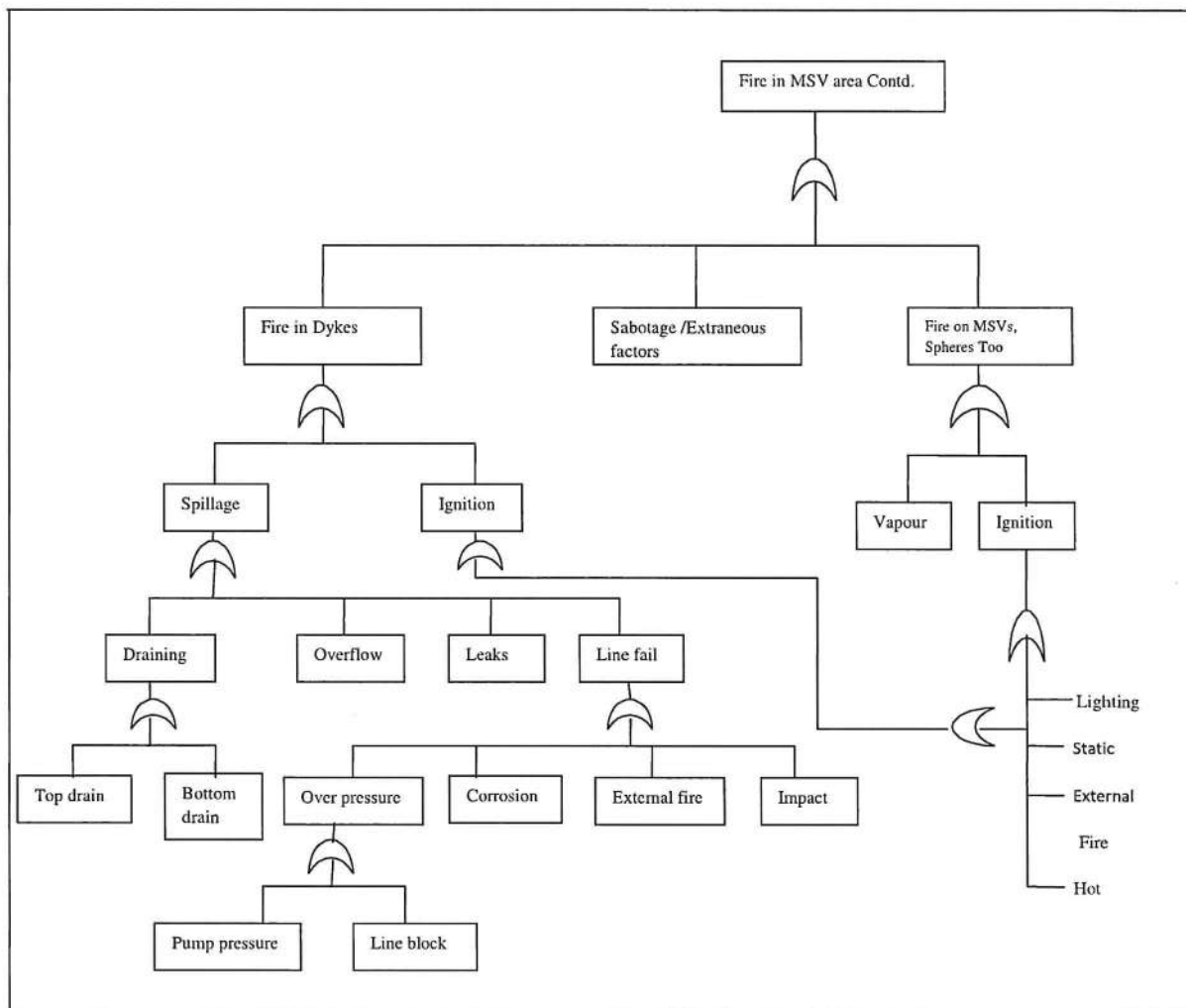


Fig 1.16 Fire in MSV Area





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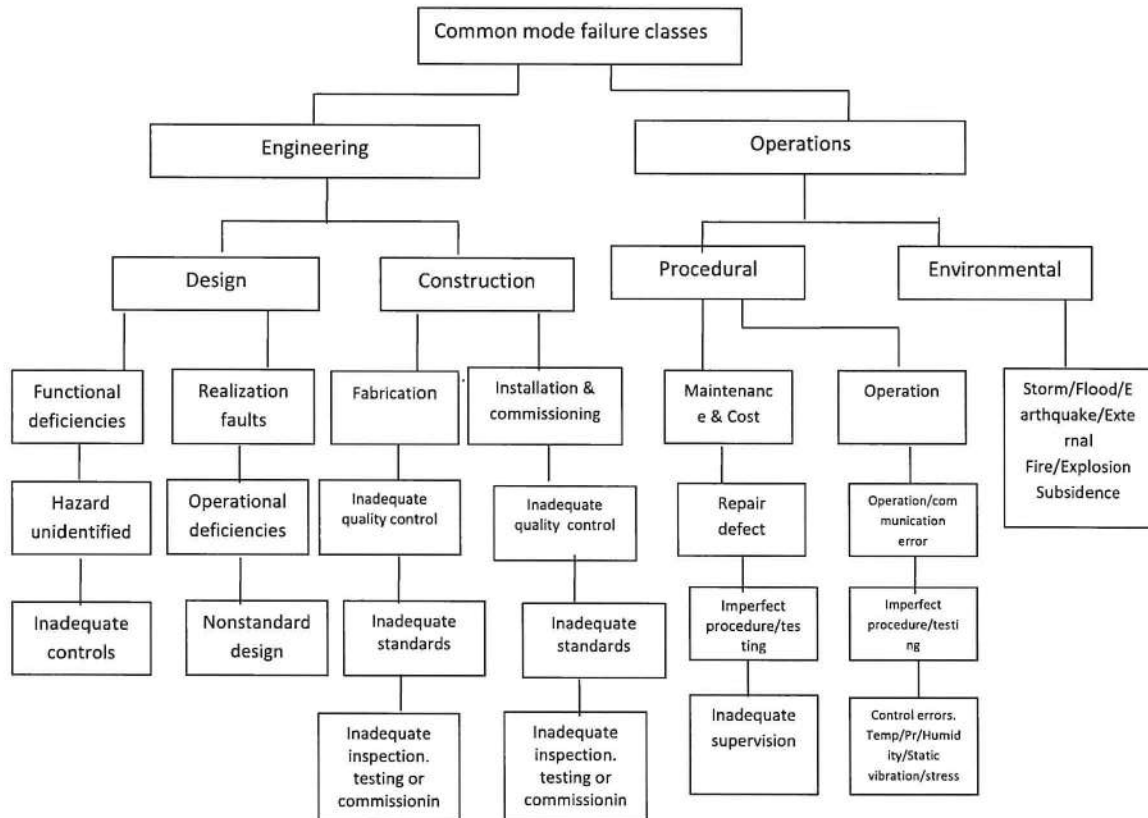
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### CLASSIFICATION OF COMMON MODE FAILURES-EVENT FLOW CHART



**Fig 1.17 Common mode failure classes**



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### 1.21 LPG TERMINAL DESIGN

The terminal has been designed in compliance with KS EAS 924-3:2020

The stipulated safety distances are as below:

**Table 2 — Safety distances**

Water capacity of storage vessel L	Minimum (safety) distances m					
	From above-ground vessel to points of gas release <sup>a)</sup>	From above-ground storage vessel to buildings and property boundaries	From buried and mounded storage vessel to buildings, property boundaries and points of gas release	From sealed surface equipment to building and property boundaries	From open flame equipment to building and property boundaries	Between above LPG storage vessels
9 000 <V ≤ 67 5 00	5.0	9.5	7.0	3.0	5.0	¼ of the diameters of adjacent storage vessels
67 500 <V ≤ 135 000	9.5	15.0	15.0			
135 000 <V ≤ 265 000	15.0	22.5	15.0			
V > 265 000	15.0	30.0	15.0			

<sup>a)</sup> For points of transfer see Clause 12 and Figure 2.

Minimum achieved distances are as per the below table:

Minimum Distances (M)					
Water capacity of storage vessel (L)	From buried and mounded storage vessel to buildings, property boundaries and points of gas release	From sealed surface equipment to building and property boundaries	School/ hospital/ place of worship/ open fires etc.	Building/ Office/ Sales Room	LPG Tanker Filling Point/ Point of Transfer
V= 30,000,000	19.95	9	208.5	20	40

### 1.22 FIRE PROTECTION AND FIRE FIGHTING SYSTEM

The plant will be equipped with a comprehensive fire protection system. Following facilities will be provided for the fire protection:

- 1) Fire Water Supply
- 2) Fire Hydrant system, Fire sprinkler system with smoke/fire detectors
- 3) Portable Fire Extinguishers





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### **1.22.1**

### **SAFETY & SECURITY FEATURES IN THE PROPOSED PLANT:**

- 1) Process and safety automation (using PLC's)
- 2) Gas monitoring system (with visual & alarm indications) with sensors at all critical areas in the plant.
- 3) Fire/ flame detectors with visual and alarm indications.
- 4) Remote operated valves (ROV's) connected to the safety automation system
- 5) All electrical equipment controlled via the process and safety PLC/
- 6) Fire Extinguishers;
  - a) DCP 10 kgs – 70-80 nos.
  - b) DCP 75 Kgs – 4 nos.
  - c) CO2 – 8-10 nos.
- 7) Paging and Announcing System for faster & safe communication
- 8) VHF communication system for two way communication
- 9) Personal Protective Equipment – Fire Entry suit, Water Gel blanket, Low temp suit /gloves, First aid, special tools, helmets, etc.
- 10) CCTV for the Incoming and outgoing vehicles and movement of personal in the premises, gantry and along the boundary line.
- 11) Biometric access for the visitors entry Control room Monitoring

### **1.23 MITIGATION MEASURES:**

Measures and recommendations for the proposed Tank Farm area are as follows:

- 1) Adherence of international engineering standards in the Design, Construction and testing
- 2) All tanks to be provided with automatic sprinkler system interlinked with fusible bulbs, the sprinkler system to confirm to TAC design guidelines.
- 3) All storage tanks to have level indicators wherever required.
- 4) All pumps used to have mechanical seal to prevent leakages and fugitive emission.
- 5) Storage areas shall be free from accumulation of materials.
- 6) There should be good communication system available near tank farm area to the control room.
- 7) The LPG storage shall be located in upwind direction from any flammable source.
- 8) A good layout should provide for adequate fire fighting access, means of escape in case of fire and also segregation of facilities so that adjacent facilities are not endangered during a fire.
- 9) All flame proof motors in hazardous area should be provided with double earthing.
- 10) All electric fittings used in the LPG pump house & storage area should be flame proof type.
- 11) A telephone should be provided which is freely available and readily accessible for the reporting of accidents or emergency situations. The emergency telephone numbers should include the fire department, ambulance service, emergency response team, hospital and police.
  - a) LPG leakage should be stopped immediately when noticed.
  - b) LPG sensors play a very important role therefore sensors should be tested at regular intervals.
  - c) Record of LPG sensors should be maintained indicating the date & time of alarm, Location of Sensors, Details of Leakage and action taken.

#### **Wind Direction Indicator:**

- d) Windsock should immediately be replaced whenever found in torn condition. It must be ensured that the indicator is visible from all places in the plant. It should be ensured that the Wind sock is visible during night time also.



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**Weeds, grass, shrubs:**

- e) Weeds, grass, shrubs or any combustible material should be removed from the plant premises.

**For Safe Operational Practices:**

- f) All Fire Extinguishers should be properly placed according to DOSHS norm. After expiry date of Fire Extinguisher It should be replace soon.

**Emergency Plan:**

- g) Mock Drill involving District Emergency services (Fire Brigade, Hospitals, Police, District Collector ate etc.) should be carried out minimum once in a year.

**1.24 CONCLUSION:**

Following are some of these references adopted for the study:

*Guide to Manufacture, Storage and Import of Hazardous Chemicals Rules*

*World Bank Technical papers relating to "Techniques for assessing Industrial Hazards".*

*"Major Hazard Control" by ILO.*

*Risk Management Program guidelines by EPA (US).*

The scenario (Catastrophic rupture) is based on large-scale release of material stored in the tank and the use of worst stability class, though this may not always happen. We have assumed catastrophic rupture for all the tanks as per the above mentioned references.





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## 2.0 VISUALIZATION OF MCA SCENARIOS

### 2.1. INTRODUCTION

A Maximum Credible Accident (MCA) can be characterized, as an accident with a maximum damage potential, which is believed to be credible. For selection of a MCA scenario following factors have been taken into account.

- a) Flammable and explosive nature of LPG
- b) Quantity of material present in a unit or involved in an activity
- c) Process or storage conditions such as temperature, pressure, flow, mixing and presence of incompatible materials

#### 2.1.1 CHEMICAL INVENTORY ANALYSIS

Maximum inventory of LPG in storage vessels and road tanker has been considered.

#### 2.1.2 IDENTIFICATION OF CHEMICAL RELEASE & ACCIDENT SCENARIOS

The accident scenarios have been divided into the following categories according to the mode of release of LPG, physical effects and the resulting damages:

- a) Pressurized liquefied gas or boiling liquid releases under pressure leading to fireball.
- b) Flammable gas release leading to Vapor Cloud Explosion (VCE)
- c) Jet fire of spillage mainly causing different levels of incident thermal radiation
- d) Spreading of hydrocarbon vapour with wind posing fire hazard to the surrounding property and population depending upon level of concentration.

### 2.2 PERTINENT PAST ACCIDENT DATA/CASE HISTORY ANALYSIS

#### 2.2.1 INDUSTRIAL DISASTERS

Analysis of past accidents provides a wealth of information and valuable clues in support of possible modes of occurrence of hazards along with their effects and consequences. Extensive coverage of past accident information could be obtained from established computerized data banks and literature databases. Bhopal gas leakage incident, series of explosions involving LPG in Mexico City resulted in 650 deaths and several thousand injuries. An explosion involving propane gas leads to 51 fatalities and many injuries in Ortuella Spain in 1980. Flixborough accident killed 28 and injured 89 persons due to cyclohexane explosion in 1974.

In all these cases the cause has been found to be different but the fact remains that storage, handling or processing of flammable, explosive or toxic chemicals has potential to cause massive loss of human life, property and environment. The damage potential, therefore, is a function of both, the inherent nature of the chemical and the quantity that is present on the site.

#### 2.2.2 TYPES & CONSEQUENCES OF PREVIOUS FIRE & EXPLOSION

Massive disaster usually occurs on loss of flammable or explosive material from containment, for example:



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Leakage of flammable chemical, mixing of the chemical with air, formation of a flammable vapor cloud and drifting of the cloud to a source of ignition leading to a fire or an explosion affecting the site and possibly populated areas nearby

“Back fire” phenomenon has been observed in most of the cases of fire and explosion. Majority of the accidents involving LPG started with comparatively smaller leakage leading to formation of a plume. The gas then drifted in the down wind direction and came in contact with an ignition source. Thus resulting in a vapor cloud explosion. Fire due to the VCE traveled back to the source of leakage and escalated the damage with occurrence of a fireball.

Because of the fireball, similar storage in the surrounding area were severely affected either due to heat intensity of the fire ball or due to mechanical damage because of pressure waves of the explosion or flying fragments of the storage vessel. Therefore resulting into another fireball and thus the escalation of fire and explosion continued destroying the complete plant. Intensities of fire, explosion and pressure waves have been found significantly dependent on many variable factors such as availability of ignition source, wind direction and speed, atmospheric stability, time of accident and weather conditions.

The effects of fire on people may be in anything from skin burns to deaths due to exposure to thermal radiation. The severity of the burns would further depend on the intensity of the heat and the exposure time. Heat radiation is inversely proportional to the square of the distance from the source.

Fires occur in industry more frequently than explosions. Fires can take several different forms, including jet fires, vapour cloud explosions, flash fires.

### 2.2.3 LESSONS FROM PREVIOUS ACCIDENTS IN CHEMICAL INDUSTRIES

A study of past accident information provides an understanding of failure modes and mechanisms of process and control equipments and human systems and their likely effects on the overall plant reliability and safety.

## 2.3 SHORT LISTING OF MCA SCENARIOS

Based on the hazard identification and comparing the nature of installation with that from past accidents in similar units, a final short list of Maximum Credible Accident (MCA) scenarios for the Plant has been made, which is given in following Table.

These are the maximum credible accidents, which may occur the respective unit.

**Table 2.1 Short Listed MCA Scenarios For the LPG Plant:**

Sr.	Unit/ Installation/ Structure	Service	MCA Scenario
1	Mounded Vessel	LPG	Jet fire, VCE
2	Pipelines	LPG	Jet fire, VCE

The above foreseen accident scenario will have certain adverse effects on the nearby units/installations/structures; which may lead to escalation of the accident further.

Consequences of all the above maximum credible accident scenario have been analyzed in detail in the subsequent chapter.





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## 2.4 MATHEMATICAL AND ANALYTICAL MODELS FOR HAZARD ANALYSIS

Sr.	Phenomenon	Application Models
1	Outflows: Liquid, Two phase Mixtures, Gas/vapor	Bernoulli flow equation; phase equilibria; multiphase flow models; orifice/nozzle flow equations; gas laws; critical flow criteria
2	Discharges: Spreading liquid  Vapor jets  Flashing liquids * Evaporation of liquids on land & water	Spreading rate equation for non-penetrable surfaces based on cylindrical liquid pools Turbulent free jet model  Two zone flash vaporization model Spreading, boiling & moving boundary heat transfer models; Film & metastable boiling phenomenon; cooling of semi infinite medium
3	Dispersion: *Heavy Gas  *Natural Gas  *Atmospheric Stability	Boundary dominated, stably stratified & positive dispersion models (similarity) 3D Models based on momentum, mass & energy conservation Gaussian Dispersion models for naturally buoyant plumes Boundary layer theory (turbulence), Gaussian distribution models
4	Heat Radiation: *Liquid pool fires  *Jet fires *Fire balls	Burning rate, heat radiation & incident heat correlation (semi imperial); Flame propagation behavior models Fire jet dispersion model API fire ball models relating surface heat flux of flame, geometric view factor & transmission coefficients
5	Explosion: *Vapor Cloud Explosion	Deflagration & Detonation models
6	Vulnerability: *Likely damage	Probit functions; Non-Stochastic vulnerability models

## 2.5 MODELS FOR DETERMINING THE SOURCE STRENGTH FOR RELEASE OF A HAZARDOUS SUBSTANCE

Source strength of a source means the volume of the substance released with respect to time. The release may be instantaneous or continuous. Continuous releases are those where the outflow is a relatively small fraction of the inventory. Instantaneous releases are those where the inventory is released in a period of 10-20 second or less.



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In case of instantaneous release, the strength of the source is given in kg whereas in continuous release source strength depends on the outflow time and expressed in kg/s. In order to find the source strength, it is first necessary to determine the state of a substance in a vessel, pipe or drum the physical properties, viz. pressure and temperature of the substance and to arrive at the phase of release.

This may be gas, gas condensed to liquid or liquid in equilibrium with its vapor. The inventory and isolation consideration are reviewed to determine if the release should be modeled as continuous, time limited or instantaneous.

### 2.5.1 INSTANTANEOUS RELEASE

Instantaneous release will occur, for example, if a storage tank fails. Depending on the storage conditions the following situations may occur.

**a) Instantaneous Release of a Gas:**

The source strength is equal to the contents of the capacity of the storage system.

**b) Instantaneous Release of a Gas Condensed to Liquid:**

In the case of a gas condensed to liquid, a flash-off will occur due to reduction in pressure of the liquefied gas to atmospheric pressure. The liquid will spontaneously start to boil.

**c) Instantaneous Release resulting from a fireball:**

A fireball is a physical explosion, which occurs when the vapor side of a storage tank is heated by fire e.g. a flare/torch. As a result of the heat the vapor pressure rises and the tank wall gets weakened. At a given moment the weakened tank wall is no longer capable to withstand the increased internal pressure and burst open. As a result of the expansion and flash-off pressure wave occurs. With flammable gases, a fireball occurs in addition to the pressure waves.

**d) Instantaneous Release of a Liquid:**

In the event of the instantaneous release of a liquid a pool of liquid will form. The evaporation can be calculated on the basis of the pool.

### 2.5.2 SEMI-CONTINUOUS OUTFLOW

In the case of a semi-continuous outflow, it is again first of all necessary to determine whether it is gas, a gas condensed to liquid or liquid that is flowing out.

**a) Gas Outflow:**

The model with which the source strength is determined in the event of a gas outflow is based on the assumption that there is no liquid in the system.

**b) Vapor Outflow:**

If the outflow point is located above the liquid level, vapor outflow will occur. In the case of a gas compressed to liquid the liquid will start boiling as a result of the drop in pressure. The source strength of the out flowing vapor is a function of the pressure in the storage system and after the liquid has reached the boiling point at atmospheric pressure the temperature will remain constant.

**c) Liquid Outflow:**

If the outflow point is located below the liquid level, liquid outflow will occur resulting in a flash-off. The outflow will generally be so violent that the liquid will be turned into drops as a result of the intensity of the evaporation. The remaining liquid, which is cooled down to boiling point, will start spreading on the





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ground and forms a pool. Evaporation will also take place from this pool, resulting in a second semi-continuous vapor source.

#### **MODELS FOR EVAPORATION:**

In application of evaporation models, LPG is a case of pressurized liquefied gas. If a gas condensed to liquid is released, flash-off will occur resulting in an instantaneous gas cloud. If there is little flash-off, the remaining liquid, which has cooled to its boiling point at atmospheric pressure, will spread on the ground and start evaporating. The same model can now be used for the evaporation as for the evaporation of gas cooled to liquid. From the pool, which is formed, evaporation will take place as a result of the heat flow from the ground and any solar radiation. The evaporation model only takes account of the heat flow from the ground since the heat resulting from solar radiation is negligibly small compared with the former. The evaporation rate depends on the kind of liquid & subsoil.

#### **2.6 MODELS FOR DISPERSION:**

The gas or vapor released either instantaneously or continuously will be spread in the surrounding area under the influence of the atmospheric turbulence. In the case of gas dispersion, a distinction is required to be made between neutral gas dispersion and heavy gas dispersion. The concentrations of the gas released in the surrounding area can be calculated by means of these dispersion models. These concentrations are important for determining whether, for example, an explosive gas cloud can form or whether injuries will occur in the case of toxic gases.

#### **2.7 HEAVY GAS DISPERSION MODEL:**

If the gas has density higher than that of air due to higher molecular weight or marked cooling, it will tend to spread in a radial direction because of gravity. This results in a "gas pool" of a particular height and diameter. As a result of this in contrast to a neutral gas, the gas released may spread against the direction of the wind.

#### **2.8 CLIMATOLOGICAL CONDITIONS:**

As LPG is heavier than air, it would try to settle on the ground from air in downwind direction. The downwind drifting & dispersion of LPG in air would be primarily decided by following factors:

1. Wind Direction & Wind Velocity

2. Atmospheric Stability. It decides mixing of LPG & air. More turbulent atmosphere is characterized by "Un-stable" Atmosphere (Class F: Highly Unstable). In this condition dilution of LPG would be fastest; whereas in Very Stable Atmosphere (Class A) dilution will be lower and up to a large distance concentration of LPG will be above LEL.

From the climatological data following three conditions are chosen for modeling VCE scenarios & finding "Back Fire" potential.

I	II	III
Very Stable Atmosphere (Pasquill Stability Class A)	Neutral Atmosphere (Pasquill Stability Class D)	Un-stable Atmosphere (Pasquill Stability Class F)
Velocity = 1 m/s	Velocity = 2 m/s	Velocity = 4 m/s



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## 2.9 RESULTS OF MAXIMUM CREDIBLE ACCIDENT (MCA) ANALYSIS

The results of MCA analysis will indicate the distance for backfire potential and various damage levels for Unconfined Vapor Cloud Explosion (UVCE) and fireball that will have been identified.

### 2.9.1 BACKFIRE POTENTIAL DUE TO CONTINUOUS RELEASE OF LPG FROM MSV CONTINUOUS RELEASE:

The most probable case could be that of a continuous release. Any leakage in the system would result in to a continuous release and the plume may travel down wind. Analyzing downwind concentration, it has been found that LPG quantity in air is well within Upper & Lower Explosion Limits (UEL & LEL) up to a considerable distance. Ignition of this plume may cause a backfire. This analysis shows the distances up to which the plume is within LEL; backfire may occur if the plume comes in contact with an ignition source.

### 2.9.2 UNCONFINED VAPOR CLOUD EXPLOSION (UVCE)

Various meteorological conditions (as mentioned above) have been considered for analyzing drifting & dilution of a vapor cloud, so that all probable consequences of a vapor cloud explosion can be foreseen. Worst come worst, there may be instantaneous release of the entire LPG vapor present in the unit. If it comes in to contact of an ignition source during or immediately after the release or as in a case of backfire resulting in jet fire, it may lead to a fireball. Otherwise, the second MCA scenario is drifting & dilution of a vapor cloud along the wind and then coming into contact of an ignition source (i.e., case of delayed ignition), leading to a VCE. This scenario is particularly important to identify unforeseen OFF-SITE emergencies. Two kinds of vapor release scenarios have been considered, i.e. instantaneous and continuous.

#### 2.9.2.1 MOUNDED STORAGE :

Mounded storage of LPG i.e. creating a sand mound around the LPG storage vessels, which are placed above the ground level, is now increasingly being considered as the best solution for protecting LPG vessels.

The mounded storage system provides the following advantages:

1. LPG stored in the form of mounded storage eliminates the possibility of fireball.
2. The cover of the mound protects the vessel from fire engulfment, radiation from a fire in close proximity and acts of sabotage or vandalism. Water cooling systems are not required.
3. The area of land required to locate a mounded system is minimal compared to conventional storage.

The mounded storage of LPG has proved to be safer compared to above ground vessels as it provides intrinsically passive & safe environment.

In addition, the mounding material provides good protection against most of the external influences like flying objects and pressure waves from explosions.

### 2.9.2.2 CONSEQUENCES OF THE IDENTIFIED ACCIDENT SCENARIOS:





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### **SUMMARY**

1. LPG leakage may lead to back fire; however it is less likely that the leaked gas would find an ignition source within the plant.
2. Pressure wave effect of VCE may collapse other structures in the plant. However, considering the mounded tanks, LPG alarms, fire hydrant points, water monitors, automatic sprinkler system, fire extinguishers, process safety alarms provided in the LPG terminal as per DOSHS norms, greatly reduce the chances of escalation of fire or explosion.

#### **2.10 DOMINO EFFECTS:**

As the proposed mounded area, there will not be any formulation of BLEVE and each tank isolated with inert material and tight packing. Hence the domino effect in tank not envisaged. Auto sprinklers and temperature recording sensors provided in order to mitigate any fire and the system totally eliminate domino effect.



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### 3.0 QRA RECOMMENDATIONS

#### MATERIAL SAFETY DATA SHEET (MSDS) FOR LPG

##### A. IDENTIFICATION

CAS No. : 68476-85-7

Formula : C<sub>3</sub>H<sub>8</sub> / C<sub>3</sub>H<sub>6</sub> / C<sub>4</sub>H<sub>10</sub> / C<sub>4</sub>H<sub>8</sub>

Description: Colorless, noncorrosive, odorless gas when pure. A foul- smelling odourant is usually added.

##### B. PHYSICAL PROPERTIES

Molecular Weight: 22 to 58

Vapor Pressure: &gt; 1 atm

Flammability Limits: Lower (LEL) = 2.1%;  
Upper (UEL) = 9.5%

Category: 1 A Flammable (Osha Classification)

Reactivity: Reacts with strong oxidizers, Chlorine Dioxide

##### C. FIRE/EXPLOSION HAZARDS

Fire Hazards: Highly dangerous when exposed to heat, can react with oxidizing material.

Explosion Hazards: Moderate when exposed to heat or flame

Fire Fighting: Carbon Dioxide, Dry Chemical Powder, Water Sprays/Fog can be used.

Target Organs: Respiratory Systems CNS

Pathway: Inhalation

Symptoms: Lightheadedness, drowsiness, irritation in eyes, nose, Skin, dermatitis, cold burn

##### D. FIRST AID

Eye - If this chemical contacts the eyes, immediately wash the eyes with large amount of water, occasionally lifting lower and upper lids. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

Skin - If this chemical contacts the skin, promptly wash the contaminated skin with soap and water. If this chemical penetrates the clothing, promptly remove the clothing and wash the skin with soap and water. Get medical attention promptly.

Breath - If a person breathes large amounts of this chemical, move the exposed person to fresh air at once. If breathing has stopped, perform mouth- to -mouth resuscitation. Keep the affected person warm and at rest. Get medical attention as soon as possible.



**FOCUS CONTAINER FREIGHT STATION LTD**  
**PROJECT: PROPOSED INSTALLATION OF A**  
**15000MT LPG TERMINAL**

**TRAFFIC MANAGEMENT PLAN**



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<b>Issue Date</b>	12 <sup>th</sup> March 2025
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### **1.0 Introduction**

#### **1.1 Purpose**

The installation and operations of the proposed LPG TERMINAL has been drafted to provide a single document which allows for external (within the site, but external to the Buildings) and Internal (within the walls of the buildings) traffic management plan for FOCUS CONTAINER FREIGHT STATION LTD TERMINAL located at CHANGAMWE AREA, MOMBASA COUNTY on LR .NO MV/VI/3711. <sup>1</sup>

**The purpose behind this Traffic Management Plan is to:**

- Ensure for a safe, smooth, efficient and simple plan for various vehicle and pedestrian movements associated with product moving into and out of the Terminal;
- Make all persons entering the terminal aware of both external and internal restricted and safe areas during the operational period,
- Highlight the extreme caution that must be taken when driving service vehicles, LPG trucks or operating forklifts moving around.

This **TMP** provides details on the management of vehicle and pedestrian traffic whilst on site. *The following types of traffic are referred to in this TMP;*

- Inbound and Outbound Heavy Vehicles
- Worker/Visitor/Contractor Light Vehicles referred to as (service vehicles)
- Pedestrians
- Forklifts and Reach Trucks

#### **1.2 Site Operational Overview**

LPG trucks entry to the site is via the main controlled Entrance GATE A, through the controlled area(operation area) straight ahead to the LOADING gantry or to the waiting reserved parking , Then outbound loaded LPG trucks exits through controlled EXIT B straight ahead.

All drivers must be screened at the entrance gate and will be checked for their induction status prior to being permitted access.

The controlled gates A and B lead to the Terminal's entry and exit for outbound respectively, which on a daily basis may include:

- LPG trucks to be loaded
- Reach trucks and folk lifts for service operations
- Cleared LPG trucks at the parking awaiting loading
- Service vehicles such as Waste Management trucks
- Light Vehicles (Courier vans) for administrative services

Unless prior permission has been obtained (e.g. Courier Vans, pre-arranged product pick-up) light vehicles using this entrance must NOT proceed through to the controlled area(operation area) but restrict their operation through GATE C to the operation offices. There are 2 marked 'Visitor' car parks beside the Administarative entrance GATE C.



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#### 1.4 Major Hazard Facility - High Hazard Area

It is important for all workers, visitors, contractors and drivers entering FOCUS CONTAINER FREIGHT Terminal to be aware that they are entering a Major Hazard Facility and High Risk area. It is therefore a requirement for all persons to complete the relevant safety induction before access permission is granted.

We strictly advise everyone entering our terminal to read the safety and warning signage posted and abide by the controls we have in place (these are covered in the Worker, Visitor, Transport and Contractor Inductions).

FOCUS CONTAINER FREIGHT STATION LTD acknowledges the hazards identified in the table below. Current controls are regularly reviewed as per the time frames agreed by the HSE Committee with the aim of continuing to reduce pedestrian, forklift/Reach Truck and LPG Trucks interactions, and their associated risks.

Table 1: Hazard Identification

Hazard ID No.	Hazard Name	Raw Risk Rating	Corrective Risk Rating
1147	Visitors/Contractors/Unauthorised People on site	HIGH	MEDIUM
1102	Forklift/reach Operation	EXTREME	HIGH
1100	Loading gantry operation and safety procedures	EXTREME	HIGH
	Hazardous Substances – Storage	TBA	
1149	Pedestrians being hit by Mobile parts	EXTREME	MEDIUM
1122	Non-wearing of PPES	EXTREME	HIGH
1101	Storage	HIGH	MEDIUM
1135	Unauthorized persons at the operation area	EXTREME	HIGH
1145	UNCONTROLLED Traffic at the terminal	EXTREME	HIGH
1126	Uncontrolled parking of the LPG TRUCKS	EXTREME	HIGH

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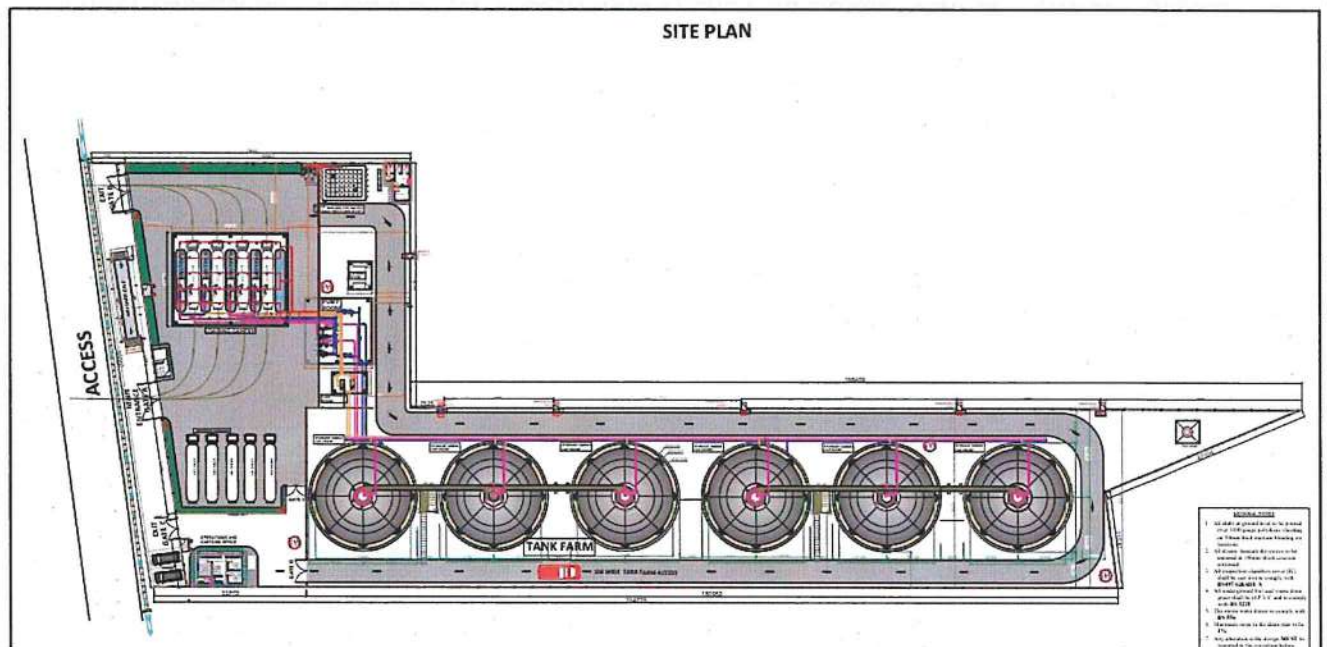
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Figure 1: Basic External Traffic Flow and Main functional Areas within the Damar Site





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## **2.0 Expected Inbound and Outbound External Traffic, and Internal Traffic**

### **2.1 Overview**

All receiving and dispatch traffic must enter FOCUS CONTAINER FREIGHT TERMINAL via the controlled entrance GATE A or C,

All Truck Drivers, visitors, contractors and staff must abide by the internal and external traffic flow plan and rules for the entire terminal. This includes all posted signage e.g. speed limits, direction of travel, PPE requirements.

All incidents in the terminal must be reported. This company rule applies to all team members, drivers, contractors, agency casualties and visitors.

The projected average volumes of inbound/outbound traffic flow per day are as follows:

- Receiving = avg **200** vehicles

### **2.2 Inbound/Outbound Heavy Vehicle Traffic**

*NOTE: All drivers must give way to any Forklifts/reach vehicles operating in the Transit operation area*

FOCUS CONTAINER FREIGHT TERMINAL operates on a booking system controlled by Supply Chain. As a guide, LPG transport companies have timeframes and schedules of when they can arrive and load to avoid congestion at the terminal .

Any LPG truck arriving outside of these agreed timeframes, are to make prior arrangements with the terminal operations team and subsequently wait for prior communication.

### **2.3 Driver Site Inductions**

Access to terminal is not permitted to any vehicle unless the driver has completed a FOCUS CONTAINER FREIGHT STATION LTD Transport Induction.

Drivers name,EPRA's drivers license and other details are recorded in the company's Data Base which is accessible by all via the FOCUS CONTAINER FREIGHT STATION LTD Intranet onsite. Verification through the Data Base of the driver's details is checked prior to entry to ensure the LPG TRUCK drivers has in fact undergone the Transport Induction.

Drivers refusing to comply with FOCUS CONTAINER FREIGHT STATION LTD site rules, will be requested to leave the site immediately. Additionally, they will be referred to their Prime Contractor and refused entry to the site until they fully comply

### **2.4 Driver Safe Zones**

- LPG TRUCK drivers are not to load unless the driver is in the Safe Zone location at the gantry , the driver will be instructed on the operation procedures at the gantry by the operation officer before loading.

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**2.5 Site Speed Limit**

The site speed limit is a maximum of **5kph** for vehicles moving around the external access route through the terminal. This is signposted accordingly at the entrance to the terminal and also around the terminal.

Internal speed is limited to 5kph, all LPG TRUCKS to the gantry and parking at the terminal have been speed limited to this effect.

Whilst on site, all drivers must wear High Visibility Clothing, helmets and safety footwear at all times.

**2.6 Interrupted Traffic Flow**

In the event of a vehicle breakdown/disabled vehicle in the FOCUS CONTAINER FREIGHT STATION LTD terminal or on the one way road around the terminal, the following actions will be adopted:

1. The truck driver will communicate to the terminal Coordinator/officer as to the issue at hand for swift action to be taken .
2. The terminal officers and technicians will inspect the vehicle of concern as to its:
  - Risk to Safety
  - Risk to the other vehicles
  - Risk to the environment
  - Disruption to the business, and
  - Location
3. Recovery - The recovery vehicle should remove the stricken vehicle from the terminal to a safe zone, prior to any attempt to repair the problem.

**2.7 Traffic Flow Un-Interrupted**

The terminal officer will organize to have the area cordoned off by means of placing safety cones around the stricken vehicle, setting up an exclusion zone. No person is to be placed at risk in any way by their actions or physical location in order to perform this action.

The terminal officer will:

- Confirm that the driver has contacted the transport operator in order to repair/remove vehicle.
- Establish with the driver as to the importance of a swift repair or removal of the stricken vehicle.
- Monitor and review in order to ensure safety is not compromised and that there remains no impact to the environment.



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**2.8 No Stopping Areas**

No stopping of trucks is permitted in the terminal unless in a designated area and prior permission has been sought. terminal consists of the driveways

- from the entrance to the parking area
- from the parking area to the loading gantry
- from the gantry to the main exit
- Driveway around the storage tanks

**3.0 Pedestrians on Site****3.1 Pedestrian Traffic**

Pedestrian traffic on site will be limited to FOCUS CONTAINER FREIGHT STATION LTD workers, inducted drivers, authorised visitors and contractors.

Pedestrians give way to forklifts and vehicles at all times.

Visitors, unless authorised are not permitted to wander around the site complex unescorted at any time. Pedestrian movement around the terminal must be limited to necessary activity. Inbound/ outbound LPG trucks and vehicles will be moving around the terminal and whilst the drivers of these automobiles will be aware of possible pedestrian movement, every effort must be made by each individual pedestrian to be aware of the possible dangers involved. Eye contact and signaled agreement to pass is essential prior to walking into the path of a moving vehicle.

**3.2 Pedestrian Restricted and 'No Go' zones**

Operation areas are restricted to visitors/contractors unless escorted at any time.

**3.3 Pedestrian PPE Requirements**

On entry to the site, pedestrians performing any work on site must wear safety footwear, safety glasses and high visibility cotton or anti-static clothing at all times.

Any visiting pedestrians not performing work on site must be accompanied by a terminal employee, wear safety glasses, enclosed footwear and high visibility cotton or anti-static clothing at all times. PPE is available for visitors use if they do not have their own.

**3.4 Car Park Overview**

FOCUS CONTAINER FREIGHT STATION LTD operation Staff Car Park – outside GATE C.

**4.0 Mobile Plant****4.1 Forklifts and Reach Trucks**

Forklifts and Reach Trucks will be utilised on the Damar site for the purposes MAINTANANCE SERVICES ONLY.

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### 5.0 Review Panel

Review Date	Document Code / Section	Review Details	New Version #	Reviewed by
12/03/2025	All	New Document	1.0	B.OSORO
Next review date due:		12/03/2026		



# **FOCUS CONTAINER FREIGHT STATION LTD**

## **TRAFFIC MANAGEMENT PLAN**



<b>Document Code</b>	FCFSL-TMP-001
<b>Issue Date</b>	12 <sup>th</sup> March 2025
<b>Version Number</b>	1.0

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### **1.0 Introduction**

A Traffic Management Plan (TMP) for a gas terminal is a critical document to ensure safe, efficient, and organized movement of vehicles and personnel around the terminal site. This plan is designed to mitigate risks associated with traffic congestion, potential accidents, and ensure compliance with safety regulations.

#### **1.1 Purpose**

This Traffic Management Plan has been prepared to provide a single document which allows for external (within the site, but external to the buildings) and Internal (within the walls of the buildings) Traffic Management for Focus Container Freight Station Limited Terminal located at Changamwe Area, Mombasa County on Lr. No Mv/Vi/3711.

**The purpose behind this Traffic Management Plan is to:**

1. **Safety:** Managing traffic flow in a way that reduces the risk of accidents and injuries. This is crucial in a gas terminal due to the hazardous materials involved, such as gas, chemicals, and flammable substances.
2. **Efficient Operations:** Ensuring that vehicles, including delivery trucks, maintenance vehicles, and personnel transport, can move in and out of the terminal without unnecessary delays, contributing to smooth operations.
3. **Emergency Access:** Designing routes that ensure emergency vehicles can quickly and safely access any area of the terminal in the event of an accident or emergency.
4. **Minimizing Congestion:** Avoiding bottlenecks, over-crowding, and traffic jams, which can lead to operational delays and hazards. Proper planning helps manage peak traffic times and minimizes the risk of accidents caused by congestion.
5. **Compliance with Regulations:** Ensuring that traffic management practices comply with local, regional, and industry-specific safety regulations and standards, especially those related to hazardous materials.
6. **Pedestrian Safety:** Separating vehicle routes from pedestrian walkways to protect staff working in the terminal area from traffic-related hazards.
7. **Environmental Impact:** Minimizing the environmental impact of traffic in terms of emissions and noise pollution. A well-planned traffic flow can help reduce fuel consumption and minimize air pollution.
8. **Coordination of Deliveries and Departures:** Planning for timely and safe delivery, offloading, and departure of materials and goods, which is especially critical in gas terminals for keeping operations running smoothly.

This **TMP** provides details on the management of vehicle and pedestrian traffic whilst on site. The following types of traffic are referred to in this TMP;

- Inbound and Outbound Heavy Vehicles
- Worker/Visitor/Contractor Light Vehicles referred to as (service vehicles)
- Pedestrians
- Forklifts and Reach Trucks

#### **1.2 Site Components**

An LPG (Liquefied Petroleum Gas) terminal is a facility where LPG is imported, stored, and distributed



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for further use in various sectors like cooking, heating, and industrial processes. It is designed to handle large quantities of LPG and consists of several components to ensure safe, efficient operations. The proposed project aims to build a 15,000 metric tonnes bulk Liquefied Petroleum Gas (LPG) storage facility with six mounded LPG Spheres, each 2,500 metric tonnes. The facility will include a loading gantry, hydrant locations, internal piping, a weigh bridge, and an administration office. The spheres will be grouped in a containment enclosure, connected to LPG liquid delivery lines and truck loading facilities

### **1.3 Site Operational Overview**

LPG trucks entry to the site is via the main controlled Entrance GATE A, through the controlled area (operation area) straight ahead to the LOADING gantry or to the waiting reserved parking,

Then outbound loaded LPG trucks exits through controlled EXIT B straight ahead.

All drivers must be screened at the entrance gate and will be checked for their induction status prior to being permitted access.

The controlled gates A and B lead to the Terminal's entry and exit for outbound respectively, which on a daily basis may include:

- LPG trucks to be loaded
- Reach trucks and folk lifts for service operations
- Cleared LPG trucks at the parking awaiting loading
- Service vehicles such as Waste Management trucks
- Light Vehicles (Courier vans) for administrative services

Unless prior permission has been obtained (e.g. Courier Vans, pre-arranged product pick-up) light vehicles using this entrance must NOT proceed through to the controlled area (operation area) but restrict their operation through GATE C to the operation offices. There are 2 marked 'Visitor' car parks beside the administrative entrance GATE C.

### **1.4 Major Hazard Facility - High Hazard Area**

It is important for all workers, visitors, contractors and drivers entering FOCUS CONTAINER FREIGHT Terminal to be aware that they are entering a Major Hazard Facility and High-Risk area. It is therefore a requirement for all persons to complete the relevant safety induction before access permission is granted.

We strictly advise everyone entering our terminal to read the safety and warning signage posted and abide by the controls we have in place (these are covered in the Worker, Visitor, Transport and Contractor Inductions).

FOCUS CONTAINER FREIGHT STATION LTD acknowledges the hazards identified in the table below. Current controls are regularly reviewed as per the time frames agreed by the HSE Committee with the aim of continuing to reduce pedestrian, forklift/Reach Truck and LPG Trucks interactions, and their associated risks.

**Table 1: Hazard Identification**

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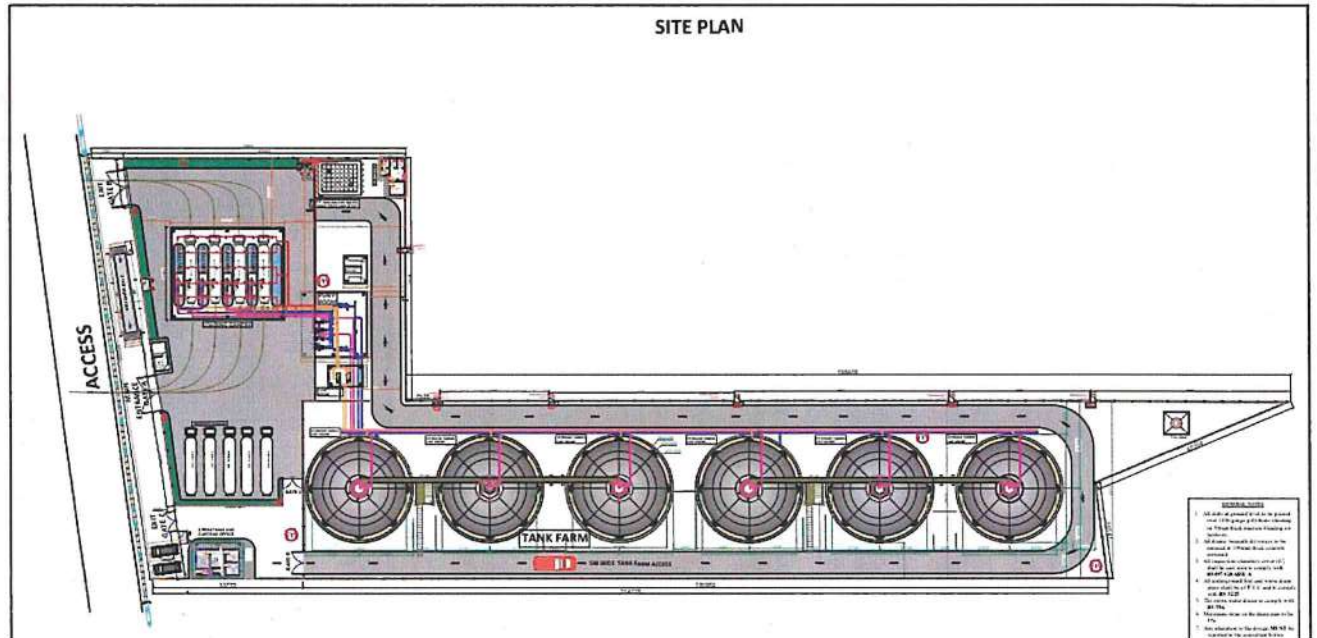
Hazard ID No.	Hazard Name	Raw Risk Rating	Corrective Risk Rating
1147	Visitors/Contractors/Unauthorized People on site	HIGH	MEDIUM
1102	Forklift/reach Operation	EXTREME	HIGH
1100	Loading gantry operation and safety procedures	EXTREME	HIGH
	<b>Hazardous Substances – Storage</b>	TBA	
1149	Pedestrians being hit by Mobile parts	EXTREME	MEDIUM
1122	Non-wearing of PPES	EXTREME	HIGH
1101	Storage	HIGH	MEDIUM
1135	Unauthorized persons at the operation area	EXTREME	HIGH
1145	UNCONTROLLED Traffic at the terminal	EXTREME	HIGH
1126	Uncontrolled parking of the LPG TRUCKS	EXTREME	HIGH



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Figure 1: Basic External Traffic Flow and Main functional Areas within the Terminal



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## **2.0 Expected Inbound and Outbound External Traffic, and Internal Traffic**

### **2.1 Overview**

All receiving and dispatch traffic must enter Focus Container Freight Terminal via the controlled entrance GATE A or C,

All Truck Drivers, visitors, contractors and staff must abide by the internal and external traffic flow plan and rules for the entire terminal. This includes all posted signage e.g. speed limits, direction of travel, PPE requirements.

All incidents in the terminal must be reported. This company rule applies to all team members, drivers, contractors, agency casuals and visitors.

The projected average volumes of inbound/outbound traffic flow per day are as follows:

- Receiving = avg **200** vehicles

### **2.2 Inbound/Outbound Heavy Vehicle Traffic**

*NOTE: All drivers must give way to any Forklifts/reach vehicles operating in the Transit operation area*

FOCUS CONTAINER FREIGHT TERMINAL operates on a booking system controlled by Supply Chain. As a guide, LPG transport companies have timeframes and schedules of when they can arrive and load to avoid congestion at the terminal.

Any LPG truck arriving outside of these agreed timeframes, are to make prior arrangements with the terminal operations team and subsequently wait for prior communication.

### **2.3 Driver Site Inductions**

Access to terminal is not permitted to any vehicle unless the driver has completed a Focus Container Freight Station Ltd Transport Induction.

Drivers name, EPRA's driver's license and other details are recorded in the company's Data Base which is accessible by all via the FOCUS CONTAINER FREIGHT STATION LTD Intranet onsite. Verification through the Data Base of the driver's details is checked prior to entry to ensure the LPG TRUCK drivers has in fact undergone the Transport Induction.

Drivers refusing to comply with FOCUS CONTAINER FREIGHT STATION LTD site rules, will be requested to leave the site immediately. Additionally, they will be referred to their Prime Contractor and refused entry to the site until they fully comply

### **2.4 Driver Safe Zones**

**LPG TRUCK drivers** are not to load unless the driver is in the Safe Zone location at the gantry, the driver will be instructed on the operation procedures at the gantry by the operation officer before loading.

### **2.5 Site Speed Limit**

The site speed limit is a maximum of **5kph** for vehicles moving around the external access route through the terminal. This is signposted accordingly at the entrance to the terminal and



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also around the terminal.

Internal speed is limited to 5kph, all LPG TRUCKS to the gantry and parking at the terminal have been speed limited to this effect.

Whilst on site, all drivers must wear High Visibility Clothing, helmets and safety footwear at all times.

### 2.6 Interrupted Traffic Flow

In the event of a vehicle breakdown/disabled vehicle in the Focus Container Freight Station Ltd terminal or on the one-way road around the terminal, the following actions will be adopted:

1. The truck driver will communicate to the terminal Coordinator/officer as to the issue at hand for swift action to be taken.
2. The terminal officers and technicians will inspect the vehicle of concern as to its:
  - Risk to Safety
  - Risk to the other vehicles
  - Risk to the environment
  - Disruption to the business, and
  - Location
3. Recovery - The recovery vehicle should remove the stricken vehicle from the terminal to a safe zone, prior to any attempt to repair the problem.

### 2.7 Traffic Flow Un-Interrupted

The terminal officer will organize to have the area cordoned off by means of placing safety cones around the stricken vehicle, setting up an exclusion zone. No person is to be placed at risk in any way by their actions or physical location in order to perform this action.

The terminal officer will:

- Confirm that the driver has contacted the transport operator in order to repair/remove vehicle.
- Establish with the driver as to the importance of a swift repair or removal of the stricken vehicle.
- Monitor and review in order to ensure safety is not compromised and that there remains no impact to the environment.

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**2.8 No Stopping Areas**

No stopping of trucks is permitted in the terminal unless in a designated area and prior permission has been sought. terminal consists of the driveways

- from the entrance to the parking area
- from the parking area to the loading gantry
- from the gantry to the main exit
- Driveway around the storage tanks

**3.0 Pedestrians on Site****3.1 Pedestrian Traffic**

Pedestrian traffic on site will be limited to Focus Container Freight Station Ltd workers, inducted drivers, authorized visitors and contractors.

Pedestrians give way to forklifts and vehicles at all times.

Visitors, unless authorized are not permitted to wander around the site complex unescorted at any time. Pedestrian movement around the terminal must be limited to necessary activity. Inbound/ outbound LPG trucks and vehicles will be moving around the terminal and whilst the drivers of these automobiles will be aware of possible pedestrian movement, every effort must be made by each individual pedestrian to be aware of the possible dangers involved. Eye contact and signaled agreement to pass is essential prior to walking into the path of a moving vehicle.

**3.2 Pedestrian Restricted and 'No Go' zones**

Operation areas are restricted to visitors/contractors unless escorted at any time.

**3.3 Pedestrian PPE Requirements**

On entry to the site, pedestrians performing any work on site must wear safety footwear, safety glasses and high visibility cotton or anti-static clothing at all times.

Any visiting pedestrians not performing work on site must be accompanied by a terminal employee, wear safety glasses, enclosed footwear and high visibility cotton or anti-static clothing at all times. PPE is available for visitors use if they do not have their own.

**3.4 Car Park Overview**

FOCUS CONTAINER FREIGHT STATION LTD operation Staff Car Park – outside GATE C.



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### **4.0 Mobile Plant**

#### **4.1 Forklifts and Reach Trucks**

Forklifts and Reach Trucks will be utilized on the Terminal for the purposes Maintenance Services Only.

### **5.0 Communication**

- **Signage:** Ensure clear and visible signage is placed throughout the terminal to direct both drivers and pedestrians.
- **Radio Communication:** Establish a system for on-site communication (e.g., radios, alarms) for coordinating traffic movements, especially in high-risk areas.
- **Coordination with Authorities:** Liaise with local traffic authorities or emergency services in case of external events affecting access to the terminal. This includes KPA, VTTI, KPC AND KMA

### **6.0 SAFETY MEASURES TO BE OBSERVED**

- **Speed Limits:** Set appropriate speed limits within the terminal, considering safety, traffic flow, and operational needs.
- **Emergency Procedures:**
  - Define emergency routes for fire trucks, ambulances, and other emergency vehicles.
  - Identify areas for emergency vehicle staging and response, such as hazardous material spill sites or fire zones.
- **Hazard Identification:** Identify areas of high risk, such as loading zones, storage tanks, and flammable zones, and provide recommendations for minimizing these risks through traffic management measures.
- **Warning Signs and Lighting:**
  - Install warning signs for hazards, speed limits, vehicle restrictions, and pedestrian crossings.
  - Provide adequate lighting in key areas to ensure visibility during night-time or low-light conditions.

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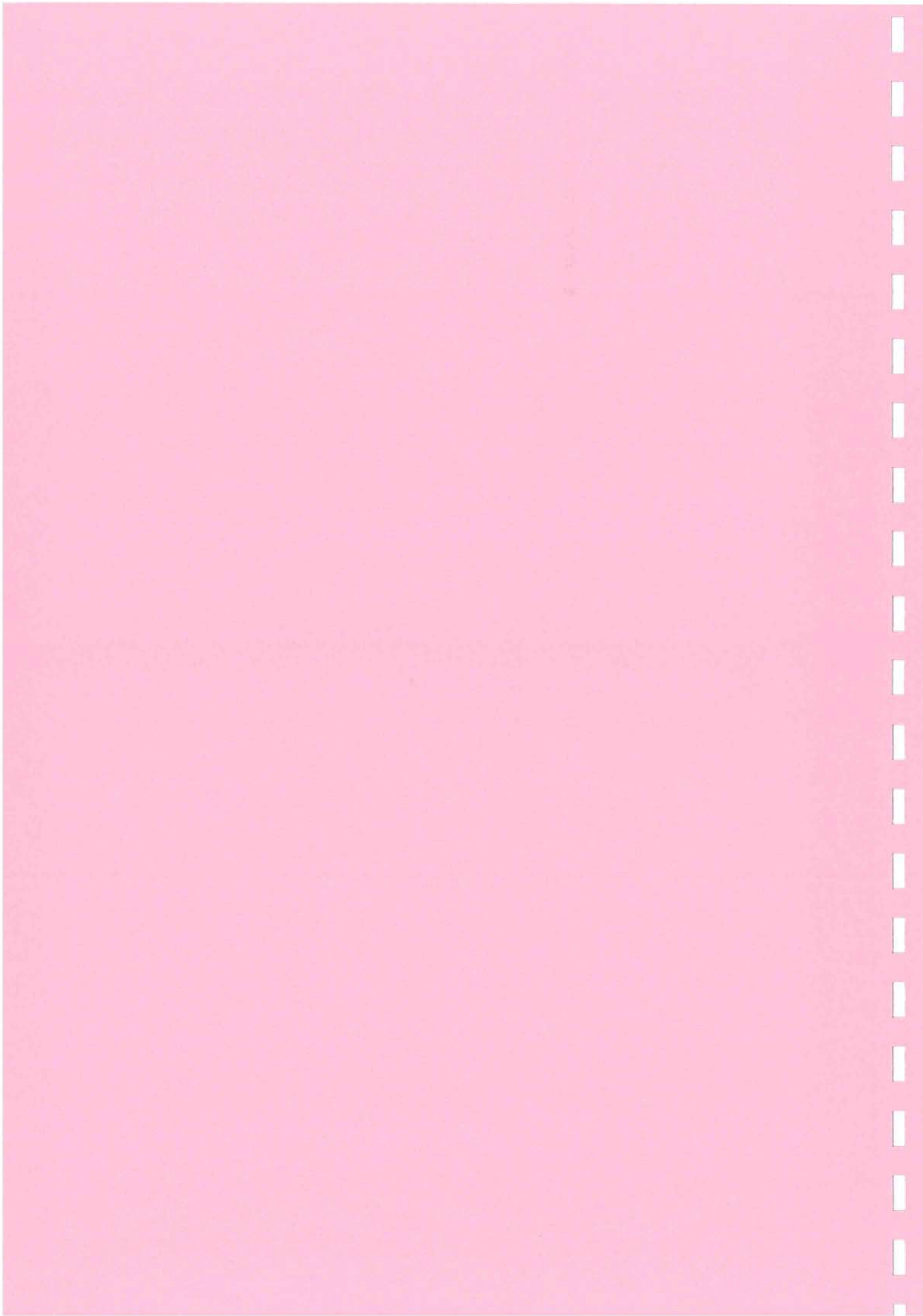
### **7.0 Review Panel**

Review Date	Document Code / Section	Review Details	New Version #	Reviewed by
12/03/2025	All	New Document	1.0	B. OSORO
Next review date due:		12/03/2026		



# **BASELINE STUDIES**

## **●AIR QUALITY**





# AMBIENT ATMOSPHERIC QUALITY MONITORING REPORT

ENVIRONMENTAL BASELINE STUDY REPORT FOR AMBIENT  
ATMOSPHERIC QUALITY MONITORING OF THE PROPOSED  
CONSTRUCTION OF A 15,000MT COMMON USER LIQUEFIED  
PETROLEUM GAS (LPG) TERMINAL IN KIPEVU ON PLOT L.R NO.  
MN/VI/3711, CHANGAMWE AREA, MOMBASA COUNTY.

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## PROJECT INFORMATION:

PREPARED FOR:  
FOCUS CONTAINER FREIGHT STATION,  
P.O. BOX 43092-80100,  
PIPELINE ROAD, KIPEVU, CHANGAMWE,  
MOMBASA, KENYA.



## CLIENT ADDRESS:

PREPARED BY:  
LAHVENS LIMITED  
P.O BOX 34153, 80118.  
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## TESTING CONSULTANTS:

DOCUMENT ID: 50124-0077 A  
TEST DATES: DECEMBER 16<sup>TH</sup> 2024  
(FINAL) REPORT ISSUED: DECEMBER 30<sup>TH</sup>, 2024

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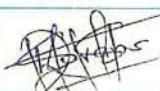


## DOCUMENT INFORMATION:

 FCFS	ENVIRONMENTAL BASELINE STUDY REPORT FOR AMBIENT ATMOSPHERIC QUALITY MONITORING OF THE PROPOSED CONSTRUCTION OF A 15,000MT COMMON USER LIQUEFIED PETROLEUM GAS (LPG) TERMINAL IN KIPEVU ON PLOT L.R NO. MN/VI/3711, CHANGAMWE AREA, MOMBASA COUNTY.	REPORT REF NO.: 50124-0077A REPORT TITLE: EBSAAQMR-77A DOI: 16 <sup>TH</sup> DECEMBER 2024 PAGE NUMBER: P A G E   1
		

## DOCUMENT REVIEW PAGE

This Technical report titled ENVIRONMENTAL BASELINE STUDY REPORT FOR AMBIENT ATMOSPHERIC QUALITY MONITORING OF THE PROPOSED CONSTRUCTION OF A 15,000MT COMMON USER LIQUEFIED PETROLEUM GAS (LPG) TERMINAL IN KIPEVU ON PLOT L.R NO. MN/VI/3711, CHANGAMWE AREA, MOMBASA COUNTY was authored by Lahvens Limited in accordance to the EMC (Air Quality) Regulation 2014, Legal Notice 34.



REV	DATE	DESCRIPTION
03	30.12.2024	Issuance of Final Report
02	23-12-2024	Re-submission to close the given comments and approvals
01	20-12-2024	1 <sup>st</sup> draft issue of the soft copy submitted for review

Accepted by			
Reviewed & Approved by	LOVANS ROBERT SPOO (LABORATORY DIRECTOR) N.E.R. NO.: 7165		30.12.2024
Prepared by	VINCENT AGIN - FIELD ATTENDANT		30.12.2024
	VALENTINE AGUTU - FIELD ATTENDANT		30.12.2024
PROJECT	Name	Signature	Date

## DOCUMENT & PROJECT PARTICULARS

DOCUMENT REF: 50124-0077A	CLASSIFICATION: A - UNCLASSIFIED (OPEN REPORT)	CONTRACT NO. AS PER TCL TOR.	REVISION: 00 FINAL
TEST FIRM CONTACT PERSON: LOVANS SPOO: (254 - 728716948)	PROJECT: PROPOSED 15,000MT COMMON USER LPG TERMINAL	NUMBER OF PAGES: 47	
AUTHOR(S): VINCENT OKUMU, VALENTINE AGUTU, LOVANS SPOO		QUALITY CONTROLLER: EDNAH MACHARIA	
ABSTRACT (ENGLISH TITLE): FOCUS CONTAINER FREIGHT STATION through Tropospace Consultancy contracted Lahvens Limited to form part of the Project's Environmental Team (ET). LAHVENS Limited was commissioned to provide consulting services of environmental baseline atmospheric quality concentrations assessment before implementation of the proposed 15,000MT COMMON USER LIQUEFIED PETROLEUM GAS (LPG) TERMINAL IN KIPEVU ON PLOT L.R NO. MN/VI/3711, CHANGAMWE AREA, MOMBASA COUNTY.			
KEY WORDS: EBS Air Quality Monitoring and Consultant Reporting.			
ABSTRACT (in ENGLISH)		PUBLICATION TYPE: Digital document (pdf)	



 FCFS	ENVIRONMENTAL BASELINE STUDY REPORT FOR AMBIENT ATMOSPHERIC QUALITY MONITORING OF THE PROPOSED CONSTRUCTION OF A 15,000MT COMMON USER LIQUEFIED PETROLEUM GAS (LPG) TERMINAL IN KIPEVU ON PLOT L.R NO. MN/VI/3711, CHANGAMWE AREA, MOMBASA COUNTY.	REPORT REF NO.: 50124-0077A REPORT TITLE: EBSAAQMR-77A DOI: 16 <sup>TH</sup> DECEMBER 2024 PAGE NUMBER: P A G E   2
		

## REVIEW AND CERTIFICATION FROM THE TESTING CONSULTANTS

All work, calculations, other activities, and tasks performed and documented in this report were carried out under my direction and supervision. This test project conforms to the requirements of Lahvens Limited's quality manual and EMC (Air Quality) Regulation 2014, Legal Notice 34.

Team Leader: VALENTINE ODUOR

Signature:



Date: 30.12.2024

I have reviewed all testing details, calculations, results, conclusions and other appropriate written material contained herein, and hereby certify that the presented material is authentic and accurate.

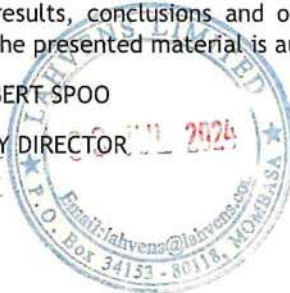
Reviewer: LOVANS ROBERT SPOO

Title: LABORATORY DIRECTOR

Signature:



Date: 30.12.2024





## CERTIFICATION FROM THE LEGAL ENTITY OF THE TESTING FACILITY:

I have reviewed the information being submitted in its entirety. Based on the information and belief formed after reasonable inquiry, I certify that the statements and information contained in this submittal are true, accurate and complete.

\_\_\_\_\_  
Signature Date

\_\_\_\_\_  
Name Printed Title

\_\_\_\_\_  
Company Name Company stamp

 <b>FCFS</b>	ENVIRONMENTAL BASELINE STUDY REPORT FOR AMBIENT ATMOSPHERIC QUALITY MONITORING OF THE PROPOSED CONSTRUCTION OF A 15,000MT COMMON USER LIQUEFIED PETROLEUM GAS (LPG) TERMINAL IN KIPEVU ON PLOT L.R NO. MN/VI/3711, CHANGAMWE AREA, MOMBASA COUNTY.	REPORT REF NO.: 50124-0077A REPORT TITTLE: EBSAAQMR-77A DOI: 16 <sup>TH</sup> DECEMBER 2024 PAGE NUMBER P A G E   3 
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## EXECUTIVE SUMMARY

FOCUS Container Freight Station is a leading Container Freight Station providing quality, customer focused storage services to a wide range of clients. They are an established market leader handling different categories of cargo coming through the Port of Mombasa and destined for all regions of Eastern Africa, including Rwanda, Burundi, Democratic Republic of Congo, South Sudan, Eritrea and Ethiopia as well as Somalia. FCFS offer Container handling, loose cargo handling, Motor vehicle transfers, out of gauge handling, Refer container handling, Project cargo, Export cargo handling & Warehousing services.

FOCUS Container Freight Station intends to diversify its services to the energy / petroleum sector having realized a gap in the petroleum sector. To meet the high demand of petroleum products (LPG) in the Country and across the border of East Africa, Focus CFS Limited; a privately owned company has proposed to construct and operate an LPG terminal (Focus LPG Terminal-FLT) on Plot L.R No: MN/VI/3711, Kipevu, Changamwe area, Mombasa County. The terminal will have a storage capacity of 15,000 Metric Tonnes in the form of 6 LPG Horton Spheres each with a capacity of 2,500 cubic metres with 16 trucks at a time loading facility. Their main agenda is to build a common user facility that will enable the oil marketers' import and supply LPG at extremely low price to the end users and also fulfil the government's blue print of increasing the per capita consumption of LPG to 10Kg from the current consumption which of <2Kg.

Constructing an LPG (Liquefied Petroleum Gas) terminal involves building a facility to receive, store, mix, and distribute LPG, requiring careful design and consideration of safety measures due to the highly flammable nature of the gas, typically including components like storage tanks, loading/unloading bays, pipelines, vapor recovery systems, and comprehensive safety equipment, all built on a designated site with proper environmental protections in place.

While LPG (Liquefied Petroleum Gas) is considered a relatively clean-burning fuel compared to other fossil fuels, the construction and operation of LPG terminals can still have negative environmental impacts, primarily related to potential leaks, spills, air emissions during operations, and the construction process itself, which can disrupt local ecosystems and generate noise pollution; however, with proper mitigation strategies, these impacts can be minimized. Although LPG emits less carbon dioxide than many other fuels when burned, leaks during storage and transfer can release volatile organic compounds (VOCs) into the atmosphere, contributing to air pollution and smog formation.

Atmospheric Environment survey was conducted to determine the EXISTING (Do minimum) air pollution around the proposed project for Environmental, Sustainability, Health, Safety and compliance purposes. Air quality remains a valued component in this environmental assessment because of their fundamental significance to the well-being of humans, wildlife and vegetation.



The objectives of environmental atmospheric baseline monitoring will be as follows;

- To monitor the existing state of atmospheric air quality environment at predetermined survey locations of the proposed project site.

- The results of these tests shall be used to demonstrate compliance with a set of emission concentration limit values for prescribed pollutants as specified in the EMC (Air quality) regulations 2014 during licensing and continuous assessments.

- Report the findings of the survey in a report which will also form part of the Environmental and Social Action Plan.



 <b>FCFS</b>	ENVIRONMENTAL BASELINE STUDY REPORT FOR AMBIENT ATMOSPHERIC QUALITY MONITORING OF THE PROPOSED CONSTRUCTION OF A 15,000MT COMMON USER LIQUEFIED PETROLEUM GAS (LPG) TERMINAL IN KIPEVU ON PLOT L.R NO. MN/VI/3711, CHANGAMWE AREA, MOMBASA COUNTY.	REPORT REF NO.: 50124-0077A REPORT TITLE: EBSAAQMR-77A DOI: 16 <sup>TH</sup> DECEMBER 2024 PAGE NUMBER P A G E   4 
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The baseline air quality report includes the National and local assessments. At the National scale the assessment considers the total mass emission of general pollutants associated with construction activities. These are sulfur dioxide (SO<sub>2</sub>), Nitrogen oxide (NO<sub>x</sub>), Ozone (O<sub>3</sub>), Particulate Matter (PM<sub>10</sub> and PM<sub>2.5</sub>) - particles with aerodynamic diameters of less than 10 and 2.5 microns respectively

The current concentrations of these pollutants are at risk of exceeding their respective Air Quality Limit Values during construction, commissioning and decommissioning phases. The estimates of the existing concentrations will be measured and compared to any relevant existing information and when the project commences, will be used as the background data. Relevant available information related to the pre-development ambient air concentration in the environment was looked into while identifying the major existing air emission sources in the environment and the existing sensitive pollution areas in the environment.

This Environmental Baseline Study is designed to characterize the atmospheric resources at the proposed site prior to establishment of the proposed LPG terminal developments in Changamwe. EBS will provide a benchmark and reference against which to compare the environmental conditions influenced by the construction, operation and closure phases of the LPG terminal development. The information will be used to assess the effectiveness of any proposed mitigation measures and to implement adaptive management, if need be.

The environmental baseline study will collect, assess, and interpret enough physical and chemical atmospheric information to: support the characterization of the atmospheric resource; enable determination of possible impacts; help predict the significance of impacts and the effectiveness of any proposed mitigation; establish thresholds for indicators of ecosystem health; and facilitate the design of monitoring programs.

Well-developed EBS often alleviate heightened perceived concerns within the community during the initial phases of any proposed development, before issues become a serious risk to the project. EBS also creates reassurance in the minds of the public and jurisdictional decision makers that key environmental issues have been identified and will be monitored and mitigated, during and after the project is approved. EBS monitoring can be looked at as an early warning system of impacts that could potentially affect the environment during the project operation phase and long after the project is decommissioned.



Atmospheric environment has been selected as a valued component because of their fundamental significance to the well-being of human health, flora and fauna health. Environmental Baseline Study is a significant component of monitoring programs for some successful development activities. This Baseline Report forms part of the Environmental and Social Action Plan of the proposed Project.

It is important to accurately determine prevailing air quality conditions against which predicted effects can be gauged and assessed for any environmental effects' assessment.

Ambient air quality survey for this study consists of **FOUR** representative monitoring locations. Information for the report is presented based on air monitoring completed for 4-hour weighted average per locale. For the purpose of the baseline investigation, monitoring of air pollutants was achieved on the 16<sup>th</sup> day of December 2024 and thereafter the results were compared against the guidelines and standards while attention given to relevant referencing sites of similar nature. Ambient air quality data were obtained from a validated and approved air quality monitoring program.

Mobile and active monitoring was done by use of real time equipment AQM-09 which integrates the main ambient gases and meteorological parameters and particulate counter meter. Temperature is measured by way of a highly accurate Air Chip 3000 while humidity is measured using a capacitive humidity sensor (accuracy < 0.8 % / 0.1 K). The gas detector and particulate matter meters were mounted at about 1 - 2 M above the ground surface. The duration information was used to calculate the gas / pm concentrations.



 <b>FCFS</b>	<p>ENVIRONMENTAL BASELINE STUDY REPORT FOR          AMBIENT ATMOSPHERIC QUALITY MONITORING          OF THE PROPOSED CONSTRUCTION OF A          15,000MT COMMON USER LIQUEFIED PETROLEUM          GAS (LPG) TERMINAL IN KIPEVU ON PLOT L.R          NO. MN/VI/3711, CHANGAMWE AREA, MOMBASA          COUNTY.</p>	<p>REPORT REF NO.: 50124-0077A          REPORT TITTLE: EBSAAQMR-77A          DOI: 16<sup>TH</sup> DECEMBER 2024          PAGE NUMBER P A G E   5</p> 
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## FIELD NOTES AND OBSERVATIONS:

Ambient air quality measurements were taken for short term exposure levels. It should however be noted that this exercise is only applicable to the time period when sampling took place and does not take into account seasonal and other local various that might occur during other months and times. However, it is still a good general overview of the existing air quality environment.

### Sensitive receptors

The proposed project site is currently used for clearance and storage of goods. The plot lies in Kipevu area in Changamwe in a notified industrial area, within the Port Area of Mombasa. The site is located approximately 2km away from the Port of Mombasa with highly populated Chaani and Migadini residential areas to the west, known as the sensitive receptors. Immediate neighbors within a radius of five hundred metres include: - KPC PS14 (Kenya Pipeline Company), Kipevu Wastewater Treatment Plant, VTTI Kenya Ltd., and Kipevu Oil Terminal (KOT) among many others. There are no sensitive receptors at the proposed site.

### Potential Pollution causes;

From the site visits and background site description, the following sources have been identified as potential pollution causes at the proposed site;

### Exhaust gases:

The survey location is accessible to heavy trucks loading and offloading the machine and othe motor vehicles that utilize diesel and petrol. Vehicle and motorcycle exhausts contain a number of pollutants including carbon dioxide (CO<sub>2</sub>), carbon monoxide (CO), hydrocarbons, oxides of nitrogen (NO<sub>x</sub>), sulphur and PM<sub>10</sub>. The quantity of each pollutant emitted depends upon the type and quantity of fuel used, engine size, speed of the vehicle and abatement equipment fitted. Once emitted, the pollutants are diluted and dispersed in the ambient air.

### Vehicular movement;

Re-suspension of roadside dust from movement of vehicles resulted in generation of relatively higher fraction of finer dust (PM<sub>2.5</sub>). Significant atmospheric dust arose from the mechanical disturbance of granular soils materials exposed to the air from motor vehicle / cycle movement. Pulverization and abrasion of surface materials by application of vehicular mechanical forces generate substantial amount of dust.

## CONCLUSIONS:

Baseline Atmospheric Environment Monitoring was conducted to characterize the existing environment before implementation (DO MINIMUM) of the proposed LPG terminal development. The conclusions below were drawn from the exercise conducted on the 16<sup>th</sup> December 2024.

### Gaseous Parameters:



All gaseous parameters (carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone and total volatile organic compounds) were measured and quantified at all the four survey locations.

Before the project implementation of the proposed LPG terminal development, all measured gaseous parameters COMPLIED with the EMC (Air quality) regulations 2024 limits.

The ambient air quality data (gaseous) measured around the monitoring locations are considered to be within a typical range of emissions for such neighborhood.

The findings of the gaseous monitoring program indicate that the air quality at the proposed LPG terminal development is generally good before commissioning of the project. All pollutants measured are at levels that do not pose Environmental, Sustainability, Health, Safety and compliance concerns to the receivers.



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#### Meteorological Parameters:

The monitoring locations in general showed Standard atmospheric environment before project implementation due to the combination of good climate and ambient conditions. Weather and Climatic conditions of the proposed LPG terminal development provided good dispersion of air contaminants.

#### Particulate Matter (PM<sub>10</sub> and PM<sub>2.5</sub>):

Particulate parameters concentrations (PM<sub>10</sub> and PM<sub>2.5</sub>) were measured and quantified across the survey stations.

Before the project implementation of the proposed LPG terminal development, all measured particulate parameters COMPLIED with the EMC (Air quality) regulations 2014 limits.

PM<sub>2.5</sub> and PM<sub>10</sub> concentration levels recorded were within the typical range of emissions for similar neighborhood.

The findings of the monitoring program indicate that the particulate matter atmospheric environment is generally good before the proposed LPG terminal development implementation. Particulate pollutants measured are at levels that do not pose Environmental, Sustainability, Health, Safety and compliance concern.



Once construction and operations begin, the client is expected to maintain the background / baseline levels.

#### RECOMMENDATIONS:

Industrialization can be a blessing to our economy and at the same time a challenge to our environmental sustainability and health curse. Sustainable industrialization can however be achieved through effective emission reduction vide influencing government, industry and stakeholders to ensure **compliance** with current legislation, to encourage **adoption** of low emission approaches, and to develop a pathway to enhanced **regulation**.

#### Compliance:

Ensuring **compliance** with existing regulation is the most effective way to reduce local emissions. This could take the form of an enhanced and consistent air quality measurement (dust & gaseous measurement), reporting system, ensuring compliance with set dust management emission policies and plans.

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## DEFINITIONS.

Table 1: List of acronyms

µg/m <sup>3</sup>	Microgram per cubic meter
AAQTL	Ambient Air Quality Threshold Limits
AQG	Air Quality Guidelines
CBS	Comprehensive Baseline Study
CO	Carbon monoxide
CO <sub>2</sub>	Carbon dioxide
EA	Environmental Audits
EIA	Environmental Impact Assessment
EMC	Environmental Management and Coordination
EPA	Environmental Protection Authority
GPS	Geographic Positioning System
hpa	Hectopascal
Km/hr	Kilometer per hour
mg/m <sup>3</sup>	Milligram per cubic meter
NEMA	National Environment Management Authority
NO <sub>x</sub>	Oxides of Nitrogen
NO <sub>2</sub>	Nitrogen dioxide
PM <sub>10</sub>	Particulate matter (<10 microns)
PM <sub>2.5</sub>	Particulate matter (<2.5 microns)
SO <sub>2</sub>	Sulfur dioxide
QAQC	Quality Assurance / Quality Control
TVOC	Total volatile Organic compounds
TWA	Time Weighted Average
WB	World bank
WHO	World Health Organization
µg/m <sup>3</sup>	Micro gram per cubic meter
VOCs	Volatile organic compounds



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## 1. INTRODUCTION

### 1.1. Project Summary and Objectives

FOCUS Container Freight Station is a leading Container Freight Station providing quality, customer focused storage services to a wide range of clients. They are an established market leader handling different categories of cargo coming through the Port of Mombasa and destined for all regions of Eastern Africa, including Rwanda, Burundi, Democratic Republic of Congo, South Sudan, Eritrea and Ethiopia as well as Somalia. FCFS offer Container handling, loose cargo handling, Motor vehicle transfers, out of gauge handling, Refer container handling, Project cargo, Export cargo handling & Warehousing services.

FOCUS Container Freight Station intends to diversify its services to the energy / petroleum sector having realized a gap in the petroleum sector. To meet the high demand of petroleum products (LPG) in the Country and across the border of East Africa, Focus CFS Limited; a privately owned company has proposed to construct and operate an LPG terminal (Focus LPG Terminal-FLT) on Plot L.R No: MN/VI/3711, Kipevu, Changamwe area, Mombasa County. The terminal will have a storage capacity of 15,000 Metric Tonnes in the form of 6 LPG Horton Spheres each with a capacity of 2,500 cubic metres with 16 trucks at a time loading facility. Their main agenda is to build a common user facility that will enable the oil marketers' import and supply LPG at extremely low price to the end users and also fulfil the government's blue print of increasing the per capita consumption of LPG to 10Kg from the current consumption which of <2Kg.

Constructing an LPG (Liquefied Petroleum Gas) terminal involves building a facility to receive, store, mix, and distribute LPG, requiring careful design and consideration of safety measures due to the highly flammable nature of the gas, typically including components like storage tanks, loading/unloading bays, pipelines, vapor recovery systems, and comprehensive safety equipment, all built on a designated site with proper environmental protections in place.



While LPG (Liquefied Petroleum Gas) is considered a relatively clean-burning fuel compared to other fossil fuels, the construction and operation of LPG terminals can still have negative environmental impacts, primarily related to potential leaks, spills, air emissions during operations, and the construction process itself, which can disrupt local ecosystems and generate noise pollution; however, with proper mitigation strategies, these impacts can be minimized. Although LPG emits less carbon dioxide than many other fuels when burned, leaks during storage and transfer can release volatile organic compounds (VOCs) into the atmosphere, contributing to air pollution and smog formation.

Atmospheric Environment survey was conducted to determine the EXISTING (Do minimum) air pollution around the proposed project for Environmental, Sustainability, Health, Safety and compliance purposes. Air quality remains a valued component in this environmental assessment because of their fundamental significance to the well-being of humans, wildlife and vegetation.

The objectives of environmental atmospheric baseline monitoring will be as follows;

- ✦ To monitor the existing state of atmospheric air quality environment at predetermined survey locations of the proposed project site.
- ✦ The results of these tests shall be used to demonstrate compliance with a set of emission concentration limit values for prescribed pollutants as specified in the EMC (Air quality) regulations 2014 during licensing and continuous assessments.
- ✦ Report the findings of the survey in a report which will also form part of the Environmental and Social Action Plan.



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## 1.2. Facility Description;

The proposed project will involve the construction of a bulk Liquefied Petroleum Gas storage Terminal with a storage capacity of 15,000 metric tonnes in the form of 6 Liquefied Petroleum Gas Horton Spheres each with a capacity of 2,500 cubic metres with 16 trucks at a time loading facility, a filling point, Hydrant location, jetty, piping, a fire wall and an office block. The project will occupy an area of approximately 7.321 hectares.

Project implementation will involve the establishment of:

- I. Import facilities at Shimanzi Oil Terminal, proposed oil/gas jetty near Naval base, Mtongwe and Common User Terminal at AGOL, all in Port of Mombasa, comprising of existing or liquefied petroleum gas new marine loading arms.
- II. Bulk liquefied petroleum gas storage facilities at FLT which shall comprise of six Horton Spheres each with a capacity of 2,500 MT.
- III. Liquefied petroleum gas pump and compressor house.
- IV. Truck loading gantry of 16 bays.
- V. Truck loading piping complete with bottom loading arms, vapour return piping and emergency break-away couplings.
- VI. Pipe line from jetty to storage terminal at FLT.
- VII. Gate security/access control, CCTV surveillance, control/inspection/validation room.
- VIII. Electricals installation including sub-station and instrumentation.
- IX. Diesel generator system for emergency power supply.
- X. Site drainage and water supply installation.
- XI. Fire water storage and firefighting system/pumping arrangement.
- XII. Vehicle parking and circulation.
- XIII. LP flare or vent system.
- XIV. Liquefied petroleum gas dosing equipment, Methanethiol (Mercaptan)
- XV. Piping manifold and layout.
- XVI. Gas leak detection system.
- XVII. Installation of state of art liquefied petroleum gas bulk automation mass flow meters.
- XVIII. A firewall
- XIX. A borehole to supplement the water supply

The storage terminal at FLT will receive LPG from jetty through ship tankers. LPG marine loading arm shall be installed for unloading purposes or alternatively use of existing SOT gantries under Management Agreement. Dedicated LPG pipe lines shall be laid from the jetty to the proposed storage area in FLT or alternatively share the Total pipeline under a Management agreement.



## 1.3. Appraisal Framework Requirements

Under the Second Schedule of the Environmental Management and Coordination Act (EMCA), Cap 387 of the Laws of Kenya, the project is categorized as a High Risk and thus should undergo a Comprehensive Environmental Impact Assessment Project Report (CPR).

Air quality monitoring is enshrined in the environmental Management Coordination (Air quality) regulations 2014 framework legal notice 34. According to EMC (Air quality) regulations 2014 framework legal notice 34 under preliminary, the interpretation of "monitoring" means any periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements or pollutant levels in various media or in humans, animal, and other living things.

The Constitution of Kenya provides that "every person has a right to a clean and healthy environment and this includes the right to have the environment protected for the benefit of present and future



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*generations.”* The prevention of atmospheric pollution is recognized as a component of a clean and healthy environment. All development therefore that are proposed to be established should comply with this provisions when their operational phase commences. It is essential therefore to take note through measurement the current / existing air quality conditions before implementation of the proposed project to justify during operations that the environmental media / parameter was not deteriorated as a consequence of the project implementation. Once the baseline values are determined, the industries are then allowed to operate in a manner that does not cause pollution, that might not lead to injury of the body and disruption of peace and comfort enjoyed by the employees and workers in the industrial areas. It is for this reason that there is a need to regulate the levels of air emissions. These regulations are set out by the National Environmental Management Authority (NEMA) to protect people from air pollution and odor.

Environmental Management Coordination (Air quality) regulations 2014 framework legal notice 34, PART XIII-MISCELLANEOUS - section 75 states that *“The Authority may in consultation with the relevant lead agencies establish baseline levels of priority air pollutants set out in the Second Schedule.*



In addition, Environmental Audit is required for all existing projects in compliance with Section 54 (A)(2) of the Environmental Impact Assessment (EIA) regulations, 2014 (as amended), promulgated under the National Environmental Management Act, 1998 (act No. 107 of 1998; NEMA). Air quality monitoring is captured as an environmental aspect that needs to be monitored under the Environmental Monitoring and Management plan (EMMP).

According to the EMC (IMPACT ASSESSMENT AND AUDIT) regulations 2003 framework legal notice 101 PART IV, THE ENVIRONMENTAL IMPACT ASSESSMENT STUDY REPORT section 18 which states that (1) A proponent shall submit to the Authority, an environmental contents of impact assessment study report incorporating but not limited to the environmental following information; - (b) a concise description of the national environmental legislative and regulatory framework, **baseline information**. PART VI - MISCELLANEOUS PROVISIONS section 43 (2) states that *the proposed policy, programme or plan specified in this regulation shall state - (d) an environmental analysis covering: (i) baseline information focusing on areas potentially affected.*

The client in adhering to the above extracts and as part of the authorization process contracted Tropospace Consultancy Limited to carry out the Environmental and Social Impact Assessment in December 2024. Tropospace Consultancy Limited together with the client commissioned LAHVENS Ltd to form the Project’s Environmental Team (ET). Lahvens Limited was responsible for providing consulting services of existing atmospheric concentrations / environment before implementation of the proposed project.

#### 1.4. Scope of Baseline Air Quality Assessment;

The baseline air quality report includes the National and local assessments. At the National scale the assessment considers the total mass emission of general pollutants associated with construction activities. These are sulfur dioxide (SO<sub>2</sub>), Nitrogen oxide (NO<sub>x</sub>), Ozone (O<sub>3</sub>), Particulate Matter (PM<sub>10</sub> and PM<sub>2.5</sub>) - particles with aerodynamic diameters of less than 10 and 2.5 microns respectively. Background information on these pollutants and why they are of concern is summarized in section 2 ‘CONTEXT OF THE AIR QUALITY & MONITORING NETWORK’. The current concentrations of these pollutants are at risk of exceeding their respective Air Quality Limit Values during construction, commissioning and decommissioning phases of the LPG terminal. The estimates of the existing concentrations will be measured and compared to any relevant existing information and when the project commences, will be

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used as the background data. Relevant available information related to the pre-development ambient air concentration in the environment was looked into while identifying the major existing air emission sources in the environment and the existing sensitive pollution areas in the environment.

### 1.5. Terms of Reference

As part of the Terms of Reference (ToR), ambient air quality measurements were undertaken in compliance with the EMC (Air quality) regulations 2014 framework legal notice 34.

The following forms the TOR of the air quality survey:

- ✚ Review of the legal context relating to air pollutants;
- ✚ Evaluation of site meteorology;
- ✚ Monitoring of background air quality:
  - Particulate Matter (PM) - particulate matter with aerodynamic diameter less than 10 microns and 2.5 microns (PM<sub>10</sub> and PM<sub>2.5</sub>).
  - Gases - sulfur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), and carbon dioxide (CO<sub>2</sub>) Total Volatile Organic Compounds (TVOC) and Ozone (O<sub>3</sub>).

### 1.6. Justification of EBS



This Environmental Baseline Study is designed to characterize the atmospheric resources at the proposed site prior to establishment of the proposed LPG terminal in Kipevu, Changamwe, Mombasa county. EBS will provide a benchmark and reference against which to compare the environmental conditions influenced by the construction, operation and closure phases of the LPG terminal development. The information will be used to assess the effectiveness of any proposed mitigation measures and to implement adaptive management, if need be.

The environmental baseline study will collect, assess, and interpret enough physical and chemical atmospheric information to: support the characterization of the atmospheric resource; enable determination of possible impacts; help predict the significance of impacts and the effectiveness of any proposed mitigation; establish thresholds for indicators of ecosystem health; and facilitate the design of monitoring programs.

Well-developed EBS often alleviate heightened perceived concerns within the community during the initial phases of any proposed development, before issues become a serious risk to the project. EBS also creates reassurance in the minds of the public and jurisdictional decision makers that key environmental issues have been identified and will be monitored and mitigated, during and after the project is approved. EBS monitoring can be looked at as an early warning system of impacts that could potentially affect the environment during the project operation phase and long after the project is decommissioned.

Atmospheric environment has been selected as a valued component because of their fundamental significance to the well-being of human health, flora and fauna health. Environmental Baseline Study is a significant component of monitoring programs for some successful development activities. This Baseline Report forms part of the Environmental and Social Action Plan of the proposed Project.



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## 2. CONTEXT OF THE AIR QUALITY & MONITORING NETWORKS

Having clean air to breathe is necessary for good health. Poor air quality reduces quality of life. Some air pollutants are irritants. Some have odor. Some air pollutants can cause respiratory disease or even cancer. Air quality is important both indoors and outdoors. Ground level ozone, particulate matter and allergens are common outdoor air pollutants. Air in its purest state is best suited for the essential task sustaining life. Air pollution is a major environmental risk to health. Air pollution can trigger heart attacks or strokes. In fact, one in three persons who have heart disease can be potentially worsened by air pollution. Breathing clean air can lessen the possibility of disease from stroke, heart disease, lung cancer as well as chronic and acute respiratory illnesses such as asthma. Lower levels of air pollution are better for heart and respiratory health both long- and short-term.

LPG is a hydrocarbon compound consisting mainly of carbon and hydrogen atoms. LPG means liquefied petroleum gas. As per NFPA 58 Section 3.3.36, LP-Gas or LPG is any material having a vapour pressure not exceeding that allowed for commercial propane that is composed predominantly of the following hydrocarbons, either by themselves or as mixtures: propane, propylene, butane (normal butane or isobutane), and butylenes. LPG is used for various applications, including industrial, commercial, power generation, agricultural, and manufacturing applications. It is widely used for cooking, heat generation, and as a fuel source to power cars.



LPG is manufactured from two main sources: the processing of natural gas and refining crude oil. Natural gas contains a high percentage of methane and a smaller percentage of hydrocarbons, including propane and butane. During natural gas processing, Liquefied Petroleum Gas (propane and butane) is extracted. LPG is produced from crude oil refining, which includes catalytic cracking, crude distillation, and other processes. The gas recovered during this process is liquefied to form LPG.

One of the most compelling environmental benefits of LPG is its lower greenhouse gas emissions compared to other fossil fuels. When burned, LPG produces significantly fewer carbon dioxide (CO<sub>2</sub>) emissions per unit of energy than coal or oil. This means that using LPG for various energy needs can help mitigate climate change and reduce carbon footprint. In addition to lower CO<sub>2</sub> emissions, LPG combustion produces fewer harmful air pollutants. Compared to coal and diesel, which emit pollutants such as sulfur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), and particulate matter, LPG burns cleaner. This can lead to improved air quality, reduced respiratory problems, and a healthier environment for both urban and rural areas.

While LPG (Liquefied Petroleum Gas) is considered a relatively clean-burning fuel compared to other fossil fuels, the construction and operation of LPG terminals can still have negative environmental impacts, primarily related to potential leaks, spills, air emissions during operations, and the construction process itself, which can disrupt local ecosystems. Most of the VOCs are non-biodegradable and very easily become component of the environment and deplete its purity.

On the other side of terminal construction, it is a well-known producer of air pollution that negatively impacts both human and environmental health via the emission of particulate matter and volatile organic compounds, among other harmful pollutants. Construction activities and equipment alike also contribute to climate change through the release of greenhouse gases. **There is also some likelihood of atmospheric quality deterioration during the construction or demolition works in three main ways:**



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**Dust nuisance.** The circulation of machinery, equipment travel, equipment exhaust, demolition operations or the loading and unloading of materials (onsite material handling operations) release suspended particles (PM<sub>10</sub>, PM<sub>2.5</sub> and PM<sub>1</sub>) that can cause health risks when inhaled, especially among the most vulnerable groups of people. Demolition activities can also expose both construction workers and nearby residents to mold, asbestos, lead, bird waste, and other respiratory irritants that package as dust. Particulate matter is one common air contaminant in construction zones that poses major damage because of its significant harm to human and environmental health.

**Atmospheric emissions from machinery.** Machinery on a construction site generates noise, dust and gases such as NO<sub>x</sub> or CO or SO<sub>2</sub>. Construction produces greenhouse gas emissions when diesel and fossil fuels are burned to run machinery. The production of finished concrete generates a significant amount of carbon dioxide emissions.

**Transport of construction materials.** The handling of construction materials also contributes to higher pollution levels, especially in the case of particulate matter.

By understanding the ways that construction negatively impacts the immediate environment, those working at the site, and nearby communities, can take action to minimize these harms through increased regulation and sustainable practices.

The environmental impact of a construction site is wide-ranging. In this sense, air quality may be relegated to the background. It is, after all, a temporary condition, generally limited to the period during which the works are being carried out. But this is no excuse for not adopting measures to help reconcile environmental protection and construction or demolition activities. Thus, it should be noted that the environmental impact of construction on the atmosphere can manifest itself in different ways:

- ✚ Ecological impacts: pollutants from construction activities can alter the quality of water resources. But they can also affect the vegetation and animal species that make up ecosystems and upset the ecological balance.
- ✚ Impact on public health: the emissions mentioned in the previous section may have a significant impact on local communities and inhabited areas in the vicinity of the construction site.
- ✚ Climate connection: the soot or black carbon which is part of fine particulate matter (PM<sub>2.5</sub>) absorbs sunlight, thus contributing to global warming.



Clean air is essential to human health and ecosystems. Five categories of general pollutants were measured at the monitoring networks at the proposed site in Mombasa county. The monitored categories of pollutants were sulphur dioxide (SO<sub>2</sub>); oxides of nitrogen (NO<sub>x</sub>) (which includes nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>)); carbon monoxide (CO); Total Volatile Organic Compounds (TVOC); ozone (O<sub>3</sub>); particulate matter (PM) (which includes particles less or equal to than 2.5 microns (PM<sub>2.5</sub>), particles less than or equal to 10 microns (PM<sub>10</sub>). The EB study includes monitoring over a 4-hour period for the above pollutants. The networks are described below:

### 2.1. Oxides of Nitrogen (NO<sub>x</sub>)

Combustion of fossil fuels from vehicles, power plants and industrial activity produces oxides of nitrogen (NO<sub>x</sub>). NO<sub>x</sub> is primarily made up of nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>). NO<sub>2</sub> is of most concern due to its impact on health. However, NO easily converts to NO<sub>2</sub> in the air - so to reduce concentrations of NO<sub>2</sub> it is essential to control emissions of NO<sub>x</sub>. National ambient air quality standards set NO<sub>2</sub> as a criteria pollutant and indicator of the larger group of nitrogen oxides.

Construction and demolition sites generate NO<sub>2</sub> from diesel or gasoline fuelled engines in industrial trucks, excavators, loaders, bulldozers, mobile cranes, off-road machinery and static engines such as



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pumps and electricity generators. Idling engines are a significant contributor to NRMM emissions and personal exposure to NO<sub>2</sub>.

Scientific evidence links short-term NO<sub>2</sub> exposures with adverse respiratory effects including airway inflammation in healthy people and increased respiratory symptoms in people with asthma. Studies also show a connection between short-term exposure and increased hospital admissions for respiratory illnesses. In addition to contributing to ground-level ozone effects on the respiratory system, NO<sub>x</sub> reacts with ammonia, moisture, and other compounds to form small particles. These small particles can penetrate deeply into sensitive parts of the lungs.

## 2.2. Carbon dioxide (CO<sub>2</sub>) & Carbon Monoxide (CO)



GHG emissions from on-site transportation are actually carbon production from fuel and energy consumption to transport building materials to the sites. Transportation on site during construction process emits carbon pollution in the atmosphere and thus provoking global warming. The diesel used to operate the equipment during construction is to move the building materials to the construction site. The construction phase involves the transport of building materials such as prefabricated concrete, tiles and cement to the site. About 6-8 % of carbon is released due to transportation of materials during an ongoing construction project. Compared to other activities, plant emissions have the highest carbon emissions due to the use of fuels and lubricants such as diesel by plant machineries like excavators, lorries and cranes on site. According to IPCC's statistical and scientific research, it was found that machinery and equipment can emit varying amounts of methane and nitrous oxide that can be classified as stationary, mobile and off-road combustion. Thus, the burning of the fuels and exhausted fumes from the vehicles on site releases carbon in the atmosphere and causes air pollution.

## 2.3. Sulphur Dioxide (SO<sub>2</sub>)

SO<sub>2</sub> can be emitted both by natural processes, such as forest fires, and as a result of human activities, such as the combustion of fuels. Sulphur dioxide (SO<sub>2</sub>) is emitted when fuels containing sulphur are combusted especially from diesel or gasoline fuelled engines in industrial trucks, excavators, loaders, bulldozers, mobile cranes, off-road machinery and static engines such as pumps and electricity generators. Idling engines are a significant contributor to NRMM emissions and personal exposure to SO<sub>2</sub>. Sulphur dioxide is a pollutant that contributes to acid deposition, which, in turn, can lead to potential changes in soil and water quality.

Sulphur dioxide (SO<sub>2</sub>) is a corrosive, acidic gas which is predominantly produced from the combustion of coal or crude oil. Direct exposure to SO<sub>2</sub> is associated with asthma and chronic bronchitis, and can lead to irritation and constriction of the airways. SO<sub>2</sub> emitted from coal burning played a key contributory role to thousands of respiratory-related deaths during the London smog in 1952. SO<sub>2</sub> can also combine with nitrogen oxides and ammonia to form particulate matter (PM) which also has serious health implications (see the PM section in this release for more information on the health impacts of PM).

SO<sub>2</sub> can also combine with water vapour in the atmosphere to form acid rain that can be transported large distances. Acid rain causes significant damage to ecosystems such as forests and freshwater habitats.

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#### 2.4. Ozone (O<sub>3</sub>)

Ground-level ozone is not directly emitted into the air, but rather is formed by chemical reactions between NO<sub>x</sub> and volatile organic compounds (VOCs) in the presence of ultraviolet (UV) radiation. Ozone is a primary component of smog.

Breathing ozone can trigger a variety of health problems including chest pain, coughing, throat irritation, and congestion. It can also worsen bronchitis, emphysema, and asthma as well as reduce lung function and inflame the linings of the lungs, permanently scarring lung tissue under repeated exposure.

#### 2.5. Volatile Organic Compounds

Volatile organic compounds (VOCs) are another type of air pollutant that acts as a major player in construction-related pollution. The American Lung Association defines VOCs as emitted gases that are both harmful on their own – as some are known to be cancer-causing – and that can react with other gases in the air to form other dangerous pollutants. Some common VOCs include benzene, formaldehyde, and toluene as well as the carcinogenic trichloroethylene and vinyl chloride.

VOCs can be emitted from a wide variety of sources and construction activities, including:

- ✚ Tile adhesive
- ✚ Roofing materials
- ✚ Paints
- ✚ Other building materials
- ✚ Gasoline
- ✚ Natural gas
- ✚ Cleaning products

#### 2.6. Particulate Matter (PM)

Particle pollution or particulate matter (PM) covers all particles suspended in the air, and is a complex mixture of extremely small particles and liquid droplets. In the context of construction sites, the two PM-related concerns of key interest are PM<sub>2.5</sub> and PM<sub>10</sub> (another way to define particle size is by measuring respirable vs inhalable dust.) The exhaust from diesel-powered construction equipment includes fine particles, virtually all of which are PM<sub>2.5</sub> (2.5 micrometres or smaller in diameter); exhaust particulate is sometimes called primary PM<sub>2.5</sub>. Fine particles such as PM<sub>2.5</sub> are also chemically formed in the atmosphere from various pollutants, some of which are emitted by diesel-powered equipment, and these particles are referred to as secondary PM<sub>2.5</sub>.

Construction-related dust includes larger size or coarse particles also known as PM<sub>10</sub> (between 2.5 and 10 micrometres). PM<sub>10</sub> is generated from bulk material operations on construction sites, such as earthworks, demolition, crushing and grinding operations, soil and aggregate stockpiling, and from smaller activities such as cutting building materials. These operations contribute to windblown dust problems—sometimes called fugitive dust—and the movement of dirt from the construction or demolition site onto nearby roadways. Once dirt or dust from a site has been ‘tracked out’ onto a road, passing vehicles can cause the dirt to become suspended in the air as re-entrained road dust. Fugitive and re-entrained dust particles can remain in the air for days or even weeks. Particle pollution is linked to a number of health problems, including coughing, wheezing, reduced lung function, asthma attacks, heart attacks and strokes. It also is linked to early death. The fine particulate matter (PM<sub>2.5</sub>) in diesel engine exhaust is classed as being carcinogenic to humans and in 2004 the World Health Organisation (WHO) advised that there is no evidence of a safe level of PM exposure or a threshold below which no adverse health effects could occur.



### 3. LEGISLATIVE AND ENVIRONMENTAL POLICY FRAMEWORK

#### 3.1. Environmental Management Coordination (Air Quality) regulations 2014



The Kenya Air Quality Regulations 2014 impose limit values as detailed in the SPECIAL ISSUE Kenya Gazette Supplement No.41, Legislative Supplement No.15, Legal Notice No. 34, compliance with the objectives (prevention, control and abatement of air pollution to ensure clean and healthy ambient air) is a legal requirement in Kenya.

Part 65 and 66 details the requirements on monitoring and assessment of ambient air quality, part 85 shows the need for establishment of baseline levels of priority air pollutants listed in the first schedule of the guideline and included PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub> and CO. Statutory requirements relevant to this study FIRST SCHEDULE are detailed in Table 2 below:

**Table 2: Ambient Air Quality Tolerance Limits**

	Pollutant	Time weighted Average	Industrial area	Residential, Rural & Other area	Controlled areas***
1.	Respirable particulate matter (<10 µg/m <sup>3</sup> ) (RPM)	24 hours**	150µg/Nm <sup>3</sup>	100µg/Nm <sup>3</sup>	75µg/Nm <sup>3</sup>
2.	PM <sub>2.5</sub>	24 hours	75 µg/m <sup>3</sup>	-	-
3.	Sulphur dioxide	Instant Peak		500 µg/m <sup>3</sup>	-
4.		Instant peak (10min)		0.191 ppm	-
5.	Non-methane hydrocarbons	instant Peak	700ppb	-	-
6.	Total VOC	24 hours**	600 µg/m <sup>3</sup>	-	-
7.	Oxides of Nitrogen	1 - hours		0.8 PPM	-
8.		Instant peak		1.4 PPM	-
9.	Nitrogen dioxide	One hour		0.2 ppm	-
		Instant peak		0.5 ppm	-
10.	Carbon monoxide / carbon dioxide	One Hour	10 mg/m <sup>3</sup>	4.0 mg/m <sup>3</sup>	1.0 mg/m <sup>3</sup>
11.	Ozone	1-Hour	200 µg/m <sup>3</sup>	0.12 PPM	-

Extract from the Ambient EMC Air Quality regulations, 2014 (Tolerance Limits)

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## 4. MONITORING METHODOLOGY

It is important to accurately determine prevailing air quality conditions against which predicted effects can be gauged and assessed for any environmental effects' assessment.

Ambient air quality survey for this study consists of **FOUR** representative monitoring locations. Information for the report is presented based on air monitoring completed for 4-hour weighted average per locale. For the purpose of the baseline investigation, monitoring of air pollutants was achieved on the 16<sup>th</sup> day of December 2024 and thereafter the results were compared against the guidelines and standards while attention given to relevant referencing sites of similar nature.

Ambient air quality data were obtained from a validated and approved air quality monitoring program.

### 4.1. Baseline Study Area;

#### 4.1.1. Sensitive Receptors

The geographical scope of the baseline assessment is currently defined as the proposed construction of a 15,000MT common user liquefied petroleum gas (LPG) terminal in Kipevu, Changamwe area boundaries and environs, including potentially high-risk zones along the routes of any existing surface access. High risk zones include locations with the potential for exceedance of regulatory standards for the protection of human health and/or **sensitive habitats**, in the initial and / or mature operations years. The issue of pollutants is particularly pertinent in areas sensitive to change, often referred to as **sensitive receptors**. Locations for the protection of human health are areas of long term exposure which are more susceptible and shall be considered to include residential properties, hospitals and schools; whereas locations for the protection of sensitive habitats / ecosystems shall be considered to include statutory designated sites (such as sites of special scientific interest (SSSIs), special areas of conservation (SACs) and special protection areas (SPAs) which contain habitat types that are also sensitive to atmospheric quality changes.



The proposed project site is currently used for clearance and storage of goods. The plot lies in Kipevu area in Changamwe in a notified industrial area, within the Port Area of Mombasa. The site is located approximately 2km away from the Port of Mombasa with highly populated Chaani and Migadini residential areas to the west, known as the sensitive receptors. Immediate neighbors within a radius of five hundred metres include: - KPC PS14 (Kenya Pipeline Company), Kipevu Wastewater Treatment Plant, VTTI Kenya Ltd., and Kipevu Oil Terminal (KOT) among many other infrastructures.

Close proximity of the emission source to the 'sensitive receptor' causes poor air quality because there is less opportunity for dispersion of emissions between the source and receptor resulting in greater concentrations of pollutants. Air quality is evaluated by comparing concentrations of pollutants against the EMC (Air Quality) regulations 2014 Legal Notice 34 first schedule of the Ambient Air Quality Tolerance Limits set at locations where exposure harm to human health and ecosystems is thought to occur.

#### 4.1.2. Existing Atmospheric Environment

The specific project area is zoned as an industrial area as per the KPA Master plan. It's however surrounded with other industrial infrastructure, planned development housing units and unplanned development mud-wall houses (Chaani) which forms the majority land use. Immediate neighbors within a radius of five hundred metres include: - KPC PS14 (Kenya Pipeline Company), Kipevu Wastewater Treatment Plant, VTTI Kenya Ltd., and Kipevu Oil Terminal (KOT) among many other infrastructures. The main source of existing air pollution is diffuse and fugitive emissions of dust particles and gaseous emissions from the mobile sources and other construction activities taking place in the neighborhood i.e material handling from the port / KPA. The anthropogenic emission sources directly associated with the proposed project will be the main concern of the appraisal framework and will be emitted from various sources including; mobile sources (cars and trucks in the neighborhood), fugitive emissions from leakages



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in petroleum products in the neighborhood, heating around the neighborhood and source emissions (generator) sources amongst other sources.



The emissions concentrations reported herein, will be a combination of the total emissions from the sources and the distance to the receptor which influences the concentrations of pollutants in the air and impacts air quality. As such, the most common ambient atmospheric emission source causing poor air quality within close proximity to sensitive receptors and the site in general will be diffuse and fugitive emissions as the dominant emission sources.

#### 4.1.3. Monitoring Locations

Baseline atmospheric quality monitoring locations were selected based on the existing facility that could or have the potential to influence the proposed project atmospheric environment. The monitoring locations at the proposed project site were determined at four project boundaries to the East (PB-1), West (PB-2), South (PB-3) and North (PB-4).

**Table 3: Description of the measurement locations**

Measurement Sites	Receivers	Description of monitoring Locations	Dates of sampling
East Project Boundary 1 (EPB-1)	KPC PS14 (Kenya Pipeline Company),	The specific project area is zoned as an industrial area as per the KPA Master plan. It's however surrounded with other industrial infrastructure, planned development housing units and unplanned development mud-wall houses (Chaani) which forms the majority land use. Immediate neighbors within a radius of five hundred metres include: - KPC PS14 (Kenya Pipeline Company), Kipevu Wastewater Treatment Plant, VTTI Kenya Ltd., and Kipevu Oil Terminal (KOT) among many other infrastructures.	09 <sup>TH</sup> August 2024.
West Project Boundary 2 (WPB-2)	Chaani Residential homes		09 <sup>TH</sup> August 2024
South Project Boundary 3 (SPB-3)	Kipevu Wastewater Treatment Plant.		09 <sup>TH</sup> August 2024
North Project Boundary 4 (NPB-2)	VTTI Kenya Ltd., and Kipevu Oil Terminal (KOT)		09 <sup>TH</sup> August 2024

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## 4.2. Baseline Air Quality Assessment process

The National and Local baseline assessments have been undertaken following the processes shown in Figure 1 and Figure 2 below.

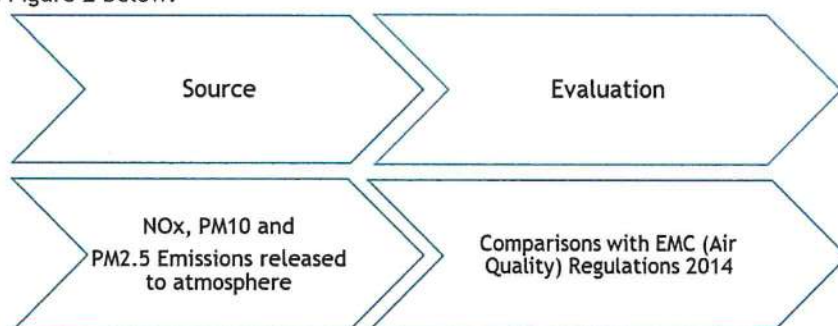


Figure 1: National Baseline Assessment Process

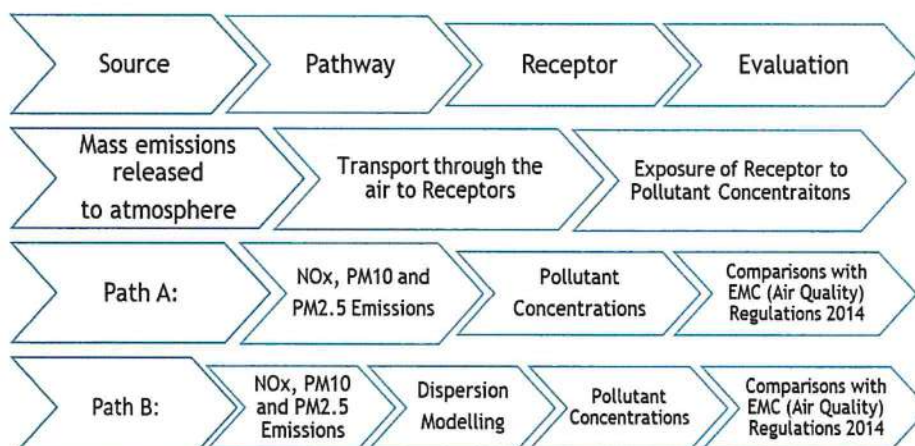


Figure 2: Local / Site Specific Baseline Assessment Process

The local baseline assessment has been undertaken following Process Path A for the first stage assessment.

## 4.3. Assessment Criteria for gaseous and particulate parameters

Sampling of gases was done using a 24-hour AQM-09 is a device which can monitor the air quality via the value of O<sub>3</sub>, SO<sub>2</sub>, NO<sub>2</sub>, CO, PM<sub>2.5</sub>, PM<sub>10</sub>, etc. The target value is converted into voltage signal by operational amplifier circuit, and then filtered through high-precision AD data acquisition system. Finally, the gas concentration is calculated by CPU. Particulates mainly use laser scattering method to produce different scattering light according to different particle diameters under laser scattering conditions. The scattered light intensity is collected by a response device, and the particle 4 concentration is obtained after amplification, filtering and AD acquisition. The obtained gas concentration and particulate matter concentration can be displayed on LCD screen in real time, and can also be transmitted to cloud platform or environmental protection platform through GPRS, 4G LTE and other network signals, so as to realize the monitoring of regional environmental quality. The gas meters were mounted at about 1 - 2 M above the ground surface. The results and sampling duration information were used to calculate the gaseous concentrations.

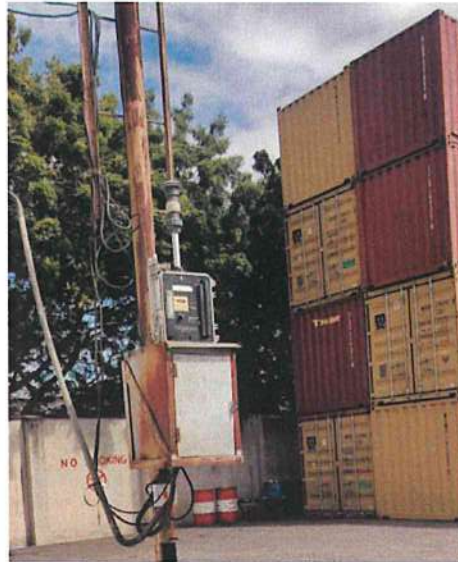
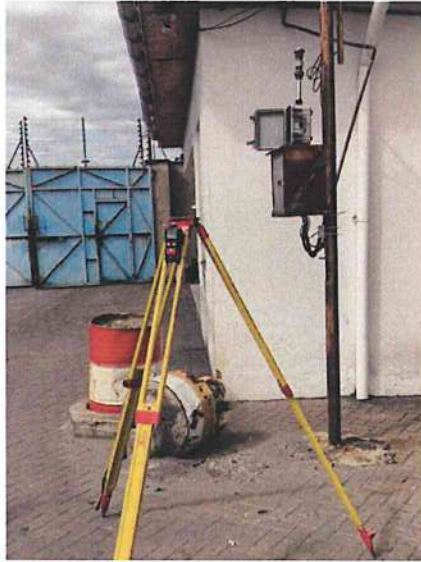




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*Ongoing atmospheric assessment*



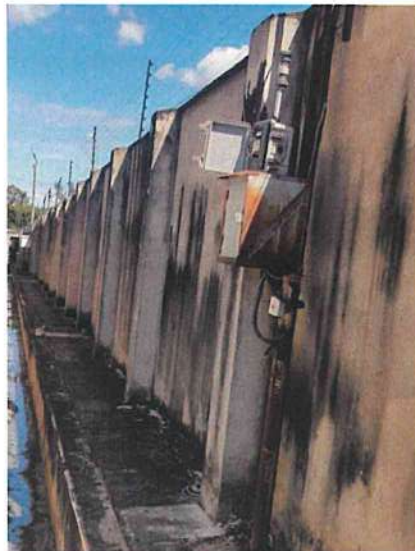
*Ongoing atmospheric assessment*



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*Ongoing atmospheric assessment at survey locations*



*Ongoing atmospheric assessment at survey locations*

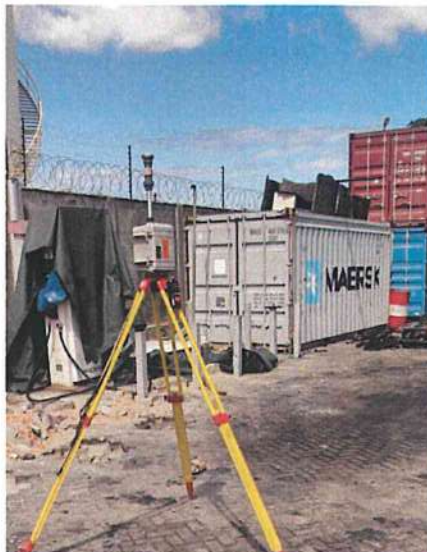






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Ongoing Atmospheric measurements

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#### 4.3.1. Carbon monoxide (CO)

CO monitoring instruments were predominantly gas filter correlation infrared (GFC-IR) absorption analyzers and the electrochemical sensor systems.

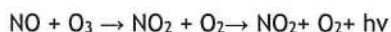
Ambient air was continuously sampled using a pump unit and the CO concentration in the sample air was measured by the absorption of infrared radiation at 4.5 to 4.9 nanometers (nm) wavelength. A reference detection system was used to alternately measure absorption due to CO in the ambient air stream and absorption by interfering species. An infrared detector and amplification system produced output voltages proportional to the CO concentration. The concentration was derived from the Beer-Lambert relation:

$$I_1 = I_0 e^{-ac}$$

where the sample was passed through a cell tube of length 'l'. The analyzer alternately measured the absorption  $I_0$  of the air path with no CO present and the absorption  $I_1$  of the ambient sample, with 'a' being the absorption coefficient, to provide the CO concentration, 'c'.

#### 4.3.2. Nitrogen dioxide (NO<sub>2</sub>)

Nitric oxide (NO) in the sample air stream was reacted with ozone (O<sub>3</sub>) in an evacuated chamber to produce activated NO<sub>2</sub>:



The intensity of the chemiluminescent radiation (hν) produced is measured using a photomultiplier tube (PMT) or photodiode detector. The detector output voltage is proportional to the NO concentration. The ambient air sample is divided into two streams; in one, ambient NO<sub>2</sub> is reduced to NO using a molybdenum catalyst before reaction. The molybdenum converter should be at least 95 per cent efficient at converting NO<sub>2</sub> to NO. This gas stream gives total NO<sub>x</sub>. The second stream measures NO directly by not passing through the molybdenum converter.

Separate measurements are made of total oxides of nitrogen NO<sub>x</sub> (= NO + NO<sub>2</sub>) and NO. The ambient NO<sub>2</sub> concentration is calculated from the difference (NO<sub>2</sub> = NO<sub>x</sub> - NO). This is an important point to remember because the contaminant of interest (NO<sub>2</sub>), is actually measured by inference rather than directly, and the efficiency of the molybdenum converter should be checked on a regular basis.

In a chemiluminescent analyzer, ambient air is drawn through the system via a pump and permature drier unit. NO<sub>x</sub> analyzers are equipped with either a single or a double reaction chamber and PMT system. A solenoid valve is used to alternately switch between NO and NO<sub>x</sub> measurements, typically at 15-second intervals.

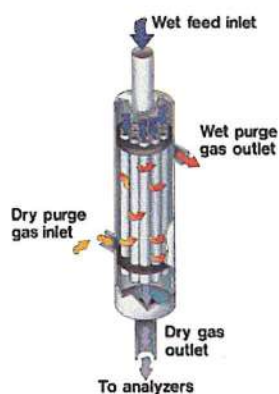


Figure 3: Permature drier unit

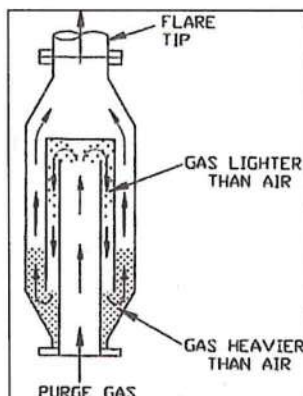




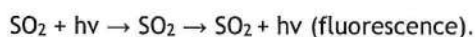
Figure 4: Air purge gas



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#### 4.3.3. Sulphur dioxide (SO<sub>2</sub>)

SO<sub>2</sub> monitoring instruments are predominantly molecular UV fluorescence analyzers. This is the recommended SO<sub>2</sub> monitoring method. UV fluorescence systems operate on the principle that an ambient air sample stream exposed to UV light excites SO<sub>2</sub> molecules in the sample to higher, but unstable, excited states. These excited states decay, giving rise to the emission of secondary (fluorescent) radiation:



The fluorescent radiation is detected by a PMT, causing an output voltage proportional to the SO<sub>2</sub> concentration. A permeable membrane 'kicker' is used to remove interfering hydrocarbons (aromatic hydrocarbons also fluoresce) before reaction. Ambient air is drawn through the system via a pump unit, and the analyzer continuously displays current SO<sub>2</sub> concentrations.

#### 4.3.4. Ozone (O<sub>3</sub>)

Ozone was measured using a direct reading using the flame-ionisation detector (FID). In the FID, an organic compound is burned in a hydrogen flame giving rise to ions which are attracted to a collector electrode. The resulting electric current is amplified and recorded. The intensity of the signal depends primarily on the number of carbon atoms of the molecule, but to some extent it is also influenced by the character or structure of the chemical. Therefore, the same number of molecules of two different ozone with the same number of carbon atoms can give rise to two different signals. The FID is very stable.

#### 4.3.5. Total Volatile Organic Compounds (TVOC)

Optical gas detection using absorption spectroscopy is based on the Lambert-Beer law (1,2):

$$I(\lambda) = I_0(\lambda) \exp[-a(\lambda)C \cdot L] \quad a[\text{cm}^{-1}]$$



$$I(\lambda) = I_0(\lambda) \exp[-\alpha(\lambda) \cdot C \cdot L] \quad \alpha[\text{ppm} \cdot \text{cm}^{-1}]$$

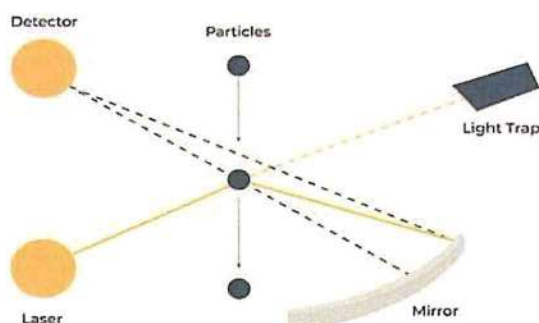
where: I—light intensity transmitted by the medium with the gas, I<sub>0</sub>—intensity of light incident on the medium, C—concentration, a, α—absorption coefficients, and L—optical path length, gas concentration.

The optical methods for volatile organic compounds detection use its absorption characteristics in the infrared range. The strongest bands occur in the area of deformation vibrations and then valence; they are weaker in the range of overtones.

#### 4.3.6. Total Suspended Particulate matter (TSP, PM<sub>2.5</sub> & PM<sub>10</sub>):

AQM 09 is an online particulate monitoring system that measures the concentration of various particulate sizes ranging from 2.5 micron to TSP such as PM<sub>2.5</sub>, PM<sub>10</sub>, and TSP in the ambient air. The PM sensor works on the principle of laser scattering hence, the active sampling-powered sensor-based air quality monitor. The PM monitor based on the physical principle of light scattering, also known as optical particle counter (OPC), measures dust particles illuminated by laser light at a 90° angle. Whereas, the light scattered from each particle is collected at approximately 90° by a mirror and detected by a photo-diode. This signal is then fed into a multi-channel size classifier where a pulse height analyzer is used to classify each pulse that is proportional to the particle size. As a result, the counts in the channel corresponding to PM<sub>2.5</sub> convert to the concentration of PM<sub>2.5</sub> and same applies to other fractions.

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#### 4.4. Tools Equipment and materials used

Below is the equipment used during air monitoring survey:

- ✚ Air quality multiparameter meter.
- ✚ Geographic Positioning System (GPS)
- ✚ Digital camera
- ✚ Calibration certificates
- ✚ Standard Reference materials & Standard operating procedures
- ✚ Equipment manuals.
- ✚ Terms of Reference & Maps of the project area

#### 4.5. Monitoring Frequency

Monitoring of air quality test parameters was done for 4 hours in the study location. Once construction works are underway, monitoring of air quality parameters should be tested at monthly interval.

#### 4.6. Assumptions

The 4-hour exposure levels of data collection for PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub>, O<sub>3</sub> and TVOC data collected is considered sufficient to understand the state of atmospheric air quality environment before implementation of the proposed LPG terminal development.

#### 4.7. Data Validity and Acceptability

All data monitored in the study was taken through data replications and quality assurance procedure to ensure that any anomalous readings or questionable data is not incorporated in the final results.

Elements of this procedure account for:

- ✚ Routine calibration and auditing of the analyzers
- ✚ Statistical rendering of outliers



## 5. PRESENTATION, DISCUSSION & CONCLUSION OF THE AIR QUALITY SURVEY RESULTS

### 5.1. Presentation of Results

#### 5.1.1. Summary of singular Air quality measurements

Table 4: Summary results for air quality and environmental measurements



Monitoring Locations	PM <sub>2.5</sub> µg/m <sup>3</sup>	PM <sub>10</sub> µg/m <sup>3</sup>	CO mg/m <sup>3</sup>	SO <sub>2</sub> ppm	NO <sub>2</sub> ppm	O <sub>3</sub> ppm	TVOC µg/m <sup>3</sup>	HUMIDITY %	TEMPS °C
East Project Boundary 1 (EPB-1)	31	48	<0.001	0.0417	0.0636	0.03880	32	61	31.7
West Project Boundary 2 (WPB-2)	25	42	<0.001	0.0504	0.0669	0.03791	39	60	31.9
South Project Boundary 3 (SPB-3)	29	45	<0.001	0.0430	0.0655	0.03951	36	60	31.8
North Project Boundary 4 (NPB-2)	50	63	<0.001	0.0493	0.0693	0.04018	49	59	32.0

(Source: Site monitoring in December 2024).

#### 5.1.2. Gaseous parameters

Table 5: Average results for gaseous parameters

Monitoring Locations	NO <sub>2</sub>		SO <sub>2</sub>		CO		Ozone		TVOC		REMARKS
	Conc. (ppm)	EMC AQR guide 2014 (ppm)	Conc. (ppm)	EMC AQR guide 2014 (ppm)	Conc. (mg/m <sup>3</sup> )	EMC AQR guide 2014 (mg/m <sup>3</sup> )	Conc. (ppm)	EMC AQR guide 2014 (ppm)	Conc. (µg/m <sup>3</sup> )	EMC AQR guide 2014 (µg/m <sup>3</sup> )	
EPB-1	0.0636	0.2	0.0417	0.191	0.005	4.0	0.03880	0.12	32	-	Complies
WPB-2	0.0669	0.2	0.0504	0.191	0.005	4.0	0.03791	0.12	39	-	Complies
SPB-3	0.0655	0.2	0.0430	0.191	0.005	4.0	0.03951	0.12	36	-	Complies
NPB-4	0.0693	0.2	0.0493	0.191	0.005	4.0	0.04018	0.12	49	-	Complies

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### 5.1.3. Particulate matter (PM<sub>10</sub>)

**Table 6: Results for Particulate matter (<10 microns)**

Monitoring Locations	PARTICULATE MATTER ≤10 (PM <sub>10</sub> )			
	Sampling time	Concentration (µg/m <sup>3</sup> )	Guideline (µg/m <sup>3</sup> )	Remarks
EPB-1	1 hour	48	-	No 1-Hr guideline for residential, rural and other areas
WPB-2	1 hour	42	-	No 1-Hr guideline for residential, rural and other areas
SPB-3	1 hour	45	-	No 1-Hr guideline for residential, rural and other areas
NPB-4	1 hour	63	-	No 1-Hr guideline for residential, rural and other areas

### 5.1.4. Particulate matter (PM<sub>2.5</sub>)

**Table 7: Results for Particulate matter (<2.5 microns)**

Monitoring Locations	PARTICULATE MATTER ≤2.5 (PM <sub>2.5</sub> )			
	Sampling time	Concentration (µg/m <sup>3</sup> )	Guideline (µg/m <sup>3</sup> )	Remarks
EPB-1	1 hour	31	-	No 1-Hr guideline for residential, rural and other areas
WPB-2	1 hour	25	-	No 1-Hr guideline for residential, rural and other areas
SPB-3	1 hour	29	-	No 1-Hr guideline for residential, rural and other areas
NPB-4	1 hour	50	-	No 1-Hr guideline for residential, rural and other areas

### 5.1.5. Environmental parameters

**Table 8: Results for Environmental parameters**

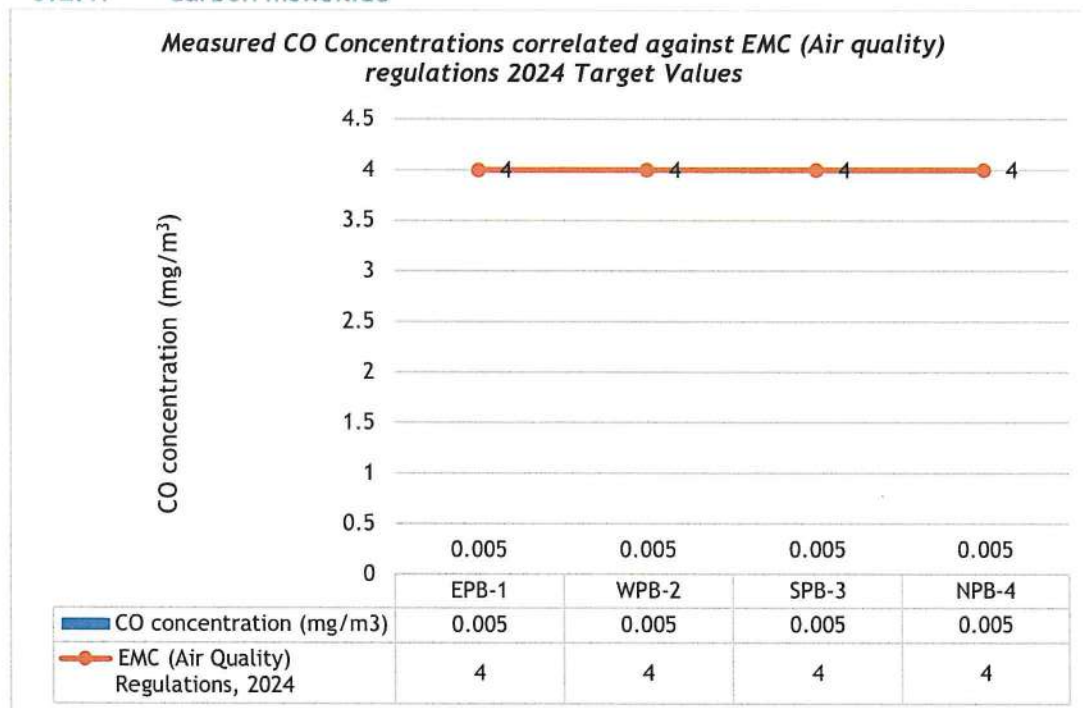
Monitoring Locations	Environmental parameters				Remarks
	Air temps °C	Pressure hPa	Humidity %	Wind Speed km/hr	
EPB-1	31.7	1011	61	17 km/hr South West wind	Ambient conditions present
WPB-2	31.9	1011	60	17 km/hr South West wind	Ambient conditions present
SPB-3	31.8	1011	60	15 km/hr South West wind	Ambient conditions present
NPB-4	32.0	1011	59	18 km/hr South West wind	Ambient conditions present
AVERAGES	31.85	1011	60.0	16.75 km/hr South West wind	Ambient conditions present



## 5.2. Discussions of air quality survey results

Air quality survey was completed for 4-hr exposure levels as the preferred time weighted averages in order to measure and quantify the air pollutant levels so as to determine the current existing conditions. Results of the gaseous concentrations and particulate parameters were thereafter correlated against the Environmental Management Coordination (Air quality) regulations of 2014 as follows:

### 5.2.1. Carbon Monoxide



The above combined graph was drawn from statistical analysis for 1-hr monitoring per location of atmospheric Carbon monoxide environment as per the requirement of TOR.

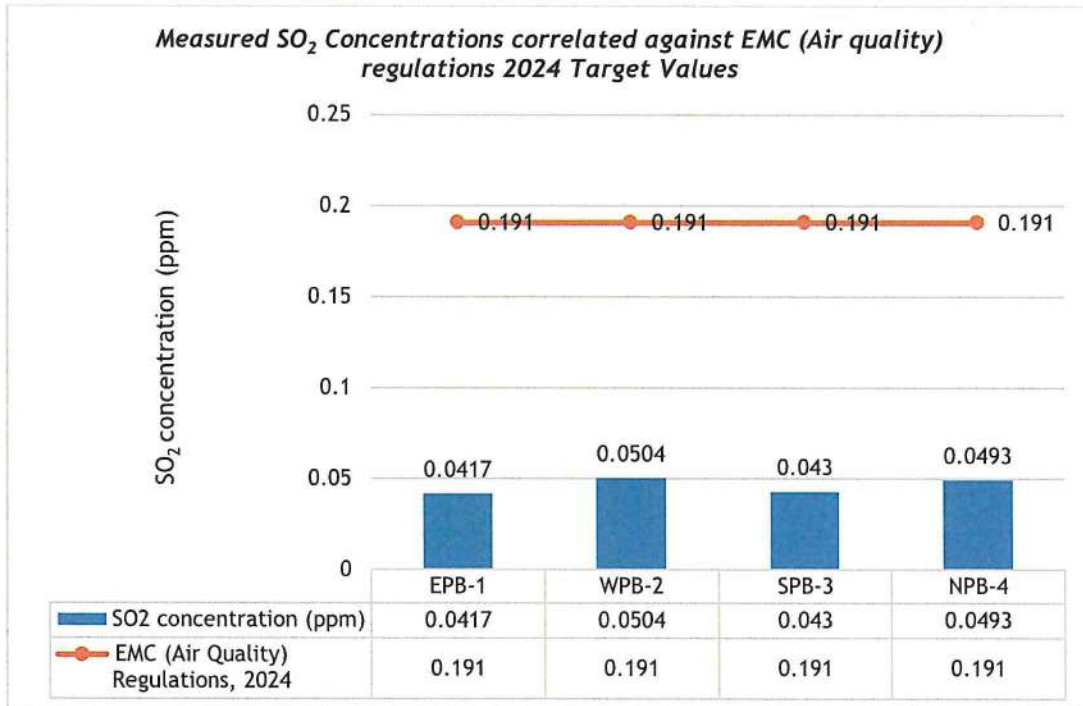
CO average concentration across the monitoring locations for the time weighted average of 4-hour were below the detection limit (0.001 mg/m<sup>3</sup>) of the testing equipment. There was no 1-hour peak exceedance of the AAQTL of 4.0 mg/m<sup>3</sup> thus the frequency of exceedance was zero.

All CO concentrations recorded in the sites before implementation of the proposed LPG terminal development COMPLIED with the EMC (Air quality) regulations 2024 of 4.0 mg/m<sup>3</sup>.

Carbon monoxide is a gas formed by the incomplete combustion of fuels containing carbon. The main outdoor source of carbon monoxide are always motor vehicles, in particular petrol-engine vehicles.

From the above combined graph results, the levels of carbon monoxide concentrations released before implementation of the LPG project did not pose either Environmental, health, safety and compliance concerns to the recipients / receivers.

### 5.2.2. Sulfur dioxide



The above combined graph was drawn from statistical analysis for 1-hr monitoring per location of atmospheric sulfur dioxide environment as per the requirement of TOR.

From the above graph, the maximum 1-hour SO<sub>2</sub> average concentration extended to levels 0.0504 ppm at the West Project Boundary 2 (WPB-2) while the minimum 1-hour SO<sub>2</sub> average concentration extended to levels of 0.0417 ppm at East Project Boundary 1 (EPB-1). The average SO<sub>2</sub> concentration at the study area extended to levels of 0.0461 ppm. There was no peak exceedance of the AAQTL of 0.191 ppm thus the frequency of exceedance was zero.

The sulfur dioxide concentrations recorded across all survey locations had concentrations levels exceeding the ambient sulfur dioxide levels of 0.02ppm.

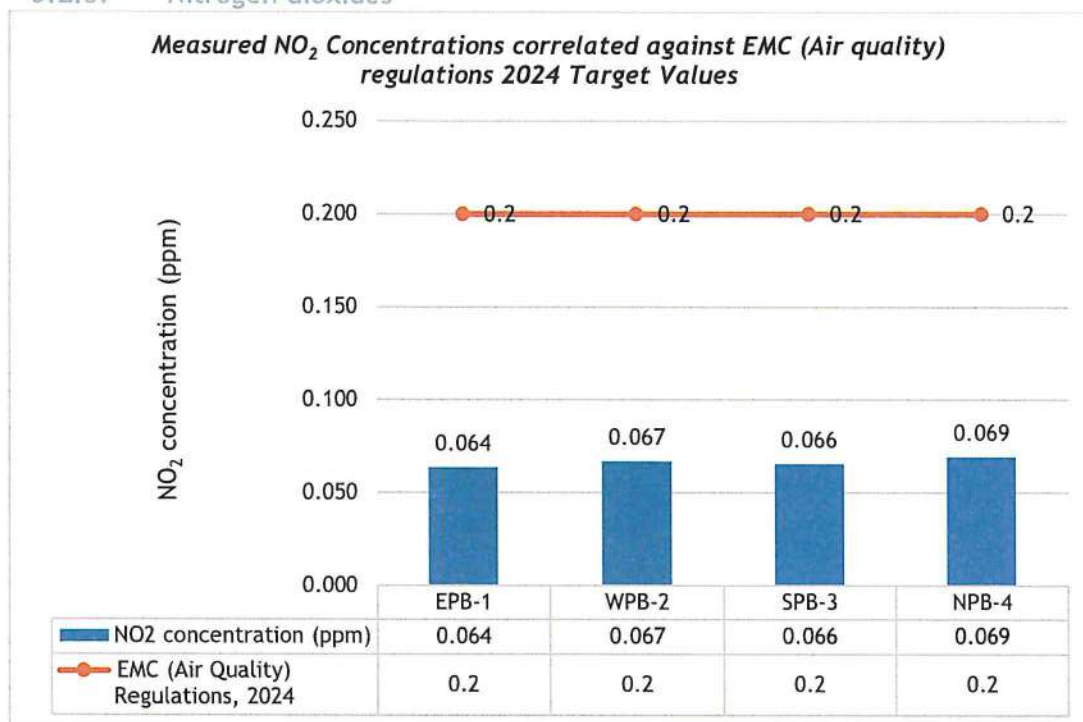
The resultant sulfur dioxide concentrations were correlated with the limit value EMC (Air quality) regulations 2014 maximum limits) for short term exposures. Results showed 100% COMPLIANCE with the limit values.

Fugitive and diffuse sources i.e. motor vehicles / cycles fuel combustion around the PROPOSED LPG project area contribute about 90% of sulfur dioxide recorded.

From the above combined graph results, the levels of sulfur dioxide concentrations released before implementation of the LPG project did not pose either Environmental, health, safety and compliance concerns to the recipients / receivers.



### 5.2.3. Nitrogen dioxides



The above combined graph was drawn from statistical analysis for 1-hr monitoring per location of atmospheric nitrogen dioxides environment as per the requirement of TOR.

From the above graph, the maximum 1-hour NO<sub>2</sub> concentration extended to levels of 0.069 ppm at North Project Boundary 4 (NPB-4) while the minimum 1-hour NO<sub>2</sub> concentration extended to levels of 0.064 ppm at East Project Boundary 1 (EPB-1). The average NO<sub>2</sub> concentration at the study area extended to levels of 0.066 ppm. There was no peak exceedance of the AAQTL of 0.2 ppm thus the frequency of exceedance was zero.

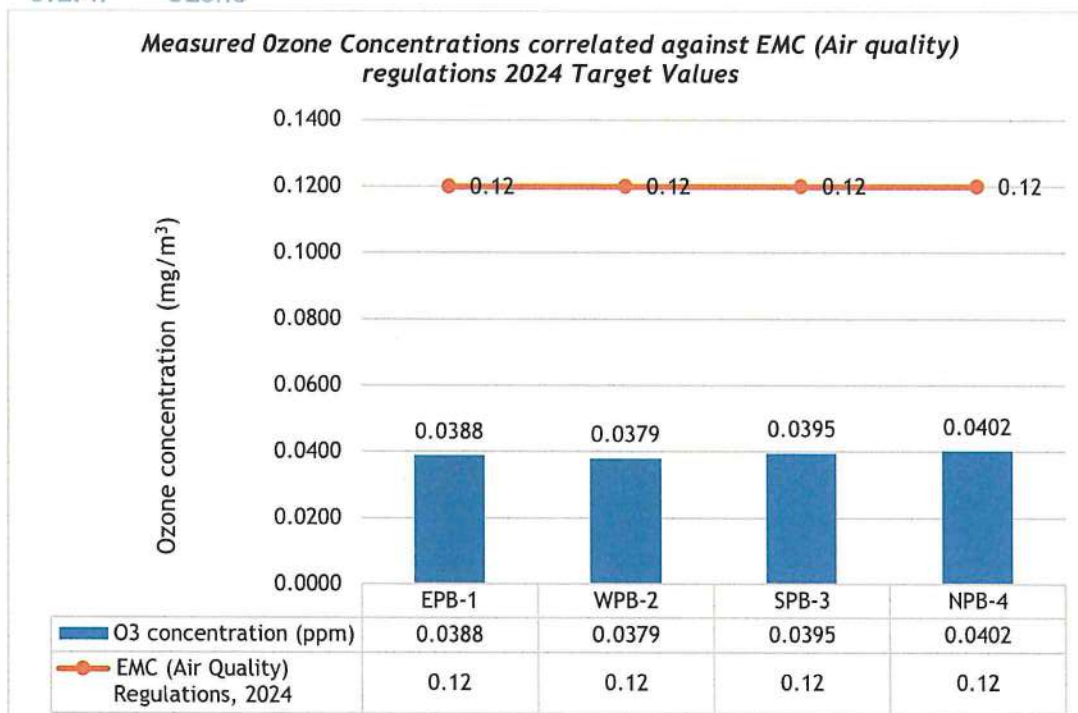
The concentration levels of recorded nitrogen dioxide gas concentration across all locations exceeded the ambient levels (0.05ppm).

The results for the nitrogen dioxide (NO<sub>2</sub>) concentrations measured below the air quality guidelines limits. The concentration of NO<sub>2</sub> at the survey locations were 100.00% in COMPLIANCE with the EMC (Air quality) regulations 2014 maximum limits.

NO<sub>2</sub> is generated due to the oxidation of N<sub>2</sub> in the atmosphere at high temperature and due to oxidation of nitrogen compounds in used fuel or due to the reaction of nitrogen radical with hydrocarbons. 90% of the NO<sub>x</sub> at the proposed project site is attributed to fugitive and diffuse motor vehicles combustion of fuel.

From the above combined graph results, the levels of nitrogen dioxide concentrations released before implementation of the LPG project did not pose either Environmental, health, safety and compliance concerns to the recipients / receivers.

#### 5.2.4. Ozone



The statistical analysis for 4-hr monitoring of ozone as outlined in the TOR was completed at four boundary monitoring locations. From the above graph, the maximum 1-hour ozone concentration extended to levels of 0.0402 ppm at North Project Boundary 4 (NPB-4) while the minimum 1-hour ozone concentration extended to levels of 0.0379 ppm at the West Project Boundary (WPB-2). The average O<sub>3</sub> concentration at the study area extended to levels of 0.0391 ppm. There was no exceedance of the 1-hour AAQTL of 0.12 ppm thus the frequency of exceedance was zero.

All ozone concentrations recorded in the project sites COMPLIED with the EMC (Air quality) regulations.

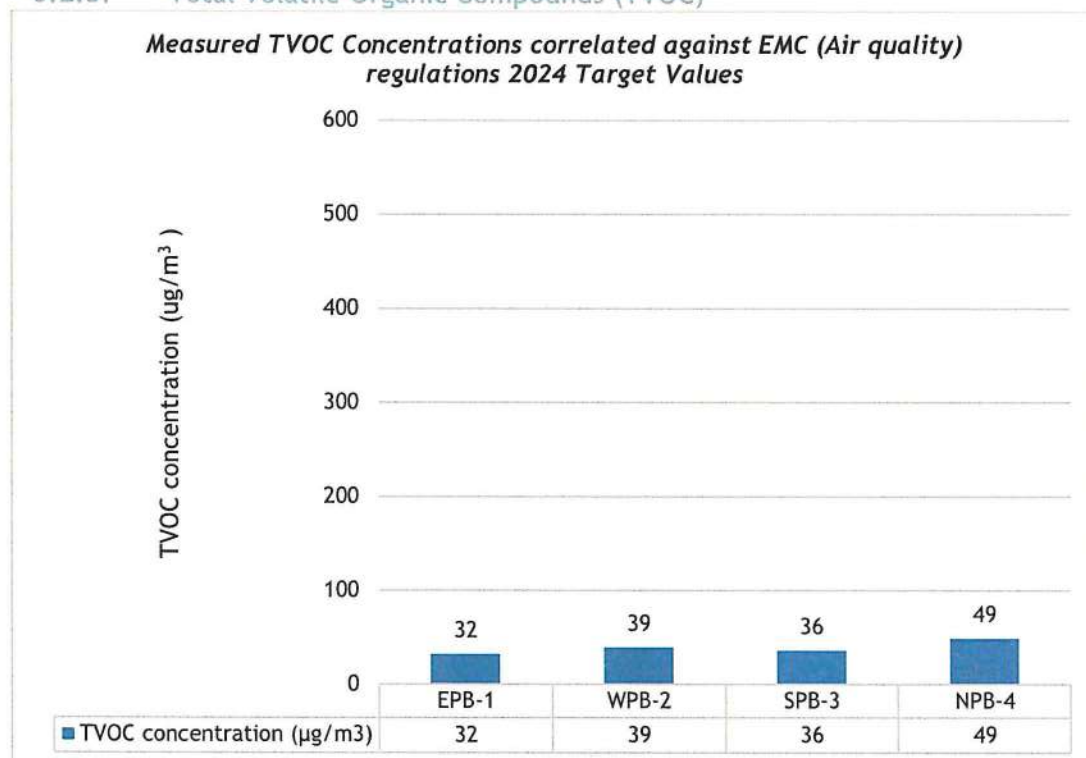
The primary natural source of surface O<sub>3</sub> is the subsidence of stratospheric O<sub>3</sub> from the upper atmosphere. In contrast, the primary anthropogenic source of surface O<sub>3</sub> is photochemical reactions involving the atmospheric pollutant carbon monoxide (CO). Ozone at ground level is primarily formed by a complicated series of chemical reactions initiated by sunlight. NO<sub>x</sub> and volatile organic compounds (VOCs), derived mainly from man-made sources, react to form ozone. These substances are produced by combustion, industrial processes and activities such as solvent use and petrol distribution and handling. NO<sub>x</sub> and VOCs are the most important precursors of elevated levels of O<sub>3</sub>.

Motor vehicles account for 40% of the ground level ozone at site. These chemical reactions do not take place instantaneously, but over several hours or even days depending on the VOCs, and once ozone has been produced it may persist for several days. Ozone measured at a particular location may therefore have arisen from VOC and NO<sub>x</sub> emissions many kilometers away, and may then travel further. Maximum concentrations, therefore, generally occur downwind of the source areas of the precursor pollutant emissions.

From the above combined graph results, the levels of OZONE concentrations emitted before implementation of the LPG project did not pose either Environmental, health, safety and compliance concerns to the recipients / receivers.



### 5.2.5. Total Volatile Organic Compounds (TVOC)



The statistical analysis for 48-hr monitoring of volatile organic compound as outlined in the TOR was completed at each of the four monitoring locations.

From the above graph, the maximum 48-hour TVOC concentration extended to levels of 49 ug/m<sup>3</sup> at North Project Boundary 4 (NPB-4) while the minimum 1-hour TVOC concentration extended to levels of 32 ug/m<sup>3</sup> at the East Project Boundary (EPB-1). The average TVOC concentration at the study area extended to levels of 39 ug/m<sup>3</sup>. There was no exceedance of the 24-hour AAQTL of 600 ug/m<sup>3</sup> thus the frequency of exceedance was zero.

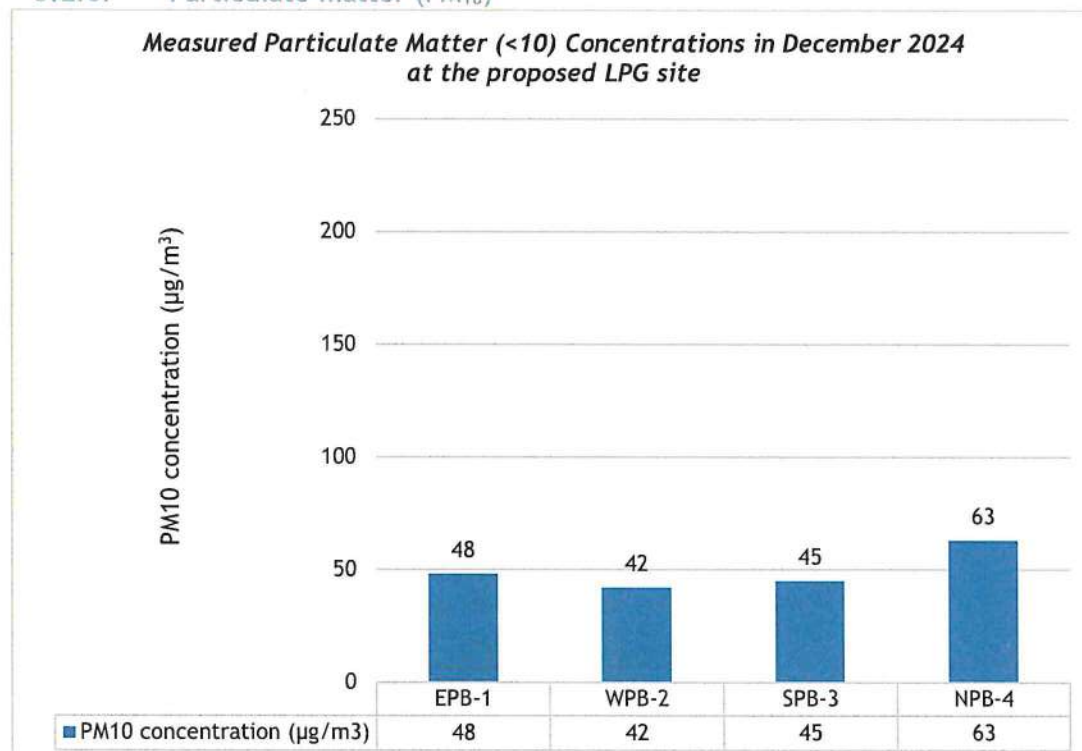
There was no peak exceedance of the AAQTL of 600 ug/m<sup>3</sup> thus the frequency of exceedance was zero. The results for the TVOC concentrations measured below the air quality guidelines limits. The concentration of TVOC at the survey locations were 100.00% in COMPLIANCE with the EMC (Air quality) regulations 2014 maximum limits.

TVOCs in ambient air at the proposed site originate from human-made sources, including emissions from vehicles and industrial processes.

Transportation including vehicle exhaust and fuel combustion are significant contributors of VOC's. The site is also surrounded by other establishment of Industrial Processes origin. Industrial processes such as manufacturing, oil refineries and other industrial facilities release VOCs. Combustion of fossil fuels (coal, oil, natural gas) and wood burning fireplaces also release VOC's

From the above combined graph results, the levels of total volatile organic compounds concentrations released before implementation of the LPG project did not pose either Environmental, health, safety and compliance concerns to the recipients / receivers.

#### 5.2.6. Particulate matter (PM<sub>10</sub>)



The statistical analysis for the combined 4-hr monitoring of Particulate matter <10 µg/m<sup>3</sup> as outlined in the TOR was completed.

From the above graph, the maximum 1-hour PM<sub>10</sub> concentration across North Project Boundary 4 (NPB-4) extended to levels of 63 µg/m<sup>3</sup> while the minimum 1-hour PM<sub>10</sub> concentration along the West Project Boundary 1 (WPB-2) extended to levels of 42 µg/m<sup>3</sup>. The overall average PM<sub>10</sub> concentrations of the project area over the 4-hour assessment extended to levels of 50.00 µg/m<sup>3</sup>.

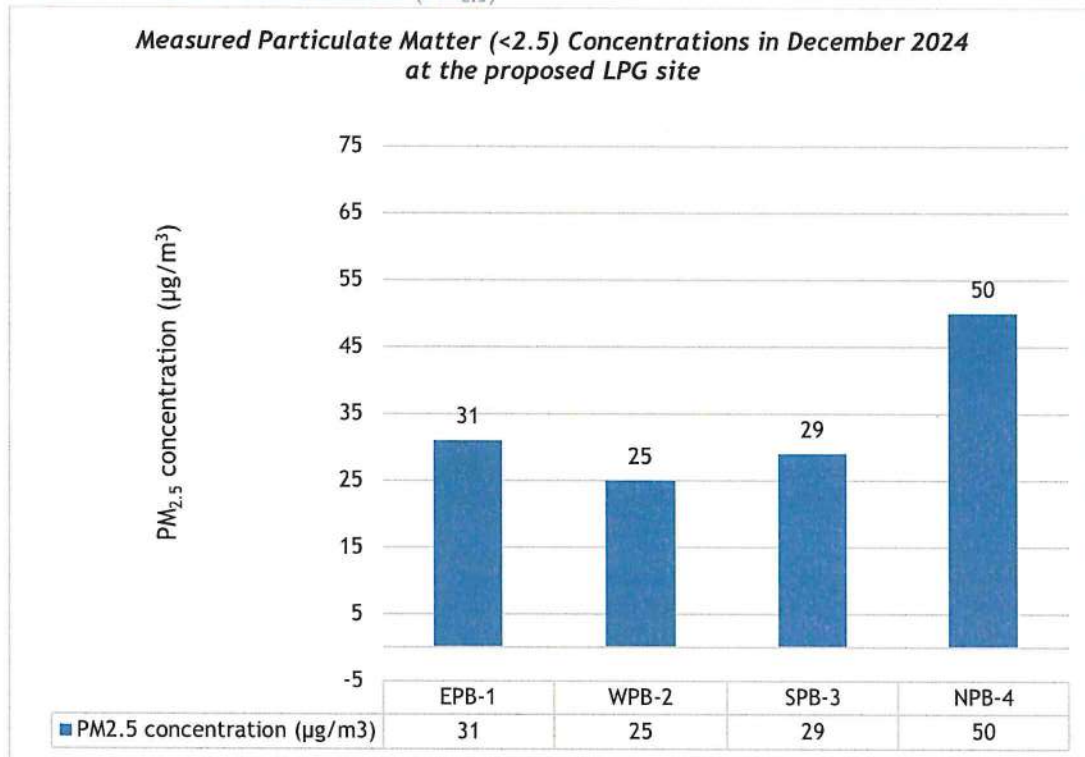
The concentration of PM<sub>10</sub> across all the survey locations were within the normal and acceptable levels of such neighborhood.

Unlike the individual gaseous pollutants, which are single, well-defined substances, particles (PM<sub>10</sub>) in the atmosphere are composed of a wide range of materials arising from a variety of sources. Concentrations of PM<sub>10</sub> comprise: primary particles, arising from combustion sources (mainly motor vehicles emissions, which in the proposed site contribute ~70%); secondary particles, mainly sulphate and nitrate formed by chemical reactions in the atmosphere; and coarse particles, suspended soils and dusts, biological particles. The relative contribution of each source type varies from day to day, depending on meteorological conditions and quantities of emissions from mobile and material handling sources.

From the above combined graph results, the levels of PM<sub>10</sub> released through existing operations at the proposed LPG development site did not pose either Environmental, health, safety and compliance concerns to the recipients / receivers.



#### 5.2.7. Particulate matter (PM<sub>2.5</sub>)



The statistical analysis for the 4-hr monitoring of particulate matter PM<sub>2.5</sub> as outlined in the TOR was completed at four survey locations.



From the above graph, the peak 1-hour PM<sub>2.5</sub> concentration extended to levels 50.0 µg/m<sup>3</sup> across North Project Boundary 4 (NPB-4) while the minimum 1-hour PM<sub>2.5</sub> concentrations along the West Project Boundary 1 (WPB-2) extended to levels of 25 µg/m<sup>3</sup>.

There are No 1-Hour guideline for residential, rural and other areas given under the EMC (Air quality) regulations 2024 for comparison of results. No comparisons were made against the regulation. However, the concentration values of PM<sub>2.5</sub> recorded seems to be within the typical range of emissions for such neighborhood.

The main sources of atmospheric particulate matter were primarily the burning of fuel from automobiles.

The fine particle fraction (PM<sub>2.5</sub>) is composed predominantly of primary and secondary particles. Particles in the range from PM<sub>2.5</sub> - PM<sub>10</sub> generally consist of coarse particles.

From the above combined graph results, the levels of PM<sub>2.5</sub> released through existing proposed site operations does not pose any Environment, Sustainability, health, safety and compliance concerns to the recipients / receivers before implementation of the LPG terminal development.

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### 5.3. FIELD NOTES AND OBSERVATIONS:

Ambient air quality measurements were taken for short term exposure levels. It should however be noted that this exercise is only applicable to the time period when sampling took place and does not take into account seasonal and other local various that might occur during other months and times. However, it is still a good general overview of the existing air quality environment.

#### 5.3.1. Sensitive receptors

The proposed project site is currently used for clearance and storage of goods. The plot lies in Kipevu area in Changamwe in a notified industrial area, within the Port Area of Mombasa. The site is located approximately 2km away from the Port of Mombasa with highly populated Chaani and Migadini residential areas to the west, known as the sensitive receptors. Immediate neighbors within a radius of five hundred metres include: - KPC PS14 (Kenya Pipeline Company), Kipevu Wastewater Treatment Plant, VTTI Kenya Ltd., and Kipevu Oil Terminal (KOT) among many other infrastructures.

#### 5.3.2. Potential Pollution causes;

From the site visits and background site description, the following sources have been identified as potential pollution causes at the proposed site;

##### Exhaust gases:

The survey location is accessible to heavy trucks loading and offloading the machine and other motor vehicles that utilize diesel and petrol. Vehicle and motorcycle exhausts contain a number of pollutants including carbon dioxide (CO<sub>2</sub>), carbon monoxide (CO), hydrocarbons, oxides of nitrogen (NO<sub>x</sub>), sulphur and PM<sub>10</sub>. The quantity of each pollutant emitted depends upon the type and quantity of fuel used, engine size, speed of the vehicle and abatement equipment fitted. Once emitted, the pollutants are diluted and dispersed in the ambient air.

##### Vehicular movement;

Re-suspension of roadside dust from movement of vehicles resulted in generation of relatively higher fraction of finer dust (PM<sub>2.5</sub>). Significant atmospheric dust arose from the mechanical disturbance of granular soils materials exposed to the air from motor vehicle / cycle movement. Pulverization and abrasion of surface materials by application of vehicular mechanical forces generate substantial amount of dust.

### 5.4. Air Quality Survey Conclusions

Baseline Atmospheric Environment Monitoring was conducted to characterize the existing environment before implementation (DO MINIMUM) of the proposed LPG terminal development. The conclusions below were drawn from the exercise conducted on the 16<sup>th</sup> December 2024.

##### Gaseous Parameters:

All gaseous parameters (carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone and total volatile organic compounds) were measured and quantified at all the four survey locations.

Before the project implementation of the proposed LPG terminal development, all measured gaseous parameters COMPLIED with the EMC (Air quality) regulations 2024 limits.



The ambient air quality data (gaseous) measured around the monitoring locations are considered to be within a typical range of emissions for such neighborhood.

The findings of the gaseous monitoring program indicate that the air quality at the proposed LPG terminal development is generally good before commissioning of the project. All pollutants measured are at levels that do not pose Environmental, Sustainability, Health, Safety and compliance concerns to the receivers.

##### Meteorological Parameters:

The monitoring locations in general showed Standard atmospheric environment before project implementation due to the combination of good climate and ambient conditions. Weather



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and Climatic conditions of the proposed LPG terminal development provided good dispersion of air contaminants.

#### Particulate Matter ( $PM_{10}$ and $PM_{2.5}$ ):

Particulate parameters concentrations ( $PM_{10}$  and  $PM_{2.5}$ ) were measured and quantified across the survey stations.

Before the project implementation of the proposed LPG terminal development, all measured particulate parameters **COMPLIED** with the EMC (Air quality) regulations 2014 limits.

$PM_{2.5}$  and  $PM_{10}$  concentration levels recorded were within the typical range of emissions for similar neighborhood.

The findings of the monitoring program indicate that the particulate matter atmospheric environment is generally good before the proposed LPG terminal development implementation. Particulate pollutants measured are at levels that do not pose Environmental, Sustainability, Health, Safety and compliance concern.

Once construction and operations begin, the client is expected to maintain the background / baseline levels.

### 5.5. Recommendations

Industrialization can be a blessing to our economy and at the same time a challenge to our environmental sustainability and health curse. Sustainable industrialization can however be achieved through effective emission reduction vide influencing government, industry and stakeholders to ensure **compliance** with current legislation, to encourage **adoption** of low emission approaches, and to develop a pathway to enhanced **regulation**.

#### Compliance:

Ensuring **compliance** with existing regulation is the most effective way to reduce local emissions. This could take the form of an enhanced and consistent air quality measurement (dust & gaseous measurement), reporting system, ensuring compliance with set dust management emission policies and plans.

#### Recommendation 1: Control and management of construction dust

##### Rationale:

As machine emissions are reducing because of fleet renewal and the adoption of cleaner technology, the issues around dust from construction will become increasingly important.



Improved coordination and dissemination of measurement of construction dust within sites - as well as improved transparency with residents - would enable better dust management practices and compliance with planning conditions. A need to quantify fugitive dust emissions more accurately from construction activity was raised in the petition.

##### Outputs

A coordinated and consistent approach to measuring and monitoring gaseous and dust parameters.

##### Outcomes

Improved dust management and reduced site emissions. Reduced particulate matter concentration in and around constructions sites, which will deliver positive health benefits and improved awareness of air pollution emissions.

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## Recommendation 2: Construction forums:

### Rationale;

One of the notable issues highlighted in the petition has been the lack of communication and transparency between the local planning authorities, the proponent and neighboring community.

### Outputs

Construction forums would help to address this issue. They would improve communication between local authority officers, proponent, neighbors and contractors and would improve communications between the parties involved.

Construction forums would help to build in best practice principles when engaging with residents. This can be positively approached as it allows for information sharing, area wide issues to be raised and addressed, as well as providing an opportunity to showcase emerging technologies and mitigation techniques.

### Outcomes

Better communication between the local authority and contractors.

Air quality issues can be more rapidly resolved without the involvement of the court system.

The forum would provide a platform to promote emerging technologies and improved working practices. It may also lead to indirect benefits such as better collaboration in future and stronger relationships between stakeholders.

Learnings from the construction forum would be used to improve the whole process of area management, inform regulators as well as support and inform local communities affected by the development.

### Adoption:

Encouraging adoption of low emission approaches prior to regulatory changes would lead to a more widespread reduction in emissions on a national and local scale.

While this may not provide the certainty for large scale investment in new technologies some parts of the industry require, the adoption of existing and emerging technologies will provide the demand required to influence supply change. This could be supported by educating and training key groups within the industry, making them aware of the available technology, its impacts, and benefits.

## Recommendation 3: Development of an emissions inventory

### Rationale

There is need for better quantification of emissions from construction sites.

This could be delivered by using emission inventories, which would be focused on the proposed site once construction begins and would capture a broader range of NRMM and other mobile equipment used on site and diesel-powered tools.

It is unknown how much these individual sources contribute to overall emissions. They could be contributing significantly to air pollution.



### Outputs

The inventory would provide insight into the barriers and incentives required to increase uptake across the construction site.

### Outcomes

This implementation would identify where the biggest air quality impacts could be gained across construction, roadworks and events and may include modelling fleet renewal, use of retrofit technology, and the benefits of accelerating the current policy requirements.



 <b>FCFS</b>	ENVIRONMENTAL BASELINE STUDY REPORT FOR AMBIENT ATMOSPHERIC QUALITY MONITORING OF THE PROPOSED CONSTRUCTION OF A 15,000MT COMMON USER LIQUEFIED PETROLEUM GAS (LPG) TERMINAL IN KIPEVU ON PLOT L.R NO. MN/VI/3711, CHANGAMWE AREA, MOMBASA COUNTY.	REPORT REF NO.: 50124-0077A REPORT TITLE: EBSAAQMR-77A DOI: 16 <sup>TH</sup> DECEMBER 2024 PAGE NUMBER P A G E   40 
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The implementation would also be used to assess where the fleet is most rapidly changing to cleaner machines and help identify where further opportunities to reduce emissions exist.

#### **Recommendation 4: Effectiveness of intervention measures and known mitigation techniques**

##### **Rationale**

The is need for highlighting information about the benefits of using low emission and emerging technologies to displace diesel driven machinery.

Most information on the efficacy of measures is provided by the manufacturer or their supplier and there are low levels of confidence in the real-world benefits by the end users and their procurement teams. This has been particularly evident in the marketing of products that claim carbon reduction potential without transparency of how the benefits were calculated.

##### **Outputs**

A review of available information, including online literature and surveys, would identify emerging technologies and abatement measures that have the potential to reduce emissions.

Trials could demonstrate reduction potential. The knowledge generated through these trials.

##### **Outcomes**

Awareness of emerging technologies, leading to wider industry adoption of improved working practices.

#### **Recommendation 5: Inclusion of low emission technologies in government and industry procurement**

##### **Rationale**

A barrier to introducing low emissions machinery - which is not covered through the planning process - is a lack of knowledge within the procurement teams. Those teams require training so they can include new requirements within contracts.

Simultaneously, there are no minimum emission stage requirements for events, road, and utility works. The below recommendation for construction equipment could therefore also be applied to events, road, and utility works.

##### **Outputs**

We recommend that procurement teams identify where there are knowledge gaps and think about what the barriers to adopting new contractual requirements are, both internally and through contractor organizations.



We also recommend that a training programme be adopted such as to increase internal understanding of cleaner machinery requirements and allow this to be adapted for external use within contracts for the on-road construction sector.

##### **Outcomes**

Inclusion of minimum emission standards for machinery used in the highways and events sectors.

Procurement teams would hold power to impose emission requirements for construction projects.



Facility hire companies would be willing to improve their fleet if there is sufficient evidence and demand. Increasing regulation into the highways and events sectors will drive demand for cleaner machinery that will be used elsewhere and in other sectors bringing wider benefits.

 <b>FCFS</b>	<p>ENVIRONMENTAL BASELINE STUDY REPORT FOR          AMBIENT ATMOSPHERIC QUALITY MONITORING          OF THE PROPOSED CONSTRUCTION OF A          15,000MT COMMON USER LIQUEFIED PETROLEUM          GAS (LPG) TERMINAL IN KIPEVU ON PLOT L.R          NO. MN/VI/3711, CHANGAMWE AREA, MOMBASA          COUNTY.</p>	<p>REPORT REF NO.: 50124-0077A          REPORT TITTLE: EBSAAQMR-77A          DOI: 16<sup>TH</sup> DECEMBER 2024          PAGE NUMBER P A G E   41</p> 
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## 6. REFERENCES

- 1) Environmental Management and Coordination Act (EMCA) 1999 (amended 2015).
- 2) Environmental Management Coordination (Air Quality) Regulations 2014 (Legal Notice No.34).
- 3) Environmental Protection Agency. (1976) Quality Assurance Handbook for Air Pollution Measurement Systems - Volume 1 Principles. EPA-600/9-76-005, Research Triangle Park, NC.
- 4) Quality Assurance and Quality Control (QA/QC) Procedures for UK Air Quality Monitoring under 2008/50/EC and 2004/107/EC
- 5) U.S. Environmental Protection Agency (2000) Guidance for Data Quality Assessment - Practical Methods for Data Analysis, EPA Report QA G-9 QA00 Update, Washington DC, July 2000. This document can be downloaded from website: <http://www.epa.gov/quality/qs-docs/g9-final.pdf>
- 6) U.S. Environmental Protection Agency. (1998) EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, Report EPA/600/R-98/018, EPA Project Boundary 2 (PB-2) or Research and Development, Washington DC. This document can be downloaded from website: <http://www.epa.gov/swerust1/cat/epaqag5.pdf>.



 <p><b>FCFS</b></p>	<p>ENVIRONMENTAL BASELINE STUDY REPORT FOR          AMBIENT ATMOSPHERIC QUALITY MONITORING          OF THE PROPOSED CONSTRUCTION OF A          15,000MT COMMON USER LIQUEFIED PETROLEUM          GAS (LPG) TERMINAL IN KIPEVU ON PLOT L.R          NO. MN/VI/3711, CHANGAMWE AREA, MOMBASA          COUNTY.</p>	<p>REPORT REF NO.: 50124-0077A          REPORT TITTLE: EBSAAQMR-77A          DOI: 16<sup>TH</sup> DECEMBER 2024          PAGE NUMBER P A G E   42</p> 
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# APPENDIX A: EQUIPMENT CALIBRATION CERTIFICATES

## APPENDIX B: LABORATORY DESIGNATION CERTIFICATES



### NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

Mobile Lines: 0724-253 398, 0723-363 010, 0735-053 046  
Telkom Wireless: 020-2101570, 020-2183718  
Incident Lines: 0786-101100, 0741-101100

P.O. Box 67839, 00200  
Pepo Road, Nairobi, Kenya  
E-mail: [dgnema@nema.go.ke](mailto:dgnema@nema.go.ke)  
Website: [www.nema.go.ke](http://www.nema.go.ke)

**NEMA/21/2/LAB 77/LLL**

**20<sup>th</sup> April, 2023**


**Lahvens Limited Laboratory  
Lahvens House,  
P.O. Box 34153-80118  
MOMBASA.**

#### **RE: LABORATORY DESIGNATION BY NEMA.**

Pursuant to your application for designation, your laboratory was inspected and evaluated based on ISO 17025 for laboratory competence to carry out tests and samplings.

The Lahvens Limited Laboratory qualified and has in principle been designated to undertake **Air Quality Analysis (Stack Emission and Ambient Air) and Noise Level Measurements** subject to the attached terms and conditions.

However, pursuant to section 119 of EMCA 1999 the Gazettement will take effect once the Authority places a notice in the Kenya Gazette.

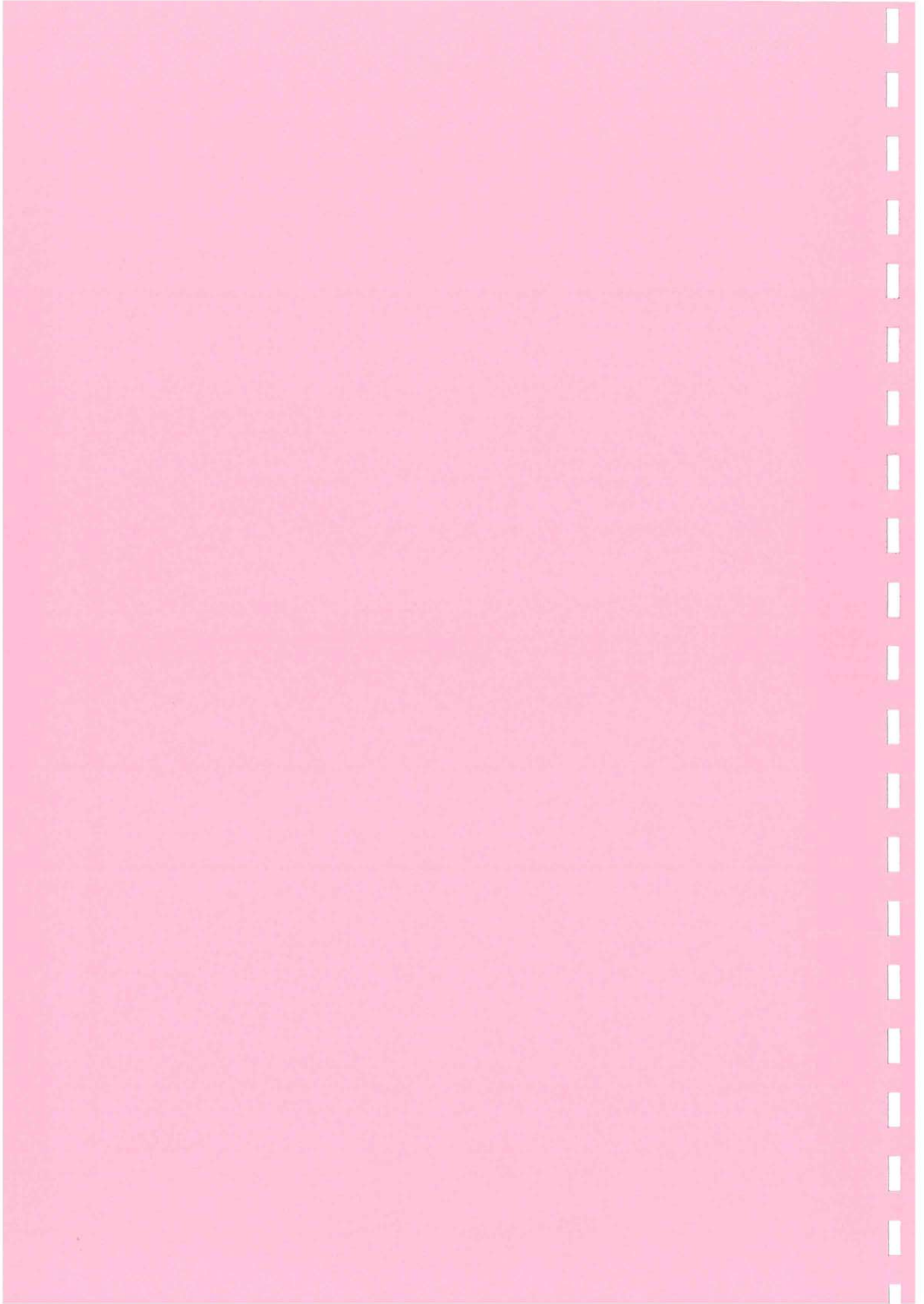


**DAVID ONGARE**  
For: **DIRECTOR GENERAL**



## **BASELINE STUDIES**

- **SOIL ANALYSIS**
- **WATER SAMPLING  
ANALYSIS**







**LABORATORY CERTIFICATE OF ANALYSIS REPORT**

Pg 1/1

Sample Description: EFFLUENT WATER	Sample ref. Number: ZTL/EFT-FCFS/295/25
Client Ref. Number: ZTL/FCFS/295/25	Sample Form Submission Number: 543
Client Name: FOCUS CONTAINER FREIGHT STATION	Date of Receipt: 21 <sup>ST</sup> FEBRUARY 2025
Postal Address: P. O BOX 43092-80100 MSA, KENYA	
Date of test performed: 21 <sup>ST</sup> - 25 <sup>TH</sup> FEBRUARY 2025	Date of Test report: 26 <sup>TH</sup> FEBRUARY 2025
Sampled by: ISAAC NAMACHI	Sample received by: MAXMILLAH MALIACHI
SPECIFICATION: EMCA 4 <sup>TH</sup> SCHEDULE MONITORING GUIDE FOR DISCHARGE OF EFFLUENT INTO THE ENVIRONMENT (GAS & OIL)	

PARAMETERS	RESULTS	STD LIMITS	TEST METHODS
<b>Chemical Parameters</b>			
pH@24.4° C	6.75	6.5-8.5	ISO 10523
Biological Oxygen Demand, Mg/L, max	5.4	30	APHA 5210B
Total Suspended Solids, Mg/L, max	0.16	30	ISO 11923
Colour, in Hazen Units, max	4	15	ISO 7887
Oil and grease, Mg/L, Max	Nil	Nil	APHA 5511D
Free available chlorine, Mg/L, max	0.01	0.10	APHA 330.5
<b>Microbial Tests</b>			
Total Coliforms/100 ml, max	Nil	30	ISO 4832

**ANALYSED:**

**Maximilian Omoke,**  
**Chemist.**



**Date of Issue:**  
**26/02/2025**

End of Page

This document is issued by the company subject to its conditions of service and current testing procedures. The results contained herein apply to the particular sample(s) tested, whose sample reference number and tests carried out as detailed in this report. Any other holder of this document is advised that information contained hereon reflects the details provided by the client and laboratory findings at the time of its participation. The decision rule applied is as per general acceptance criteria only and within the client's instructions. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the full extent of the law.



**Designated Laboratory**





**LABORATORY CERTIFICATE OF ANALYSIS REPORT**

Pg 1/1

Sample Description: SOIL SAMPLE	Sample ref. Number: ZTL/EFT-FCF5/296/25
Client Ref. Number: ZTL/FCF5/296/25	Sample Form Submission Number: 544
Client Name: FOCUS CONTAINER FREIGHT STATION	Date of Receipt: 21 <sup>ST</sup> FEBRUARY 2025
Postal Address: P. O BOX 43092-80100 MSA, KENYA	
Date of test performed: 21 <sup>ST</sup> - 25 <sup>TH</sup> FEBRUARY 2025	Date of Test report: 26 <sup>TH</sup> FEBRUARY 2025
Sampled by: ISAAC NAMACHI	Sample received by: MAXMILLAH MALIACHI
SPECIFICATION: N/A	


PARAMETERS	RESULTS	STD LIMITS	TEST METHODS
<b>ORGANIC POLLUTANTS</b>			
Benzene, ug/kg	<10	-	EPA 8260C
Toluene, ug/kg	<10	-	EPA 8260C
Ethyl-benzene, ug/kg	<10	-	EPA 8260C
Total Xylenes, ug/kg	<20	-	EPA 8260C
Total Petroleum Hydrocarbons, GRO, C <sub>6</sub> -C <sub>10</sub> , mg/kg	<1	-	EPA 8015C
Total Petroleum Hydrocarbons, DRO, C <sub>10</sub> -C <sub>28</sub> , mg/kg	<1	-	EPA 8015C
Total Polycyclic Aromatic Hydrocarbons, PAHs, mg/kg	<1	-	EPA 8310

**Note:**

GRO- Gasoline Range Organics

DRO- Diesel Range Organics

**ANALYSED:**

  
Maximilian Omoke,  
Chemist.



Date of Issue:  
26/02/2025

End of Page

This document is issued by the company subject to its conditions of service and current testing procedures. The results contained herein apply to the particular sample(s) tested, whose sample reference number and tests carried out as detailed in this report. Any other holder of this document is advised that information contained hereon reflects the details provided by the client and laboratory findings at the time of its participation. The decision rule applied is as per general acceptance criteria only and within the client's instructions. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the full extent of the law.



**nema** Designated Laboratory







No. C. 161022


## CERTIFICATE OF INCORPORATION

*I hereby Certify, that—*

FOCUS CONTAINER FREIGHT STATION LIMITED .....

is this day Incorporated under the Companies Act (Cap. 486) and that the Company is LIMITED.

Given under my hand at Nairobi this FIFTH day  
of SEPTEMBER Two Thousand AND EIGHT.

  
Dy. Registrar of Companies





**Certificate Date :** 05/01/2021**Personal Identification Number**

P051231860S

This is to certify that taxpayer shown herein has been registered with Kenya Revenue Authority

**Taxpayer Information**

<b>Taxpayer Name</b>	FOCUS CONTAINER FREIGHT STATION LIMITED
<b>Email Address</b>	AISHA.MOHAMED@FOCUS.CO.KE

**Registered Address**

<b>L.R. Number :</b>	<b>Building</b> FOCUS BLDG
<b>Street/Road</b> FOCUS IMPASSE PIPELINE ROAD	<b>City/Town :</b> MOMBASA CITY
<b>County :</b> Mombasa	<b>District</b> Kilindini District
<b>Tax Area</b> Kilindini	<b>Station</b> MTO
<b>P. O. Box</b> 43092	<b>Postal Code</b> 80100

**Tax Obligation(s) Registration**

<b>Sr. No.</b>	<b>Tax Obligation(s)</b>	<b>Effective From Date</b>	<b>Effective Till</b>	<b>Status</b>
1	Income Tax - Company	17/09/2008	N.A.	Active
2	Income Tax - PAYE	01/01/2010	N.A.	Active
3	Value Added Tax (VAT)	05/11/2010	N.A.	Active

The above PIN must appear on all your tax invoices and correspondences with Kenya Revenue Authority. Your accounting end month is June unless a change has been approved by the Commissioner-Domestic Taxes Department. The status of Tax Obligation(s) with 'Dormant' status will automatically change to 'Active' on date mentioned in "Effective Till Date" or any transaction done during the period. This certificate shall remain in force till further updated.





MOBASA DISTRICT  
LAND REGISTRY

232 91 JUN 14 -9 10

(T)



REPUBLIC OF KENYA

THE REGISTRATION OF TITLES ACT  
(Chapter 281)

GRANT: NUMBER CR. 2152

ANNUAL RENT: Shs 112,000/-

TERM: 99 Years From 1.6.1991

KNOW ALL MEN BY THESE PRESENTS that in consideration of the sum of shillings five hundred and sixty thousand (Shs 560,000/-) by way of stand premium paid on or before the execution hereof THE PRESIDENT OF THE REPUBLIC OF KENYA hereby GRANTS unto INDUSTRIAL AND COMMERCIAL DEVELOPMENT CORPORATION a body corporate duly incorporated under the Industrial and Commercial Development Corporation Act (Cap 445) of the laws of Kenya of NAIROBI (Post Office Box Number 45519)

(hereinafter called "the Grantee") ALL that piece of land situate in Mombasa Municipality in Mombasa District containing by measurement seven decimal three two one (7.321) hectares hectares/acres or thereabouts that is to say L.R. No. MN/VI/3711

which said piece of land with the dimensions abutments and boundaries thereof is delineated on the plan annexed hereto and more particularly on Land Survey Plan Number 155541 deposited in the Survey Records Office at Nairobi

TO HOLD

for the term of Ninety nine (99) years from the

First day of June One thousand nine hundred and

Ninety One

year of the annual rent of shillings One hundred and twelve thousand (Shs 112,000/-) (REVISABLE)

(b) the provisions of the Government Lands Act (Chapter 280) and (c) the following Special Conditions (namely):

[P.T.O.]

## SPECIAL CONDITIONS

1. No buildings shall be erected on the land nor shall additions or external alterations be made to any buildings otherwise than in conformity with plans and specifications previously approved in writing by the Commissioner of Lands and the Local Authority. The Commissioner shall not give his approval unless he is satisfied that the proposals are such as to develop the land adequately and satisfactorily.
2. The Grantee shall within six calendar months of the actual registration of the Grant submit in triplicate to the Local Authority and the Commissioner of Lands plans (including block plans showing the positions of the buildings and a system of drainage for disposing of sewage surface and sullage water) drawings elevations and specifications of buildings the Grantee proposes to erect on the land and shall within 24 months of the actual registration of the Grant complete the erection of such buildings and the construction of the drainage system in conformity with such plans drawings elevations and specifications as amended (if such be the case) by the Commissioner PROVIDED that notwithstanding anything to the contrary contained in or implied by the Government Lands Act if default shall be made in the performance or observance of any of the requirements of this condition it shall be lawful for the Commissioner of Lands or any person authorized by him on behalf of the President to re-enter into and upon the land or any part thereof in the name of the whole and thereupon the term hereby created shall cease but without prejudice to any right of action or remedy of the President or the Commissioner of Lands in respect of any antecedent breach of any condition herein contained.
3. The Grantee shall maintain in good and substantial repair and condition all buildings at any time erected on the land.
4. Should the Grantee give notice in writing to the Commissioner of Lands that it is unable to complete the buildings within the period aforesaid the Commissioner of Lands shall (at the Grantee's expense) accept a surrender of the land comprised herein:
  - (i) Provided further that if such notice as aforesaid shall be given within 12 months of the actual registration of the Grant the Commissioner of Lands shall refund to the Grantee 50 per centum of the stand premium paid in respect of the land, or
  - (ii) at any subsequent time prior to the expiration of the said building period the Commissioner of Lands shall refund to the Grantee 25 per centum of the said stand premium. In the event of notice being given after the expiration of the said building period no refund shall be made.
5. The land and the buildings shall only be used for Industrial purposes only
6. The buildings shall not cover more than 90 per centum of the area of the land or such lesser area as may be laid down by the Local Authority in its by-laws.
7. Accommodation not exceeding square metres may be provided for a caretaker or night watchman or such lesser area as may be laid down by the Local Authority in its by-laws.
8. The land shall not be used for any purpose which the Commissioner of Lands considers to be dangerous or offensive.
9. The Grantee shall not subdivide the land.
10. The Grantee shall not sell transfer sublet charge or part with the possession of the land or any part thereof or any buildings thereon except with the prior consent in writing of the Commissioner of Lands. No application for such consent (except in respect of a loan required for building purposes) will be considered until Special Condition No. 2 has been performed.
11. The Grantee shall pay to the Commissioner of Lands on demand such sum as the Commissioner of Lands may estimate to be the proportionate cost of constructing all roads and drains and sewers serving or adjoining the land and the proportionate cost for the supply of both the water and the electric power to the land and shall on completion of such construction and the ascertainment of the actual proportionate cost either pay (within 30 days of demand) or be refunded the amount by which the actual proportionate cost exceeds or falls short of the amount paid as aforesaid.
12. The Grantee shall from time to time pay to the Commissioner of Lands on demand such proportion of the cost of maintaining all roads and drains serving or adjoining the land as the Commissioner may assess.
13. Should the Commissioner of Lands at any time require the said roads to be constructed to a higher standard the Grantee shall pay to the Commissioner on demand such proportion of such construction as the Commissioner may assess.
14. The Grantee shall pay such rates taxes charges duties assessments or outgoings of whatever description as may be imposed charged or assessed by any Government or Local Authority upon the land or the buildings erected thereon including any contribution or other sum paid by the President in lieu thereof.
15. The President or such person or authority as may be appointed for the purpose shall have the right to enter upon the land and lay and have access to water mains service pipes and drains telephone or telegraph wires and electric mains of all descriptions whether overhead or underground and the Grantee shall not erect any buildings in such a way as to cover or interfere with any existing alignments of main or service pipes or telephone or telegraph wires and electric mains.
16. The Commissioner of Lands reserves the right to revise the actual ground rental payable hereunder after the expiration of the thirty-third and sixty-sixth year of the term hereby granted. Such rental will be at the rate of per cent of the unimproved freehold value of land as assessed by the Commissioner of Lands.



# REPUBLIC OF KENYA

DISTRICT OF MOMBASA

Locality *Mombasa Municipality*

Reference Map *South A 37 2*

Bearings	Distances
a	Metres
A-B 336 40 12	17.25

Land Reference No.

Orig No.

Sub division No. *374* (Orig No. *15*)

of Section No. *II Mainland North*

Area = *7.321 Ha (Approx.)*

WHEREAS WHEREOF SECTION 6-2-1  
of the Commission of Lands have by order of  
the President pursuant to the said Act  
the thousand nine hundred and Ninety  
in the presence of:

REGISTRAR OF TITLES

*MN/V/5711*

BAND TITLES REGISTRY MOMBASA-KENYA  
REGISTRAR OF TITLES ACT

*Change to Commercial Bank Limited*

*DEED OF RECTIFICATION RECTIFYING THE  
CHANGE NO. 2 ABOVE TO READ SECTION  
VI MN AND NOT SECTION V MN*

*E.M.J. Kiguru  
Licensed Surveyor*

*502* Date of Execution

DISCHARGE OF CHANGE OF  
NO. 2 ABOVE

*Kogut J.P.A.*  
for Director of Surveys

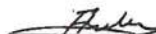
Scale *1:47* Date of Survey *1991*  
Nairobi

Traced by  
Compared by

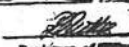
DEED PLAN No. *155541*

16. The Commissioner of Lands reserves the right to revise the annual ground rent payable hereunder at the expiration of every ten years of the term. Such rental shall be at a rate to be determined by the Commissioner of Lands of the unimproved value of the land as at the end of every tenth year of the term.

IN WITNESS WHEREOF I WILSON GACANJA  
the Commissioner of Lands have by order of  
the President hereunto set my hand this  
13<sup>th</sup> day of JUNE  
One thousand nine hundred and Ninety One  
in the presence of:

  
REGISTRAR OF TITLES

LAND TITLES REGISTRY - MOMBASA - KENYA  
REGISTRATION OF TITLES ACT

14<sup>th</sup> June 1991  
9:09am  
  
Registrar of Titles

THE FOLLOWING INSTRUMENT HAS BEEN REGISTERED AGAINST THE  
Charge to Commercial Bank of Africa  
Limited

(2)

0412 Date of Registration 29.5.97 Section  
THE FOLLOWING INSTRUMENT IS HEREBY REGISTERED AGAINST THE  
DEED OF RECTIFICATION RECTIFYING THE  
CHARGE NO. 2 ABOVE TO READ SECTION  
VI M.N. AND NOT SECTION V M.N.

(3)

002 Date of Registration 1-11-92 Section  
THE FOLLOWING INSTRUMENT HAS BEEN REGISTERED AGAINST THE

DISCHARGE OF CHARGE OF ENTRY  
NO. 2 ABOVE

(4)

147 Date of Registration 10.11.2005 Section



THE FOLLOWING INSTRUMENT HAS BEEN RECORDED AGAINST THE TITLE:

TRANSFER TO FOCUS CONTAINER

FREIGHT STATION LIMITED

(5)

Registration No. 148

Date of Registration 10/11/2009

Register

THE FOLLOWING INSTRUMENT HAS BEEN RECORDED AGAINST THE TITLE:

CHARGE TO INDUSTRIAL &

COMMERCIAL DEVELOPMENT CORPORATION

(6)

Registration No. 149

Date of Registration 10/11/2009

Register









# Chuo Kikuu cha Tom Mboya sasa kutoa mafunzo ya ujenzi wa meli

NA GEORGE ODIWUOR

**KAMPUNI** ya Kujenga Meli Nchini (KSL) imebuni ushiki wa Chuo Kikuu cha Tom Mboya, kilicholikuwa majini katika Ziwa Victoria. Ikiwa ni kuhusu ujenzi wa ukarabati wa vyombo hivyo vya uchukuzi wa majini.

Hiyo ni sehemu ya mpango wa kupunguza ajali na kuhusisha meli na vyombo vingine vya kusafiri majini katika Ziwa Victoria.

Chuo cha ushirikiano huo, KSL itatoa mafunzo ya kiteknojia kwa wanafunzi ilhali chuo nicho kikuu kitatumika katika kitovu cha kutoa mafunzo ya kiufundi.

KSL ni kampuni ya serikali na inasimamiwa na Waziri wa Ulinzi.

Waziri wake mkuu ni kusanii miundo na kuenga meli za kisasa.

Imekuwa ikiendesha shughuli zake katika jiji za Kiunga na ilipata umaarufu baada ya kujengwa kwa jina MVI Uhuru II. Meli hiyo ilizinjuliwa rasmi na Rais William Ruto mnamo Oktoba mwaka jana.

Kampuni hiyo sasa itatoa mafunzo ya kozi kuu za ujenzi wa meli kwa watu kutoka Kaunti ya Tom Mboya eneo zima la Nyanza.

Mafunzo yatatolewa katika Chuo Kikuu cha Tom Mboya, kulingana na Mkataba wa Maelewano (MoU) uliotiwa saini na taasisi hizo mbili ili kuanzisha mafunzo hayo ya kiufundi.

Mafunzo yataongozwa na KSL, Meja Jenerali Mwangi, Chansela wa chuo hicho Profesa Jha Ochocha na Gavana wa Homa Bay Gladys Njiru. Walishuhudia hafla ya kutiwa saini kwa MoU hiyo mnamo Jumatatu.

Meja Farah alisema ushirikiano huo unatambua pakubwa katika mpango wa kuimarisha usalama katika Ziwa Victoria.

Ali na kuandaa kwa kituo cha mafunzo ya utengenezaji wa meli katika Chuo Kikuu cha Tom Mboya ni hatua kubwa ya kihistoria.

Kampuni hiyo itakadwa kwa kituo hicho kunatokana na ushirikiano wa kipekee wa kuleta pamoja mahitaji ya ujenzi wa meli na uwezo wa kiusomi kwa eneo la kustawisha sekta ya utengenezaji meli nchini Kenya na mataifa ya nje," Meja Jenerali Farah akasema.

Ali na ongeza kuwa meli na vyombo vingine vya kusafiri majini vitakavyotengenezwa katika kituo hicho itaweza kutumika katika maziwa mbalimbali ya humu nchini pamoja na bahari.



## BI TAIFA

**ESTHER MWENJE, 27** ndiye malka wa taifa leo. Bi Mwenje ni mfiadini wa nyabishi wa jiji Nakuru. Uraibu wake ni kusikiliza muziki na kutangamana na marafiki wanya. **PICHA: RICHARD MAOSI**

MAENDELEO | Utakuwa mradi wa kwanza tangu 2022 kutekelezwa na serikali Makuani

# Mutuse 'atuzwa' barabara ya lami kutimua Rigathi

NA PIUS MAUNDU

**MBUNGE** wa Kibwezi Magharibi Mwengi Mutuse, kwa mara ya kwanza amefichua kuwa ni Rais William Ruto ndiye alimpa kibarua cha kuwasilisha hoja ya kumtimua aliyekuwa Naima Rais Rigathi Gachagua.

Na mshahara wa kazi hiyo, akaeleza, ni mpango mpya wa serikali wa kuweka lami Barabara ya Emali-Ukia, inayopita katikati ya Kaunti ya Makuani.

Itakuwa mradi wa kwanza kutekelezwa na serikali ya Kenya Kwanza katika kaunti hiyo tangu Rais Ruto alipoingia mamlakani Septemba 2022.

Bw Mutuse, alisema: "Kuweka lami barabara hii muhimu ni tunu kutoka kwa Rais Ruto kwangu baada ya kuwasilisha na kuwezesha kupitishwa kwa hoja ya kumtimua Gachagua."

"Bw Gachagua alikuwa anapanga kupeleka Sh2 bilioni ambazo serikali ilipata kutoka China, hadi eneo la Mlima Kenya kufadhili uwekaji lami Barabara ya Mau Mau. Nilipofaulu kumwondoa mamlakani, sasa Rais ameniambia serikali itaweka lami Barabara ya Emali-Ukia," Bw Mutuse akawaambia waombolezaji katika kijiji cha Mutituni.

Alisema hayo wakati wa mazishi ya Mama Naomi Mulatya, mamaake Florence Mulatya, aliyekuwa mkakilishi wa kitenge cha Elimu katika ubalozi wa Kenya nchini Australia.

Ilikuwa ni mara ya kwanza kwa Bw Mutuse aliyechaguliwa kwa Chama cha Maendeleo Chap Chap, kuzungumzia mchakato wa kuondolewa mamlakani kwa Bw Gachagua, shughuli iliyomweka kwenye ramani ya kitaifa.

Mbunge huyo alimsuta Bw Gachagua kwa kuendeleza ukabila na kuhujumu maendeleo katika eneo la Ukambani. Tangazo la Mutuse liliwachangamsha wakazi japo wengine waliikuwa na shauku.

"Haya yatakuwa mafanikio makubwa ya serikali hii katika Kaunti ya Makuani. Tumesubiri kwa miongo mingi," akasema George Mutinda.

"Kila Desemba sisi huambi-



**Kuwekwa lami barabara hii ni tunu kutoka kwa Rais Ruto baada ya kupitishwa kwa hoja ya kumtimua Gachagua**

Mwengi Mutuse

wa kuwa barabara hi itawekwa lami Februari mwaka unaofuata. Tumezoa ahadi kama hizi," akasema Charity Wavinya Mwalimu.

Wakati ambapo hoja ya kumtimua Bw Gachagua ilikuwa ikijadiliwa na mashtaka 11 kujadiliwa, wabunge waliopinga walidai Bw Mutuse hakuielewa yaliyomo.

"Huyu Mutuse si mmiliki wa hoja hii kwa sababu haelewi chochote kuhusu. Mmiliki kamili wa hoja hii si mwingine ila Rais Ruto," akasema Mbunge wa Mukrwe-ini, John Kaguchia, mnamo Oktoba 8, 2024 kabla ya

hoja hiyo kupigiwa kura katika Bunge la Kitaifa.

Na katika Bunge la Seneti, Bw Mutuse alikabiliwa na wakati ingumu alipodadiwa na mawakili wa Bw Gachagua wakiongozwa na Ndegwa Njiru.

Mara kadhaa, Mbunge huyo wa Kibwezi Magharibi alioneka na kulemewa na makombora ya maswali kutoka kwa mawakili hao.

Barabara hiyo ya Emali-Ukia, ni sehemu ya barabara kuu inayounganisha Tanzania na Ethiopia, kupitia kaunti kadhaa, na ni yenye umuhimu mkubwa kwa wakulima wa matunda katika Kaunti ya Makuani.

"Kuwekwa lami kwa barabara ya Emali-Ukia kutaweka pesa mifukoni mwa wakulima wa matunda kwa sababu wataweza kufikisha mazao yao sokoni mwa urahisi," Spika wa Bunge la Kaunti ya Makuani, Douglas Mbilu, akasema jua.

Wakati wa kampeni ya kuelekea uchaguzi mkuu wa 2022, mradi wa uwekaji lami barabara hiyo ni miongoni mwa ile ambayo Rais Ruto na kiongozi wa Azimio Raila Odinga waliachidi kutekeleza kwa manufaa ya wakazi wa Makuani.



## NOTISI YA MASHAURIANO YA UMMA

Sisi, Focus Container Freight Station, tunapendekeza kujenga kituo cha Pamoja chakuchakatagesi (LP6) kwenye kipande chetu cha ardhi, nambari ya usajili L.R.N.O MN/VI/3711 eneo la Changamwe kule Kipevu, kaunti ya Mombasa.

Kama Mhusika/Mshiriki/Mwanajamii ambaye huenda akavutiwa na suala hili, tunakualika uhudhuri mkutanoni wa mashauriano ya umma/Baraza litakalofanyika Alhamisi Desemba 19 2024 saa Tatu na Nusu asubuhi hadi saa saba mchana, katika eneo la Mradi ambapo ni kwenye ardhi ya Focus Container Freight Station. Ajenda ya Mkutano ni kuwasilishwa kwa pendekezo la mradi na wataalamu na kukusanya maoni yako kabla ya kuyawasilisha kwa Mamlaka ya Kitaifa inayosimamia Mazingira (NEMA).

TAIFA LEO



**THE PROPOSED CONSTRUCTION OF A 15,000  
MT LIQUIFIED PETROLEUM GAS TERMINAL  
LOCATED IN KIPEVU LR. NO. MN/VI/3711,  
CHANGAMWE AREA ,MOMBASA COUNTY**

**BILLS OF QUANTITIES**

**CONSULTANT**

**SYMETRICS LIMITED  
P.O. BOX 78517-00507  
NAIROBI**

**QUANTITY SURVEYORS**

**AKE- BILL CONSULTANTS  
P.O. BOX 10110-00100  
NAIROBI**

  
**SYMETRICS LIMITED**  
P.O. Box 78517 - 00507, NAIROBI.  
Tel: +254 722 684 025  
Email: info@symetrics.co.ke

### **SECTION 3: MEASURED WORKS**



**BILL NO.1:EXCAVATIONS AND EARTHWORKS**

ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT KSHS
	<b><u>ALL PROVISIONAL'</u></b>				
A	Mass excavation to a depth of an average 750mm	Cm	1699.25	500	849,625
B	Excavate for Column bases not exceeding 1.5 m deep	Cm	84	350	29,400
C	Ditto:strip footing for retaining wall	Cm	280	350	98,000
E	Allow for rock excavation in all classes of rock	Cm	125	1,500	187,500
	<b><u>Disposal</u></b>				
F	Load excavated material and cart away to CGM designated sites	Cm	1923.25	550	1,057,788
	<b><u>Backfill</u></b>				
G	Backfill selected excavated materials around excavations	Cm	140	150	21,000
	<b><u>Insecticide treatment</u></b>				
H	TERMIDOR 25 EC' or other equal and approved chemical insecticide treatment prepared and applied to the manufacture's instructions	Sm	2225.25	200	445,050
	<b><u>Hardcore as described:</u></b>				
I	400 mm thick approved hardcore filling handpacked in two layers	Cm	890	1,500	1,335,000
	<b><u>Blinding</u></b>				
J	50 mm thick murrum blinding or other approved blinding to surface of hardcore rolled smooth to receive polythene sheeting[m.s]	Sm	2225.25	150	333,788
	<b><u>Damp proof membrane</u></b>				
K	1000 gauge polythene plastic sheet damp proof membrane laid on blinding(measured nett-allow for laps)	Sm	2225.25	200	445,050
<b>Total for Bill No.1; Excavations and Earthworks carried to summary page</b>					<b>4,802,200</b>

**BILL NO.2:REINFORCED CONCRETE STRUCTURE**

ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
					KSHS
	<b><u>In-situ concrete work</u></b>				
	<b>Mass concrete as described to:-</b>				
A	50 mm thick blinding under strip footing	Sm	282	450	126,900
B	Ditto; to column Bases	Sm	88	450	39,600
C	Ditto; Base slab	Sm	2225.25	450	1,001,363
	<b>Vibrated reinforced concrete class 25/20-1:1.5:3 as described to:-</b>				
D	Strip footing	Cm	140	14,000	1,960,000
E	Column Bases	Cm	84	14,000	1,176,000
F	Columns	Cm	24.5	14,000	343,000
G	Beams	Cm	123.5	14,000	1,729,000
H	300 mm thick concrete base slab	Sm	2225.25	4,200	9,346,050
I	200mm thick Suspended slab	Sm	2225.25	2,800	6,230,700
J	175 mm thick retaining wall	Sm	526.25	2,450	1,289,313
	<b>Carried to next page</b>				<b>23,241,925</b>



**BILL NO.2:Cont'd**

ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
					KSHS
	<b>Total brought forward</b>				23,241,925
	<b>Expansion Joint</b>				
A	25 mm wide expansion joint filled with styropol material	Sm	61.25	1,200	73,500
B	25 mm wide expansion joint filled with styropol material	Sm	61.25	1,200	73,500
	<b>Steel reinforcement(provisional)</b>				
C	Supply and fix reinforcementst including bending hooks ,tying wires and spacer blocks all in position				
	<b>High tensile square twisted bars to B.S. 4461</b>				
D	Assorted reinforcement bars	Sm	111963.25	170	19,033,753
	<b>Sawn formwork as described to:-</b>				
E	Vertical sides of columns bases	Sm	33	600	19,800
F	Sides of Strip footing	Sm	28	600	16,800
G	Vertical sides of Columns	Sm	122.375	600	73,425
H	Vertical sides and soffits of beams	Sm	311	600	186,600
I	Vertical sides of Retaining wall	Sm	526.25	600	315,750
J	Soffits of suspended slab	Sm	1112.625	600	667,575
K	Edges of base slab 225-300mm high	Lm	70	150	10,500
L	Edges of suspended slab 150-200mm high	Lm	70	120	8,400
	<b>Carried to Summary page</b>				<b>43,721,528</b>

**SUMMARY**

ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
					KSHS
1	EXCAVATIONS AND EARTHWORKS				4,802,200
2	REINFORCED CONCRETE WORKS				43,721,528
TOTAL CARRIED TO GRAND SUMMARY PAGE					48,523,728



**BILL NO. 3: TANK MOUNDS**

ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
					KSHS
A	Fine aggregate fillings around tanks to approval	Cm	8452	2,400	20,284,800
	carried to collection				20,284,800
	COLLECTION Brought down from page 7 above				20,284,800
	Total carried to summary page				20,284,800

**PERIMETER WALLING**

ITEM NO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT KES
	<b><u>SUBSTRUCTURE WORKS</u></b>				
A	Excavate for foundation trenches commencing from ground level and not exceeding 1.5m average	Cm	329.5	200	65,900
B	Ditto; Column bases	Cm	165.5	200	33,100
C	Return, fill and ram excavated materials around excavations	Cm	49	150	7,350
D	Cart away excess excavated materials away from site	Cm	23	500	11,500
	<b><u>In- situ Concrete Works</u></b>				
	<b>Mass concrete as described:-</b>				
E	Blinding to boundary wall	Sm	297.5	450	133,875
F	Ditto; Column bases	Sm	165.5	450	74,475
	<b>Vibrated reinforced concrete class 25/20 as described to:</b>				
G	Boundary wall footing	Cm	39.5	14,000	553,000
H	Column Bases	Cm	33	14,000	462,000
I	Columns	Cm	6.5	14,000	91,000
J	Ground beam	Cm	39.5	14,000	553,000
	<b>Expansion Joint</b>				
K	25 mm thick expansion joint filled with styropol material	Sm	15	750	11,250
	Total carried to next page				<b>1,996,450</b>



ITEM NO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
					KES
	Total brought forward				1,996,450
	<b><u>Reinforcements</u></b>				
	High tensile square twisted iron bars as described to:-				
A	Assorted reinforcement bars	Kg	17790	170	3,024,300
	<b><u>FormWork</u></b>				
	Soft sawn formwork to as described to:-				
B	Vertical sides of Columns	Sm	168	600	100,800
C	Ditto:ground beam	Sm	396	600	237,600
	<b><u>Walling</u></b>				
	200 mm thick natural stone walling in cement sand [1:3]mortar and reinforced with hoop iron at every alternate course as described:-				
D	Substructure Walling	Sm	495	2,000	990,000
	<b><u>DPC</u></b>				
E	200mm wide hessian based bituminous felt	Lm	0 495	200	99,000
	Total carried forward Summary page				6,448,150

ITEM NO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT KES
	<b><u>SUPERSTRUCTURE WORKS</u></b>				
	Vibrated reinforced concrete class 25/20 as described to:				
A	Columns	Cm	32	14,000	448,000
	<b><u>Reinforcements</u></b>				
	High tensile square twisted iron bars as described to:-				
B	Assorted reinforcement bars	Kg	2400	170	408,000
	<b><u>FormWork</u></b>				
	Soft sawn formwork to as described to:-				
C	Vertical sides of Columns	Sm	263.5	600	158,100
	<b><u>Expansion joint</u></b>				
D	25 mm thick expansion joint filled with styropol material	Sm	72	750	54,000
	<b><u>WALLING</u></b>				
	Natural coral reef stone walling in cement sand [1:3]mortar and reinforced with hoop iron at every alternate course as described:-				
E	200 mm thick	Sm	1189	2,000	2,378,000
	<b>Total carried forward</b>				<b>3,446,100</b>



ITEM NO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT KES
	B/F				3,446,100
	<b>Plaster works</b>				
A	12mm thick cement sand (1:4) plaster finished smooth with a steel trowel	Sm	1189.5	450	535,275
B	275 mm wide pre- castconcrete coping in cement and sand(1:4) mortar	Lm	234.5	550	128,975
C	450 x 450 mm pier caps	No	82.75	550	45,513
	<b>Weep Holes</b>				
D	50mm diameter PVC Weep holes including cutting 200 mm diameter holes on boundary walling fixing and making good to Architect's satisfaction	No	225	250	56,250
	<b>Gate</b>				
E	6000 x 2200 mm high Gate to details	No	2	150,000	300,000
F	20 x 2200 mm high sliding gate to details	No	2	750,000	1,500,000
	<b>Painting and decoration</b>				
G	Prepare and apply one undercoat and two finishing coats of gloss oil paint on general metal surfaces	Sm	233	350	81,550
<b>Total carried to Summary page</b>					<b>12,985,863</b>

ITEM NO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
					KES
	<b>SUMMARY</b>				
1	SUBSTRUCTURE WORKS				6,448,150
2	SUPERSTRUCTURE WORKS				12,985,863
<b>Total carried to Summary page</b>					<b>38,513,538</b>



**BILL NO.3:STORM WATER DRAINAGE**

ITEM NO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
					KSHS
A	Excavate for invert block drain(ms) average 600mm wide and (average) 500 mm deep,part return excavated material and cart away surplus compacting bottom,cutting and trimming to required slope	Lm	700	250	175,000
B	Allow for keeping excavation free from water and mud by bailing,pumping or otherwise	item			50,000
C	Allow for maintaining and supporting sides of all excavation and keeping same free from fallen materials	item			50,000
D	150 mm thick compacted murram to bottom and sides of drain	Sm	630	200	126,000
	<b>Invert Blocks:</b>				
E	Precast concrete(1:2:4) invert block drain fair face finished;overall size 450mm x 225mm deep; 300mm diameter drain tongued on one end and grooved in the other end for proper jointing; grooved at both sides for precast concrete slabs(ms) jointing all jointed and neatly pointed in cement and sand(1:3) mortar complete	Lm	700	3,000	2,100,000
<b>TOTAL FOR STORM WATER DRAINAGE CARRIED TO SUMMARY PAGE</b>					<b>2,501,000</b>

**BILL NO.4:PARKING AND DRIVEWAY**

ITEM NO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
					KSHS
	<b>Excavations including maintaining and supporting sides and keeping free from water, mud and fallen materials:-</b>				
A	Excavate for parking average 150 mm deep and cart away from site including keeping free from water and holding sides of excavations	Sm	13542	100	1,354,200
B	Level and compact bottom of excavation to receive hardcore(m.s)	Sm	13542	100	1,354,200
C	300 mm thick handpacked stone base compacted in 200 mm thick layers to 99% MDD ASSTO density to receive quarry dust(m.s)	Sm	13542	550	7,448,100
D	50 mm thick quarry dust blinding to receive cabro blopping(ms)	Sm	13542	100	1,354,200
E	80 mm thick heavy duty density cabro blox compacted	Sm	13542	2,500	33,855,000
F	125 x 250 mm straight kerbs on concrete foundation	Lm	1,800	1,050	1,890,000
G	Ditto to radii kerb	Lm	456	1,250	570,000
H	125 x 50 mm straight channels	Lm	1,800	1050	1,890,000
I	Ditto to radii channel	Lm	456	1250	570,000
<b>Total for Pavement and Driveway carried to summary page</b>					<b>48,931,500</b>



# PC SUMS AND PROVISIONAL SUMS

ITEM NO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
					KSHS
A	ALLOW FOR CONSTRUCTION OF STORES/ WAREHOUSE	SUM			12,000,000
B	ALLOW FOR CONSTRUCTION OF 2NO. WATER TANKS	SUM			4,000,000
C	ALLOW FOR CONSTRUCTION OF GUARD HOUSE	SUM			1,000,000
D	ALLOW FOR CONSTRUCTION OF 3 NO. PUMP HOUSES	SUM			3,000,000
E	ALLOW FOR CONSTRUCTION OF OFFICE	SUM			5,000,000
F	ALLOW FOR CONSTRUCTION OF DRIVERS SHED	SUM			1,000,000
G	ALLOW FOR PLUMBING AND DRAINAGE WORKS	SUM			5,000,000
Total for arried to summary page					31,000,000

**GRAND SUMMARY PAGE**

ITEM NO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
					KSHS
1	GAS STORAGE STRUCTURE				48,523,728
2	TANK MOUNDS				20,284,800
3	PERIMETER WALLING				38,513,538
4	STORM WATER DRAINAGE				2,501,000
5	PARKING AND DRIVEWAY				48,931,500
6	PC SUMS AND PROVISIONAL SUMS				31,000,000
CIVIL AND STRUCTURAL TOTAL FOR EXTERNAL WORKS CARRIED TO GE					189,754,565



	Max Pressure: 24.14 bars			
	Drive: 10 HP 1500 RPM, 4 Pole EFF2 3 Phase, 415V AC, 3 Phase, 50 Hz, CGL / BBL Make Flameproof Motor.			
	DOL Starter: 10HP, Flameproof to IS 2148			
	LPG Hose with end fittings: Liquid hose of 3" diameter; 0.6mtr length for Liquid & Vapour. - 1 No. per compressor (to dump vibration)			
	LPG Hose with end fittings: Liquid hose of 2" diameter; 0.6mtr length for Liquid & Vapour. - 1 No. per compressor (to dump vibration)			
	Materials of Construction - Neoprene rubber hose double wire braided			
	Test pressure - 60 Bar			
	End Connection - Flanged end as per ASA 300 class			



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BOQ FOR 6 x 5,000M3 LPG TERMINAL, FIREFIGHTING SYSTEM & RELATED WORKS				
No	DESCRIPTION	QUANTITY	UNIT PRICE (USD)	AMOUNT (USD)
1	<b>LPG STORAGE TANKS</b>	6	15,000,000.00	90,000,000.00
	Capacity-5000 Cu. Mtr.			
	Design Code ASME SEC VIII DIV 2 and Amendments / PD 5500			
	Design pressure 15Kg/cm2 ,			
	Test pressure 19.5Kg/cm2 ,			
	Inner diameter TBA by Supplier ,			
	Post Weld Heat Treatment			
	As per ASME Code			
	Overall Diameter TBA by Supplier, 100% Radiography .			
	Finish			
	Internal			
	Internal Shell Surface- shotblast to SA 2½			
	Weld Seams- As welded			
	External			
	External surface- shotblast to SA 2½ prior to painting			
	Weld Seams- As welded			
	Cleaning			
	After shot blasting-tank internal surface shall be vacuum cleaned. After cleaning, tank openings are sealed			
	Leak Test and Nitrogen Purge			
	Supplier must perform leak test and purge tank .			
	Painting (marine Coatings)			
	The exterior of tank and saddle frames shall be degreased before application of paint.			
	First Coat Zinc Primer 50 micron minimum DFT			
	Intermediate Coat Primer 70 micron minimum DFT			
	Final Coat Marine coat 400 micron DFT			
	Color: White			
	Nameplate			
	One Set of stainless data plate as per code requirements			
3	<b>LPG BULK LOADING &amp; OFF-LOADING SYSTEM FOR TANKERS</b>	1 set	6,000,000.00	6,000,000.00
	LPG Bulk Loading & Off-Loading Pumps - with Flame proof motor, common base frame and coupling ( – Qty. 6 No's + 1 No. standby			
	Strainer			
	Non Return Valves – ASME B 16.5 Flanged 300 #, raised face Serrated Finish. Body ASTM A216 GR. WCB			
	POP Action Valve – Size ½", (Reference = Make Rego USA)			
	Pressure Gauge - Glycerine filled, Range 0 – 40 Kg/cm2 (Reference Make = General Instruments)			
	Ball Valves :			
	Body: ASTM a 216 Gr WCB			
	Stem: AISI 316			
	Body Seal: PTFE			
	Gland Packing: Graphite			
	Ball: ASTM A 351 Gr CF 8M			
	Insert: ASTM A 105 or ASTM 216 Gr WCB			
	Fire safe Test: API 607			
	Seat: PTFE			
	Body Test : 79 Kg/cm2			
	Seat Test: 5.6 Kg/cm2			
	Ends : ANSI B 16.5 Flanged 300 class			
	Supplier shall make provisions for the following:			
	Liquid line provided with Hydrostatic Valves (minimum qty 4 but dependent on pipe length)			
	Both liquid and Vapour line must have Emergency Shut-off Valve (ESV) with provision for remote operation			
	Both liquid and vapour line must a pull away coupling installed just befor termination of loading lines			
	Weigh Bridge (Design ONLY) :- 1 No. at the entrance to the loading/ off-loading bay			
	Design of 80 Ton 18 metre long Electronic Weighbridge with data software			
4	<b>LPG COMPRESSOR</b>	2 set	2,000,000.00	4,000,000.00
	LPG compressor with flame proof motor (reference Make = Corken USA, model 691)			
	Type: Vertical, Single Stage, double acting, air cooled and reciprocating LPG compressor model 291AM3FBANSNN			
	Piston Displacement: At 400 rpm : 29.2 CFM			
	At 825 rpm : 60.2 CFM			
	Max Pressure: 24.14 bars			
	Drive: 10 HP 1500 RPM, 4 Pole EFF2 3 Phase, 415V AC, 3 Phase, 50 Hz, CGL			
	/ BBL Make Flameproof Motor.			
	DOL Starter: 10HP, Flameproof to IS 2148			
	LPG Hose with end fittings: Liquid hose of 3" diameter; 0.6mtr length for Liquid & Vapour. - 1 No. per compressor (to dump vibration)			



	LPG Hose with end fittings: Liquid hose of 2" diameter; 0.6mtr length for Liquid & Vapour. - 1 No. per compressor (to dump vibration)			
	Materials of Construction - Neoprene rubber hose double wire braided			
	Test pressure - 60 Bar			
	End Connection - Flanged end as per ASA 300 class			

<b>5</b>	<b>SUPPLY OF PIPE AND PIPE FITTINGS</b>	<b>1 set</b>	<b>15,000,000.00</b>	<b>15,000,000.00</b>
	LPG Pipeline System: Interconnecting all tanks for liquid, vapour, liquid return etc and consisting of Schedule 80 pipelines for high pressure with ASA 300 flanges, Hardware, Bends, Reducers, Tee, Gaskets and other fittings.			
	a) Pipes:			
	Type: Seamless			
	Specifications: SA 106 Gr.B Sch.80			
	Joining: Flanged & welded			
	Material of Construction of: SA 234 WPB			
	Length of pipe = 6000mm. Size of pipe in diameter as shown:			
	b) Pipe Fittings:			
	i) Flanges: SA 105 Forged Class 300#			
	ii) Studs: SA 193 Gr. B7			
	iii) Nuts: SA 194 Gr. 2H			
	iv) 90° Elbows: SA 234 WPB			
	v) Tee Pieces: SA 234 WPB			
<b>6</b>	<b>BALL VALVES</b>	<b>1 set</b>	<b>10,000,000.00</b>	<b>10,000,000.00</b>
	Isolation valves for Liquid and vapour.			
	Class 300 fire safe design.			
	Flanged Ball Valve:			
	Body: ASTM A 216 Gr WCB			
	Stem: AISI 316			
	Body Seal: PTFE			
	Gland Packing: Graphite			
	Ball: ASTM A 351 Gr CF 8M			
	Insert: ASTM A 105 or ASTM 216 Gr WCB			
	Fire safe Test: API 607			
	Seat: PTFE			
	Body Test: 79 Kg/cm <sup>2</sup>			
	Seat Test: 5.6 Kg/cm <sup>2</sup>			
	Ends: ANSI B 16.5 Flanged 300 class			
<b>7</b>	<b>PNEUMATIC SYSTEM</b>	<b>2 set</b>	<b>2,000,000.00</b>	<b>4,000,000.00</b>
	Air Compressor with 30 h.p. motor with air receiver and drive unit			
	Type - Reciprocating Air Compressor complete with Filter /Dryer and Double Stage Air Regulator (Reference make = Atlas Copco)			
	Pressure - 7 Kg/Cm <sup>2</sup>			
	Motor 3Phase -30HP			
	Flow rate: 125 CFM			
	Pneumatic Pipeline:			
	Consisting of Schedule 40 pipelines for connection from air compressor to various points with ASA 150 flanges, Hardware, Bends, Reducers, Tee, Gaskets and other fittings (Reference Make = General Instruments)			
	Type: Mild Steel – ERW Pipes			
	Specifications:			
	1" Pipe - 6000mm length			
	1" Elbows			
	1" Tee pcs			
	1" Unions			
	1" Nipples			
	1" Sockets			
	Ball Valve 1"			
	IS 1239 (Part I) Heavy Class (C- class) / IS 3589			
	Dimensional Standard: IS 1239 / IS 3589			



B FIRE FIGHTING SYSTEM		1 set	5,000,000.00	5,000,000.00
Water Sprinkler & Hydrant system for storage tanks, Transport tankers loading area, LPG pump station, consisting of Electric Resistance Welded (ERW) class C pipeline with spray nozzles and water inlet connection				
a) Fire fighting Pumps :				
i. Diesel Pump				
Specifications:				
Make : Reference = Armstrong series 40 MF Diesel				
Qty : 1 Nos				
** Parameters are indicative and actual ones will be based on Equipment builders specifications				
ii. Electric Pump				
Specifications:				
Make : Reference = Armstrong series 40 MF 50Hz				
** Parameters are indicative and actual ones will be based on Equipment builders specifications				
b) Fire Hydrant System:				
- NSF/ANSI 61 Approved				
Fire Hydrants with 63 MM double valves				
15mtrs long fire canvas hose reels and				
Hose boxes reputed ISI make				
Fire Monitor of ISI Make with 360 degrees				
Flow: 1600 LPM				
Hydrant piping inside LPG yard for hydrant system: Fire Hydrant Ring of 100NB with Pipe Sprinkler Header to the Tank and the Shed of 80NB. And Sprinkler Ring of 2"				
c) Pipe & Fittings :				
Type: Mild Steel — ERW Pipes				
Specifications:				
IS 1239 (Part I) Heavy Class (B or C- class) / IS 3589				
Dimensional Standard : IS 1239 / IS 3589				
Length of pipe = 6000mm. Size of pipe in diameter as shown :				
i) Piping for Pumps Header - 6"				
ii) Ring Main - 4"				
iii) Sprinkler Piping - 3"				
iv) Sprinkler Ring - 2"				
Pipe Fittings:				
i) Flanges : SA 105 Forged Class 150#				
ii) Studs: SA 193 Gr. B7				
iii) Nuts: SA 194 Gr. 2H				
iv) 90° Elbows : SA 234 WPB				
v) Tee Pieces : SA 234 WPB				
d) Sprinkler System :				
For LPG storage tanks, Gantry, Pump shed.				
- Sprinkler Nozzles for foam - K 22 and 120 Degrees of U L Approved make M/s H D Fire (Aluminium)				
- Sprinkler Nozzles for fire water K 22 and 120 Degrees of U L Approved make M/s H D Fire - (Bronze)				
e) Water Tank:				
Tank size: Diameter = 9560mm, Height = 8000mm				
i) Plate Material: S275JR				
Size: 6000mm x 2000mm				
1) Thickness: 8mm				
2) Thickness: 6mm				
ii. Roof Structures Materials: ASTM A 36				
1) I Beam 160 x 80 x 6000mm				
2) Angle bar 80 x 80 x 6000mm				
3) Angle bar 50 x 50 x 6000mm				
4) Flat bar 50 x 50 x 6mm x 6000mm				
5) Chequer Plate 2400 x 1200 x 4.5mm				

<b>f) Deluge Valve:</b>			
Model A, UL Listed For Vertical inlet to Horizontal outlet mounting, Cast Iron material, Flanged end to ANSI B16.1, Class 125, without any trim			
- Detection: Single Ring around each tank of Quartzite bulb ring with detection range above 55 Deg C.			
- Location: One for the Tank Area sprinkler; One for Unloading Shed; One for Pump and Compressor Shed			
<b>g) Leak Detection System:</b>			
<b>i. Sensors</b>			
Make: Reference = Industrial Scientific USA			
Suitability: Propane / Butane			
Construction: Reference = Ix-Ex Proof, with CCoE and CMRI Certification			
Operating Voltage/ Power Supply : 240 V AC or 6 V DC			
Cable: 3 Core Cable			
Termination: PCB Mounted terminal box			
Operating Temp: Upto 95 Deg C			
<b>ii. Control Panel</b>			
Make: Reference = Industrial Scientific USA			
Design: Micro Controller Technology with CCoE and CMRI certification			
Operating Voltage/ Power Supply : 240 V AC or 6 V DC			
Features: 10 LED Display for each detector, Modular Design for card replacement, Digital Indicator for the leakage indication showing the % leakage and the fault indicator Two reset Buttons			
<b>iii. Alarm System</b>			
Installed at various locations			
<b>iv. Cabling</b>			
Type: Armoured 3 Core Copper Cable; Laid on a cable tray			
Mounting: Sensors mounted in a canopy at location pre-specified Control Panel and indicators mounted in the Control Room			
Location: * Tank Bottom (4 Nos) * Tank Top (4 Nos) * Pumping Room (4 Nos) * Tank Loading Bay (4 Nos)			
<b>9 ELECTRICAL SYSTEM</b>	<b>1 set</b>	<b>30,500,000.00</b>	<b>30,500,000.00</b>
<b>Electrical System Installations</b>			
Electrical Boards			
Cabling			
Lighting			
Equipment Terminations			
<b>MECHANICAL AND ELECTRICAL TOTAL FOR EXTERNAL WORKS CARRIED TO GRAND SUMMARY PAGE</b>			<b>164,500,000.00</b>

GRAND SUMMARY PAGE			
FOCUS LPG TERMINAL			
	QTY	UNIT	AMOUNT
1	1		
CIVIL AND STRUCTURAL TOTAL FOR EXTERNAL WORKS CARRIED TO GRAND SUMMARY PAGE		189,754,565.00	189,754,565.00
2	1		
MECHANICAL AND ELECTRICAL TOTAL FOR EXTERNAL WORKS CARRIED TO GRAND SUMMARY PAGE		164,500,000.00	164,500,000.00
GRAND TOTAL			354,254,565.00

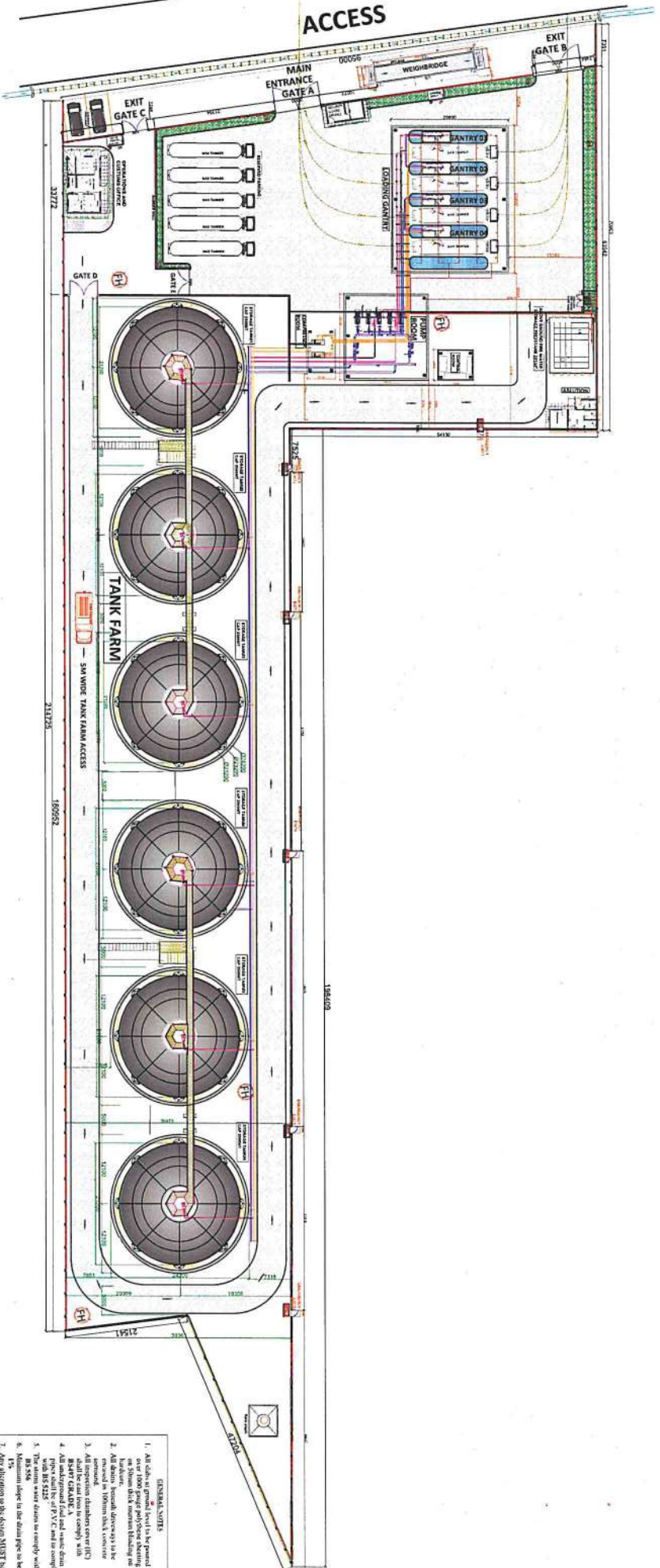
*John*

**SYMETRICS LIMITED**  
P.O. Box 78517 - 00507, NAIROBI.  
Tel: +254 722 684 023  
Email: info@symetrics.co.ke





# SITE PLAN



## GENERAL NOTES

1. All data is given as a level to be passed over 1000 gauge (pavement) showing the location of the structure within the site.
2. All dimensions shown are to be as shown on the drawings.
3. All inspection chambers (IC) shall be installed in accordance with the relevant standards.
4. All underground services shall be installed in accordance with the relevant standards.
5. The main water drains shall comply with the relevant standards.
6. All structures shall be constructed in accordance with the relevant standards.
7. Any alterations to the design shall be made in accordance with the relevant standards.
8. Any construction shall be in accordance with the relevant standards.
9. Any construction shall be in accordance with the relevant standards.
10. Any construction shall be in accordance with the relevant standards.

## TECHNICAL NOTES

1. Specific construction and installation details shall be referenced.
2. The following standards have been referenced:
  - a. BS 5958:2008 Standard for Bulk LPG Installation
  - b. API 2018 Standard for design and installation of storage tanks
  - c. API 650 Standard for design and construction of welded tanks
  - d. ASME VIII Div 1 Standard for pressure vessels

## REVISION

NO.	DATE	REVISIONS

PROJECT	CLIENT	PLANT DETAILS	DETAILS	CONSULTANT
PROPOSED 1500MT LPG STATION	L.B. NGUYEN/THI NGUYEN/THI NGUYEN	ALL DIMENSIONS IN MM	SCALE: 1:1000	SYMETRICS LIMITED

TITLE	DATE	BY	CHECKED BY	APPROVED BY
SITE PLAN				







BEACON RE-LOCATION ON MN/VI/3711  
KIEPVU  
MOMBASA COUNTY

CLIENT:  
FOCUS CONTAINER FREIGHT STATION

NOTES:

SURVEY BASED ON  
F/R 210/175, 422/184, 337/44,  
103/72

AREA OF MN/VI/3711 = 7.321 Ha

AREA ENCROACHED BY MN/VI/3957  
= 0.5285 Ha  
(1.31 Acres)

LEGEND:

—DC10

BOUNDARY BEACON EXISTING

— CADASTRAL BOUNDARY

— EXISTING BOUNDARY WALL

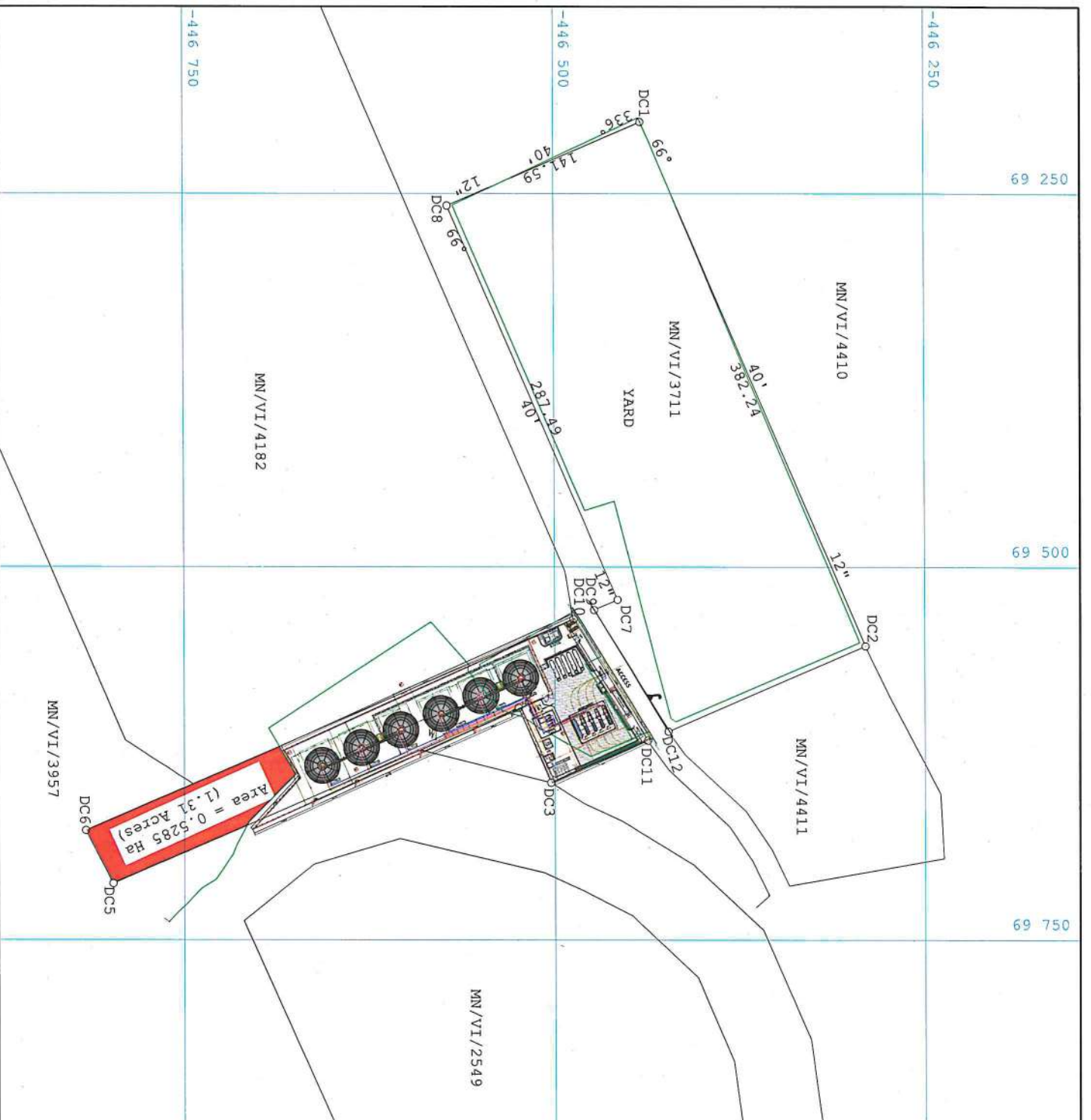
—446 500

GRID VALUE



SCALE 1 : 2 500

PREPARED BY:  
GEOCAD SERVICES LTD  
P.O BOX 87819-80100  
MOMBASA







## LOCATION PLAN



### NOTE

- Distance from the spherical storage tank to the nearest residential 208,534mm









EAE23064029

FORM 7

**nema**  
Mazingira Yetu | Uhai Wetu | Wajibu Wetu

(r.15(2))

**NATIONAL ENVIRONMENT MANAGEMENT  
AUTHORITY(NEMA)  
THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT  
ENVIRONMENTAL IMPACT ASSESSMENT/AUDIT (EIA/EA) PRACTICING  
LICENSE**

License No: NEMA/EIA/ERPL/23141

Application Reference No: NEMA/EIA/EL/30149

**M/S TROPOSPACE CONSULTANCY LIMITED**

(individual or firm) of address  
P.O. Box 15225 - 00400 NAIROBI

is licensed to practice in the  
capacity of a (Lead Expert/Associate Expert/Firm of Experts) **Firm of Experts**  
registration number **10008**

in accordance with the provision of the Environmental Management and Coordination  
Act Cap 387.

Issued Date: 3/13/2025

Expiry Date: 12/31/2025

Signature.....

(Seal)

**Director General**  
**The National Environment Management Authority**

P.T.O.



ISO 9001 : 2015 Certified









EAE 2 3063943

FORM 7

**nema**  
Mazingira Yetu | Uhai Wetu | Wajibu Wetu

(r.15(2))

**NATIONAL ENVIRONMENT MANAGEMENT  
AUTHORITY(NEMA)  
THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT  
ENVIRONMENTAL IMPACT ASSESSMENT/AUDIT (EIA/EA) PRACTICING  
LICENSE**

License No : NEMA/EIA/ERPL/23048

Application Reference No: NEMA/EIA/EL/30148

**M/S BONFACE NYAGOTUGA OSORO**

(individual or firm) of address  
P.O. Box 15225 - 00400 Nairobi

is licensed to practice in the  
capacity of a (Lead Expert/Associate Expert/Firm of Experts) **Lead Expert**  
**General**

registration number **7121**

in accordance with the provision of the Environmental Management and Coordination  
Act Cap 387.

Issued Date: 3/7/2025

Expiry Date: 12/31/2025

Signature.....

(Seal)

**Director General**

**The National Environment Management Authority**

P.T.O.



ISO 9001 : 2015 Certified

#### Conditions For Licensing

1. This license expires on 31<sup>st</sup> December of the year it is issued.
2. The expert shall comply with code of practice and Professional Ethics for EIA/EA experts.
3. The expert shall comply with the attached conditions.

#### General Conditions

1. All Environment Experts certified and registered in the accordance with the provision of relevant Regulations, may establish professional associations to complement and implement the objectives of the Code of Practice.
2. An Expert shall act professionally, accurately, fairly and in an unbiased manner in undertaking his work.
3. The Director General, in consultation with relevant stakeholders, may from time to time issue guidelines for the proper conduct of registered Environmental Impact and Audit Experts.
4. Every Environmental Expert shall each year attend at least two relevant seminars organized by the authority for the purposes of improving the professional expertise of its members.
5. No Expert shall exploit the inexperience, lack of understanding, illiteracy or other lack of technical knowledge in environmental matters of a project proponent, owner or the public, for his personal gain.

#### Receiving Instructions

1. No Environmental Expert shall act for any project proponent unless he has received written instructions form such project proponent or his authorized agent.
2. An Environmental Expert shall not unreasonably delay the carrying out of instructions received from the project proponent of his authorized agent.
3. An Environmental Expert shall discharge his responsibilities to the project proponent with due diligence and integrity.
4. An Environment Expert may terminate a contract on carrying out an environmental impact assessment or audit as stipulated in section 8 of the Code of Practice and Professional Ethics of EIA/EA Experts.

#### Carrying out an EIA/EA

1. An Environmental Expert shall follow relevant regulations or guidelines and directives issued by the Authority.
2. As Environmental Expert shall take due care and diligence to collect the relevant data to address the significant environmental issues in the various stages of the assessment or audit process and fully acknowledge the source of any data that is not the result of his findings.
3. Environmental Expert shall consult widely with all the relevant agencies, stakeholders, interested parties and the general public on all the matters that likely to affect them.
4. An Environmental Impact Assessment or Audit Report shall be based on the Terms of Reference of the Assignment and shall include all the matters relevant to the findings of the study, all the relevant matters are required by statutory provisions, and must be guided by professional standards and judgments.

#### Responsibility of Lead Environmental Experts

1. (1) An Environmental Lead Expert shall be responsible for the documents prepared by him/her on behalf of the project proponent.  
(2) An Environmental Expert shall guide the proponent throughout the preparation of the environmental impact assessment and/or environmental audit, and/or during implementation of the Environmental Management Plan.  
(3) An Environmental Expert shall disclose to a client or employer any relationships of conflicting or competing interests that may influence his judgment prior to the carrying out of work.

#### Misconduct of Environmental Experts

1. An Environmental Expert who contrivances a provision of Code of Practice and Professional Ethics shall be deemed to have committed professional misconduct and shall be subject to disciplinary action by the Authority as appropriate and as stipulated in the Code of Practice and Professional Ethics of Environmental Experts.

#### Disciplinary Action

1. Where an Environmental Expert is found to have committed professional misconduct by the Environmental Experts' Advisory Committee/Authority shall be punished as stated under section 19 of the code of Practice and Professional Ethics.

#### Appeals

1. (1) An Expert aggrieved by the decision of the Authority may apply for the review of such decision in the High Court.  
(2) If an application for judicial review shall not have been filed at the expiry of 30 days from the date of the decision of the Authority, the director General may publicize the disciplinary action taken against the Expert.